HYDRONAUT

MAPPING THE WATERS FOR A SAFER TOMORROW

2025

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From the
EDITOR'S DESK

Cdr L Karteek Reddy
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Hydronaut Magazine

Namaste and welcome to the latest edition of Hydronaut. As we navigate through 2025, the currents of Indian hydrography are stronger and more dynamic than ever before. This year marks not just another turn of the calendar, but a significant juncture where we reflect on the rich history of charting our waters, celebrate the remarkable advancements that have propelled us forward, and cast our gaze towards the exciting horizons that lie ahead. With India's extensive coastline and growing maritime interests, accurate hydrographic data is crucial for navigation, coastal management, and national security.

India, with its vast coastline, its intricate network of inland waterways, and its growing maritime interests, holds a pivotal position in the global hydrographic landscape. For generations, Indian hydrographers have dedicated themselves to this crucial task, braving challenging conditions and employing ingenuity to unveil the secrets hidden beneath the surface.

Looking back at the years gone by, the evolution of hydrographic surveying in India has had a fascinating journey. From the early days of manual lead lines and sextants to the introduction of echo sounders and electronic positioning systems, each technological leap has significantly enhanced our ability to acquire precise bathymetric data. The tireless efforts of pioneering hydrographers laid a strong foundation, meticulously charting harbors, shipping channels, and coastal areas, often under demanding circumstances. Their legacy of accuracy and dedication continues to inspire us even today.

The past decade has seen an acceleration with the widespread adoption of multibeam echo sounders (MBES) for detailed seabed mapping, enhanced by IMUs and GNSS for precise positioning. Remote sensing technologies, AUV and ROV are playing an increasingly vital role in efficient data acquisition.

This edition of Hydronaut emphasizes this collaboration, featuring articles from Indian hydrographic officers and sailors, sharing research methodologies, and field experiences. The magazine will continue to serve as a vital platform for fostering dialogue, disseminating knowledge, and celebrating the achievements within the Indian Navy. Thank you for sailing with us through these narratives. May each story guide your thoughts and actions as we all continue to map our way forward. We thank you for your continued support and engagement. Your feedback, encouragement, and curiosity drive us to keep evolving and delivering content that matters.

Happy Reading!

VAdm L S Pathania

Foreword By

CHIEF HYDROGRAPHER

It is with immense pride and satisfaction that I present this maiden edition of Hydronaut,a publication that stands out to be a beacon of professional excellence and a platform for vibrant intellectual exchange within the hydrographic community.

As the Chief Hydrographer, I have had the privilege of witnessing the relentless dedication and remarkable evolution of our officers and sailors in the field of hydrography. From traditional lead line to state-of-the-art multibeam echo sounders, autonomous survey platforms and AI - powered data analysis, our journey has been both inspiring and transformative. This magazine stands as a testament to the adaptability, resilience, and innovation that define Indian hydrography today.

Hydronaut, vividly showcases the dynamic blend of tradition and technology that define our profession. It features a rich spectrum of articles from enclosed area surveys and bathymetric mapping innovations to sustainable hydrography and indigenous software development. These contributions reflect the growing intellectual depth of our community and more importantly, its commitment to continuous learning and professional excellence.

It is also heartening to see young officers bringing fresh perspectives and solutions to long-standing challenges, paving the way for future ready hydrographic practices. The magazine's focus on both professional insight and real-world field experiences fosters a unique synergy that strengthens the core of our hydrographic fraternity.

I commend the editorial team, contributors, and all personnel involved in making this edition a resounding success. May Hydronaut continue to inspire thought, sharpen skills, and strengthen our collective resolve to navigate uncharted waters with confidence.

Fair Winds and Following Seas.

Foreword By

JOINT CHIEF HYDROGRAPHER

RAdm Peush Pawsey

It gives me immense pride and satisfaction to present Hydronaut, a magazine envisioned as a dynamic forum for hydrography professionals to share, reflect and stay abreast of the evolving technological landscape of our domain.

Hydrography, as a critical maritime science, stands at the confluence of tradition and transformation. From the age-old practices of lead-line surveys to the present-day deployment of Autonomous Underwater Vehicles (AUVs), the discipline has witnessed a remarkable metamorphosis. In recent years, the integration of Artificial Intelligence, enhanced geospatial analytics and unmanned systems has not only amplified the precision and efficiency of our surveys but has also redefined the scope and impact of hydrographic operations.

Hydrography today is not what it was a decade ago. These advancements have not only increased the speed, accuracy and reliability of our surveys but have also opened new frontiers in undersea exploration, maritime safety, resource management and national security. As a service that underpins both civil and military maritime operations, staying at the forefront of these innovations is not a luxury—it is a necessity.

This magazine is a testament to our collective commitment to innovation, professional growth and operational excellence. It brings to light not just the latest in technological adoption, but also the rich experiences, challenges and field-tested insights of our officers. Within its pages, one will find insightful articles authored by our officers and practitioners who share their experiences from the field, reflect on operational challenges and present novel solutions and research findings. Topics range from AI-driven bathymetric analysis to the operational use of hybrid survey platforms and from retrospective narratives of landmark surveys to emerging trends in coastal zone management. It is through such open knowledge exchange that we strengthen the foundation of our service and inspire the next wave of hydrographers.

I commend the efforts of all contributors—officers and editorial members—who have made Hydronaut a reality. May this initiative continue to serve as a beacon of knowledge, a chronicle of achievements and a catalyst for thought leadership in the field of hydrography.

Let us continue to navigate the depths with precision, purpose and a relentless pursuit of excellence.

Preface

Officers and Sailors contributed articles to the magazine, sharing insights on advancements in hydrography, surveying techniques,data analysis and their experiences in the field of hydrography. These articles serve as a platform for professionals to discuss challenges, present research findings, and promote best practices. Articles often cover topics of hydrography like autonomous underwater vehicles, years gone by and the use of AI in hydrographic surveying. The magazine is prepared by capturing and balancing two core contents i.e Experience sharing and professional knowledge.

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Automation in Data Processing Using Process Design Module

Introduction.

1. Different surveys are carried out, each requiring deliverables in different time lines. In areas of constant change and shifting sand/mud banks there is a requirement of repeated surveys in a short time frame. With automation in multiple domains, concomitant to technology advancement the need for speed was felt in hydrographic data collection to deliverables. Hydrography being a niche domain, with very less margin of error due to its sensitivity and economical dependency has seen a leap in automation. With ASV (Autonomous Surface Vessels), AUVs (Autonomous Under Water Vehicle), drone based lidars, automation and swift data collection is quickly merging. This paper delves into the automation that can be done once raw data is received onboard the mother ship/base unit. Caris describes "**Ping to Chart**[1]"as the automation method which they have inculcated in data processing.

2. The raw data which is collected by multibeam echo sounder is an amalgamation of depth, position, attitude and sound velocity data. There are multiple correction and editing in the raw data in the processing step. The manual data processing using Caris HIPS and SIPS[2] is a tedious task with an operator intervention at all stages. An inadequately trained operator may apply erroneous filters and delete useful data.

3. Here for the assessment of process design module which automates the data processing in Caris HIPS & SIPS, multibeam data of Agatti island in Lakshadweep group of islands in the West coast of India was

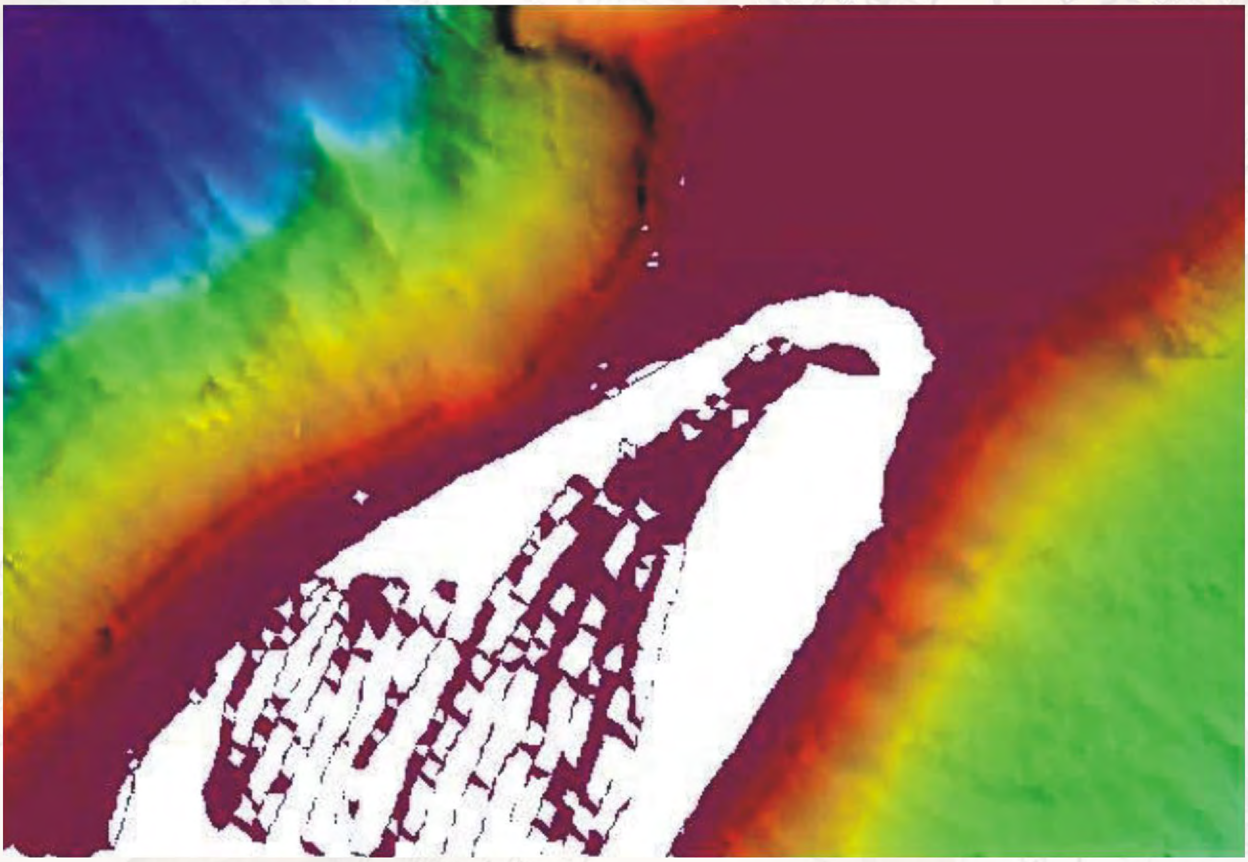


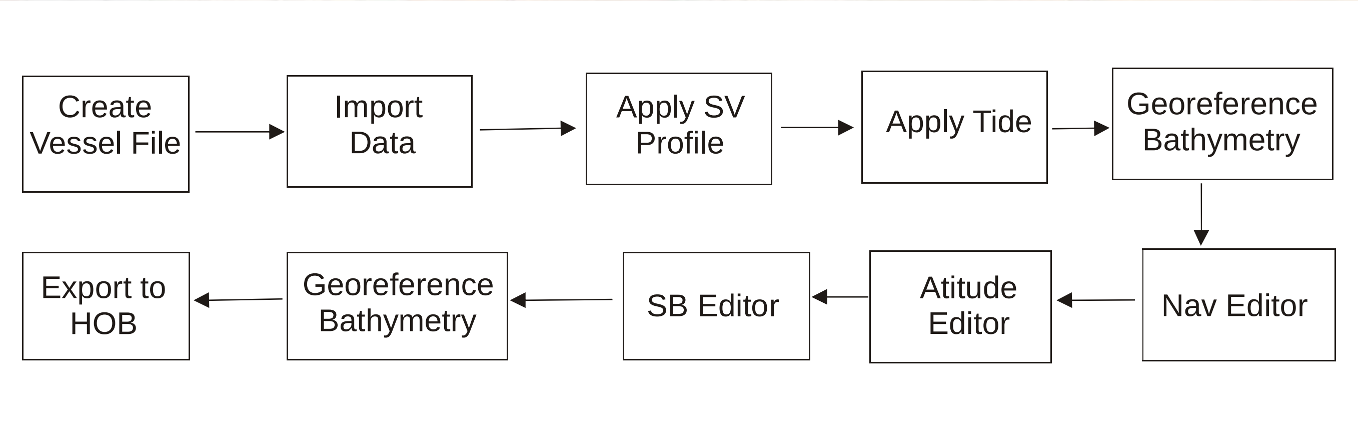
Fig.1-Gridded bathymetry sheet of Agatti Island in Lakshadweep

[1] CARIS trademark, [2] CARIS HIPS & SIPS processing software

used. The data once collected using ship fit multibeam Teledyne Reason HSDS MBES System at 180 KHz frequency was readily available in the processing work station as acquisition and processing work stations are on network. The process design module was run and output of the design was gridded bathymetry. On completion, gridded surface was available for further editing and filtering. The gridded bathymetry can then be further exported as *.HOB and opened in Caris PCC[3] as required by user. If there exist a data set for comparison, a quick differential analysis can be done. By this, the time taken from the ping to the final sounding on sheet has been considerably reduced.

Existing Work Flow.

4. Bathymetry data (SBES & MBES) is processed in Caris HIPS/SIPS using the following steps as per the existing SOP's[4].



Flow chart for processing SB Data

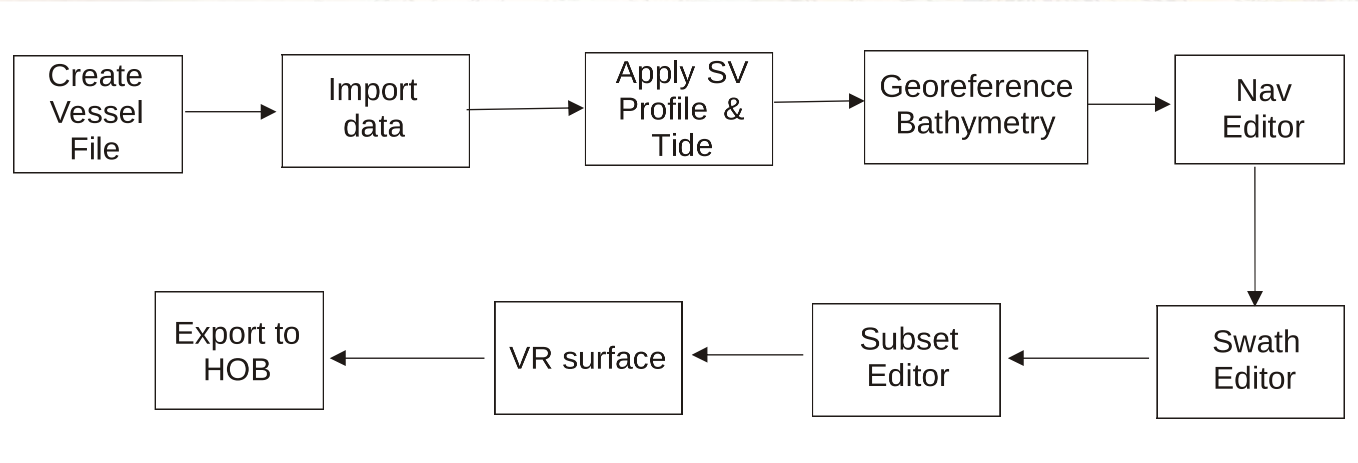


Fig.2-Flow chart for processing MBES Data

5. Each of these steps are selected by the operator and data goes from one step to another. This design of work flow depends on the expertise of the operator who is carrying out the processing. Process designer is a semi-automated data processing module in Caris HIPS/ SIPS which can be preprogrammed with each step and each source data (raw data, SVP file, tide file) destination mapped. The process designer once made is saved as *.processdesign file, which can be opened in process design editor. The *.processdesign file can be run and the end state (the output) as described in the design will be saved to the location.

Automation in Processing.

6. The process design module is a graphical programming tool for automating data processing in Caris HIPS and SIPS. The repetitive steps involved in data processing has been automated with operator having

[3] CARIS PCC software, [4] C 13

complete control by a combination of automation and operator involvement. As human intervention is necessary, a VR (Variable Resolution) surface is kept as the output in the process design. The *.hips file can be opened from the destination and further editing if required may be carried out.

