Detailed Workshop Report

Sediment Classification and Field Experiment

at

Khadakwasla Lake

for

Water Resource Management

Organized by

Maritime Research Center

Indian Maritime Foundation, Pune

Sponsored by

Bajaj Auto Limited

In Partnership with

NirDhwani Technologies Pvt Ltd

09 to 13 Oct 2017

Pune

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Mentor

Dr. (Cdr.) Arnab Das

Director, MRC Pune

MD NirDhwani Technology Pvt Ltd

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Workshop on Sediment Classification and Field Experiment

1. Background

The Maritime Research Center (MRC), with its vision of Underwater Domain Awareness (UDA) is applying itself on multiple socially relevant issues to impact real world problem solving in the Indian Ocean Region (IOR). The detailed perspective plan of MRC is attached at enclosure-1. The MRC is engaged on three levels to be able to bring about structural change and sustained impact rather than superficial attempt at raising issues. The three levels are:

(a) Strategy and Policy framework – The multiple aspects of strategy and policy framework at the decision making level need periodic review and revision. The policy makers and decision makers need to be supported by citizen groups and independent bodies with in-depth research and deliberations to bring about structural change.

(b) Technology and Innovation – The strategy and policy inputs need to be backed by detailed technology and innovative solution to make sustained impact on socio-economic front, particularly for a developing nation like ours or even other nations in the IOR. Multi-disciplinary and multi-activity research on a long term basis is critical to ensure positive change.

(c) Human Resource Development – Structural change for sustained impact demands mass movement backed by skilled human resource at multiple levels. Many of our challenges demand comprehensive approach. However, lack of capable human resource leads to dilution and ineffectiveness on all fronts. Creating new areas of opportunities for nation building is another big area of concern to channelize the demographic dividend into constructive output potential.

The MRC with the guidance of its senior advisers, deliberated on multiple aspects of UDA and shortlisted **water resource management** as one priority area for socially relevant and critically required real world problem solving aspects. A detailed project proposal was drawn and a small pilot study in the form of a workshop was finalized. MRC approached the Bajaj Auto group for support under their Corporate Social Responsibility (CSR) initiative. The response from the Bajaj Auto group was extremely forthcoming and support was approved within 45 days of the submission of the proposal. The detailed plan was drawn keeping in mind a long term perspective and a five day workshop was scheduled w.e.f. 09 Oct 2017. The stakeholders, supporting agencies and many more were kept in mind during the planning process. A multi-disciplinary and multi-activity workshop took shape and the detailed schedule was finalized. This being the first of its kind unique workshop also ran the risk of not being able to convince the environment enough to find good participation. We overcame all odds and managed to run a very successful workshop in terms of getting very positive feedback and demand for regular events like this.

2. Motivation for the Workshop

Water for domestic purposes is a critical resource and growing population coupled with urbanization is causing serious concern in ensuring long term sustainability of this resource. The tropical regions like India face a unique challenge of concentration of annual monsoon within three months causing high flow rate and consequent high volume of silt getting carried to the reservoirs. Heavy siltation of our freshwater systems, causes flooding of the down plains during monsoons and water shortages during dry spell. De-siltation efforts require precise information on the type of silt deposited in these lakes and reservoirs. Sediment classification efforts use sonars to identify the silt type. However, the tropical waters further present sub-optimal performance of these sonars for any credible underwater application due to random diurnal and seasonal fluctuation of the surface temperature. Good understanding of the acoustic propagation and quantification of the tropical medium impact on the sonar performance can aid in enhancing the sediment classification efforts. Import of sonar technology in the absence of local scientific inputs through field experiments has not helped.

Our own city of Pune is fed through a system of Dams that store water collected in the monsoons for the long dry spell. Our lakes are operating at less than 50% capacity. Sediment classification in reservoirs, lakes, rivers and many other water systems is a critical component of the resource management efforts in these freshwater bodies. Precise sediment classification is important for multiple stakeholders like the fresh water management authorities to initiate de-siltation efforts for enhancing storage in the water bodies, flood management agencies to minimize spillages, underwater archaeology researchers to study the evolution of the layers, instrumentation engineers to understand sensor behavior and the impact of the underwater medium, sonar operator specialists to enhance their deployment effectiveness and many more. The tropical region in the Indian sub-continent has limitations of sub-optimal performance of sonars due to medium fluctuations. The import of sophisticated technology has failed to give us good results as the medium fluctuations are characteristic of our local conditions and significant indigenous efforts are required to understand these limitations and improve our underwater domain awareness. The workshop attempted to address these issues with a comprehensive framework of modeling and simulation along with field validation. A detailed paper is enclosed at enclosure-2 that brings out the entire workshop concept in the right perspective.

3. Objectives of the Workshop

The objectives of the workshop were as given below:

(a) The Underwater Domain Awareness (UDA) is the foundation for any comprehensive water resource management initiative. Acoustics will always remain the fundamental capability for any UDA effort however in India we find minimal awareness on such a critical technology aspect. Thus, the first objective was to bring together all the young technology students and marine archaeology students, practitioners in freshwater management efforts and policy makers to get exposed to the acoustic techniques.

(b) Modelling and simulation with ground validation is the most effective scientific technique to solve such so called complex problems. A structured approach with significant research content was used to expose the students and others to an effective scientific approach of real world problem solving.

(c) Marine Archaeology is a relatively new area in India. However it has significant ramifications for effective freshwater resource management. The siltation could be controlled with far higher UDA and understanding of the sedimentation patterns. The data generated during the field experiments at this workshop will be useful for marine Archaeologists to study the patterns and provide inputs for managing siltation in the future.

(d) The tropical regions like India face a unique challenge of concentration of annual monsoon within three months causing high flow rate and consequent high volume of silt getting carried to the reservoirs. Heavy siltation of our freshwater systems causes flooding of the down plains during monsoons and water shortages during dry spell. Focusing on de-siltation efforts with precise information on the type of silt deposited in these lakes and reservoirs was another objective of this workshop. Thus, it has significant socio-economic intent for a developing country like ours. This will act like a pilot project to be replicated in other lakes in the country.

