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HYDROSPATIAL 2026: SHAPING THE FUTURE OF MARINE DISCOVERY

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Education: Key to 'Shaping the Future of Marine Discovery'

Takhou Law, David Crossman

All the activities, emerging developments, innovations, and advances proposed within this conference for the shaping of Future Marine Discovery will be underpinned by knowledge, professional development, training and education. Whether this be the learning of new skills to support emerging technology, professional development of yourself or staff, obtaining certification and recognition of your hard-earned experience, or the training of new personnel to bring them into the industry; training and education remain key.

Traditionally, the lack of accredited training in our region has been a cause of frustration to both employers and potential students, limiting the growth of professionals in the region and, at times, hampering companies' ability to tender for, or undertake, work. Up until recently, the issue has remained unchanged due to the effort required to establish such training programs and the uncertainty of student uptake. This situation has been partially addressed by the IIC Academy with the introduction of its annual regional deliveries of FIG/IHO/ICA International Board on Standards of Competence (IBSC) recognised Programs. The first being the S-5 Category B Hydrographic Surveyors (S-5B) Program and the second being The S-8 category B Marine Geospatial (Nautical Cartography) Program. Both of these programs have run annually within the region since 2021.

At HYDRO 2022 IIC presented a paper and presentation titled 'Education: Key to Hydrography of the Future'. Based on consultation, that presentation proposed that the **Australasian Need** in the Training and Education space included:

1. Increasing the corporate knowledge of The Community.
2. Increasing the levels of Certification and Recognition of personnel within The Community.
3. Increasing diversity.
4. Increasing the numbers of personnel in the hydrographic profession.

The presentation then considered how the newly released IIC Academy S-5B Hydrographic Surveyor Programs were meeting or not meeting those requirements, and opened discussion on areas for improvement by the Academy and the Community.

With four of each of the IIC Academy Programs now complete, two dedicated Programs delivered to regional Nations for Capacity Development on behalf of the Australian Government, as well as two Programs currently underway, this presentation will consider the same questions and discussions undertaken in 2022, and determine if where the IIC Academy Programs have achieved the desired intent, but also where the Academy and the Community could do more. Discussion will also allow an opportunity to determine if there are other factors that could or should be considered and how the IIC Academy can continue to best serve the community in this space.

AHS NZ Women in Hydro Experience

Belen Jimenez Baron

Women qualified in hydrography represent only 25% of the global workforce (International Hydrographic Organisation, 2024). The Women in Hydro Experience program was established as an initiative to address this imbalance in Aotearoa–New Zealand. It began with the hypothesis that providing paid work experience to women at the early stages of their studies could help influence their career choices toward the hydrographic industry, addressing not only the gender imbalance but also the shortage of professionals in this field.

This presentation offers a retrospective overview of the three years of the program, its evolution, current operation under the AHS NZ branch, and plans for the future.

A time for renewal: Hydrography Governance and the Australasian Hydrographic Surveyors Certification Scheme

Rebecca Cusack

This presentation outlines the future for the Australasian Hydrographic Surveyors Certification Scheme, following a year of triumphs and challenges. In 2025 we celebrated continued international recognition by the International Board on Standards of Competence (IBSC) – making the AHSCP the longest running, continuously recognised, professional certification scheme for hydrographic surveyors in the world.

In 2025, we also saw the liquidation of the Geospatial Council of Australia, the Australian professional partner for the AHSCP. This event triggered a reappraisal of the AHSCP, with one constant – feedback that the AHSCP is vital for the hydrographic profession in Australia, New Zealand as well as in Asia and the Pacific. This presentation will outline the AHSCP moving forward with renewed professional partnerships in place, continuing 31 years of assuring the professional competence of hydrographic surveyors working in Australasia.

Our reappraisal also provided an opportunity to consider what has worked well in the past, and to apply these lessons for the future. One key learning was that a professional certification scheme like the AHSCP needs to be supported by a strong governance framework with representation from industry, government and professional partners. I will outline what governance looks like for the AHSCP as we move forward.

The presentation will also discuss renewal on the international front, with the IBSC nearing the completion of the review of the S5 and S8 Standards, which drives education for hydrographic surveyors and nautical cartographers. The Australian and New Zealand maritime geospatial communities have been very active in engaging with the IBSC though these revisions.

Join us as we outline the renewed AHSCP, as we embark in 2026 on a new pathway for a secure, well-governed professional certification scheme for Australasia's hydrographic surveyors.