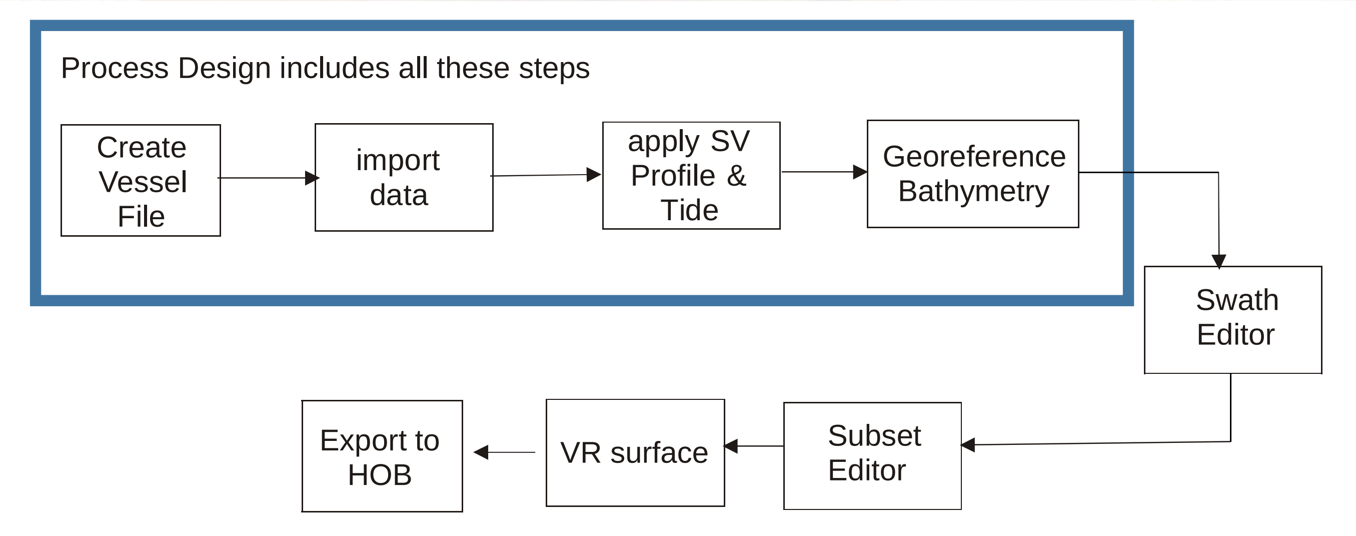


Fig.3 - Flow chart for processing MBES Data with process design

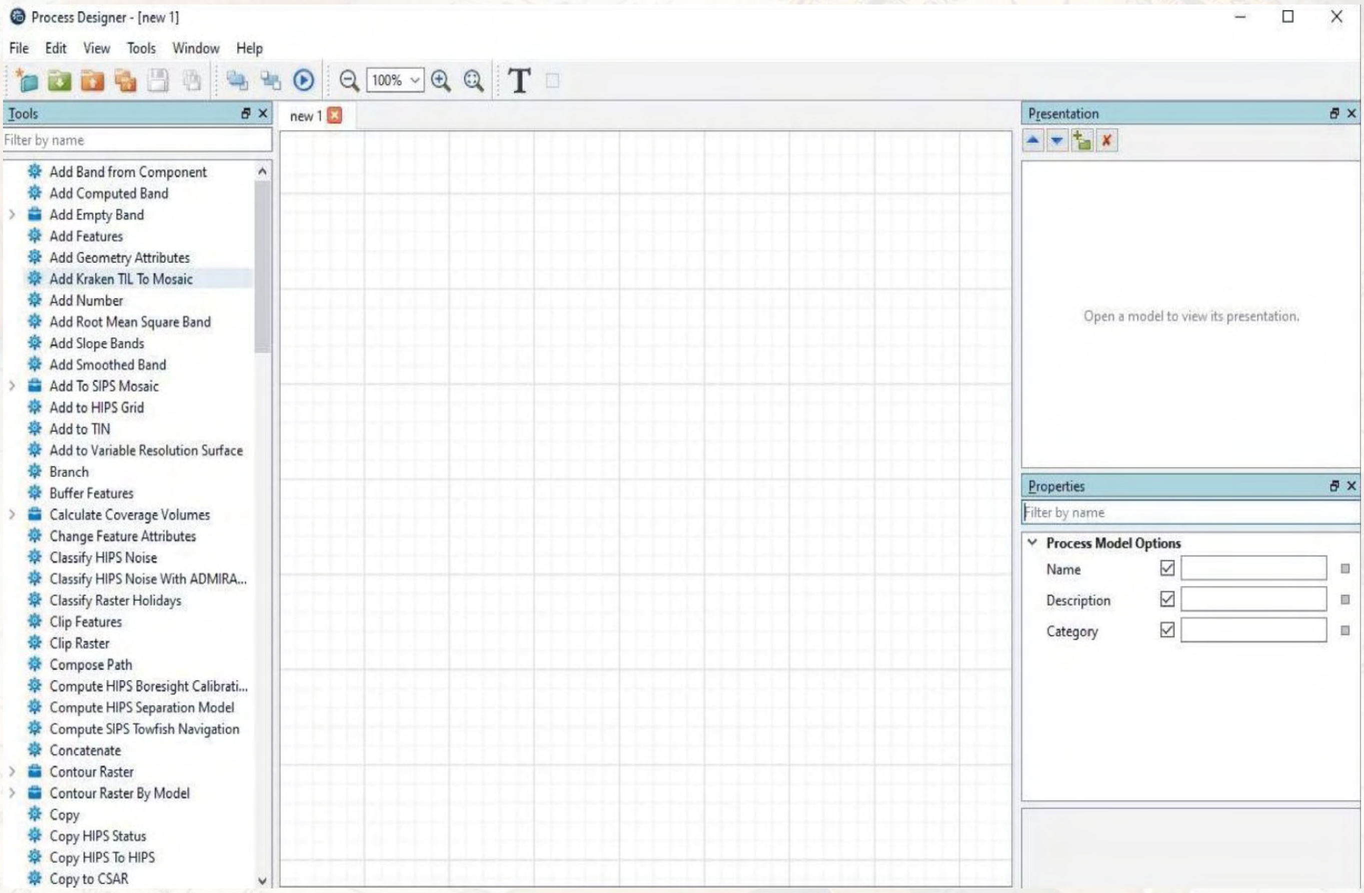


Fig.4 - Process design graphical interface

7. The model intakes raw data and outputs a gridded bathymetry, from thereon the operator ensures the QA/QC of the data. The automation data processing benefits bathymetric Marine Information Overlays (BMIOs or bENC)[5]. These are areas with high traffic which are required to be navigated by deep draught vessels. These products are supplement to an existing ENC. For example, a channel may be surveyed daily and new bENC overlays necessitates an automated workflow.

[5] Burns Foster, Travis Hamilton, Karen Cove, Cameron McLeay "Automating the ping to chart workflow".

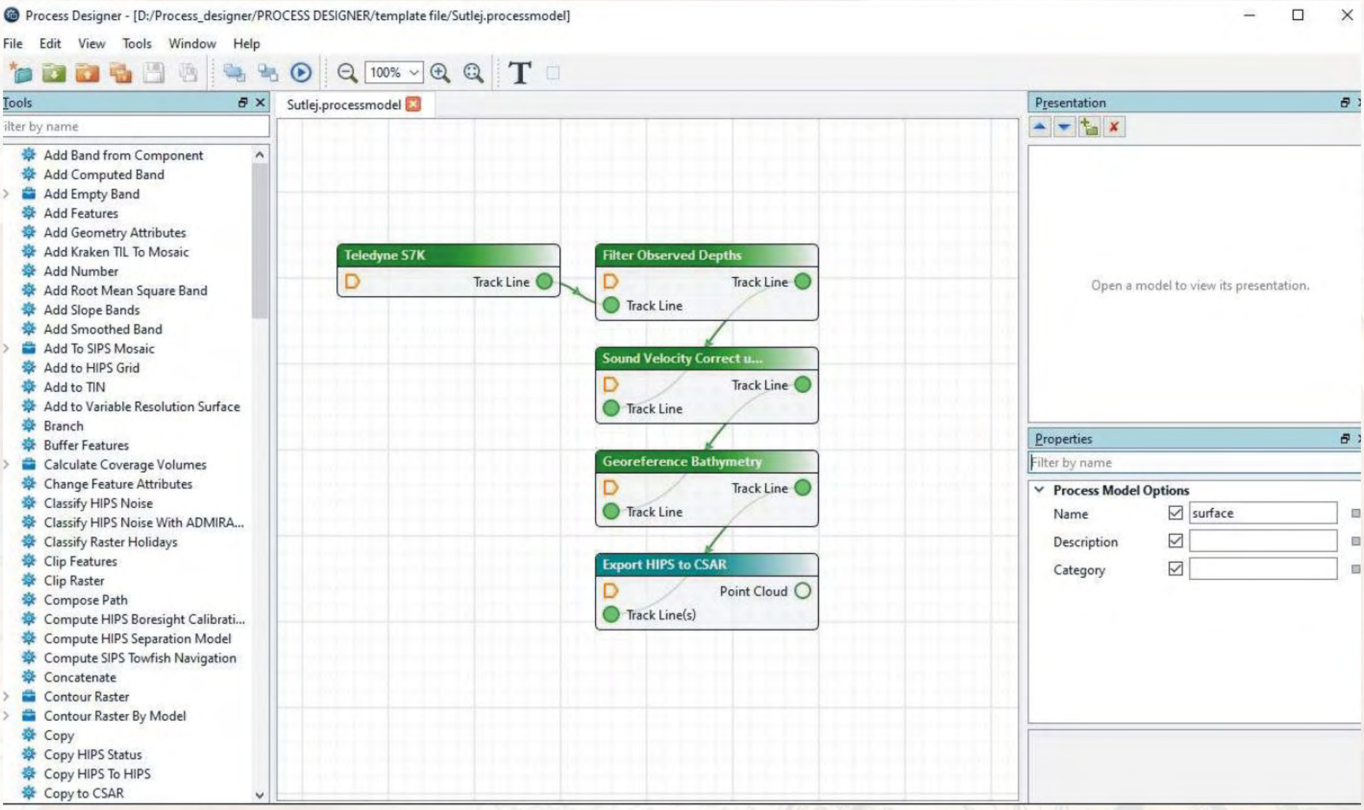


Fig.5 - Process design model used for Agatti survey

8. The gridded surface generated is available to operator for decision making, on completion of the survey, the whole project file can be accessed from the location as mapped by user.

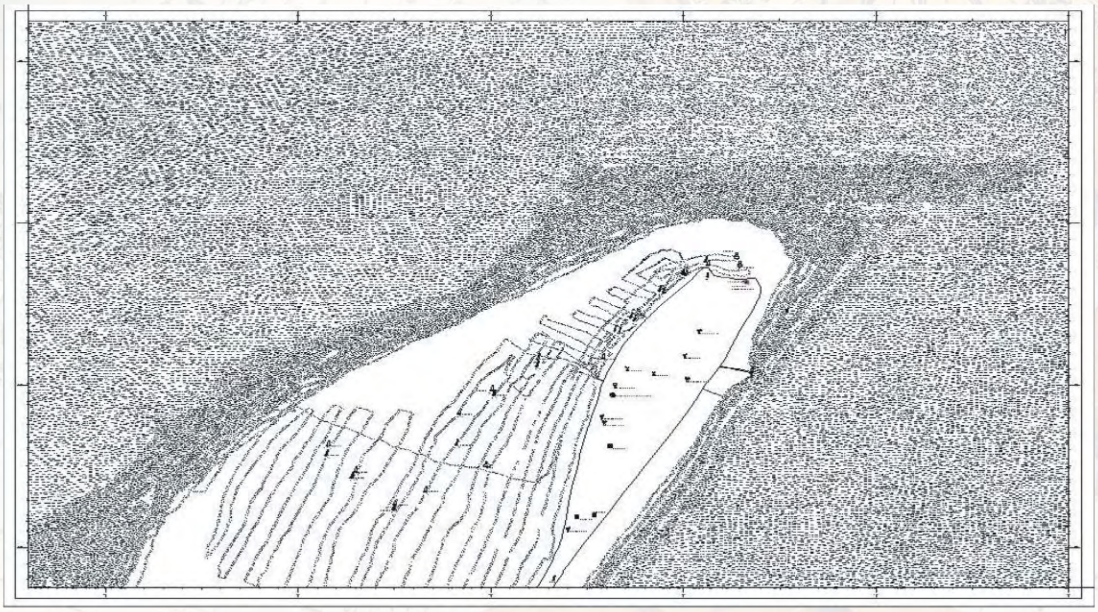


Fig.6 - Final fair tracing

Conclusion.

9. **Network and Prerequisites**. MBES work station, NAS storage and processing station needs to be seamlessly networked with complete access of data from processing station. As the ship runs on a line and stops logging, the data of the line is stored in acquisition work station. The source destination in process design is set to the folder on acquisition work station or copied to processing station automatically. On running the process designer, the line data is fetched from work station and the output is given at the desired location in processing PC.

10. **Advantages and Applicability**. In the erstwhile frame work it was ubiquitous for the operator to perform each task individually and any error in input file would result in erratic data. Once the process design file is created, each line data processing involves running the model by selecting the raw data. The data is appended to the existing *.hips file. As modern technology enables the user in reducing the time of collection to chart production this module can play a vital role. Following are the advantages: -

(a) Ease of processing data for data review in the execution time

(b) Holiday detection in MBES data on a large survey area using MBES in the execution phase. Data review on daily basis with reduced processing time.

(c) Preventing errors arising from operator's expertise

(d) Ease of data management as all the data can be in the NAS storage and only the *. hips file is accessed. Multiple copies of data set are avoided thereby saving disk space.

(e) Automation in data processing

11. **Recommendation**. The process designer module is intuitive and user-friendly. Automated data processing segment can be implemented with the existing logic of data processing. With a need for speed in processing and 'Ping To Chart[6]', all domains from data acquisition to final deliverable needs to pace up. With this tool an operator can simplify the steps in data processing and avoid repetitive tasks.

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Hydro Warriors

We are Hydro warriors, we are strong and true.

We fight everyday, we have much to prove.

Many of us are sick and scared, but we bring light and hope to our loved ones.

"We will never give up" Hydro Warrior rises up and be brave.

Although our heads have been shaved, our hearts are filled with love.

We are the strength in the world, that many will follow.

We are Hydro Warriors and we are here to lead the way.

ABHISHEK SINGH CHANDEL
LS(HY)

[6]CARIS trademark

Hydrographic Survey of an Enclosed Area

Introduction.

1. Hydrographic surveying is an essential aspect of marine navigation, coastal engineering, and underwater infrastructure development. The process involves the measurement and description of features beneath and above water surfaces, ensuring accurate mapping and assessment of underwater terrains. Enclosed water areas, such as enclosed docks, and submarine berths, present unique challenges that require specialised surveying techniques.

2. This article presents an case study of a hydrographic survey conducted in an enclosed jetty. The survey was carried out by crew of erstwhile INS Sandhayak. The study outlines the methodologies used, challenges encountered, and recommendations for improving future hydrographic surveys in confined spaces.

Fig.1 - INS Sandhayak off Pamban, Tamilnadu

Background and survey tasking.

3. **Prelude**. Serving onboard erstwhile Sandhayak in 2019-20 as a Senior Hydrographic Surveyor was a unique opportunity, as it was my first independent billet immediately post long hydrography course at the National Institute of Hydrography (NIH). The East coast of India, unlike the West coast, presents unique challenging conditions for hydrographic surveys due to its rough sea states, river deltas, and complex coastal morphology.

4. **Preliminary Reconnaissance**. Prior commencing the survey, a reconnaissance mission was conducted using the Survey Motor Boat (SMB). This recce helped in determining the following:-

(a) Accessibility to the jetty.
(b) Estimated time required for data collection.
(c) Equipment selection for an optimal survey.

Challenges in Enclosed-Space.

5. **Physical Constraints**. The construction of jetty with enclosed shed was just completed and the survey was vital to ascertain the area is safe for berthing.

6. **GPS Accuracy Limitations**. The primary issue in enclosed-space hydrographic surveys is the reduced effectiveness of Global Positioning System (GPS) due to obstructions blocking direct satellite signals. The Automatic Data Logging System (ADLS) linked to the GPS could not receive accurate horizontal positioning, requiring an alternative methodology for positional accuracy.

7. **Survey Methodology**. To overcome these challenges, two distinct methods were implemented; the Grid System and the use of Total Station.

8. **Grid System Survey**. A reference grid was established over the jetty, allowing systematic depth measurements. The approach included:

(a) Setting up reference transit markers at the front of the jetty.
(b) Using a rope with markers at one-meter intervals to guide the SMB's movement.
(c) Recording depth soundings using an echo sounder at each grid intersection.
(d) Plotting the observed depth soundings onto a fair sheet using satellite imagery.

9. **Execution**. A 5m x 1m grid was demarcated, ensuring comprehensive coverage of the enclosed water space. The SMB was moved in a controlled manner along these grid lines, stopping at predefined intervals to record soundings manually by establishing the transits ahead and abeam.

10. **Advantages and Limitations**.

(a) Advantages:-

(i) Simple methodology requiring minimal additional equipment.
(ii) Effective for small-scale surveys with minimal positional errors.

(b) Limitations:-

(i) Manual positioning increases the chances of human error.
(ii) Time-consuming and labor-intensive compared to automated methods.

11. **Use of Total Station (TS10)**. Given the constraints of GPS-based positioning, a Total Station TS10 was used to establish control coordinates and ensure accurate positional fixes.

(a) A point with clear satellite visibility was selected for establishing control coordinates using the International Terrestrial Reference Frame (ITRF) station.
(b) The Total Station was set up over the known control point.
(c) A prism was mounted on the SMB to allow real-time position tracking.
(d) The hydrographer at the Total Station communicates with the SMB operator to log positional fixes at regular intervals.

12. **Data Processing**. The collected data was processed using the HYDAS software, with geographical coordinates manually entered into a script file. The dataset was then imported into Hydrographic Information Processing System (HIPS) via a Generic Data Parser, ensuring accurate and reliable data integration.

13. **Advantages and Limitations**.

(a) Advantages:

(i) Higher positional accuracy compared to manual methods.
(ii) Effective in enclosed environments where GPS signals are weak.

(b) Limitations:

(i) Requires specialised equipment and trained personnel.
(ii) Time-intensive setup compared to conventional GPS surveys.

Recommendations.

14. **Need for Automation**. The methodology employed during this survey was an innovative yet labor-intensive approach. As the demand for surveying enclosed areas increases due to expanding maritime infrastructure, automation and advanced technology integration will be critical.

15. **Future Technological Improvements**. To improve efficiency and accuracy in enclosed space, the following advancements are recommended:-

(a) **Use of Autonomous Survey Platforms**.

(i) Deployment of Autonomous Surface Vehicles (ASVs) or Autonomous Underwater Vehicles (AUVs) equipped with Side scan sonar and Multi-Beam Echo Sounders (MBES) for real-time data collection.
(ii) Utilisation of systems like Inertial Navigation system / quantum positioning system
(iii) Integration of Artificial Intelligence (AI) for automated depth analysis and anomaly detection.

(b) **Database Integration and Python Scripting**. Development of automated Python scripts for seamless integration of Total station data and echosounder data into a single HIPS readable raw data file.

Conclusion.

The hydrographic survey of the enclosed jetty presented multiple challenges, primarily due to space constraints and GPS signal obstructions. By employing a combination of grid-based surveys and Total Station measurements, the team successfully mapped the seabed in the confined space. However, the experience highlighted the need for more automated and efficient methodologies. With advancements in technology, future hydrographic surveys in enclosed environments can be conducted with higher accuracy and efficiency.

Lt Cdr Denish Ganesan is an alumnus of 84th ICC & NIH. A CAT 'A' Qualified Officer from National Institute of Hydrography, Goawith 11 years of experience in Hydrographic surveying carrying out specialist duties onboard various ships. He is currently posted as Executive Officer onboard INS Makar. He is passionate about research and critical thinking, actively contributing to magazines.

आई आई आई AHC है आई

आई आई आई AHC है आई, हमारे लिए नई नई HI है लाई।

Ops room ने किया HIs को go through, हो गई तैयारी Survey Season की शुरू।

पहली HI का TOT 40 दिन का हुआ, 01 Oct को शिप सर्वेक्षण के लिए cast off हुआ।

बीवी ने बोला दिवाली साथ में मनाना, कृपया पतिदेव दिवाली से पहले वापस आ जाना।

CO साहब ने बोला TOT से पहले HI complete है करना, वर्ना दिवाली मेरे साथ at sea में ही मनाना।

आई आई आई खुशियों की लहर है आई, harbour वापसी की खबर सुनने में है आई।

CO साहब ने HI Completion से पहले harbour entry है कराई, सभी ने खुशी खुशी घर पर दिवाली है मनाई।

दिवाली मनाके ship फिर हुआ castoff, मई महीने तक हम चलते रहे non stop.

08 महीनों में पूरी कर दी सारी HI, now we are waiting for new HIs.