(e) The demographic dividend that we keep referring to needs to be channelized into a constructive nation building effort. The crisis of freshwater scarcity is real and only likely to get worse. Comprehensive and structured approach is the only way forward and mass effort will require qualified young human resources to take on the big revolution going forward. This initiative will attempt to prepare young India to take on this challenge in the future. Multi-disciplinary and multi-activity approach is very unique and is thus likely to bring about a cultural change in our national approach, too.

4. About the Program

A five day workshop on sediment classification with field experiments was organized for multi-disciplinary students, faculties, researchers, practitioners, service providers and policy makers. The program was a unique opportunity for the participants to get exposed to modeling and simulation with ground validation along with multiple technological aspects. Sonar operations and deployment was demonstrated along with data analysis and laboratory discussions. The analysis of the data on multi-disciplinary fronts including high performance computation and marine archaeology was introduced as part of the workshop. The program commenced w.e.f. ***09 Oct 2017*** for duration of five days.

(a) The concept of Underwater Domain Awareness (UDA) was introduced along with its implications on the freshwater resource management in the tropical region of the Indian sub-continent.

(b) Modeling and simulation concepts were presented with hands-on exposure for the participants to parallel computing, deep learning and HPC.

(c) Field exposure at the Khadakwasala lake with real experimental deployment of sonars for data collection using a single beam sonar, side scan sonar and a sub-bottom profiler along with a CTD probe was demonstrated.

The detailed workshop poster initially sent to the participants is attached at enclosure-3.

5. Program Details

The five day program was structured for a well rounded and fruitful interaction of the participants to achieve the stated goals. The detailed day wise program is attached in enclosure-4. The broad details are given below:

Day – 1 Panel discussion on the entire crisis of water resource management and the process of sediment classification and the possible way ahead. The rest of the day was focused on introduction to UDA and Acoustics in the Tropical Waters.

Day – 2 Modeling and Simulations with introduction to Parallel Computing and High Performance Computing.

Day – 3 Field experiments at Khadakwasala Lake.

Day – 4 Real Experimental Data Collection continued and a parallel session on deep learning on HPC with hands on exposure was conducted at MRC.

Day – 5 Data Analysis and real data interpretation for multiple Applications.

6. Resource Persons

Dr. (Cdr.) Arnab Das, Director MRC and MD of NirDhwani Technologies Pvt Ltd was the mentor for the entire workshop. He coordinated all aspects of the workshop. The resource persons for conduct of different sessions at the workshop were as follows:

Sonar and Acoustic Signal Processing	-	Dr. (Cdr.) Arnab Das, Director MRC, MD NirDhwani
Modeling and Simulations Mumbai	-	Prof. PSV Nataraj, IIT Bombay
Marine Archaeology	-	Prof. P. D. Sabale, Deccan College
High Performance Computing	-	Prof. Priyadarshan Dhabe, MIT Pune
Hands on in HPC	-	Mr. Umesh Gupta, Data Science
Geologist for Acoustic Survey	-	Mr. Prabal, M/s Unique Group
Data Processing and Analysis	-	Mrs. Jyoti Sadalge, VPKBIET

7. Expected Program Output

The proposed initiative titled "Workshop on Sediment Classification and Field Experiment at Khadakwasala Lake" was proposed to have multiple applications and advantages going forward. The same has been put in three different categories:

Short Term: The immediate gain was awareness among stakeholders (fresh water management authorities, practitioners and policy makers) regarding the effectiveness of acoustic techniques for such a critical aspect of socio-economic activity. Further, availability of data for research will promote more and more local efforts in realizing effective sonar performance in the tropical littoral region. Acoustic techniques will ensure efficient de-siltation efforts to improve storage capacity for dry seasons and prevent floods during the monsoons.

Mid Term The involvement of interdisciplinary experts based on local data analysis will encourage not just de-siltation but also generate inputs on the siltation process. Understanding of the siltation process with the involvement of marine archaeologists will give a historical perspective that will aid in decision making and policy aspects for effective resource management and governance.

Long Term The precise understanding of the siltation process may facilitate even measures to counter or prevent such events in future. Gradual tapering of silt or re-routing may have significant socio-economic impact.

Probably the most significant impact of such an initiative will be to involve the next generation into socially relevant research for real world problem solving. The acoustic techniques will bring about effective fresh water management in the country and good governance. Water is such a critical resource, a mass movement is required and such initiatives will facilitate a structured and efficient mass movement.

This was a small initiative to build confidence between the collaborators and also between the technology and the practitioners. MRC has already identified partners with complementary skills and expertise to make it a mass movement for larger public good. We look at achieving the short term objective in this proposal and are optimistic that post this event there will be far more areas of support that we will be able to convince.

8. Achievements of the Workshop

The workshop had 22 registered participants from 14 different institutes and six different locations. The participants represented diverse stakeholders including academia, industry, government agencies, PSUs and more. The detailed list of participants along with their affiliations is attached at enclosure-5. The mix of students, faculty, industry representatives, researchers, practitioners, policy makers and more taking interest in all the multi-disciplinary and multi-activity aspects of the workshop and pledging to take forward the vision forward was extremely encouraging. The pictorial overview of the workshop for all the five days is presented in enclosure-5. The achievements of the workshop can be listed as:

(a) Mobilization and deployment of three different types of sonars along with a CTD probe for acoustic survey. This gives us lot of confidence to organize any kind of field experiment involving any kind of acoustic survey effort for UDA. Commercially available hiring equipment is far more viable for such work. The working relation developed with the equipment supplier and their deployment and operation team was very effective.

(b) The support received from the National defence Academy and the enthusiastic participation of their team facilitated successful completion of very complex acoustic survey plans necessitating precise boat handling. There were absolutely no delays during changeovers and runs intervals.