Visualizing Anchoring Pressure: Large Commercial Vessel Anchor Chain Scour Predictive Model

Edwin Brooks

International marine shipping has long been known to have many ecological costs. While many aspects of freighter ecological harm have been thoroughly investigated, anchor chain scouring of the seafloor has not. Studies have been done on anchor chain scour at specific sites using bathymetric data linked to Automatic Identification System (AIS) tracks, and studies have been done on the length of anchor chain that lays on the seafloor in certain instances, but no comprehensive predictive model of chain scour damage has been developed. By developing a model of anchor chain scour that incorporates AIS tracking (AIS transponders), tide stations, nautical chart data and anchor chain physics, we produce a predictive model that will support harbour authorities to better select freighter anchoring locations and be used to evaluate potential vessel ecological impacts. In addition, we develop geovisualizations of current and potential anchor scour that will support ecological research and community monitoring of near-shore vessels.

Using an autonomous profiler to resolve the drivers of temperature variability and marine heatwaves on the Campbell Plateau

Cassidy Collier

Autonomous profiling float observations are fundamental to physical oceanography and have greatly advanced understanding of upper-ocean structure and mixed layer variability. This study uses an eight-year, quasi-stationary Argo float time series from the Campbell Plateau to construct an observational mixed layer temperature budget and investigate the drivers of seasonal to interannual mixed layer temperature variability, with particular focus on the 2017-18 and 2022-23 summer marine heatwaves (MHWs).

The Campbell Plateau provides a relatively quiescent hydrographic environment, enabling Argo float 5902449 to drift less than 60 km over eight years, compared to typical Argo trajectories of 2,000–10,000 km. This unique setting allows mixed layer temperature budget terms to be resolved without significant change in horizontal gradients. Argo-based measurements, combined with a range of observationally-constrained products, is used to quantify contributions from air-sea heat fluxes, vertical and horizontal advection.

Results show that anomalous mixed layer shoaling dominated the 2022-23 MHW, with mixed layer depths decreasing to ~12 m and driving the 210-day MHW. In contrast, the 2017-18 event exhibited more balanced contributions from surface heat flux anomalies and mixed layer depth variability. This study demonstrates the capability of strategically located Argo observations to diagnose physical mechanisms driving upper-ocean temperature variability in data-sparse regions.

USV use in the New Zealand setting – Honours Research Project

Grace Cinque

I am a fourth-year student at the National School of Surveying at the University of Otago; over the last few years I have done a range of papers over a variety of surveying disciplines. Last year I took two hydrographic surveying papers. I enjoyed my time learning more about this field, getting out on the boats and putting this learning into practice. In my final year I have decided to do a year-long honours project in addition to my fourth-year papers. I am lucky to be supported during this year by the DML Scholarship.

My honours project involves investigating Uncrewed Surface Vessels (USV). I am interested in this because last year Global Survey made a trip to Dunedin and as students, we used the USV including path planning and object detection through to data processing and outputs. This Hydrospatial presentation is focused on the background research I have done to prepare myself for this project including the current New Zealand landscape, common uses and what guidance/legislation is in place.

Characterising the Chatham Rise to support dynamic marine protected areas

Tui Gunn

The Chatham Rise is a unique bathymetric feature within Aotearoa New Zealand's maritime jurisdiction, serving as the foundation for biodiversity and commercial fisheries in the region.

Marine protection has not been considered for this area since the establishment of Benthic Protection Areas in 2007, despite decades of study indicating the ecological, economic and social value of this ecosystem to Aotearoa New Zealand.

Application of remote sensing products from the European Space Agency enables access to free, long-range observations of surface ocean properties. This facilitates understanding of ecosystem indicators at the spatial scale necessary for open ocean management, in which dynamic oceanographic patterns contribute to the ecosystem services.

This research aims to provide decision makers with evidence to support dynamic ocean management; based on the characterisation of key areas of chlorophyll-a accumulation on the Chatham Rise derived from ESA Ocean Colour products. Results indicate an overall increase in the magnitude of chlorophyll-a concentrations, with distinct seasonal patterns in the spatial distribution throughout the region.

AHS Education Award Recipient Presentation - Scanning the Horizon: Can Hand-Held Laser Scanners Redefine Hydrographic Surveying

Meg Catley

Recent advancements in mobile laser scanning technology have introduced lightweight, hand-held systems capable of rapid data capture with minimal setup requirements. While these systems are increasingly used in terrestrial applications, their potential within hydrographic surveying remains largely unexplored. This research investigates whether hand-held laser scanners can provide value in hydrographic surveying workflows, particularly in dimension control processes where traditional survey methods can be inefficient, resource-intensive, or operationally constrained.