क्यूँकी.................. अब अगले बरस फिर से

आई आई आई AHC है आई

ARUN KUMAR
LS (HY)

Flowing Green: Hydrography for Tomorrow

1. **“Water is the driving force of all nature.”- Leonardo Da Vinci**. This quote captures the essence of hydrography’s role in understanding and harnessing the power of water for a sustainable future. For centuries, hydrography - the science of measuring and mapping such water bodies, focused on practical needs: ensuring safe navigation, tapping resources, or building infrastructure. But in the present day, with climate change accelerating and freshwater resources dwindling, hydrography is undergoing a profound transformation. "Flowing Green: Hydrography for Tomorrow" represents this new era, where sustainability is the guiding principle, and advanced technologies are harnessed to protect rather than exploit our waterways.

2. **<u>Redefining Hydrography for a Sustainable Age</u>**. Traditional hydrography was a utilitarian pursuit. Mariners needed charts to avoid shoals; engineers needed data to dam rivers or dredge ports. Today, the mission is broader and more urgent. With growing environmental concerns, sustainable hydrography has emerged as a critical field, integrating ecological metrics like water quality, biodiversity, sediment flow, and carbon dynamics into its datasets. It’s no longer enough to know a river’s depth; we must understand its role in mitigating floods, supporting fish populations, or filtering pollutants.

<u>Fig.1 - United Nations’ Sustenance Development Goals</u>

3. **<u>This shift reflects a Global Awakening</u>**. The United Nations’ Sustainable Development Goals[1], particularly Goal 6 (Clean Water and Sanitation) and Goal 14 (Life Below Water), underscore the need for water stewardship. Hydrography, once a niche field, is now a linchpin in achieving these targets.

4. **<u>The Technological Backbone of Flowing Green</u>**. At the heart of green revolution are technologies that blend precision with sustainability. Autonomous Underwater Vehicles[2] (AUVs) are a standout example. These robotic explorers, dive into oceans and rivers, equipped with sensors that measure temperature,

[1] United Nations. (2023). *Sustainable Development Goals: Water and Oceans*. https://sdgs.un.org/goals
[2] National Oceanic and Atmospheric Administration. (2024). *AUV in Hydrography*. https://www.noaa.gov

salinity, dissolved oxygen, and even micro plastic levels. In the Gulf of Mexico, AUVs track hypoxic "dead zones" caused by nutrient runoff, providing data that guides agricultural reforms upstream. Their battery-powered, low-impact design makes them ideal for sensitive ecosystems, minimizing disruption compared to traditional manned vessels.

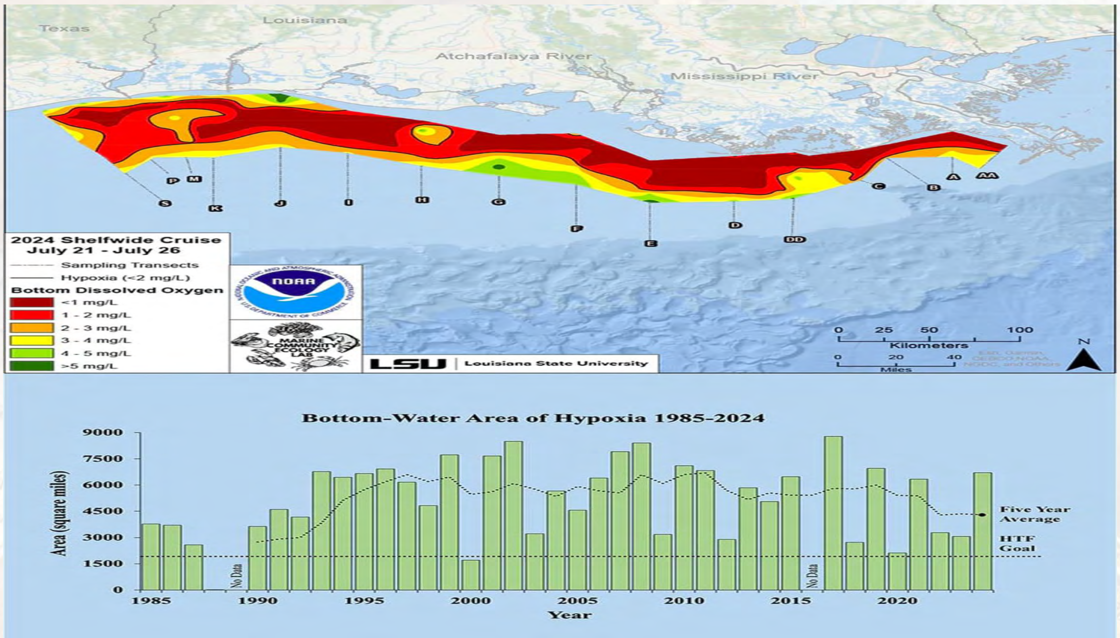
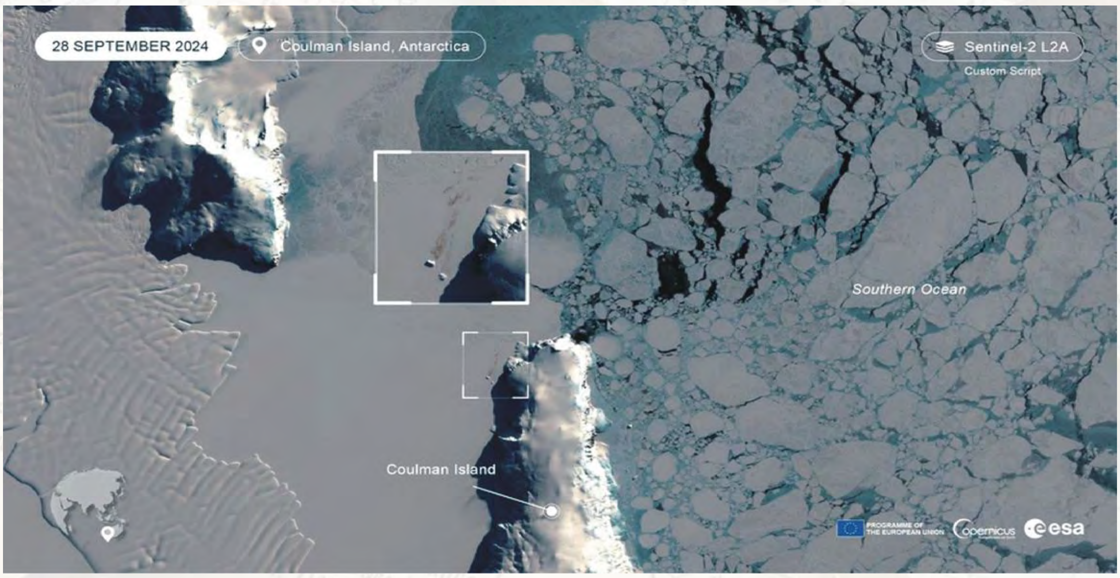


Fig.2 - Hypoxic Dead Zones Depicted in the Gulf of Mexico

5. **Above water surface, drones are rewriting the rules of hydrographic surveying**. Armed with LiDAR and multispectral cameras, these drones capture high-resolution images of shorelines, wetlands, and floodplains. In the Mekong Delta, drones are being used to monitor sediment shifts that threaten rice paddies, helping farmers adapt to changing flows. These drones are nimble and carbon-efficient, reducing the environmental footprint of data collection. Their affordability also democratizes hydrography, enabling cash-strapped regions to map their waters.

6. **Satellites, have undoubtedly been an absolute game changer in the field of hydrography**. The European Space Agency's Sentinel satellites, for instance, use radar and infrared imaging to track water levels, detect pollution, and monitor ice melts across continents. Today, this data is freely accessible via platforms like Copernicus[3], empowering nations to collaborate on transboundary water issues. Likewise, the Indus River Basin, shared by India and Pakistan, help negotiators balance irrigation needs with ecological



[3] European Space Agency. (2025). *Copernicus Programme.https://www.esa.int/Applications/Observing_the_Earth/

preservation, turning potential conflicts into cooperative solutions.

7. Artificial intelligence (AI) has been the primary approach to bind all these tools together to get useful information from these datasets. AI algorithms process terabytes of data from AUVs, drones, and satellites, spotting trends that elude human analysts. Harmful Algal Blooms (HABs), with continuous rise of pollution in water bodies pose threats to both drinking water supply systems and the ecological health of water resources. The Proliferation of such HABs have been a major issue in water quality management in many countries around the world, including Australia, China, the European Commission, South Korea, and the United States of America (USA), over the past few decades.

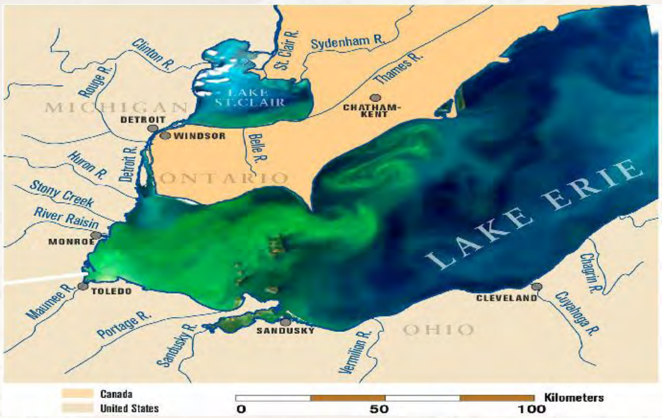


Fig.3 -Proliferation of Harmful Algal Blooms (HABs) in Lake Erie, USA

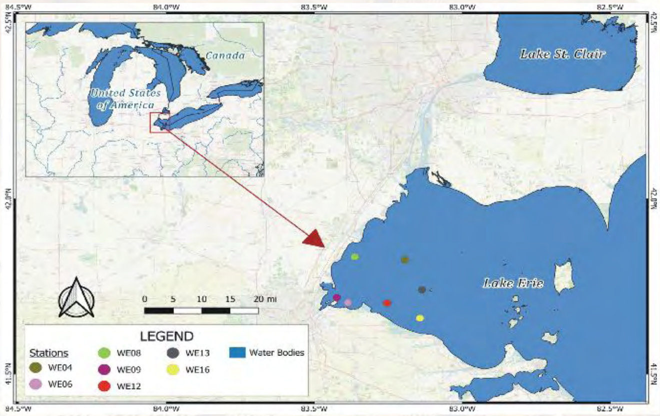


Fig.4 - HAB monitoring stations in Lake Erie

8. The primary culprits behind the surge in HAB incidents include nutrient pollution, primarily from agricultural production and industrial waste, coupled with climatic variables such as rising water temperatures and altered water quality characteristics. HABs are notorious for producing dangerous toxins, undermining the aesthetic and recreational value of waterways, and challenging the provision of clean drinking water. According to a recent study there have been significant advances in machine learning/AI models which have enhanced the accuracy and efficiency of detecting and predicting algal blooms, contributing to the protection of aquatic ecosystems and human health.

9. **Small-Scale Innovations with Big Impact**. Beyond these high-profile technologies, smaller innovations in this field are making waves as well. Bio-inspired sensors, that mimicked the sensitivity of fish gills or jellyfish tentacles, detect contaminants like heavy metals or pesticides at parts-per-billion levels. Deployed in India's Ganges River at various locations from Haridwar to Diamond harbour in West Bengal, these low-cost devices help pinpoint pollution sources, aiding cleanup efforts in a waterway sacred to millions. Their simplicity makes them scalable, especially in developing nations where budgets are tight.

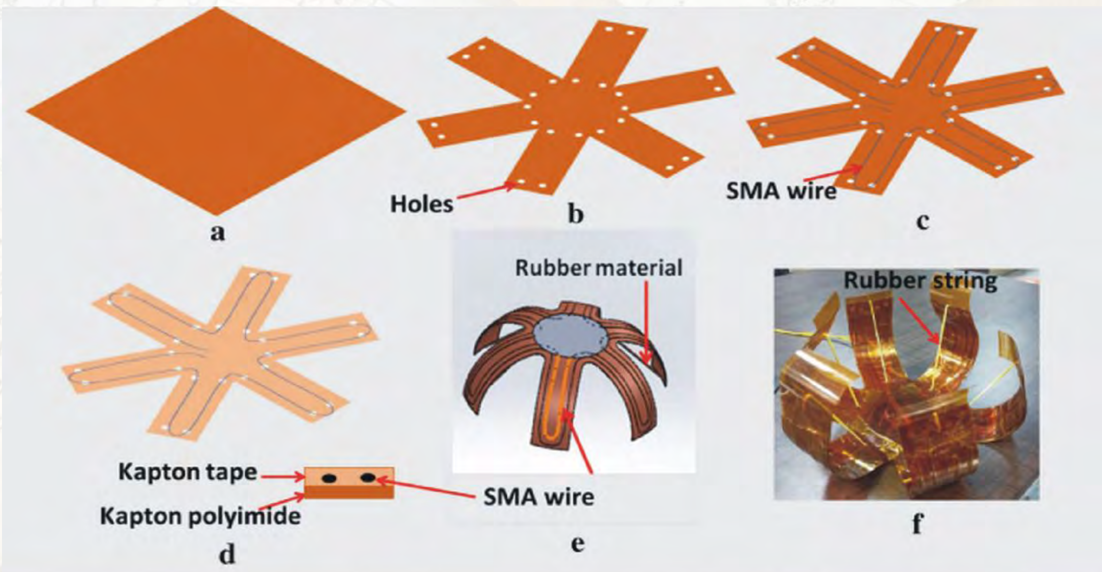


Fig.5 - Cost-effective bio-inspired soft jelly fish sensors

10. Citizen science[4] has been another significant contributor to small scale innovations. There are apps like iNaturalist and Waterkeeper that allow ordinary people to log river levels, photograph erosion, or report spills, feeding real-time data into hydrographic models. For instance, according to a study in Bangladesh, where monsoon floods are a yearly threat, citizen-collected data has helped in mapping vulnerable zones, guiding the placement of flood barriers. This grassroots approach not only expands coverage but also fosters public ownership of water conservation.

11. Energy efficiency is also a key priority for promoting sustainable hydrography. Solar-powered buoys, bobbing in lakes and seas, monitor currents and water quality without relying on fossil fuels. In the Arctic, where melting ice demands constant vigilance, these buoys replace costly ship expeditions, cutting emissions while gathering critical data. Similarly, hybrid survey vessels that combine solar, wind, and electric propulsion - are emerging as sustainable alternatives to diesel-powered fleets, proving that hydrography itself can go green.

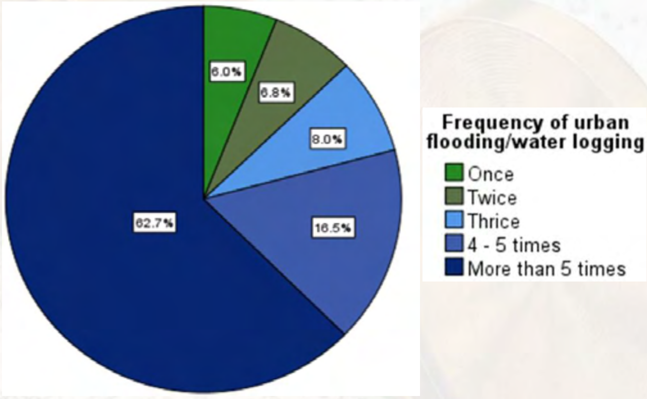


Fig.6 - Citizen Science data depicting experience of respondents over frequency of urban flooding in the two city corporations in Dhaka

12. **Challenges and Opportunities**. Despite its promise, sustainable hydrography has been perpetually facing hurdles. Funding has been a perennial issue - governments often prioritize short-term gains (like port expansion) over long-term mapping projects. In remote regions, like the Amazon's headwaters, poor infrastructure and political instability hinder data collection. Integrating of green goals with economic demands would always remain a challenge. Yet, these challenges are spurring new innovations. Public-private partnerships are filling funding gaps; big tech companies like Planet Labs and NVIDIA are investing in satellite and AI tools. Lightweight, portable technologies like foldable drones or handheld sensors are reaching isolated areas. Moreover, international frameworks, such as the UN's Decade of Ocean Science for Sustainable Development[5] (2021–2030), are fostering collaboration and aligning nations around shared water goals.

Fig.7 - Hybrid French hydrographic vessel

13. **The Road Ahead**. As we look ahead, hydrography stands at the crossroads of innovation and sustainability. Advancements in remote sensing, AI-driven data analysis and eco-friendly surveying techniques are transforming how we map and manage water bodies. By embracing green technologies and

[4] Waterkeeper Alliance. (2024). *Citizen Science in Water Management*. https://waterkeeper.org
[5] UN Decade of Ocean Science for Sustainable Development.*Ocean Science Roadmap*. https://oceandecade.org

interdisciplinary collaboration, we can ensure that hydrography continues to serve as a vital tool for environmental stewardship and sustainable development. By 2030, sustainable hydrography could halve freshwater pollution, restore millions of hectares of wetlands, and safeguard coastal communities from sea-level rise. It's a bold vision, but the tools are here. AUVs dive deeper, drones soar higher, and AI connects the dots, weaving a tapestry of data that links humanity to its most vital resource. Tomorrow's hydrography isn't about dominating water - it's about nurturing it, ensuring every drop flows green.

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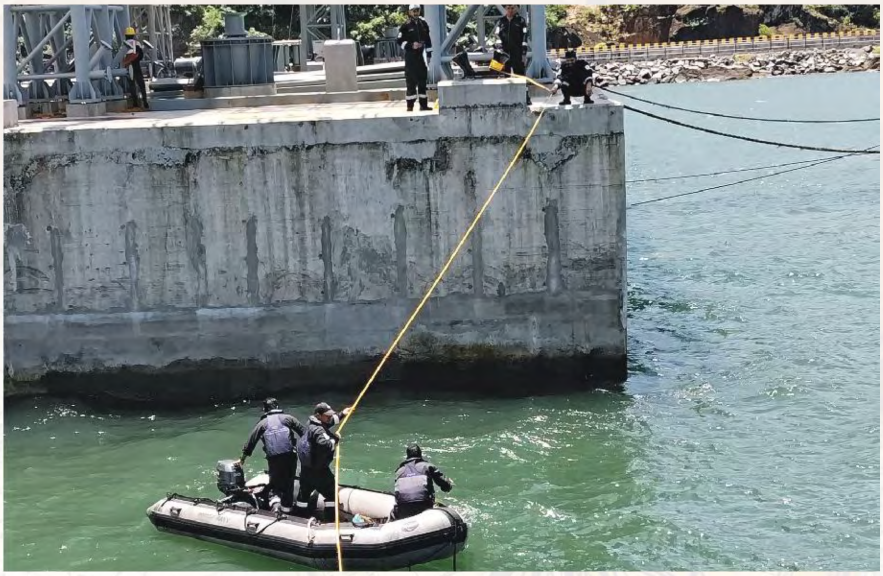
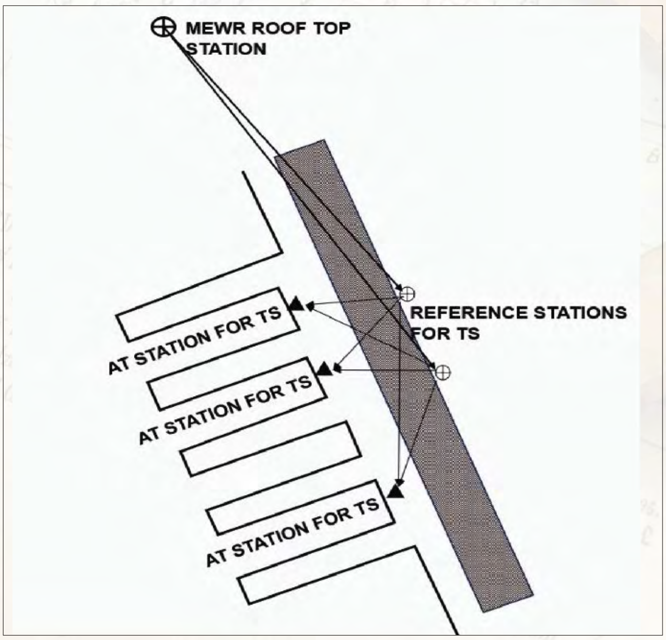
CDR RATHEESH R

Bathymetric Survey of Sheltered Berths: A First for the Hydrographic Unit



1. The Hydrographic Survey Unit of Karwar successfully conducted a comprehensive bathymetric survey of a sheltered berth utilizing a Total Station for precise positioning and a singlebeam Echosounder for accurate depth measurements. This innovative approach, a first within for the department, showcases the unit's commitment to adopting innovative modern techniques and enhancing its hydrographic capabilities.