(c) The large number of participants were given field exposure without any safety concerns. The participants took part in all the activities with lot of enthusiasm and energy. The uniqueness of the workshop and the value it brought for the participants was repeatedly expressed by each one of them. Their eagerness to continue their interaction was encouraging.

(d) The comprehensive exposure to multi-disciplinary participants with high quality resource persons along with seamless administrative and logistic support was acknowledged and appreciated.

(e) The real data collection has opened up multiple new research ideas that will generate significant local understanding of various aspects of UDA and will support comprehensive water resource management initiative on a massive scale. The researchers are extremely excited to take forward the research ideas and contribute to the long term sustainable plan.

9. Way Ahead

MRC would like to first acknowledge the support received in terms of funding from Bajaj Auto that encouraged us to make a point on the importance of such a critical issue and demonstrate the success of this unique pilot study. However, there is substantial work to be done before we collectively congratulate ourselves for having achieved success in the true sense. The mass movement is important. The following are proposed to be done in future:

(a) The research and analysis needs to continue to support multiple researchers to come out with more scientific inputs on their entire problem of water resource management. The Khadakwasala will continue to be the study site for this sustained initiative. Detailed project proposal for the numerous research questions along with request for specific support will be submitted.

(b) The pilot study needs to be repeated in other water bodies across the state and the country. Involving participants in other locations to solve their local issues will entail a structured program and MRC would be happy to take that on. Detailed proposal will be submitted for the same.

(c) The structural change and sustained impact require regular awareness and sensitization of the stakeholders and policy makers with more local

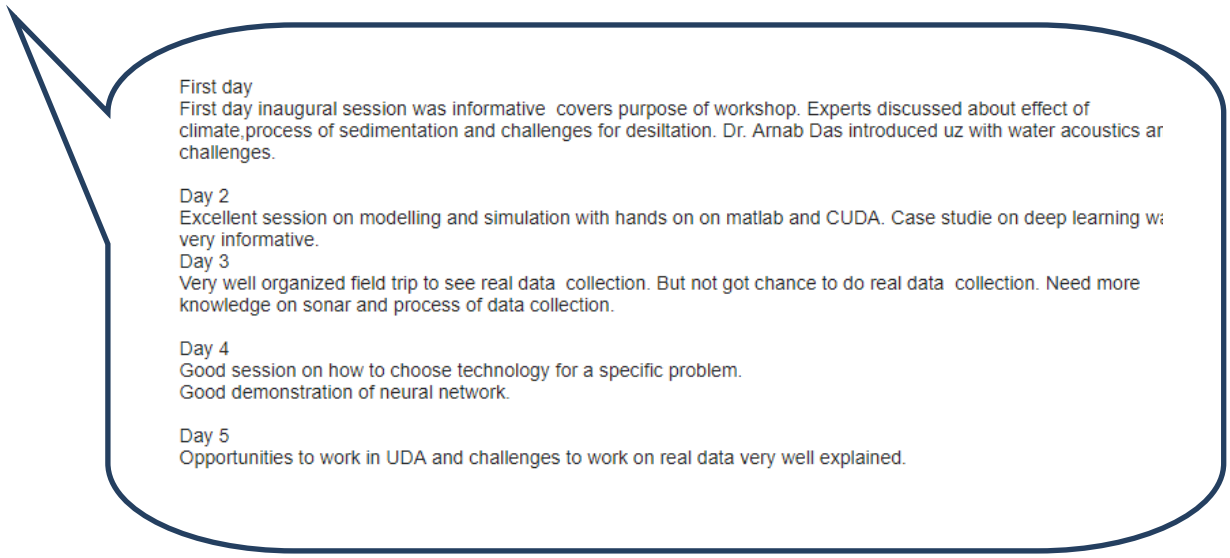
inputs. MRC would like to initiate a campaign to reach out to the entire community on this important aspect of water resource management. A multi-disciplinary team needs to be created and supported for the same. The awareness campaign backed by multi-disciplinary research and field data analysis will be the way forward. A detailed project proposal for the same will be submitted for this.

(d) The multi-disciplinary approach will include scientific and technology inputs, socio-economic perspective, policy review and structural model to implement big change. MRC would like to lead such a comprehensive initiative and is confident to take up this responsibility with the guidance of its senior advisers. Consultants can be taken onboard as required.

(e) MRC is already geared up for the massive human resource creation framework. Such a mass movement will require highly skilled and motivated youth to take the lead. Such an initiative has the potential to provide a positive alternative to the massive demographic challenge that we are facing in the country. A good alternative to channelize the young energy does present itself through this campaign. University programs and synergized initiative will have to be worked out.

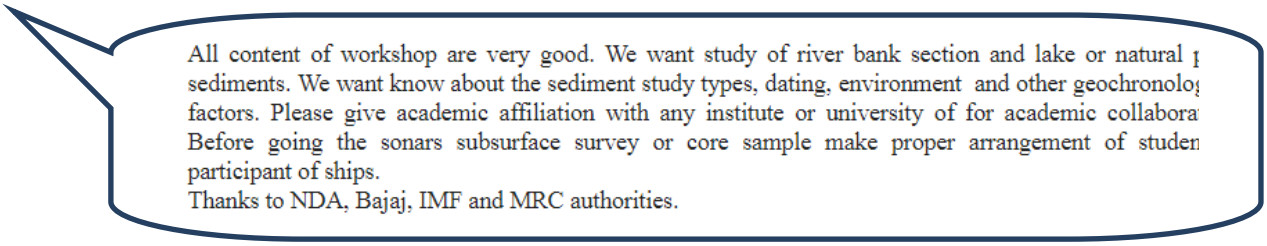
10. Participants Feedback

Prof. Sumitra Puranik



Prof. Ambareesh Kshirsagar

Dr. Shivaji Kshirsagar



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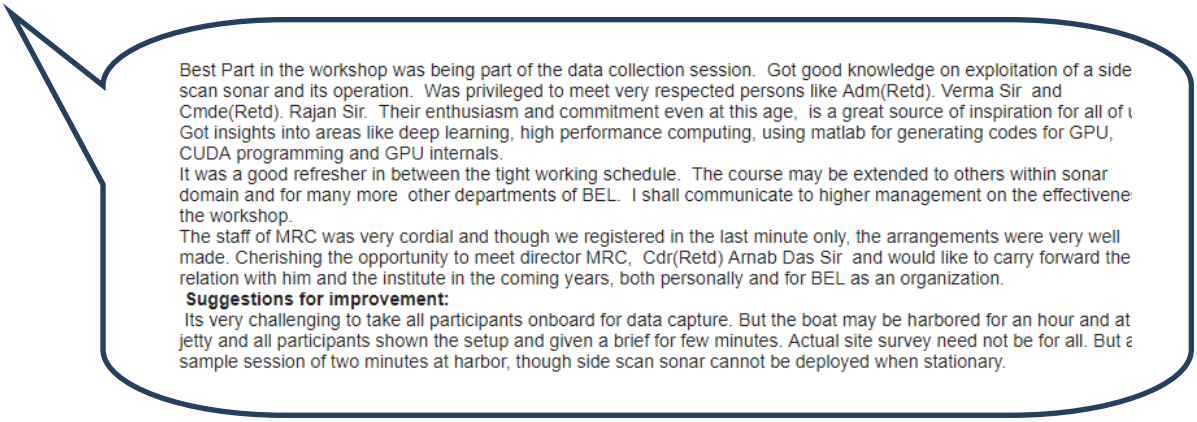


Enclosure-1

Maritime Research Center
Perspective Plan

The Maritime Research Center (MRC) was started in Dec 2014 for supporting research in the maritime domain and also complement, the Indian Maritime Foundation (IMF) efforts in creating awareness on the said subject. The fellowship program for generating monographs was launched, and three scholars were awarded fellowships to work on monographs related to the Maritime Domain. The first fellow, Dr. (Cdr.) Arnab Das completed his book titled "Marine Eco-Concern and Its Impact on the Indian Maritime Strategy" and the book launch was held on 02 Feb 2017. The event was also marked as the formal inauguration of the MRC and an ambitious perspective plan was embarked upon. Dr. (Cdr.) Arnab Das was designated as the Founder Director of MRC and entrusted with the responsibility to take forward the new vision.

Potential Stakeholders

The potential stakeholders for the MRC could be categorized into four main categories that are expected to provide a safe, secure and sustainable growth for the nation by tapping the maritime potential in the Indian Ocean Region (IOR):

(a) **National Security Apparatus** These include the Navy, Coast Guard, Coastal Police, etc. They are entrusted with the security and defence of the country in the IOR.

(b) **Maritime Industries** All corporate entities engaged in maritime activities for commercial purposes. This includes the shipping industry, oil and gas industry, undersea mining, etc., that are engaged in maximizing the contribution of the maritime sector to the GDP.

(c) **Marine Environment and Disaster Management** Regulatory authorities and disaster management agencies involved in ensuring safe and sustainable growth.

(d) **Science and Research** Agencies involved in providing scientific and technical inputs in the undersea space.

Research Area

The research areas to start with will be "***Underwater Domain Awareness***" and "***Anthropogenic Noise and Its Impact on the Marine Eco-system***." More areas will be added as the work progresses along with more experts joining. The book by the first MRC fellow and now Director adequately brings out the broader vision of MRC. These areas are new areas globally and potentially can give MRC an opportunity to make a mark.

Publications

All research activities at or supported by MRC will be translated to publications in appropriate journals, conference proceedings, magazines, etc. These publications will be under the affiliation of MRC. MRC will support Seagull magazine with regular articles and in the future attempt to collaborate with a well-known national and international journal for regular publication of its research efforts.

Vision

The prime vision of the MRC is to be a nodal research center on maritime issues and contribute as a technology driven think tank on the broader Underwater Domain Awareness (UDA) framework (discussed at the end) in the Indian Ocean Region (IOR). Towards that it will formulate specific research areas that can generate significant local inputs in the IOR both scientific and strategic to guide technology development, business environment and regulatory formulations.

Mission

The mission is categorized into three levels to meet the broader vision of UDA in IOR:

(a) The maritime strategy formulation with the UDA framework in the IOR. Here, MRC will engage with the practitioners, decision makers and policy formulators to drive the Indian Maritime Strategy with an effective UDA framework at its core.

(b) The technology and innovation required to provide effective and enhanced UDA in the IOR is critical, particularly in the light of significant challenges due to tropical littoral limitation causing sub-optimal sonar performance. MRC will identify specific challenges and work towards providing scientific inputs on multi-disciplinary aspects.

(c) The human resource that understands the various facets of UDA to drive effective Maritime Strategy is extremely scarce in this country. MRC will work towards generating the critical pool of young graduates in multi-disciplinary areas that appreciates the nuances of UDA in the IOR.

Goals

The MRC has formalized their goals in three categories for clarity of purpose and ease of execution:

(a) **Short Term** (One year) In the short term, we need to generate awareness regarding the concept of UDA and its potential contribution for the stakeholders. Multiple workshops, seminars, collaborative training sessions, lecture series, internships, etc., will be undertaken at MRC, stake-holders premises and other venues to sensitize them of MRC activities and expertise.

(b) **Medium Term** (up to three years) MRC will participate in joint research and training. The joint research will translate to student project guidance at training institutes and universities. Submission of research projects to funding agencies will be another area that will be accorded priority along with joint research guidance for the students registered in universities in topics related to the UDA.