2. Traditionally, bathymetric surveys in similar environments rely on using the spot sounding method. Hand lead line for depth and transit marks along and across the planned lines for positioning. This is a tedious task considering the amount of time and manpower required for the same due to the maneuverability constraints inside the small enclosed berth. Ropes need to be passed to the boat from the jetty to position it exactly at the transit intersections for obtaining a position for the measured depth.



3. However, recognizing the need for high-resolution data for safe navigation and effective berth management, the team embarked on this ambitious endeavor. The integration of a Total Station for positioning, a technology commonly employed in land surveying, with a singlebeam Echosounder for depth acquisition, presented a unique and potentially highly efficient solution.

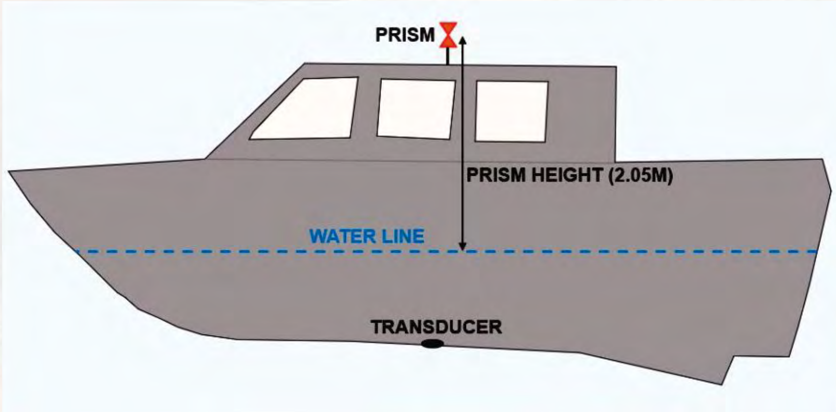
<u>The Methodology: A Synergy of Precision</u>.

4. The survey methodology involved a meticulous and well-coordinated effort. Control points for the total station were established by using RTK method near the sheltered space and were extended to the berth area using Known Backsight method.

5. The prism was mounted directly on top of the transducer and the vertical offset of the prism from waterline was fed in the total station thus avoiding horizontal position shifts. The Total Station, strategically positioned on stable control points around the sheltered berth, provided real-time, high-accuracy horizontal positioning (x, y) of the survey vessel.

6. This instrument's ability to precisely track the vessel's movement ensured that each depth measurement acquired by the singlebeam

Echosounder could be accurately georeferenced. The total station was used in single (fast) mode enabling us to take one measurement every second.The SMB was allowed to stream on line with both engines to achieve the minimum possible speed and occasional engine pushes were used for keeping the ahead movement and for maintaining on transit. The shore team and vessel team maintained uninterrupted communication and fixes were taken at every 3 seconds for easy integration of data from both sources. The synchronized data streams from the Total Station and the Echosounder were then processed.



Challenges and Innovations.

7. Undertaking a "first-time" activity naturally presented its own set of challenges. The team had to navigate the intricacies of integrating two distinct technologies, ensuring seamless data acquisition and processing. This involved:-

(a) Developing a robust communication protocol between the Total Station operator and the Echosounder acquisition system.

(b) Establishing an efficient workflow for data synchronization and quality control.

(c) Maneuvering the Vessel inside the restricted area and adjusting the prism to face the total station when the vessel is close for continuous target lock.

8. **Preliminary Findings and Future Implications**. The post processing results indicated the successful acquisition of high-resolution bathymetric data for the sheltered berth. This method was successfully able to find a 0.5 m feature resulting in a 7.8 m depth inside the basin where the least maintained depth is supposed to be 8 m. This feature was missed during spot sounding by the contractor but was ensonified by the echosounder with ample digital trace records to prove its existence.

9. In comparison to the traditional spot sounding method where the accuracy of measurement can only be claimed to be sub metric considering the factors affecting the measurements. The innovative approach of integrating two independent equipment has helped us achieve sub centimetric accuracy for both depth and positioning. This detailed information will be invaluable for:-

(a) Ensuring safe navigation for vessels utilizing the berth.

(b) Optimizing dredging operations and berth maintenance planning.

(c) Understanding sediment accumulation patterns and their impact on berth depth.

(d) Providing a baseline dataset for future monitoring and change detection.

10. The experience gained and the methodologies developed during this survey will undoubtedly be valuable for future hydrographic operations within the department and potentially for other organizations facing similar survey challenges in sheltered waters.

Commander K Victor Paul was commissioned in July 2006 and presently serving as Officer- in- Charge of Hydrographic Survey Unit, Karwar. The Officer is a qualified 'Charge surveyor' with IHO FIG Category 'A' Qualification from National Institute of Hydrography, Goa. The Officer has carried out various appointments onboard the Survey ships and posted in NHO as CDR (H) MSIS/ PUBL.

Breaking New Ground: Drone Based Shallow Inland Water Hydrographic Surveys

Introduction.

1. The rapid evolution of UAV technology has transformed industries ranging from agriculture to disaster management. Among its most impactful applications are terrain mapping and hydrographic surveying - fields critical to understanding the Earth's surface and underwater environments. Drones, or Unmanned Aerial Vehicles (UAVs), equipped with advanced sensors and imaging systems, have become indispensable tools for collecting high-resolution data quickly, safely, and cost-effectively. This article explores how drone technology is revolutionizing terrain mapping and hydrographic surveying, its key advantages, current limitations, and the promising future it holds.

2. **Foundations of Terrain Mapping and Hydrographic Surveying**. Terrainmapping involves creating detailed representations of land surfaces, capturing elevation, contours, and features like hills, valleys, and vegetation. Traditionally, this was done through ground-based surveys using theodolites and total stations or by ariel photography/radar techniques using manned aircrafts. These methods, while effective, were time-consuming, expensive, and often impractical in remote or hazardous areas. Hydrographic surveying, on the other hand, focuses on mapping underwater environments, such as seabed, riverbeds, and lake floors. It is essential for navigation, infrastructure development (e.g., ports and dams), and environmental monitoring. Historically, hydrographic surveys relied on ships equipped with single beam and multibeam bathymetry tools. These approaches were limited by accessibility, weather conditions, and high cost of deployment. However, in the recent times, the advent of drone technology has bridged these gaps, offering a versatile platform that combines aerial and aquatic capabilities with cutting-edge sensors. By integrating tools like LiDAR (Light Detection and Ranging), photogrammetry and multispectral imaging, drones are redefining how we map and understand both terrestrial and aquatic landscapes.

Drone based Applications in Terrain Mapping And Hydrographic Surveying.

3. Drones have become a game-changer in terrain mapping due to their ability to cover large areas quickly and produce high-resolution 3D models. Modern drones used in terrain mapping are equipped with LiDAR systems, high-resolution cameras, and GPS units. LiDAR equipped drones can efficiently create detailed point clouds that represent the terrain's surface. Photogrammetry, an alternative method, uses overlapping aerial photographs to reconstruct 3D models. Both approaches can achieve centimeter-level accuracy, far surpassing traditional methods in speed and detail. While drone technology has a myriad of use cases in terrain mapping such as urban planning, construction, agriculture and disaster management, it extends a variety of applications in the field of hydrographic surveying as well. Various applications of drone technology in Hydrographic Surveying are enumerated below :-

(a) **Bathymetric Charting**. Accurate bathymetric maps ensure safe maritime navigation by identifying underwater hazards and mapping the sea bottom.

(b) **Infrastructure Development**. Ports, bridges, and offshore wind farms rely on hydrographic data for design and construction.

(c) **Environmental Monitoring**. UAV based sonar systems track sediment movement, monitor coral reefs, and assess the impact of climate change on coastal ecosystems.

(d) **Search Operations**. Drones can aid underwater search operations in close grid searches over known wreck sites in shallow waters and precisely locate underwater objects

4. **Advantages Over Traditional Methods**. Traditional hydrographic surveys require large vessels, specialized crews, and favorable weather conditions. Drones, by contrast, are compact, deployable from shore, and less affected by surface conditions. They also excel in shallow or confined waters where boats cannot navigate, such as narrow rivers or mangrove swamps. Aerial drones equipped with lightweight sonar systems or bathymetric LiDAR can survey shallow water coastal zones, rivers, and lakes where traditional vessels struggle to operate. In deeper waters, hybrid drone technology comes into play. Autonomous Surface Vehicles (ASVs) - essentially aquatic drones - carry multibeam sonar and side-scan sonar to map seabed with high precision. These ASVs can operate independently or in tandem with aerial drones, creating seamless land-to-water datasets.

5. **Technological Advancements Driving Drone Capabilities**. The success of drones in terrain mapping and hydrographic surveying hinges on several technological breakthroughs :-

(a) **Sensor Miniaturisation**. Advances in miniaturization have made it possible to mount powerful tools like LiDAR, sonar, and multispectral cameras on small drones. These lightweight sensors maintain high accuracy while allowing drones to fly longer and cover more ground.

(b) **Battery Life and Propulsion**. Improved battery technology and hybrid propulsion systems (e.g., solar or hydrogen-powered drones) extend flight times, enabling surveys over vast areas. For aquatic drones, efficient electric motors enhance endurance in challenging currents.

(c) **Artificial Intelligence and Automation**. AI algorithms process raw data from drones, converting point clouds or sonar readings into usable maps. Machine learning also enables autonomous flight paths, obstacle avoidance, and real-time anomaly detection, such as identifying underwater debris or unstable slopes.

(d) **Data Integration and Cloud Computing**. Drones can upload data to cloud platforms where it can be analyzed, shared, and integrated with Geographic Information Systems (GIS). This allows stakeholders—engineers, scientists, or policymakers—to collaborate seamlessly.

Challenges and Limitations.

6. Despite their transformative potential, drones face several hurdles in hydrographic surveying:-

(a) **Regulatory Restrictions**. Stringent regulations on drone operations in different areas of operations including but not limited to altitude limits, no-fly zones, maritime laws and licensing requirements may complicate conduct of drone operations.

(b) **Environmental Constraints**. Strong winds, heavy rain, or dense fog can ground aerial drones, while turbulent waters or murky conditions impair sonar and bathymetric LiDAR performance. Battery life also remains a bottleneck for long-duration missions.

(c) **Accuracy in Complex Environments**. Dense vegetation can obstruct LiDAR pulses in terrain mapping, while underwater currents and thermoclines can distort sonar readings. Calibration and post-processing are often needed to correct these errors.

(d) **Cost of Advanced Systems**. While drones are cheaper than manned aircraft, survey ships and Autonomous underwater systems, high-end niche proprietary models with LiDAR or multibeam sonar can have significantly high cost implication owing to complex maintenance philosophies.

7. **Adaptability of UAV/Drone Technology into INHD**. The Indian Naval Hydrographic Department (INHD) is the nodal agency for Hydrographic surveys and Nautical charting in India functioning under the aegis of National Hydrographic Office, Dehradun. One of the major objectives of the department is to provide hydrographic services to National and International agencies and Public as well as Private sector undertakings. The department also caters to hydrographic requirements of friendly foreign nations in the Indian Ocean Region (IOR). In the recent past, the services of INHD have been requisitioned for high altitude lake surveying to inland waterway surveying. The spectrum of operations has expanded to all sorts of inland surveying requirements while not being limited to conventional marine surveys. In order to keep up with the changing landscape of operations and to stay ahead of the curve in this highly competitive technology-oriented space of hydrographic surveying, it is of vital importance to adapt cutting edge drone technology

into the wherewithal of the department. There exists a variety of drone-based surveying systems in the COTS market with customizable payloads amongst which UAV based Single Beam Echo Sounder (SBES) is an easily employable and adaptive equipment capable enough to meet surveying requirements of detached surveys in shallow waters.

8. **UAV based Single Beam Echosounder, a Force Enabler**. There are multiple kinds of devices utilizing echo sounding principle such as SBES, which may be single-frequency and dual-frequency; Multi Beam Echo Sounders (MBES) and Side Scanning Sonars. All these, except SBES, are usually bulky and not suitable for tethered deployment from UAVs. Additionally, integration of sound velocity and tilt sensors into the SBES payload can improve the accuracy and quality of acquired data. A dual-frequency echo sounder payload can improve the accuracy of surveying by catering for irregular bottom characteristics of survey area; the higher frequency will give measurements till the first surface or obstacle and the lower frequency will pass through seaweeds/vegetation on the bottom, thereby reporting clean readings of the bottom. This method is both time and cost efficient and suitable for mapping, measuring, inspections and environmental monitoring. Various advantages of adopting this equipment are enumerated below:-

(a) **Increased Operational Tempo**. Deployment of UAVs can obviate lead time associated with initial set up and launch, compared to traditional vessel-based surveys.

(b) **Improved Safety**. UAVs can operate in shallow or hazardous waters, reducing the risk of accidents and injuries.

(c) **Cost-Effectiveness**. UAVs are often less expensive to operate than traditional survey vessels, making them a cost-effective solution for hydrographic surveys.

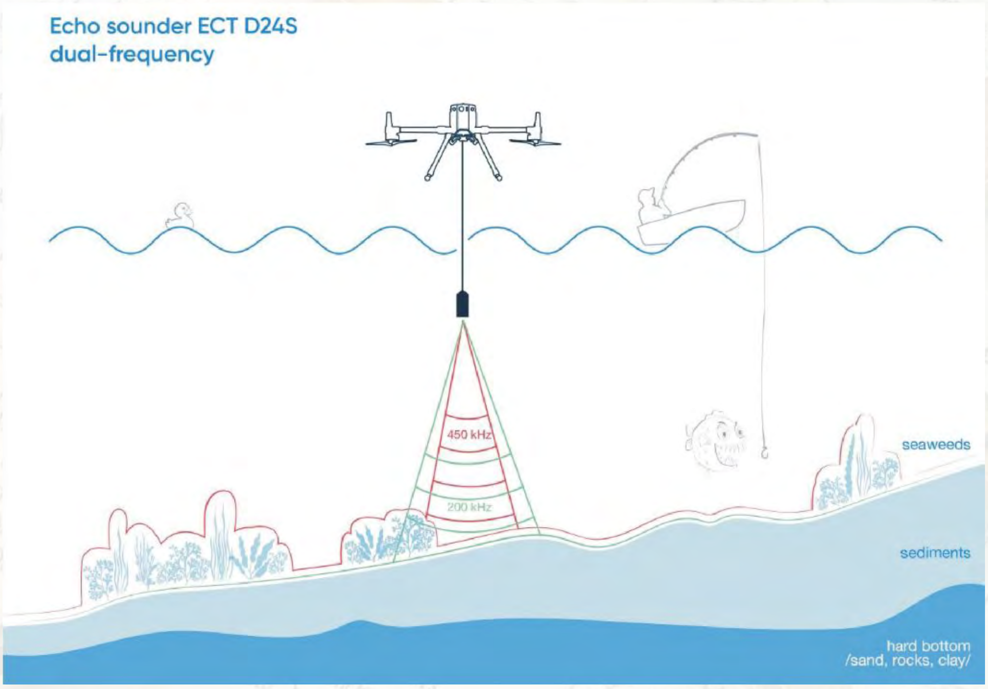
(d) **Real-Time Data**. UAVs can transmit data in real-time, enabling faster decision-making and response times.

(e) **Reduced Environmental Impact**. UAVs produce less noise and disturbance than traditional survey vessels, reducing the environmental impact of hydrographic surveys.

(f) **Flexibility and accessibility**. UAVs can be easily transported and deployed, making them ideal for surveys in remote or hard-to-reach areas. It can be particularly useful in detached surveys.

(g) **High-Resolution Imagery**. UAVs can also be customised to capture high-resolution imagery and video, providing valuable contextual information for hydrographic surveys.

(h) **Integration with Other Sensors**. UAVs can be integrated with other sensors, such as LiDAR, cameras, and multispectral sensors, to provide a more comprehensive understanding of the survey area.



Soure: https://www.sphengineering.com/integrated-systems/technologies/echo-sounder#echo-sounders

<u>Conclusion</u>.

9. Drone technology has ushered in a new era for terrain mapping and hydrographic surveying, blending precision, efficiency, and versatility in ways that were unimaginable just a decade ago. From rugged mountains to ocean depths, drones are unlocking insights that drive innovation across industries. In the backdrop of rapid proliferation of drone technology in the naval air and surface arms, it is imperative that INHD look forward to integrating drone-based solutions onboard its platforms. While challenges like regulation and environmental limitations persist, ongoing advancements in sensors, AI and automation promise to overcome these barriers. Inclusion of Drone based surveying techniques in the Hydrographic Capability Perspective Plan (HCCP) will go a long way in strengthening the stance of INHD as a premier regional Hydrographic service in the IOR and beyond.

Lieutenant Commander Shibin Babu is a Hydrography Specialist from the 90th course of Indian Naval Academy. He has tenanted afloat appointments on IN Ships Investigator and Jamuna in the capacity of Assistant Hydrographic Surveyor. Presently, he is appointed as Senior Hydrographic Surveyor onboard INS Makar.

Hydrographer's Daily Struggles

With Deso, Seabeam and hemisphere bright,
We measure the depths from morning to night.
The sea looks calm, the waves seem shy, Still, Boat ME is looking dizzy, why?

<u>A MILESTONE MET, YET TROUBLE FOUND</u>.
We sailed ahead with charts in hypack, Surveyed the depths and mapped the lands.
120 Nautical miles – what a feat! A record set, a day complete.
Still CO frowns, his glare is cold, The data's wrong, something amiss.
A quiet sigh, a sinking mode… Was all this in **Simulator Mode**?