(c) **Long Term** (beyond three years) MRC will work as a think tank and contribute towards maritime policy formulation and strategic guidance. MRC will work towards developing our in-house expertise and provide a platform to freelance experts and young researchers to use our resources for their research and projects. It will present itself as an independent and unbiased knowledge partner to industry and activists for their strategic planning and operational management.

Activities

The first and foremost activity is to generate awareness among stakeholders and people at large. The activities at the MRC are focused on industry relevant research that are able to contribute towards real world problem solving and also generate competent human resource for the growing maritime sector. The MRC will act as a meaningful interface between the academic institutes and the industry. The activities include:

(a) Seminars and workshops at MRC or premises of academic institutes.

(b) Training programs for the industries on specific areas of interest.

(c) Long term research participation for research scholars.

(d) Field experimental research for industry and user agencies.

(e) Policy formulation and business development models.

Projects

The ongoing projects at MRC are related to enhancing our Underwater Domain Awareness (UDA) relevant to the four stakeholders. Significant technical and scientific inputs will be generated to support the stakeholders in their decision making and regulatory formulations. The projects include:

(a) Acoustic Habitat Assessment and formulation of Environmental Impact Statement for projects in the marine environment and freshwater systems.

(b) Ambient noise assessment in the IOR for security related formulations and sonar deployments.

(c) Acoustic / hydro-graphic surveys for freshwater systems to enhance fresh water management efforts in the IOR. Field experiments are planned to validate the modeling and simulation efforts.

(d) Machine learning formulation for underwater signal analysis.

(e) Design and Development of Underwater Vehicles for enhanced UDA in the IOR.

(f) Regulatory framework for Acoustic Habitat Degradation in the IOR.

(g) UDA framework and its implications for the Indian Maritime Strategy.

(h) Maritime strategy formulation and analysis based on technology and scientific inputs.

(i) Business development models for Underwater Domain Awareness in the IOR.

Governing Council

The Governing Council (GC) has been formed to guide and support the activities of the MRC. Dr. (Cdr.) Arnab Das, Director MRC, independently manages the activities of MRC in consultation with the Governing Council. The GC comprises of the following:

(a)	President IMF	-	Cmde. Rajan Vir (Retd)
(b)	Vice President IMF	-	Capt. Anand Dixit
(c)	Director MRC	-	Dr. (Cdr.) Arnab Das

Advisers

The MRC has a panel of advisers to guide and monitor growth of MRC on specific aspects. These are individuals with significant contribution and reputation on subjects of value to MRC. Director MRC regularly updates them on all activities and seeks their directions. The panel meets once in six months to review the growth of MRC and formulate directions. The following are advisers to MRC on specific domains as mentioned:

(a)	Strategy and Security	-	Vice Admiral SCS Bangara (Retd)
(b)	Technology & Innovation	-	Vice Admiral DSP Varma (Retd)
(c)	R&D and Human Resource	-	Prof PSV Nataraj, IIT Bombay
(d)	Blue Economy	-	Mr. Praful Talera, Dynamic Logistics
(e)	Marine Environment	-	Mr. Vivek Menon, CEO WTI
(f)	Overall Coordination	-	Capt. Inderjit Roy

Panel of Experts

A panel of experts on specific subjects is constituted, to support Director MRC in formulating and conducting research and strategy formulation. They also supervise students working on multiple projects at MRC and support Director MRC in formulating project proposals. The panel of experts are as follows:

(a)	Maritime Security	-	Rear Admiral S Y Shrikhande (Retd)
(b)	Underwater Acoustics	-	Dr. (Cdr.) Arnab Das.
(c)	Maritime Law	-	Mrs. Minoo Daryanani.
(d)	Hydrodynamics	-	Dr. (Cdr.) Vijay Kumar, IIT Chennai
(e)	Communication	-	Ms. Scharada Dubey
(f)	Marine Mammals	-	Dr. Dipani Sutaria

Opportunities

Students, professionals and practitioners desirous of working at MRC will be required to join as student intern for six weeks initially with a nominal registration fee. The internship will be towards understanding the work and project ideas at MRC and formalize their areas of interest. On completion of this initial attachment, meritorious students will be offered long term opportunities as research assistants and associates based on their background and abilities.

Project based and research based hiring is also planned through the student internship model. Research scholars may also enrol at MRC to progress their work with explicit approval from their institute. Students desirous of working with MRC may contact Director MRC with their CV and Statement of Purpose. Customized association can be formulated based on individual requirement based on approved models from the Governing Council.

Resource Generation

Resource generation will be undertaken through all known soft funding means, like institutional memberships, student internships, sponsorship, project funding, collaborations, etc.

Institutional Membership

Academic institutes and corporates can opt to become institutional members of MRC with a nominal annual registration fee of Rs. 50,000/- for academic institutions and Rs. 1,00,000/- for corporates, to avail all benefits. The institutional members will be entitled to:

(a) Sharing of expertise with regular interaction.

(b) Sharing of research outcomes and publications.

(c) Invite to regular events and co-hosting of events.

(d) Access to the Maritime Library.

(e) Participation in the Open Day event held every six months.

(f) Participation in the research activities.

(g) Data sharing only for research scholars at MRC.

(h) Hosting of students for project work with expert guidance.

(i) Joint submission of research project proposals is possible.

MoUs with Institutes

Memorandum of Understandings (MoUs) will be signed with institutes on very focused collaboration programs with clear terms of reference. Institutes need to become institutional members prior to finalizing MoUs.

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 many 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 communities 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 the shape of an event.