<u>UNDER THE SUN, YET SHADOW REMAINS</u>.
Under the sun, with sweat on my brow, An Antenna on back, no shelter to allow.
Viva in hand, I marked the line, Fixed the coast – each point each sign.
Conspicuous objects, tall and clear, Plotted with care, no doubt, no fear.
Yet "**Ambiguity not resolved**", the processing guy say,
Though I mapped it right in the light of day.
The weather was clear, the signals strong, So, tell me now – what went wrong?

<u>A GROUNDED TALE</u>.
With tides in mind and depths in site, I steered the boat from dawn to night.
The course was set, the path was clear, No hidden shoals, no cause of fear,
Yet all at once, a sudden sound, A sudden stop, and we ran aground.
So now we wait, no choice but stay, Till, high waters comes and clear the way!

<u>THE ENDLESS SURVEY</u>.
The lines are run, the data's tight, The fairsheet sent, oh what a sight!
A breath is drawn, a moment's rest, At last we're done, we have done our best.

But then suddenly phone begins to ring, A dreaded sound, a piercing sting.
The HDM guy is on the line, His tone is calm, but not benign.
"A quick concern, just one more check" Here it comes, oh what the heck.
A **query** looms, a doubt takes flight, Looks like won't get rest tonight!

KARTIK SAMBYAL
LS (HY)

Hydrography in 21st Century: Innovations and Challenges

"It is not the strongest of the species that survive, nor the most intelligent, but the one most responsive to change"

– Charles Darwin

1. Embracing change is not an option but a necessity. Those who adapted to new technology today will navigate the future with confidence. Hydrography, the science of measuring and describing physical features of bodies of water and their coastal areas, has witnessed remarkable advancements in recent years. These innovations have revolutionised maritime navigation, coastal management, and underwater exploration.

2. The Indian Naval Hydrographic Department (INHD) plays a pivotal role in ensuring maritime safety, national security, and economic growth through precise hydrographic surveys and charting. As the maritime domain evolves with new challenges and opportunities, INHD also requires to upgrade its procedural and technological capabilities to enhance efficiency, accuracy, and effectiveness.

Innovations.

3. With advancements in global maritime operations, hydrography has expanded beyond traditional methods, necessitating the adoption of cutting-edge technologies. The latest advancements in hydrographic surveying are as follows:-

(a) **Multi Beam Echo Sounders – Enhancing Accuracy**. Traditionally, single-beam echo sounders were used for mapping underwater terrains. However, the advent of **Multi Beam Echo Sounders (MBES)** has drastically improved data collection by covering wider swaths of the seabed with greater precision. These systems use multiple acoustic beams to create high-resolution bathymetric maps, reducing gaps in data and increasing survey efficiency.

(b) Modern Multi Beam Echo Sounder (MBES) systems are now equipped with backscatter analysis, providing valuable insights into seabed composition. This advancement plays a crucial role in marine habitat mapping and sediment classification, aiding resource management and environmental conservation. To enhance deep-sea survey capabilities, all upcoming survey vessels are being fitted with state-of-the-art MBES systems, capable of operating at depths of up to 11,000 meters.

(c) Like all electronic equipment, MBES systems have a finite operational lifespan and require periodic upgrades. Few older survey vessels are still operating outdated MBES units, whose performance has significantly declined due to limited availability of spare parts and technological obsolescence. Given the rapid advancements in hydrographic survey technology, it is imperative to upgrade these systems at regular intervals to maintain operational efficiency and ensure precise data collection. Proactive modernization of MBES will enhance survey accuracy, optimize maritime operations, and ensure that INHD remains at the forefront of hydrographic excellence.

(d) **Airborne LiDAR Bathymetry: Revolutionizing Shallow Water Surveys**. Airborne **Light Detection and Ranging (LiDAR)** technology has become a game changer for surveying shallow waters and coastal regions. Unlike traditional vessel based surveys, Airborne LiDAR Bathymetry (ALB) uses laser pulses to penetrate water bodies and measure seafloor depth. The ability to cover vast areas quickly makes ALB particularly useful for coastal zone management, disaster response, and habitat monitoring. Recent advancements in ALB have increased depth penetration, allowing for more comprehensive shallow-water mapping.

(e) **Autonomous and Unmanned Survey Systems**. The use of Autonomous Underwater Vehicles (AUVs) and Unmanned Surface Vehicles (USVs) has significantly transformed hydrographic surveying by enhancing efficiency and reducing operational costs. These robotic systems can conduct long duration surveys in challenging environments without the need for direct human intervention. Equipped with high resolution sensors, AUVs and USVs provide realtime data transmission and improved survey coverage. Their ability to operate in hazardous zones or in extreme weather conditions, makes them indispensable tools for modern hydrography.

(f) **Satellite Derived Bathymetry: A Cost-Effective Alternative**. Satellite Derived Bathymetry (SDB) is emerging as a valuable alternative for hydrographic surveying, especially in remote and inaccessible regions. By using satellite imagery and algorithms to estimate water depth, SDB provides a cost-effective and rapid method for preliminary seabed mapping. While it lacks the precision of traditional surveys, it serves as an excellent tool for reconnaissance surveys, navigational updates and monitoring coastal changes over time.

4. **Artificial Intelligence in Hydrography**. As AI technology continues to evolve, its integration into hydrography will lead to smarter, faster, and more efficient maritime survey operations. Traditional hydrographic surveys involve processing vast amounts of sonar, satellite, and sensor data, which is time consuming and prone to human error. AI powered algorithms will streamline this process by automating data interpretation, reducing manual workload, and increasing precision. Machine learning models can identify seabed features, classify sediments, and predict underwater terrain patterns with remarkable accuracy, making hydrographic surveys more reliable and efficient.

5. **Real-Time Data Transmission and Cloud-Based Hydrography**. With the advent of real-time data transmission technologies, hydrographic survey data can now be processed and shared instantly via cloud-based platforms. This advancement allows for remote monitoring and collaborative analysis among maritime agencies, researchers, and naval forces. The ability to access and analyse hydrographic data in real-time enhances decision making for navigation safety, disaster response, and marine resource management.

Challenges.

6. Before charting the course for the future, it is crucial to address existing challenges while simultaneously preparing for emerging ones. Ignoring these current obstacles can hinder progress and make future advancements more difficult to implement. Some of the major challenges are as follows:-

(a) **Maintenance of Equipment**. Maintenance of survey equipment remains a significant challenge, primarily due to the lack of a dedicated training school for equipment maintainers. Sailors learn basic maintenance,while working on the equipment at field. This reactive approach leads to inefficiencies, increased downtime, and dependency on external agencies for repairs and overhauls.

(b) To address this issue, there is a pressing need to integrate with **INS Valsura** to produce a specialised pool of officers (electrical officers) and sailors (EAP/EAR) with vertical expertise in equipment upkeep. By establishing a structured training program, electrical officers and sailors can gain in depth knowledge of troubleshooting, preventive maintenance, and advanced repair techniques before being deployed onboard ships.This initiative would not only enhance self-reliance but also create an in-house cadre of skilled maintainers, ensuring the longevity and optimal performance of survey equipment. A well trained maintenance workforce will contribute to operational efficiency, reduce costs, and ensure uninterrupted hydrographic operations.

(c) **Training**. For every new equipment being procured, an additional two units should be provisioned - one for the NIH (training operators) and another for INS Valsura(training maintainers). It will ensure personals receive hands-on experience in handling, troubleshooting, and maintaining the equipment before being deployed onboard ships.

(d) Dedicated training units will enhance skill development, reduce on-the-job learning time, and improve overall equipment longevity. By integrating this approach, operators and maintainers will be better prepared, minimising downtime and dependency on external agencies. This proactive measure will strengthen self-reliance and operational readiness across all domains.

(e) **Human Resource Management**. Human resource management is a critical challenge, especially given that ships serve as the workhorses of operations, it requires adequate and well trained personnel at all times. Over the past few years, there has been a noticeable rise in the number of officers and sailors placed under low medical categories (LMC), impacting overall manpower availability onboard ships. At times, the situation becomes so critical that ships lack the minimum required manpower to ensure safe watch keeping at sea or harbour.

(f) To ensure optimal manning and operational efficiency, it is essential to implement measures that keep personnel motivated, physically fit, and mentally resilient. Regular skill development initiatives, and career progression opportunities can enhance morale and retention. Additionally, improving onboard living conditions, fostering a supportive work environment, and recognizing individual contributions can significantly boost motivation, ensuring that crew members remain committed to their duties while maintaining high levels of operational readiness.

Conclusion.

7. In the 21st century, hydrography is undergoing a transformative shift, driven by rapid technological advancements and evolving maritime challenges. The integration of cutting edge survey techniques, digital mapping, and AI-driven analytics has redefined the accuracy and efficiency of hydrographic operations. Indian Naval Hydrographic Department (INHD), with its commitment to modernisation, is not only safeguarding national security but also contributing to India's maritime economy by facilitating seamless trade, port development, and marine resource management.

8. However, with innovation comes the challenge of adapting to new technologies, maintaining operational efficiency and addressing existing/ emerging threats. INHD must continue to evolve by investing in skill development, infrastructure enhancement and international collaborations to stay at the forefront of global hydrographic practices. By fostering a culture of continuous learning and strategic foresight, the department can effectively navigate future challenges and strengthen India's position as a leading maritime power.

Lt Cdr Bipin Bhatt is from 16th NOC(Ext) course of the Indian Naval Academy. The officer has served as Navigating Officer onboard INS Karuva, INS Nirupak and INS Makar. Post completion of Long Hydrography course, officer has served onboard INS Investigator as Senior Hydrographic Officer. Presently, officer is borne onboard INS Nirdeshak as commissioning crew and serving as Senior Hydrographic Officer.

CDR RATHEESH R

Hydrography - Underpinning the Blue Economy

Introduction.

1. Hydrography is the branch of applied science which deals with the measurement and description of the physical features of oceans, seas, coastal areas, lakes and rivers, as well as with the prediction of their change over time for the primary purpose of safety of navigation and support of all other marine activities. Hydrography has a significant impact on the Blue Economy. The Blue Economy encompasses the sustainable use of ocean resources for economic growthy. It promotes conservation while fostering innovation in maritime industries. By leveraging marine resources responsibly, nations can address socio-economic challenges and environmental concerns simultaneously. This is reflected in the Sustainable Development Goal (SDG 14) which calls for conserving and using the oceans, seas and marine resources for sustainable development. In addition to maritime safety, Hydrography gives sustenance to the Blue Economy, involving the activities such asenergy, maritime transport, telecommunications, tourism, fishing, meteorology etc.

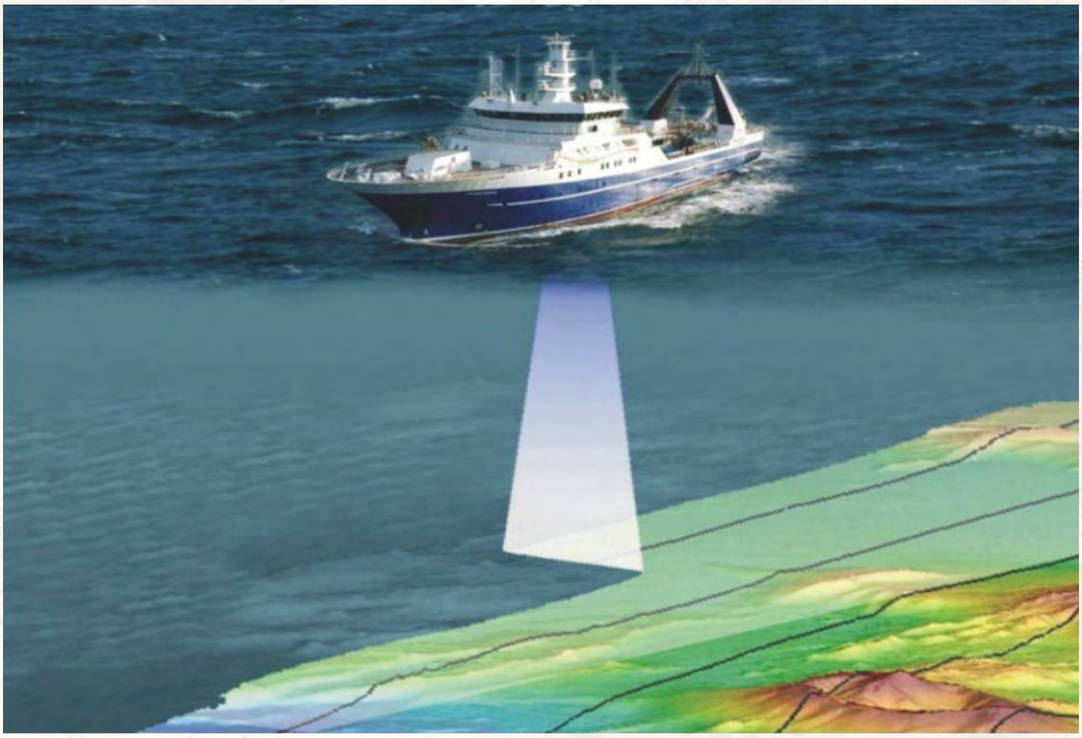


Fig.1 - Blue Economy in India.

2. Blue economy focuses on livelihood generation, achieving energy security, building ecological resilience and improving coastal communities' health and living standards.

(a) The blue economy would reinforce the Indian Government's efforts to achieve the SDGs of hunger and poverty eradication and sustainable use of marine resources by 2030.

(b) India has11,098 kmlong coastline covering nine states and two union territories and an Exclusive Economic Zone (EEZ) of 200 nm. The marine services sector could serve as the backbone of India's blue economy.

(c) The Indian Ocean is a significant conduit of trade with as much as 80% of global oil trade occurring in it. Better regional connectivity will significantly cut transport costs and maritime resource wastage, making trade sustainable and cost-effective.

"India's Blue Economy" – A Draft Policy Frame Work.

3. The Ministry of Earth Sciences (MoES) has rolled out the draft blue economy policy for India in the public domain inviting suggestions and inputs from various stakeholders including NGOs, academia and citizens. The draft blue economy policy document outlines the vision and strategy that can be adopted by the Government of India to utilise the plethora of oceanic resources available in the country. The policy emphasis the holistic growth of India's economy which is in consonance with the Government of India vision of New India by 2030. The document recognizes the following seven thematic areas:-

(a) National accounting framework for the blue economy and ocean governance.

(b) Coastal marine spatial planning and tourism.

(c) Marine fisheries, aquaculture and fish processing.

(d) Manufacturing, emerging industries, trade, technology, services and skill development.

(e) Logistics, infrastructure and shipping including trans-shipments.

(f) Coastal and deep-sea mining and offshore energy.

(g) Security, strategic dimensions and international engagement.

Dependency on Hydrography.

4. Blue Economy depends on Hydrography in various aspects. Some of the examples are illustrated below:-

(a) **Marine Resource Management**. Hydrography plays a crucial role in the sustainable management of marine resources like fisheries and aquaculture. It helps to identify the bathymetry and oceanographic conditions which is vital for optimalfishing grounds and aquaculture sites by ensuring sustainable exploitation of marine resources. Hydrographic conditions such as water temperature, salinity and currents influence marine biodiversity and fish migration patterns. Understanding these factors through hydrography can improve the management of fisheries, ensuring sustainable harvests and better yields for the fishing industries which is a key part of blue economy.

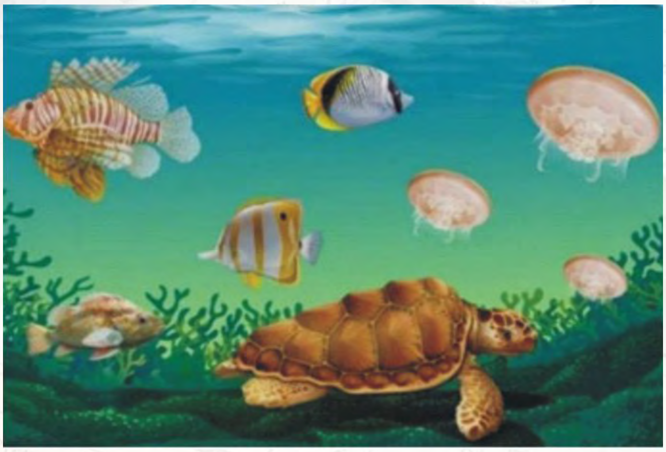


Fig.2 - Marine BiodiversityManagement

Fig.3 - Conservation of Environment

(b) **Environmental Conservation**. Hydrographic data assists in monitoring the environmental changes such as sea level rise, coastal erosion and habitat degradation. By identifying the areas at risk, hydrography supports the management of Marine Protected Areas (MPAs) and conservation efforts helping balance economic activities with environmental protection.

(c) **Climate Change Adaptation**. Hydrography is integral in understanding the impact of climate change on marine and coastal systems. It provides insights into shifting currents, ocean temperatures and sea level which can influence the management of fisheries, infrastructure and coastal communities ensuring the long-term sustainability of blue economy sectors.

Fig.4 - Impact of Climate change

Fig.5 - Generation of Wind Energy

(d) **Marine Renewable Energy**. Hydrographic data is vital for the development of marine renewable energy resources such as tidal and wave energy. Understanding the ocean currents, wave heights and other water conditions helps in selecting optimal sites for energy generation, ensuring the viability and sustainability of these green energy sources.

(e) **Coastal and Marine Infrastructure**. Hydrography informs the design and construction of infrastructure like ports, harbours and offshore energy platforms. The Sagarmala project is a strategic initiative for port-led development which involves extensive use of IT-enabled services to modernize ports. Knowledge of tide patterns, wave heights and seabed conditions ensure that these projects are built in suitable locations and can withstand environmental challenges by supporting the blue economy's development. It also aids in flood risk management by providing information about the tidal patterns and sea level rise.

Fig.6 -Development of Ports and Infrastructure

Fig.7 - Marine Transportation

(f) **Marine Navigation and Transport**. Accurate Hydrographic data, such as bathymetry and seabed mapping are essential for safe and efficient navigation. It helps to identify navigable routes by avoiding hazards like underwater rocks and reefs which is vital for the shipping and logistics industries that drive international trade. It boosts trade and economic activities that rely on maritime transport. Efficient shipping reduces costs and improves global supply chains, benefiting the blue economy.

(g) **Tourism Development**. Marine tourism including activities such as scuba diving, snorkeling and recreational boating is significantly influenced by the hydrographic conditions. The beauty of coral reefs clear waters and accessible coastlines, all depend on the hydrographic factors. The coastal and marine tourism depends on safe and accessible waterways, beaches and ecosystems. Hydrographic data ensures that tourist routes are safe and helps in sustainable tourism strategies, protecting coral reefs, beaches and underwater cultural heritage.