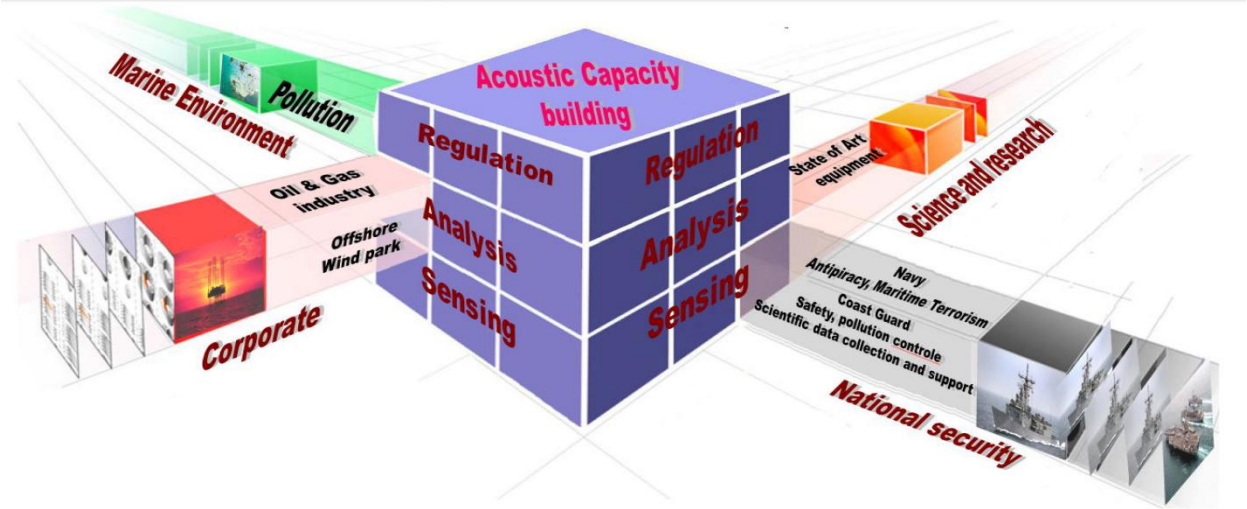


Fig. 1 Comprehensive Perspective of Undersea Domain Awareness

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.

Director's Profile

Dr. (Cdr.) Arnab Das is a retired naval officer with over two decades of active service spread over sea tenures, R&D assignments, training duties and dockyard exposure. He has delivered multiple strategic R&D projects and made pioneering contributions towards innovative technology development and strategic formulations. He has done his Master's and PhD from IIT Delhi on underwater signal processing and has over fifty papers and a book on underwater technology and maritime strategy to his credit. He has reasonable academic and research exposure in globally recognized labs like the Institute of Industrial Sciences at Tokyo University and the Acoustic Research Lab at National University of Singapore. He has founded his own start-up for underwater technology development and attempts to map the entire Underwater Domain Awareness (UDA) concept as a viable and sustainable venture. He continues his academic and research activities through his association with institutes as a visiting professor and has been guiding research students. His passion is to engage the young generation to the UDA concept and channelize their energy towards making India a strong maritime nation.

About the Book

"Marine Eco-concern and Its Impact on the Indian Maritime Strategy"

The entire vision of MRC is woven around the book authored by Dr. (Cdr.) Arnab Das. The book dedicated to the 'safe, secure and sustainable blue economy' for India in the Indian Ocean Region (IOR) was supported by the Indian Maritime Foundation, Pune. The book attempts to put in perspective the aspect of acoustic habitat degradation and also the complex interplay of issues in the IOR. The unique concept of Underwater Domain Awareness (UDA) proposed in the book can provide a sustainable way ahead for the developing economies in the region. The Indian Maritime Strategy (work in progress) formulation does get substantial inputs from the UDA framework to comprehensively address issues unique to the IOR.

The continental outlook in India has been challenged and sea-mindedness has been encouraged through a very novel aspect in the maritime domain. The country needs to recognize the challenges of the present maritime thrust and take appropriate political, economic and diplomatic measures. The general population needs to participate and make it politically compelling for the political leadership to accord this priority. The book does trigger passionate reactions to the status quo. A scientific and logical approach, towards enhancing maritime consciousness, through a delicate aspect of the degrading marine ecosystem, this book is a must read for all.

Enclosure-2

Water Resource Management and the Relevance of Underwater Domain Awareness (UDA)

Dr. (Cdr.) Arnab Das

The fresh water resource is increasingly getting strained and the growing population and the associated developmental activities is further adding to the disproportionate demand supply gap. Developing countries, particularly India are facing a potential crisis situation, with the water resource management efforts in complete disarray on one hand and the demand growing at an alarming rate on the other. Let us focus on the supply side of the water resource management problem. The distribution, recycling, demand effectiveness and more, may be left to another discussion.

The supply of freshwater typically comes from the rain water that gets stored in reservoirs, groundwater and other freshwater systems that collect freshwater during the monsoon season and support consumption during the off-season. The reservoirs with adequate storage capacity play a critical role in controlling floods during the monsoons and effectively manage the dry spells by providing the much needed resource. Thus, the capacity management of these reservoirs is a very critical aspect for any water resource management initiative. Freshwater resource with its socio-economic dimension has major relevance to the governance aspects as well.

The tropical regions with their characteristics monsoon pattern have a very peculiar situation. The monsoons are concentrated within three months of the year and the heavy rains ensure high flow of freshwater from the catchment areas to the reservoirs. The high flow rate is accompanied with high siltation that finally gets deposited into the reservoirs, severely impinging on the storage capacity of these water bodies. The eroded storage capacity has a very devastating, and two fold impact leading to flooding during the monsoons in the downstream areas and shortages during the dry seasons.

In India, typically most of our storage systems were built during the British era and over the years, the siltation has lead to more than fifty percent capacity being lost. The population pressures have lead to high demands and on the other hand the disappearance of the non-designated storage areas, causing depletion of ground water has further strained the availability. The downstream areas have also shrunk with more and more urbanization and the global warming coupled with climate change has led to high intensity nonseasonal rains. The flooding as a consequence has resulted in catastrophic manifestations with significant loss of life and property in urban areas. The poor retention in terms of storage capacity and also depletion of ground water has created a crisis situation.