Fig.8 - Sustainable Tourism Development

Fig.9 - Production of Oil and Natural Gas

(h) **Offshore Energy**. Hydrographic data is important for offshore energy production such as oil, natural gas etc. These data are used to determine the best locations for energy infrastructure, evaluate environmental impacts and ensure the safety of installations of oil rigs.

(j) **Marine Spatial Planning**. Hydrographic surveys provide data for sustainable management of ocean resources, helping to allocate space for various blue economy activities like fishing, tourism, renewable energy and conservation efforts.

6. **Underwater Infrastructure, the foundation of Blue Economy**.

(a) **Submarine Telecommunication Cables**. 99% of the world's intercontinental internet traffic depends on undersea fiber-optic cables supported by major technology companies like Meta, Google and Microsoft.These undersea cables are vital enablers for business activities.

(b) **Subsea Electricity Interconnectors**. Underwater cables connect offshore wind turbines and onshore electrical grids, enabling the growth of the renewable energy sector.

(c) **Subsea Mining Equipment**. Specialised pipes, pumps and other machinery enable the extraction of resources from the seabed, unlocking new economic avenues.

(d) **Subsea Pipelines**. Underwater pipelines play a crucial role in meeting the world's energy demands by transporting trillions of cubic meters of natural gas and oil every year.

7. **Statistics of Subsea Cables and Interconnectors**.

(a) The global submarine cable network stretches over 1.3 million kilometers and supports over USD 10 trillion in economic activity annually.[1]

(b) Across 66 developed countries, a 10% rise in broadband penetration could lift Gross Domestic Product (GDP) growth rates by 1.2 percentage points.[2]

(c) The market for submarine power cables is expected to grow to USD 32.9 billion by 2032, driven by the need for efficient power transmission from renewable sources like offshore wind farms.[3]

(d) The SEA-ME-WE 3 cable is currently the longest submarine fiber-optic cable in operation, spanning 24,233 miles connecting Europe, the Middle East and India.[4]

8. Hydrographysupports the blue economy by providing crucial data and understanding of coastal and marine environment. Hydrography underpins blue economy unswervingly as well as circuitously in various sectors:-

[1] Submarine Cables- The National Bureau of Asian Research, accessed 10 Sep 24.
[2] Minges and Michael – "Exploring the relationship between Broadband and Economic Growth", World Bank.
[3] Subsea power Cables: The Future of Global energy Transport. Markets Insider, 28 Dec 23.
[4] SEA-ME-WE 3, Submarine Cable Networks, accessed on 10 Sep 24.

HYDROGRAPHY

Directly

- Navigation and Safety
- Resource Management
- Sustainable Development
- Offshore Renewable Energy
- Aquaculture and Fisheries
- Marine Transportation
- Telecommunication
- Laying of Underwater Pipelines and Cables

Indirectly

- Coastal Protection
- Capacity Building
- National Sovereignty and Defense
- Foundation and Understanding Management
- Environment Protection and Climate Adaptation
- Marine Infrastructure

9. Around the world, governments are taking steps to boost the resilience of blue economy infrastructure through policy, legislation and granting new powers to critical entities.

<u>Conclusion</u>.

10. Hydrography is fundamental for optimizing the sustainable use of marine and fresh water resources, driving sectors like shipping, tourism, fisheries and renewable energy which are key to the success of the blue economy. Precise hydrographic data underpins environmental sustainability while supporting economic growth. Hence, Hydrography plays a vital role in the economic growth as well as maritime security aspects in a deliberated manner.

Shukadev Jena is a PO 'Q' (HY) qualified from National Institute of Hydrography and holds Diploma in Hydrographic Survey from CUSAT University. He has served onboard various ships namely erstwhile Sandhayak and Nirupak. Presently, he is serving onboard INS Makar.

Keepers of The Deep

Where sunbeams fade and silence flows, They go where no land-dweller knows.

With charts in hand and eyes a glow, They map the blue from crest to below.

The Echo Sounder hums its tune, Measuring depths from dawn to noon.

“Tell us your truth, O silent sea” and back it pings, precisely, free.

Side Scan Sonar paints the floor, Like ocean’s art on nature’s door.

ADCP rides the current’s flow, Decoding secrets from below.

With 2DACM and leveling gear, They measure each rise, each dip sincere.

The DNA03 knows every bend, Each coastal curve, each river’s end.

Survey Motor Boats glide with flair, Swift like dolphins, cutting air.

Their ECDIS screens shine bold and bright, Plotting safe paths through day and night.

RADAR spins its tireless arc, A lighthouse eye in weather dark.

"How deep today?" it kindly asks, While AquaDopp performs its tasks.

From Dehradun to distant shores, Their mission sails through open doors.

Mauritius, Maldives, and Lanka too, They share the science of the blue.

No trumpets sound, no spotlights gleam, Yet every sailor knows their dream.

For every port and every bay, They've lit the paths where anchors lay.

Guardians of waters vast and wide, Through silent depths, they turn the tide.

With every chart, they light the way, For ships to sail both night and day.

So here’s to those who chart the tide, Who let no secret sea things hide.

With tech and grit, they claim the map, while others nap — they bridge the gap.

Beneath the waves, where secrets sleep,
They scan the blue, the depths they keep.
With sonar’s song and echoes bright,
They turn the dark into guiding light.
Through shifting tides and waters vast,
They chart the future, honor the past.
With steady hands and vision wide,
They carve the paths where ships will glide.
The sea may rage, the storm may call,
Yet they stand firm and map it all.
A legacy in waters spun,
Their work endures with rising sun.

KARAN PRAJAPATI
LS (HY)

Experience Sharing

Representation at the Hydrographic Services and Standards Committee : An Invaluable Experience

Coming together is a beginning; Keeping together is progress; Working together is Success.

-Henry Ford

Introduction.

1. The opportunity to represent an International Committee constitutes a significant professional engagement and is a matter of pride. In January 2024, the Naval Headquarters selected the author as the representative of the Indian Naval Hydrographic Department to the Hydrographic Services and Standards Committee for a three-year term. Subsequently the author participated in the 16th meeting of the HSSC convened in Tokyo, Japan from 27 to 31 May 24. This article presents a comprehensive account of the Committee's activities and key aspects of the aforementioned meeting, including pertinent discussions and the author's recommendations.

2. The Hydrographic Services and Standards Committee (HSSC) operates as a technical steering group under the framework of the International Hydrographic Organisation (IHO). Its core mandate encompasses the promotion and coordination of the development of hydrographic standards, specifications and guidelines to all official products and services intended to meet the diverse requirements of mariners and other users of hydrographic information. The HSSC reports its proceedings to the IHO Council, which in turn informs the IHO Assembly, representing the collective interests of the member states. Key responsibilities of the HSSC include: -

(a) Focusing on the implementation of the strategic direction of developing, improving, promulgating and promoting uniform, global hydrographic standards to enhance safety of navigation at sea, protection of marine environment and economic development.

(b) Monitor the work of specified IHO Inter-organisational bodies involved in hydrographic services, standards and associated technical activities as directed by the IHO Assembly providing guidance to the IHO Member states, as necessitated.

(c) Maintain technical liaison with all relevant stakeholders, such as type approval authorities, navigation equipment manufactures and the hydrographic data user community.

(d) In close association with the Working Groups, study, review and propose methods and standards for acquisition, assessment and provision of official hydrographic data, nautical products and related services.

(e) Prepare and monitor the Committee Work Programme (CWP) in support of the IHO Work Programme 2 (Hydrographic Standards and Services) and also consider, decide upon proposals for new work items under the CWP, including the financial, administrative and wider stakeholder consequences including the IHO Strategic Plan, ensuring report to each meeting of the Council.

(f) Liaise regularly with relevant IHO and other bodies, to ensure that the IHO work activities are coordinated with other International Organisations and Non-Government International Organisations.

3. The 16th meeting of the HSSC convened in Tokyo, Japan, was hosted by the Japan Hydrographic and Oceanographic Department. The meeting brought together representatives from numerous member states, industry professionals, technical laboratories and stakeholders involved in hydrographic services and standards. The meeting commenced with the opening address by the HSSC Chair, who highlighted the significance of the HSSC charter in development and promulgation of hydrographic standards and services aimed at enhancing safety of navigation at sea and fostering economic development. Vice Admiral (Dr.) Fujita Masayuki, Chief Hydrographer of Japan, then delivered the welcome address, emphasising the significance of the committee and wishing all participants successful deliberations and tangible decisions.

4. The Chairpersons of the various HSSC Working Groups presented their reports to the members, which were followed by discussions and the subsequent decisions of the HSSC Chair. A list of the HSSC Working groups present are as appended below:-

(a) S 100 Working Group

(b) S-100 Infrastructure Center Establishment Project Team (ICEPT)

(c) Electronic Navigational Chart Standards Working Group (ENCWG)

(d) Nautical Information Provision Working Group (NIPWG)

(e) Nautical Cartography Working Group (NCWG)

(f) Data Quality Working Group (DQWG)

(g) Hydrographic Survey Working Group (HSWG)

(h) Hydrographic Dictionary Working Group (HDWG)

(j) Tide Water and Surface Current Working Group (TWCWG)

5. Subsequently, the HSSC members reviewed the progression of the governance document supporting the Dual Fuel Concept for S-100 ECDIS implementation, wherein the necessity of using S-101 ENCs in parallel with S-57 ENCs especially during the transition phase was deliberated. The HSSC noted the six IHO - Singapore Lab projects, namely S-57 to S-101 Conversion Guidance, S-131, a testbed ECDIS capable of displaying S-102 and S-104 data over S-101, IHO-IALA S-124/S-125 interoperability with S-101, availability of S-57 and S-101 along major shipping routes and integration of sea and land datum for monitoring possible sea level rise. The IHO - Singapore Lab representative also apprised the members of the around the world passage of the Italian Naval vessel 'Vespucci' and the availability of an ECS capable of testing dual fuel concept data sets on it. The voyage route and the Port of calls of the vessel were highlighted, the vessel was planned to dock at Mumbai from 28 Nov to 02 Dec 24.

6. The HSSC Chairperson briefed the members of the themes identified during the session and invited member states to select three strategic plans from the list derived during the brainstorming towards reporting the same to the IHO Council, for consideration in the revised strategic performance indicators. Industry representatives from CRIM, PRIMAR and KRISO delivered presentations, wherein each firm highlighted their ongoing activities and progress made in support of the S-100 roadmap including developing systems for S-100 type approved services. They reiterated the need to ensure that the product specifications were frozen, to enable focussed attention for timely availability of type-approved systems for trials and subsequent implementation by the maritime community. The meeting concluded with the closing remarks from the Chairperson, who summarised the key aspects deliberated and the decisions reached, and expressed gratitude to all participants for their active participation during the deliberations.

7. The HSSC has been pursuing a significant quantum of work, effectively supported by its associated working groups. In light of the evolving standards and specifications, it is imperative to continuously correlate and monitor them to ensure that the National Hydrographic Office in India, are aligned and promptly adopt the revised IHO standards promulgated. The following points are recommended for being pursued by INHD:-

(a) Sustain the momentum towards preparation of dual fuel (S 57 and S 101 ENCs) for early adoption and trials within the specified timeframes during the transition phase.

(b) Adopt the latest product specifications and streamline the processes towards production of S-101 ENCs by early 2025.

(c) Envision and plan the cessation of S-57 production and establish timelines for the phasing out of paper charts following the implementation of the S-100 products.

(d) Foster interaction with DG Shipping, DGLL, INCOIS, NODPAC and IWAI to facilitate synergy and the realization of various S-100 products and services as envisaged.

(e) Adapt to the Cyber security guidance document and ensure its effective implementation.

(f) Ensure post-approval, the implementation of S-44 Ver 6.2, Standards for Hydrographic Surveying.

(g) Consider the feasibility of participating in and sharing relevant dual cell data for utilization on the non-type approved ECDIS onboard the Italian Navy Ship Vespucci, which was on a global voyage and scheduled to visit Mumbai from 28 Nov to 02 Dec 24.

(h) Explore the potential of using the test bed areas including those facilitated by Canada in St Lawrence River, through data sharing or using appropriate simulators to test and validate the S-100 data sets being pursued by INHD.

(j) Actively engage in and attend the IBSC workshops to gain understanding of the processes concerning IHO/IBSC submission towards certification, particularly in anticipation of the forthcoming Recertification of courses at the National Institute of Hydrography.

(k) Consider formation of a National regulatory body with all stakeholders from relevant marine fields, as prevalent in few countries towards effective implementation of the S-100 products and associated services.

(l) Proactively support and provide timely inputs to all the HSSC Working groups and endorse India's stand as and when sought, through IHO circular letters for implementation.

(m) Continue interacting with other Regional Hydrographic Offices, RENCs and VARs regularly to address regional challenges and promote effective hydrographic services towards ensuring that India's interest in Area of responsibility is safeguarded.

Conclusion.

8. The HSSC meeting served as a significant platform for in-depth deliberation on critical issues and for advancing towards decisions aimed at the enhancement of hydrographic services and standards. To ensure continued cooperation and coordination among member states, industry stakeholders, and relevant organisations, and to proactively and effectively address emerging challenges, a comprehensive meeting report has been prepared and disseminated to the National Hydrographic Office. The report would serve as a formal record of deliberations, decisions and key initiatives undertaken during the meeting, which are expected to contribute to ongoing efforts focussed on the efficient management of vital hydrographic information. Ultimately, these endeavors are directed towards enhancing safety at sea and promoting sustainable objectives for maritime and overall national development.

Commodore Sajeev K Nair was commissioned in the Navy on 01 Jan 1993. He is an alumnus of Naval War College, Goa, Defence Services Staff College, Wellington and holds a Master in Hydrographic Surveying from Goa University. He has commanded IN Surveying Ships Nirdeshak and Jamuna and carried out hydrographic surveys in both national and foreign waters. The Officer is presently the Officer-in-Charge at the National Institute of Hydrography.

Myanmar: A Hydrographers' Perspective

1. Myanmar, also known as the Land of Golden Pagodas, captivated me the moment we began our journey along the Irrawaddy River in March 2019. Nestled between two giant neighbours India and China this resource-rich country was in the throes of a remarkable transformation. A communication revolution was underway, alongside the rise of glittering shopping malls, the arrival of international fast-food chains and rapid infrastructure development. It felt reminiscent of India's economic liberalization in the early 1990s.

2. My journey to this fascinating country was onboard a hydrographic survey ship as part of a joint hydrographic cooperation between India and Myanmar, an area of strategic and technical partnership that continues to grow stronger. India has played a key role in supporting Myanmar through joint hydrographic surveys, charting its coastal waters and building capacity in maritime safety and navigation. It was during breaks between these intensive survey missions that I had the opportunity to experience the soul of Myanmar beyond its waters.

3. The streets of Yangon (formerly Rangoon) were alive with contrasts. The earthy scent of green tea and the aroma of organic rice mingled in the air, while men and women clad in Longyi (lungi) sporting Thanaka on their cheeks (an organic sunscreen paste made from Thanaka tree bark) moved through the bustling streets. Buddhist monks in pale saffron robes walked calmly past busy fruit markets and charming bookshops tucked into every corner, all creating a cityscape that straddled the old and the new.

4. Yangon's architecture reflected this duality, colonial-era British Gothic structures stood beside modern buildings, wide boulevards met at elegant fountains and history whispered from every stone. My first destination was the iconic Shwedagon Pagoda, perched atop Singuttara Hill. Said to house relics of Gautama Buddha within its sacred chamber, the temple shimmered in golden splendour, surrounded by captivating local legends and folklore.

5. Next, I visited a site steeped in poignant history the quiet tomb of the last Mughal emperor of India, Bahadur Shah Zafar. Exiled by the British, he spent his final days in Yangon and today his modest mausoleum stands as a solemn reminder of India's colonial past. In a twist of shared history, Myanmar's last king, Thibaw, also died in exile this time in Ratnagiri, India, another casualty of British imperialism.

6. I also paid my respects at the Taukkyan War Cemetery, where the names of hundreds of Indian soldiers who fought and fell during the British Burma Campaigns in the World Wars are etched in stone, a moving tribute to forgotten heroes.

7. A brief but memorable visit to Nay Pyi Taw, Myanmar's capital city by a short flight, left me in awe watching the beauty of the country side. With its meticulously planned layout and grand avenues, it reminded me of Lutyens' Delhi. Though time was limited and my visit mostly confined to a windshield tour, I managed to explore the impressive National Museum and the majestic Uppatasanti Pagoda, home to the revered Royal White Elephants. These elephants are believed to symbolize peace, prosperity and national harmony.

8. After spending nearly two months on hydrographic surveys in Thandwe (Sandoway), I had looked forward to unwinding at the famed Ngapali Beach celebrated for its white sands, swaying palms and pristine waters. Sadly, time and circumstances cut that plan short and I returned to Yangon with a heavy heart, hoping to return someday.

9. Today, Myanmar stands at a crossroads. Despite its rich culture, heritage and natural beauty, the country has faced significant political and social challenges in recent years. As a neighbour that shares both land and maritime boundaries, India has a crucial role to play in extending a supportive hand. Our hydrographic

cooperation, rooted in trust and technical excellence, is one of the many bridges through which we can continue to engage meaningfully.

10. This collaboration is not just about charts and navigation, it is a testament to the spirit of India's Act **East Policy**. Strengthening maritime domain awareness, improving safety of navigation and enhancing regional connectivity through hydrography form a quiet yet vital pillar of India's engagement with Southeast Asia. Myanmar, with its strategic location and shared history with India, remains central to this vision. By deepening our partnerships in hydrography, we contribute to a future where peace, stability and prosperity return to Myanmar and echo far beyond, across the waters of the Indo-Pacific.

Commodore J Gurumani was commissioned in the Navy on 01 July 1994. He is an alumnus of Naval War College, Goa, Defence Services Staff College, Wellington and a Master in Hydrographic Surveying from Goa University. He has held various appointments afloat and ashore that includes Commanding Officer of IN Ships Investigator and Darshak. The Officer is presently Cmde (H) at NHQ/ MoD.

INS Makar : A Legacy Forged in Troubled Waters

1. As I pen this reflection as the proud Captain of the Indian Naval Survey Ship Makar, I am reminded of nothing else but the indomitable spirit of the ship and her crew. From her inception, Makar has been a vessel shaped not only by steel and machinery but by her resilience, determination, and a shared commitment to excellence.

2. The journey of INS Makar has always been marred with challenges that could have easily deterred the faint-hearted. As the most advanced and sophisticated survey vessel till date with state-of-the-art equipment, the hurdles we faced were as high as our expectations. The days at sea are always marked with teething troubles—technical glitches, operational complexities, and then the daunting task of mastering a vessel so advanced in her capabilities and it's hull-form. There were times when setbacks tested our patience and moments when the odds really seemed insurmountable.