De-siltation of the reservoirs is the obvious way forward and urgent measures are critical. The de-siltation effort requires precise information on the sediment type to efficiently and effectively plan any removal initiative. The Underwater Domain Awareness (UDA) in the broad contour of water resource management includes understanding of the extent of siltation, type of siltation including layered information, possible source of sediments and trends. The detailed understanding of the

sediment characteristics supported by Archaeological studies can provide information on the process of sedimentation and probably facilitate prevention.

UDA in the basic construct requires use of Sonars to undertake acoustic surveys to ascertain the surface and sub-surface characteristics of the sediment. The medium fluctuations in the underwater areas in the tropical waters cause severe deterioration in the sonar output requiring indigenous efforts to mitigate the distortions due to the medium fluctuations. The efforts involve underwater channel modeling and ambient noise characterization for design and development of mitigation strategies. Real field experimental validation becomes an important part of the exercise to ground truth the geological parameters. The present trend of importing high value sonar equipment without local ground truthing has not yielded any tangible result and acoustic surveys have failed to be in the main stream of water resource management initiatives.

The multidisciplinary effort to achieve effective sediment classification involves soft capabilities of acoustic signal processing, modeling and simulation, high performance computing, machine learning, geophysical analysis, archaeology and many more. The seamless coordination of each of these experts over a sustained period spread over varying geophysical conditions can facilitate effective strategies for water resource management. Extensive data collection to effectively map the local condition and correlation with the geological parameters can only provide a viable way ahead. Multiple, isolated efforts without exchange of ideas and information among the different disciplines has ensured sub-optimal results and consequent lack of interest in taking forward any tangible initiative.

Underwater signal processing and acoustic analysis has been a weak link in this entire initiative and probably the most critical link given that the acoustic surveys using sonars present sub-optimal performance due to the tropical shallow water behavior. Intense and sustained modeling and simulation efforts with validation are the only way forward to mitigate the medium distortions and enhancing the precision of sediment classification data. Effective UDA has to be a national priority given the critical concern of the water resource management initiative. The import of high value hardware in the absence of soft acoustic capability has not yielded results since independence. The awareness of the complex issues associated with acoustics in the tropical shallow water region to ensure effective UDA is highly limited among practitioners and policy makers.

The Maritime Research center (MRC) under the aegis of the Indian Maritime Foundation (IMF) at Pune has started a very unique concept called the UDA that has numerous aspects including the water resource management aspect discussed in this paper. Their mission includes promoting UDA at three levels – the policy level, the technology and innovation level and the human resource development level. Towards achieving the stated objective the MRC has planned a five day workshop on sediment classification at the Khadakwasala lake to study the impact of tropical shallow water medium fluctuations on the sediment classification results. The workshop deals with multiple technology and social aspects with the prime focus on water resource management. The multidisciplinary experts have been brought together to interact with the participants to provide a comprehensive and effective solution to the problem.

Enclosure-3


Maritime Research Centre
presents
Workshop on
Sediment Classification and
Field Experiments
Comprehensive modelling and simulation with field data validation using three types of SONARs with hands on exposure to Machine Learning and High Performance Computing
Date: 09th to 13th Oct. 2017
For more information please click Here
Venue: Maritime Research Centre,
Department of Archaeology,
Deccan College, Yerawada, Pune
For any query contact:
director.mrcpune01@gmail.com
+91-9665033463
Sponsored by:
BAJAJ
Distinctly Ahead

Enclosure-4

Programme for Day-1
Introduction

Inaugural Event

0930 hrs Welcome Address Cmde. Rajan Vir (Retd), President IMF, Pune.

0935 hrs Opening Address Dr. (Cdr.) Arnab Das, Director MRC.

1000 hrs Introductory Address Prof. V Shinde, Vice Chancellor
Deccan College Post Graduate and Research Institute Deemed University, Pune.

1015 hrs Panel Discussion

Prof. Ranjan Ratnakar Kelkar,
Former DG of Indian Meterological Department, Government of India.
"Climate Change, Monsoons and the Challenges of the Future".

Dr. D M More,
Former DG of Water Resource Department, Govt of Maharashtra.
"Sedimentation Process and the Importance of Desiltation".

Ms. Scharada Dubey,
Author and Columnist
"Socio-economic perspective of Water Resource Management".

1100 hrs Comments from the Audience

1125 hrs Vote of Thanks
Capt. Inderjit Roy,

1130 hrs Tea

Workshop Begins

1200 hrs Workshop Briefing - Dr. (Cdr.) Arnab Das

1300 hrs Lunch

1400 hrs Underwater Acoustics & Challenges of Tropical Shallow Water Acoustics – Dr. (Cdr.) Arnab Das

1530 hrs Tea

1600 hrs Sediment Analysis – Marine Archaeologist Perspective
Prof P D Sabale

End of Day 1

Programme for Day-2
Analysis Tools

0930 hrs Welcome Address - Dr. (Cdr.) Arnab Das

0940 hrs Opening Address – Prof PSV Natraj

1000 hrs Case Studies on Deep Learning by Research Scholars at IIT Bombay Ms. Richa Singh and Ms. Bhagyashree.

1100 hrs Tea

1130 hrs Modeling & Simulation - Prof PSV Natraj

1200 hrs Parallel Computing - Prof PSV Natraj

1300 hrs Lunch

1400 hrs Address by Vice Admiral DSP Varma (Retd)

1430 hrs High Performance Computing by Prof. Priyadarshan Dhabe

1600 hrs Tea

1630 hrs Hands on Matlab session on parallel computing on HPC machine by Prof. Priyadarshan Dhabe

End of Day 2

Programme for Day – 3
Field Trials

0830 hrs Reporting at MRC

0840 hrs Bus departs for Khadakwasala Lake

1000 hrs Briefing at the Lake side

1030 hrs Commence Acoustic Survey

1200 hrs Bus depart back to MRC

1330 hrs Lunch

1430 hrs Sediment Analysis – Prof P D Sabale

1600 hrs Tea

1630 hrs Lab visit for Sediment Analysis – Prof P D Sabale

End of Day 3

Programme for Day – 4
Data Analysis and Coring

0930 hrs Welcome Address – Dr. (Cdr.) Arnab Das

0940 hrs Deep Learning State-of-the-art and applications – Mr. Umesh Gupta

1100 hrs Tea

1130 hrs Python programming basics – Mr. Milap Rane

1300 hrs Lunch

1400 hrs Hands-on Session on Deep Learning

1530 hrs Tea

1600 hrs Hands-on Session on Deep Learning

Parallel Session
Civil Engineers practitioners and Geology students will participate in the field work on coring and sample collection.