3. But every storm encountered, every day spent at sea has only strengthened our resolve. The men who served Makar till date have displayed an unwavering determination to overcome these obstacles. With every challenge, we have grown stronger, more cohesive, and more innovative in finding solutions. The camaraderie amongst the crew, the late nights spent troubleshooting, and the collective will to succeed is the true essence of Makar.

4. Our mission to ensure safe navigation and provide accurate hydrographic data to the nation has been beyond ordinary. From enduring rough seas to braving operational pressures, the ship and her crew have worked relentlessly to fulfill the expectations of our nation. Each successful survey, every underwater search, every ditched aircraft, every sunken boat, every hope of the families of finding the mortal remain of their loved ones to ensure closure, Makar has never disappointed till date. The ship is the only survey ship to find itself mentioned numerous times in the news segments, a testament to the dedication of the team - a reflection of their professionalism and pride in service.

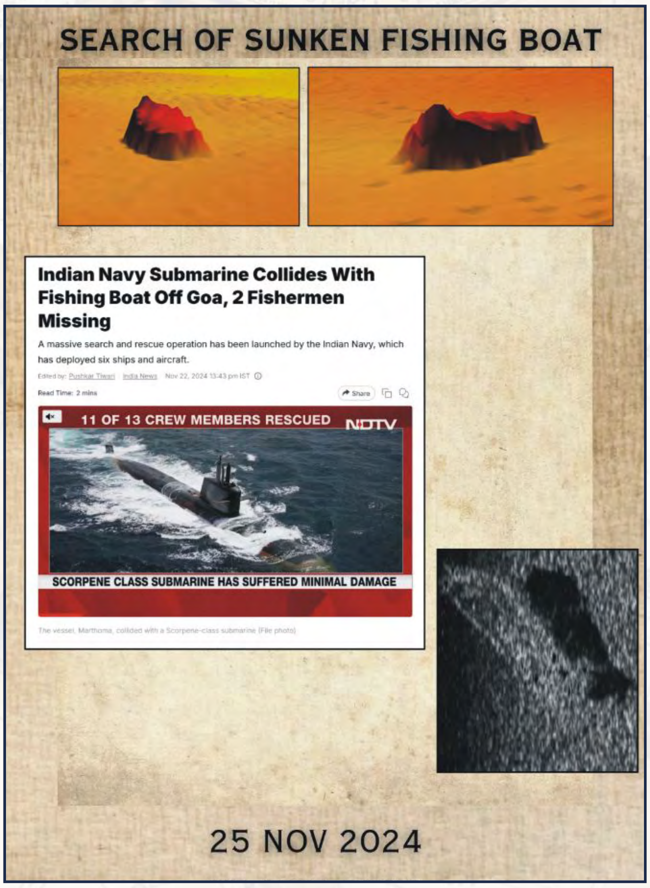
5. The culmination of our activities has been nothing short of remarkable. The once-daunting tasks are now executed with precision and confidence. Makar has not just turned the tide but has emerged as a symbol of what unity and perseverance can achieve. She has charted not only the waters beneath her keel but also a path of inspiration for all who serve in the Navy.

6. As I stand on her deck, looking out at the vast expanse of the ocean, I am filled with gratitude. Gratitude for the crew who turned challenges into opportunities, for a ship that has been both a workplace and a home, and for the privilege of leading this extraordinary journey.

7. INS Makar is more than just a ship, she is a legacy of resilience and triumph, a soul that will continue to light the way for those who sail in her wake. Cheers to the ship and her spirit—steadfast, undaunted, and eternally inspiring.

Commander Kishore Padam Singh Aer an alumnus of 72nd Naval Academy and DSSC, Wellington. The Officer is a qualified 'Charge surveyor' with CAT 'A' Qualification and MSC in Hydrography and presently Commanding INS Makar. He is passionate about research and critical thinking, actively contributing to magazines, journals, and other forums.

Intent Matters – Legacy of INS Makar over the Years



SAR OPS FOR PAWAN HANS HELO CRASH

Pawan Hans chopper crash: Pilot's body recovered off Mumbai coast

uesday, 10 November 2015 | TN RAGHUNATHA | Mumbai

Five days after a Pawan Hans helicopter crashed and sank off the Bombay High, the Indian Coast Guard (ICG) and Navy personnel late on Monday evening recovered a portion of the wreckage and the body of one of the two pilots on board the ill-fated helicopter.

In a prolonged search operation coordinated by the ICG's Maritime Rescue Coordination Centre (MRCC Mumbai), with the help of the Navy, coast guard and ONGC, the ICG personnel involved located the wreckage of the Pawan Hans Helicopter (of Dauphin make) AS 365 N3 was located on the sea bed.

"The cockpit with body of one pilot was recovered late this evening. The wreckage of the helicopter has been recovered in few parts at a depth of 75 meters and search and recovery of the remaining parts. We are on the look-out one more missing pilot," a defence spokesperson said late in the night.

The helicopter, with two pilots on board, had crashed and sank in the Arabian Sea, 80 km north-west off Mumbai. The two pilots had gone missing. The ships of the Indian Coast Guard, Indian Naval Ships and OSVs of ONGC were pressed into the service.

The helicopter was carrying out night landing practice at the ONGC oil platforms at the Bombay High when the mishap took place on the night of November 4.

"Based on a request received from the Pawan Hans ltd, Indian Navy had deployed two vessels for assistance in location of the submerged debri/fuselage. The Sonar searches were undertaken by the ships of Indian Navy as well as MSV Fugro Mapper since Wednesday last. The searches were complemented by the surface search by Naval and Coast Guard Ships & Dornier aircraft as well as other vessels of ONGC," the spokesperson said.

"After analysing throughly the Underwater locator Beacon and sonar inputs, diving was undertaken in various ocations for the past four days. Finally, on the basis of the inputs received from INS Makar and MSV Fugro Mapper, the diving undertaken by PSV Samudra Sevak led to the location of the ill-fated helicopter wreckage. While we have recovered the body of one pilot, our search is on for the other pilot and remaining wreckage of the helicopter," the spokesperson said.

06-08 NOV 2015

INVESTIGATION OF INS KHUKRI

Azadi Ka Amrit Mahotsav

The Navy Never Forgets its Fallen – A Unique Tribute Under the Deep Sea to INS Khukri

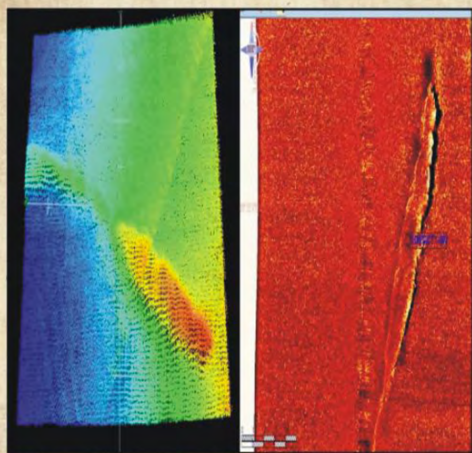
Posted On: 12 FEB 2023 12:37PM by PIB Mumbai

The Indian Navy on 11 Feb 23 paid unique tribute in eternal gratitude to the ultimate sacrifice of the brave INS Khukri and her crew by laying wreaths underwater at the final resting place of the ship that was lost in the 1971 War.

Named after the curved battle dagger of the indomitable Gorkhas, the Khukri sank on the night of 9th December 1971 with 18 officers and 176 sailors, including the Commanding Officer, Captain Mahendra Nath Mulla, who stayed courageously on the Bridge as the ship went down. The gallant Captain was later awarded the Mahavir Chakra posthumously. The ship and her fearless crew now lie at a depth of approximately 80m, about 100 nautical miles off Diu.

On 11 Feb 23, the Navy paid them touching homage through a poignant reunion as deep sea divers of Diving Support Ship, INS Nireekshak, placed three wreaths on the Khukri; one on behalf of the survivors and families of those lost, the second on behalf of all ranks of the Indian Navy and the third on behalf of the Operational Commander, the Commander-in-Chief of the Western Naval Command.

Khukri continues to live and will forever inspire a grateful nation and her Armed Forces.



07-13 OCT 2021

SHIRUR LANDSLIDE SEARCH OPS

20 JUL- 28 AUG 2024

Close Call in Coral Waters: A Field Experience in Coastal Hydrography

1. Conducting hydrographic surveys in remote and ecologically sensitive areas often presents a unique set of challenges, both technical and human. During a hydrographic survey task near a distant island with no network connectivity and difficult sea conditions, I had a harrowing experience that reminded me of the ocean's unforgiving nature. It was a day that tested not just my knowledge and training, but also the ability to remain calm, decisive and cohesive as a team leader in a life-threatening situation.

Setting the Scene.

2. In April 2022, I was posted onboard INS Nirupak post completion of my Basic Hydrography course, as Officer in charge of a survey motor boat, I was deployed to carry out close-coast hydrographic survey operations around TRAK and TREIS islands in Nicobar region. The ship anchored approx. 10 miles from these isolated islands. The area was known to be covered by the coral reefs and submerged rocks as well as active surf breaking along the shore. My team consisted of four sailors and given the complex underwater terrain, I had stationed one sailor on the foxle to maintain visual monitoring of the seabed, especially in coral-rich patches. We navigated slowly and cautiously, with the echo sounder providing continuous depth readings while maintaining visual lookout for any signs of danger.

The Moment Everything Changed.

3. A sudden and unusually large wave approached from our bow. Initially, it seemed like the many waves we had already encountered that day. I instructed the sailor on the foxle to brace himself. But this wave was different. It lifted the bow violently and before we could react, the sailor was thrown overboard. I was standing at the quarterdeck and narrowly managed to hold on myself. The shock was immediate but there was no time for panic as we had a man overboard, in dangerous surf, with no immediate rescue support nearby.

The Rescue Challenge.

4. The sailor who had gone overboard was not a strong swimmer. The waves were towering, visibility was poor, and he was quickly disappearing behind the swells. By the time we sighted him clearly again, he had drifted approximately 200–300 meters from our position and was moving further out. We attempted to turn the SMB towards him, but the combination of shallow water, coral formations and the high sea state made manoeuvring extremely difficult. Every second felt critical. We attempted radio communication using our Motorola set, successfully contacting our mother ship for assistance. However, we had very little time to react and wait for the assistance from ship. We could hear the sailor calling out, pleading not to be left behind. He was clearly exhausted and struggling to stay afloat. It was a heartbreaking and terrifying moment for all of us onboard.

A Risky Decision.

5. As the situation grew more dire, I realized that waiting for help was not an option. The sailor was unknowingly drifting towards a cluster of partially submerged rocks, a potentially fatal outcome. Assessing the risk, I decided to take the SMB into extremely shallow waters using astern propulsion. The echo sounder was reading 0.8 meters, dangerously close to our vessel's 0.6-meter draft.

6. We approached within 20 meters from him and threw a lifebuoy towards him. But he was too fatigued to secure it. Manoeuvring closer could have risked SMB overriding him due to the strong surge, yet staying

back meant he might slip away. After several intense attempts, coordinating closely with the coxswain and crew, we managed to edge close enough to safely retrieve him without further harm. He was completely exhausted but alive and back on deck.

<u>Lessons from the Sea</u>.

7. That incident remains vivid in my memory - not only because of its intensity, but because of what it taught me. It was a stark reminder of how unpredictable and dangerous the marine environment can be, especially during close-shore hydrographic operations. Even with all our planning and precautions, nature had its own script. Three things proved decisive that day: quick situational awareness, the courage to make a high-risk call, and the seamless teamwork of my crew. This experience reaffirmed the importance of training for worst-case scenarios and always respecting the sea.

<u>Conclusion</u>.

8. Hydrography often requires us to work in areas that are not only technically demanding but physically hazardous. As we collect data to support navigation, coastal development, and environmental monitoring, we must never lose sight of the human element involved in these operations. On that day, off Trak & Treis Islands, it was not just about charts and soundings. It was about judgment, leadership and survival.

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From Lead Lines to Learning Machines: The Evolution of Hydrography and Nautical Cartography

1. Hydrography and nautical cartography have seen a profound transformation from the days of manual depth measurement using hand lead lines to today's use of sophisticated, automated systems empowered by Artificial Intelligence (AI) and Machine Learning (ML). This evolution has not only revolutionized the way we understand and navigate marine environments but also enhanced the efficiency, accuracy and accessibility of hydrographic data and products.

Manual Surveying and Charting.

2. Historically, hydrography relied on rudimentary tools such as the hand lead line for measuring depth and sextants or theodolites for determining position. These methods required significant skill and labour, often carried out from small boats in physically demanding and hazardous conditions. Positions were manually fixed using celestial navigation or visual triangulation and depths were recorded one point at a time.

3. Nautical charts were drawn by hand and updates were infrequent. Cartographers relied on field notes and rough sketches, which limited the reliability and coverage of navigational products. Despite these challenges, early hydrographers laid the foundation for marine navigation by painstakingly documenting the seafloor and coastline features with great accuracy.

Echo Sounders and Electronic Navigation.

4. The introduction of echo sounding in the early 20th century marked a critical turning point. Sound waves allowed for rapid and continuous depth measurement, vastly improving the resolution and speed of surveys. The transition from lead lines to single-beam and later multi-beam echo sounders transformed the accuracy and completeness of seabed mapping.

5. Concurrently, electronic navigation systems such as LORAN and subsequently the Global Positioning System (GPS) replaced manual position fixing. These advancements enabled real-time positioning with unprecedented accuracy, further enhancing the value of hydrographic data.

Digital Era and The Advent of GIS.

6. By the late 20th century, Geographic Information Systems (GIS) began to integrate hydrographic data with geospatial analysis tools. This allowed cartographers to create dynamic, layered representations of marine data. Paper charts evolved into digital vector products such as Electronic Navigational Charts (ENCs), supporting real-time navigation and safety services on digital displays.

7. Data collection also became more systematic and extensive, with survey vessels equipped with motion sensors, sonar systems and onboard computing. Hydrographic organizations began digitizing their archives, enabling better data sharing and analysis.

Autonomous Platforms.

8. In recent years, Uncrewed Surface Vehicles (USVs) and Autonomous Underwater Vehicles (AUVs) have emerged as vital tools in hydrography. These platforms operate with minimal human intervention, accessing hazardous or remote areas while collecting high-resolution bathymetric data.

9. Autonomous surveys reduce operational costs and risks to personnel. Equipped with multi-beam sonars, cameras and environmental sensors, USVs can perform complex surveys with a high degree of repeatability and precision. They are increasingly employed in coastal, port and inland waterway surveys.

10. The integration of satellite positioning and automated route planning enhances these capabilities, while cloud-based systems allow surveyors to monitor missions remotely.

<u>AI and ML - Turning Big Data into Smart Products</u>.

11. As hydrographic data becomes more voluminous, AI and ML have emerged as indispensable tools for managing, analyzing and interpreting complex datasets. These technologies are used to automate data cleaning, identify seafloor features, classify bottom types and detect anomalies.

12. Machine learning models are trained on historical survey data to predict bathymetry in unsurveyed areas. AI-driven systems assist in the generation of nautical products such as ENCs, automatically placing features and ensuring compliance with cartographic standards.

13. These smart systems accelerate production timelines and improve the consistency and reliability of charts. They also facilitate real-time updates, enabling mariners to access the most current information available.

<u>Future Trajectory</u>.

14. Looking ahead, the integration of hydrographic data with other geospatial and oceanographic datasets will create more holistic marine spatial frameworks. Real-time data streams from autonomous platforms, satellites and sensor networks will feed into adaptive cartographic systems.

15. AI and ML will continue to evolve, providing predictive insights into seabed change, aiding in disaster response and supporting Marine Spatial Planning (MSP). Enhanced interoperability between hydrographic databases and user systems will democratize access to high-quality marine data.

16. Moreover, cloud computing and web services will allow nautical products to be updated and distributed more efficiently, supporting both professional navigation and wider environmental applications.

<u>Conclusion</u>.

17. From humble beginnings with manual tools to today's sophisticated autonomous platforms powered by AI, hydrography and nautical cartography have made remarkable strides. This evolution has enabled safer navigation, better maritime planning and deeper scientific understanding of marine environments.

18. As the field continues to embrace innovation, it is poised to play a central role in addressing global challenges such as climate change, sustainable resource management and ocean conservation. The synergy of technology, data and expertise will ensure hydrography remains a cornerstone of our relationship with the world's oceans.

Commodore J Gurumani was commissioned in the Navy on 01 July 1994. He is an alumnus of Naval War College, Goa, Defence Services Staff College, Wellington and a Master in Hydrographic Surveying from Goa University. He has held various appointments afloat and ashore that includes Commanding Officer of IN Ships Investigator and Darshak. The Officer is presently Cmde (H) at NHQ/MoD.

The Great INS Makar Debut: A Near Miss with 'Prema' and My Career

1. They say a ship's first sea sortie under a new captain is a momentous occasion - a day of pride, anticipation, and calculated nerves. For me, taking command of INS Makar was not just a step forward in my naval career; it was the culmination of years of training, endless watchkeeping as the ever-faithful Number Two, and the thrilling prospect of finally being the one calling the shots. What I didn't know was that my debut as Captain would begin with a comedy of errors that nearly turned into a tragedy - if not for some last-minute divine intervention and a very forgiving fender.

The Setup: Calm Before The Comedy.

2. INS Makar, my fine lady, had just emerged from an extended refit. After much coaxing, paperwork, and enough basin trials to qualify as a full-blown groundhog day, she was finally ready for her first real sea sortie. We were berthed at Karwar's ship lift mouth, second in line, with two water tankers moored just ahead - one of them being the mysterious, brooding Prema.

3. Prema was not just any water tanker; she was a massive, ponderous beast, seemingly indifferent to the world around her. She sat there, unmoved, like a veteran sailor who had seen too much and simply didn't care anymore. Unfortunately for me, she was also the one ship standing between my career and eternal ridicule.

The Problem No One Saw Coming.

4. The basin trials had been smooth - deceptively so. My maneuvering approach had been simple: dead slow ahead on the outer shafts, dead slow astern on the inner shafts, and voila! She held position like a dream. It was too easy. The trick, as it turned out, was that I never actually checked if the engines were obeying my orders or just staging a silent mutiny.

5. Unbeknownst to all, there was a polarity issue. Yes, in the grand tradition of naval mischief, my engines had developed a unique talent: interpreting commands in reverse. Dead slow ahead? No problem. Just kidding - it's actually astern. Astern? Hah! Let's go forward. The realization, however, came at the worst possible time - during departure.

The Moment of Truth.