1230 hrs Early Lunch

1300 hrs Proceed to Khadakwasala Lake by bus

1430 hrs Briefing at the Lake

1500 hrs Coring Commence

1700 hrs Return to MRC

End of Day 4

Programme for Day – 5
Conclusion and Valedictory

0930 hrs Welcome Address and Feedback – Dr. (Cdr.) Arnab Das

1000 hrs Research Perspective on Sediment Classification – Mrs. Jyoti Sadalge

1100 hrs Tea

1130 hrs Sediment Analysis Results – Prof. P D Sabale

1300 hrs Lunch

1400 hrs Real Analysis Perspective – Dr. (Cdr.) Arnab Das

1500 hrs **Valedictory Session**

1500 hrs	Opening Address – Cmde. Rajan Vir (Retd)
1510 hrs	Workshop Report – Dr. (Cdr.) Arnab Das
1530 hrs	Feedback Report – Ms. Scharada Dubey
1550 hrs	Sediment Analysis Report – Prof. P D Sabale
1600 hrs	Comments by the Participants
1610 hrs	Green Thumb Presentation – Col. Vijay Kaushik
1625 hrs	Distribution of Certificates
1640 hrs	Tea

End of Workshop

Enclosure-5

List of Participants

S.No.	Name	Position of work	Name of the College or Industry
1.	Karan Bhat	Student	DIAT Pune
2.	Sumitra P Pundlik	Faculty	MITCOE Pune
3.	Rashmi Sharma	Student	SGGSIET, Nanded
4.	Nishant Shetty	Industry Personal	Herald Maritime Services Pvt. Ltd.
5.	Shivaji Ksirsagar	Student	Deccan College PG and RI (Deemed University) Pune 6
6.	Ambareesh Kshirsagar	Faculty	JSPM'S Rajarshi Shahu College Of Engineering
7.	Jitendra Thakur	Student	DIAT Pune
8.	Sindhu. P	Industry Personal	Bharat Electronics Ltd.
9.	Pratik Baheti	Student	Shri Ramdeobaba College of Engineering and Management, Nagpur
10.	Milap Rane	Student	Georgia Institute of Technology
11.	Shailesh Thonte	Industry Personal	CWPRS
12.	AP Meshram	Industry Personal	CWPRS
13.	Madhavi Gajre	Industry Personal	CWPRS
14.	Snehal Shinde	Industry Personal	CWPRS
15.	Piyush Asolkar	Faculty	Shri Ramdeobaba College of Engineering and Management, Nagpur
16.	Kushank Bajaj	Industry Personal	Indian Institute of Tropical Meteorology
17.	Uday Mithapelli	Student	Dr. Babasaheb Ambedkar Technological University , Lonere
18.	Sonali Kale	Faculty	KJEI's Trinity
19.	Shital Dhatrak	Faculty	KJEI's Trinity

Enclosure-6

Pictorial Workshop Report

Workshop on

Sediment Classification and Field Experiment

9th – 13th October 2017

Dr. Arnab Das

Director, Maritime Research Centre, Pune.

Objective of workshop

- Multi-disciplinary and Multi-activity approach for research based Real World problem solving.
- Comprehensive technology approach to Underwater Domain Awareness.
- Innovative Water Resource Management Initiative.
- Addressing the Challenges of UDA in the Tropical Regions.

Day 1 : Inaugural Event & Panel Discussion

- Welcome address by Cmde Rajan Vir (Retd)

Day 1 : Introduction to UDA and Acoustics in Tropical Waters

- Opening Address by Dr. (Cdr) Arnab Das.

Day 1 : Introduction to UDA and Acoustics in Tropical Waters

- Good Participation from over 14 institutes (7 places)

Day 1 : Introduction to UDA and Acoustics in Tropical Waters

- Sediment Analysis – Marine Archaeologist Perspective by Prof. P. D. Sabale

Day 2 : Modeling & Simulation

- Prof PSV Natraj, IIT Mumbai

Day-2 : Analysis Tools

- Case Studies by Bhagyashri and Rucha from IITB

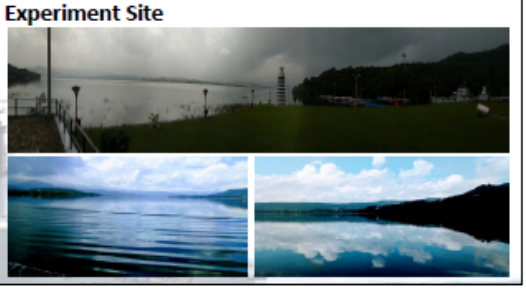
Day-2 : Analysis Tools

- Address by Admiral DSP Varma (Retd).

Day-2 : Analysis Tools

- High Performance Computing and its Hands on session - Prof. Priyadarshan Dhabe

Experiment Site



Experimental setup and team

Day – 3 : Field Trials

- Field Experimentation at Khadakwasla Lake

Day – 3 : Field Trials

Day – 4 :Data Analysis and Coring

- Deep Learning State-of-the-art and applications – Mr. Umesh Gupta

Day – 4 :Data Analysis and Coring

- Field work on coring and sample collection.

Day–5 : Conclusion

- Research Perspective on Sediment Classification – Mrs. Jyoti Sadalge

Day–5 : Conclusion

- Feedback session