6. Lines cast off, tugs standing by, the morning sea breeze gently nudging the ship, it was the perfect setting for a textbook departure. I had rehearsed this moment a hundred times in my head: cant the stern, apply dead slow astern on outer shafts, and elegantly back out like a true sea lord. Only, instead of backing out, Makar surged forward. My first reaction? Complete, gut-wrenching shock. My second reaction? Panic. Pure, unfiltered panic. We were no longer a disciplined warship but rather an enthusiastic bull charging at a very confused Prema. My entire career flashed before my eyes, and none of it involved ramming a water tanker on Day One. My bridge crew froze. My young, nervous navigating officer looked at me with the expression of a man expecting the end times. And in that microsecond, I saw my future unraveling: A lifetime of explaining, in increasingly awkward job interviews, how I left the Navy because I collided with Prema.

The Save.

7. In desperate times, instincts take over. Fortunately, the steering gears worked correctly, which was a blessing from Neptune himself. Hard port! Hard starboard! Makar wove through the water like an over-

caffeinated dolphin, narrowly missing Prema by a foot - a foot that felt like the longest foot in the history of naval warfare. The fenders, lowered just in time, brushed against Prema's hull in what I can only describe as a slow-motion naval handshake. She barely reacted. She was above such things. My bridge crew? Dead silent. My Navy? Still waiting for me to explode. Instead, I took a deep breath, turned to my crew, and with a completely straight face said, “Well, if I had to leave the Navy today, at least my resignation letter would have an interesting reason: ‘Captain Samir quit after he banged Prema.’” The bridge erupted in laughter. We finally got tugs, centered the ship in the channel, and, this time with a thorough engine check, sailed out for our trials.

The Aftermath.

8. Since that day, the bridge team remained cheerful under all circumstances, knowing that if we could survive nearly headbutting a water tanker, we could survive anything. We also made one critical addition to our pre-sailing checklist. Confirm engine polarity before leaving jetty. Looking back, I can laugh about it. But at the time? Oh, it was a career-killer in the making. And yet, through sheer dumb luck, quick thinking, and a very well-placed fender, INS Makar and her Captain lived to sail another day.

Moral of The Story.

9. When life (or a water tanker named Prema) comes at you fast, just remember: always check your engines, always trust your steering, and if all else fails - at least have a good resignation letter ready.

Captain Samir S Gokhale was Commissioned on 01 July 2003 and an alumnus of Naval War College, Goa. The Officer has commanded INS Makar and served over five years as Executive Officer on survey ships. The officer is presently posted at NHO Dehradun, handling personnel and training for the Hydrography Cadre.

A Voyage Beyond Ice : My Antarctic Odyssey with the Argentine Navy

"One does not simply go to Antarctica; one is summoned by its silence."

1. It was a crisp chilled August night when I landed in Buenos Aires, after a never-ending flight and with my heart racing with the promise of something profound. Accompanying me was my better half Dr. Anisha Singh, glowing with maternal grace and two months pregnant. Thus began the first chapter of an extraordinary journey: the theoretical phase of an ice navigation course at the Escuela de Ciencias del Mar (School of Marine Sciences), running from 25 Aug to 09 Sep 2024.

Buenos Aires - Of Charts, Choripán, and Cravings.

2. The school, nestled in the historic maritime quarters of Buenos Aires, provided an elegant confluence of academia and seafaring lore. Each day began with intricate lectures on polar climatology, navigation in ice-infested waters, and the enigmatic language of the egg code. Our instructors were retired naval officers, stoic and sharp; wove narratives of ice floes and survival in the latitudes where compasses falter and men are tested. I was privileged to be part of a class wherein we were student officers from Argentina, Chile, Uruguay, Spain, USA and me from India. They were all not just friendly but developed bond of a lifetime in no time.

3. Post-classes, the city revealed itself in hues of tango and torrontés. My wife's culinary cravings, intensified by her pregnancy, led us through street-side stalls and family-run bodegas. I soon became a connoisseur of choripán and empanadas, while dulce de leche seemed to find its way into every dessert and occasionally, into my lectures via sugar-fueled daydreams. I wondered how every Argentine travels with Matte kit, sips it more than water and realised it was not just their beverage but a tradition and excuse to chill with mates.

4. We wandered through La Boca's kaleidoscope alleys, strolled hand-in-hand in the Palermo gardens, shopped in Florida street and watched the sun disappear over the Tigre, each moment deepening my bond not just with her, but with this vibrant land. Yet beneath it all lay an undercurrent of anticipation - for the sea was calling.

***ARA* Irizar - The Icebreaker and the Indian**.

5. On 24 Jan 2025, I returned to the naval dockyards of Buenos Aires, this time alone and to begin the second, more formidable chapter of my training: the practical sailing phase aboard the ARA Almirante Irízar. Towering in red, the icebreaker looked less like a ship and more like a colossus forged from fire and steel.

6. Boarding her was surreal. This ship, reborn from a devastating fire, now stood as a testament to Argentine resilience and was to be my home for the next seven weeks. Life aboard was rigorous and exhilarating. I was embedded into the Argentine Navy's operational watch system, observing and eventually contributing to their navigational routines. The bridge became my sanctuary, its windows framing the white void beyond, its consoles aglow with radar pings and navigational chatter, mostly in rapid-fire Spanish. I spoke little at first, thanks to my poor Spanish but salt and steel are fluent languages of their own. I have to mention that Argentine are over friendly people and are extremely fond of Indians and our great country.

Sailing South - Into the Land of Eternal Light.

7. As the *Irizar* crossed 60°S, the very air seemed to change; crisper, heavier, and yet somehow purer. The sun, now reluctant to dip below the horizon, bathed us in a perpetual golden haze. Days and nights dissolved into a single timeless glow, confusing our body clocks and inspiring poetic journal entries. The ocean

morphed into a frozen sculpture garden. Icebergs, some as tall as city blocks, loomed silently - ivory titans adrift. Pancake ice gave way to dense floes, and the ship groaned heroically as it carved a path through the frozen crust. Each crack under the hull was a sonnet to engineering.

8. Then came a rite of passage: the crossing of the Antarctic Circle and the traditional sailor's ceremony. Imagine this: officers clad in makeshift costumes, smearing faces with ketchup and toothpaste, performing mock baptisms with buckets \of ice water. Laughter echoed over the desolate expanse; it was juvenile, joyful, and utterly unforgettable. That day, I was reborn as a polar mariner.

Stations of the Ice - Argentina's Antarctic Legacy.

9. Our journey was marked by calls at six Argentine Antarctic bases - each a bastion of endurance and discovery:

(a) **Marambio Base**. The aerial lifeline of Antarctica. Winds roared like mythical beasts as aircraft landed on ice runways carved out of frozen rock. Here, I felt the immediacy of life in extremis. It is the primary Argentine air logistics hub in Antarctica and the largest base.

(b) **Petrel Base**. Remote and rugged, home to men with beards as wild as the landscape. We drank mate and exchanged tales wherein me of Indian monsoons, they of whiteouts and ice quakes. Originally a summer-only base, it is being reconstructed as a permanent station with enhanced infrastructure, a planned airstrip, and docking capabilities.

(c) **Orcadas Base**. Antarctica's oldest permanent outpost established in 1904. I stood before structures built over a century ago, their timber weathered but their spirit undiminished. The Argentine flag snapped sharply in the katabatic wind as we honoured generations past.

(d) **<u>Belgrano II Base</u>**. Situated on the Filchner-Ronne Ice Shelf, this was the southernmost point of our voyage. It was here, at over 80°S, that I etched my name into history as the **first Indian to reach this latitude**. I stood upon the white continent, awash with emotion and humbled by its vast, echoing silence. The southermost permanent station stands as a powerful testament to human resilience and scientific ambition. The station is built directly into glacial ice, with its infrastructure buried below the surface to protect against extreme winds and sub-zero surface temperatures.

(e) **<u>Esperanza Base</u>**. A settlement that redefines permanence. The base is infiltrated with penguins and you get the feel of Ice Age. It is also one of the upcoming base stations which is expanding and the only one to have civilians populace.

(f) **Carlini Base**. A crucible of science and curiosity. Here, I conversed with researchers studying glacial acoustics and penguin genetics, and with a cook who, between meals, recited Neruda with enviable flair.

10. Each base had a soul, each interaction a story. I shared insignias, raised toasts, and fielded questions about India's Antarctic programme. The warmth of Argentine hospitality stood in poetic contrast to the cold around us.

Life Onboard - The Rhythm of Ice.

11. Days blurred into a cadence of watches, weather readings, and wonder. I launched meteorological balloons, observed whale pods - humpbacks and orcas playing tag with the bow and once mistakenly reported a floating chunk of whale fat as an ice hazard. We played Play Station on the Wardroom, celebrated birthdays with improvised cakes, and debated over dinner whether asado could ever dethrone Indian tandoori (Consensus: a diplomatic tie).

12. There were meditative moments too; watching snow fall in absolute silence, or staring out into the infinite white, feeling both insignificant and infinite. I wrote long letters I never posted, sketched ice formations in my logbook, and learnt the nuanced art of brewing mate just right.

Ushuaia - The Southern Farewell.

13. On 13 Mar 2025, I stepped ashore at Ushuaia - the world's southernmost city. At the edge of the world, where snow-kissed peaks meet the restless sea, Ushuaia stands like a whisper of wilderness - bold, remote, and breathtaking. Often referred to as the 'End of the World', Ushuaia is a place where the grandeur of nature converges with a profound sense of remoteness. Nestled between the jagged peaks of the Martial Mountains and the icy waters of the Beagle Channel, this southernmost city of the world is both a frontier and a sanctuary. The landscape is a breathtaking symphony of snow-draped mountains, dense subantarctic forests, and windswept coastlines where sea lions and penguins find refuge. As the ship was at anchorage and I was in a hurry to be in time prior to my wife's delivery, I disembarked through a Gemini and entered the city. I had left as a student and returned an initiate of the ice. My hairdo had grown wild, my soul richer, and my understanding of the planet's fragility far deeper. From Buenos Aires' cobbled streets to Belgrano II's icy silence, I had traversed not just latitude but perception. I had tasted the world at its purest edge and emerged, perhaps, transformed.

<u>Epilogue - The Cold That Warms the Heart</u>.

14. Antarctica does not offer comfort; it offers clarity. It strips you bare of distractions and layers you instead with awe. I returned not just with photographs and data, but with an altered heartbeat, one that now pulses with ice.

15. To this day, when my daughter asks where I was when they were in the womb, I'll smile and say: "Floating near the bottom of the world, dodging icebergs, and learning to survive at -30°C while plotting courses over the last great wilderness."

16. And that tale, ladies and gentlemen, will always warm even the coldest night.

Lt Cdr Kumar Shaswat is an alumnus of Indian Naval Academy and a CAT 'A' qualified Officer from National Institute of Hydrography, Goa. A passionate Hydrographer, the officer has served in various survey ships and recently underwent the prestigious Ice Navigation Course in Buenos Aires, Argentina. A fervent writer, the officer has authored and published article in Indian Naval Despatch (INDES). He is presently serving as Executive Officer onboard INS Makar.

Liability in Delict of the Chief Hydrographer to The Government of India : a Critical Analysis

Abstract.

1. The art and science of hydrography have been identified with safe maritime navigation and charting. The scientific development in recent times and the realisation of the economic potential of the ocean have greatly enhanced the importance of hydrography. Nothing has ever been more important for navigation and linked to seaborne trade for a littoral state than the production and updating of a marine map or chart produced because of hydrographic hard work and vision of a Hydrographer. Hydrography is critical in maritime safety, environmental protection, and economic sustainability. Given the strategic importance of accurate hydrographic data, the legal implications of inaccuracies, especially those that lead to damage or loss, have gained increasing attention in both domestic and international jurisprudence. This article explores the concept of delictual liability within the framework of hydrography, focusing on the responsibilities and potential liabilities of the Chief Hydrographer under Indian and international law.

Introduction.

2. Hydrography, the science of surveying and charting bodies of water, underpins the safety of navigation and maritime operations. In India, this responsibility falls to the Indian Naval Hydrographic Department, led by the Chief Hydrographer to the Government of India. As the NAVAREA VIII and NAVTEX Coordinator, the Chief Hydrographer holds critical accountability for broadcasting marine safety information (MSI) and producing up-to-date nautical charts. Failure to uphold this responsibility can result in maritime accidents, environmental degradation, and legal liability. The nature of such liability, particularly civil liability arising from wrongful acts or omissions, falls within the scope of delictual law[1].

Understanding the Concept of Delict.

3. In common law jurisdictions, the term “tort” is used, whereas civil law systems use “delict.”[2] A delict refers to a civil wrong that results in harm to another, leading to liability independent of contractual obligations. In hydrography, examples of delictual acts include: -

(a) Publication of outdated or inaccurate navigation charts.

(b) Failure to update hydrographic data following construction or natural changes.

(c) Omission to issue timely warnings through NAVTEX or other systems.

4. The legal foundation of a delictual claim generally requires the plaintiff to establish: -

(a) A duty of care,

(b) Breach of that duty,

(c) Causation,

(d) Actual harm or damage.

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[1] Guy NR, The liability in delict of the state Hydrographer, 2002.IHO publication.
[2] Donoghue v. Stevenson [1932] AC 562 (House of Lords).

Legal and Regulatory Framework.

5. **National Legislation**. Hydrographic liability in India is shaped by several domestic legal instruments:-

(a) Indian Contract Act, 1872 – Governs obligations arising from contractual relationships, which may indirectly relate to hydrographic services provided to commercial entities.

(b) Merchant Shipping Act, 1958 – Directly relates to maritime safety, including the carriage of nautical charts.

(c) Admiralty (Jurisdiction and Settlement of Maritime Claims) Act, 2017 – Empowers Indian courts to adjudicate maritime claims, including those based on navigational failures.[3]

(d) Indian Penal Code (IPC) – Addresses criminal negligence, which may overlap with civil delict in cases of gross misconduct.

6. **Navy and Administrative Regulations**.

(a) Regulations for the Navy, Part 1, Chapter 20 – Defines the scope and duties of the Indian Naval Hydrographic Department.

(b) Government of India Business Rules, 1961 – Establishes administrative responsibilities, reinforcing the accountability of hydrographic authorities.

7. **International Obligations**. India is a party to several international conventions relevant to hydrography:

(a) IMO SOLAS Chapter V (Safety of Navigation) – Mandates member states to ensure hydrographic services and issue up-to-date nautical publications.

(b) International Hydrographic Organization (IHO) standards – Prescribe the technical guidelines for chart production.[4]

(c) United Nations Convention on the Law of the Sea (UNCLOS), Article 94- Obligates states to ensure that vessels flying their flags are navigationally safe.[5]

Case Studies.

8. **Queen Elizabeth 2 Grounding (1992)**. In a landmark case, the Queen Elizabeth 2 struck a shoal near Rhode Island due to outdated hydrographic data, which failed to reflect a 30 ft depth where charts indicated 39 ft. The U.S. government faced a $50 million lawsuit. Although the court eventually exonerated the government, it underscored the necessity of regular chart updates and improved hydrographic diligence (US Court of Federal Claims, 1993).[6]

9. **Danish Hydrographic Office Case (2001)**. A Danish yacht ran aground on a submerged sewer pipe inaccurately depicted in official charts. The hydrographic office had prior knowledge of the change but failed to revise the chart. The court found the Danish HO liable, reinforcing that state hydrographers can be held accountable under delict law for known but uncorrected inaccuracies (High Court of Eastern Denmark, 2003).[7]

10. **Key Legal Considerations in Hydrographic Delict**. Legal evaluation of hydrographic negligence generally hinges on: -

(a) **Duty of Care**. Hydrographers owe a duty to mariners relying on official charts and notices.

(b) **Breach of Duty**. Any lapse from IHO or SOLAS standards could qualify.

(c) **Reliance and Foreseeability**. Plaintiffs must show they reasonably relied on the hydrographic output.

(d) **Causation**. A clear causal link must exist between the data inaccuracy and the resultant harm.

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[4] International Hydrographic Organization. (2023). IHO Standards for Hydrographic Surveys (S-44).
[5] United Nations. (1982). United Nations Convention on the Law of the Sea (UNCLOS).
[6] The Queen Elizabeth 2 Incident, US Court of Federal Claims, 1993.
[7] High Court of Eastern Denmark, 2003 – Danish Hydrographic Office Ruling

(e) **Negligence vs. Error**. Courts distinguish between reasonable errors and negligence—only the latter invites liability.

(f) **Governmental Immunity**. Certain jurisdictions provide limited immunity to state functions, though this is increasingly challenged.

11. **Obligations of Contracting Governments**. Governments must thus balance sovereign immunity with the global imperative for safe seas, as embodied in SOLAS Regulation V/9[8] and IHO S-100 series standard. Under the IMO and IHO, states are responsible for:

(a) Issuing Notices to Mariners regularly.

(b) Updating electronic and paper charts to reflect changes.

(c) Ensuring data quality through ISO 9001-certified workflows.

(d) Establishing legal redress mechanisms for damage caused by hydrographic negligence.

Conclusion.

11. Hydrography is not merely a technical service, it is a legal responsibility embedded in national and international frameworks. In an era of automated navigation, digital charting, and increasing maritime trade, the accuracy of hydrographic data has never been more critical. As demonstrated by international jurisprudence and evolving maritime law, the delictual liability of state hydrographers is a developing field requiring greater legal scrutiny, operational diligence, and administrative accountability.

Captain Tribhuvan Singh was commissioned in the Executive branch of Indian Navy in 1999. He is an alumnus of the Indian Naval Academy, National Institute of Hydrography, DSSC Wellington and Naval War College Goa. He is a qualified Charge Hydrographic Surveyor and is presently Commanding INS Sarvekshak.

[8] International Maritime Organisation. (2020). SOLAS Consolidated Edition.

Glimpses

MEN AT WORK

MEN AT WORK

TRAINING

TRAINING

FOREIGN


Maynmar Navy Delegate onboard INS Sarvekshak

COOPERATION

Commissioning of Survey Vessel Large Class Ships


AVY- COMBAT READY, CREDIBLE, COHESIVE & FUTURE PROOF

VISIT


हर काम देश के नाम

Hydrography - Metamorphosis

Projecting the timeline of evolution of Hydrography in four parts ranging from ancient times to the present and beyond. The portrayal is focused on the constant evolution w.r.t the prevailing practical technology. The author does not intend to portray the past in a dark-muted colours and further, the future in a post-apocalyptic burnt theme either, hence the artwork may be viewed as purely as an imagination/ make-belief mode. The reference for the theme was inspired from the murals of Argentinian artist Diego Rivera and murals from erstwhile Soviet era. The Lead-Lines from the past, to the pre-independence era sailor using a (possibly) Bar-Check from his Clinker-Boat, the modern-day surveyor from his GRP Survey Motor Boat helping to lower a Side Scan Sonar Towfish to the future surveyor (possibly) a Jet-Pack with a portable device which can scan the sea-bottom and he/ she is assisted by overhead Drones for information interchange and monitoring etc. has been depicted.In all these conditions the sea has been portrayed as an unforgiving, never changing entity which has spanned from the past to the future.

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O I/C MWDC