The study evaluates the performance of four survey systems: the Trimble S5 total station, Trimble TX5 terrestrial laser scanner, GeoSLAM Zeb Horizon RT hand-held laser scanner, and CHCNAV RS10 hand-held laser scanner. Field experiments were conducted in both land-based and water-based environments, including surveys undertaken from the vessel Tūhura. Data was collected across a range of surface types and site conditions to assess positional accuracy, point cloud density, coverage efficiency, and operational practicality.

Comparative analysis was undertaken by referencing mobile laser scanning outputs against control data derived from conventional methods. Metrics considered included absolute positional accuracy, relative precision, data completeness in complex environments, and workflow efficiency from acquisition through to processing. Additionally, investigation went into the integration of hand-held laser scanning within hydrographic survey workflows, including its suitability for capturing coastal infrastructure.

Results indicate that while hand-held mobile laser scanning does not yet replace traditional control-based methods for high-order hydrographic deliverables, it offers significant advantages in speed, accessibility, and safety. The hand-held laser scanners demonstrated strong performance in complex and obstructed environments, with rapid deployment and reduced logistical requirements compared to static scanning. However, limitations were observed in absolute accuracy and drift over extended trajectories, particularly in feature-poor environments common to some coastal settings.

The research demonstrates that hand-held laser scanners are best used as complementary tools within the hydrographic industry. They are particularly effective for contextual site capture, preliminary mapping, and areas where traditional setups are impractical or hazardous. When integrated with robust control networks and GNSS validation, these systems can enhance efficiency without compromising required survey standards. However, potential is shown for this equipment to produce better results with minor improvements from methods undertaken in this study.

This study contributes practical, field-based evidence to inform decision-making around emerging mobile mapping technologies in hydrographic surveying. As projects increasingly demand rapid, flexible, and multi-sensor data acquisition, understanding the strengths and limitations of hand-held laser scanning is critical.

3D Coastal Mapping – Improving Key Baseline Datasets for Aotearoa's Coastal Resilience

Stuart Caie

In 2023 Toitū Te Whenua Land Information New Zealand (LINZ) commenced the 3D Coastal Mapping (3DCM) programme of work to improve the baseline data upon which resilience to coastal hazards and climate change impacts can be assessed and mitigated.

The programme represents a significant advancement in New Zealand's approach to coastal data collection and management. By creating comprehensive, high-resolution topographic-bathymetric datasets covering priority coastal areas, the programme is establishing a foundation for improved coastal hazard assessment, planning, and adaptation strategies.

The 3DCM programme consists of two streams of work; installing new or upgrading existing Global Navigation Satellite System (GNSS) equipment at existing tide gauge locations; and mapping up to 40% of the coastline, 200 metres inland extending seaward to a water depth of 25 metres with LiDAR. This equates to approximately 10,000 km2.

In late-January 2025 two suppliers started the mapping component, completing about 1,900km2 or 20% of the scope by May. As anticipated, New Zealand's coastal environment presented challenges for bathymetric LiDAR. Water clarity varies considerably throughout the regions, with turbidity conditions fluctuating dramatically, especially following rainfall events and subsequent river outflow and in estuarine environments. Frequent coastal weather systems significantly limit suitable flying windows, creating logistical hurdles for data collection efforts. Adding further complexity is New Zealand's intricate coastal morphology, characterized by a highly indented coastline featuring numerous islands, inlets, and diverse coastal formations - all of which necessitate sophisticated and meticulous flight planning to ensure the area is mapped efficiently.

The 3DCM data is designed to support a wide range of applications critical to New Zealand's coastal resilience and management. LINZ is engaged with stakeholders to ensure the data, when available, is used to demonstrate the value and benefit of the programme.

This presentation will provide an overview of the programme, touching on the journey LINZ has been on before the planes got off the ground. It will provide an update on what has been achieved so far, including the challenges of using bathymetric LiDAR in the New Zealand environment, and present some features of interest to others beyond the purpose of the programme.

Bridging the Land–Sea Gap: Topo-Bathymetric LiDAR Mapping of New Zealand's Coastline

Colin Cooper, Lara Heitmeyer, Jared Ritchey

New Zealand's *3D Coastal Mapping Project*, part of the broader *Mapping NZ 2025* initiative led by Toitū Te Whenua Land Information New Zealand (LINZ), is producing seamless, high-resolution elevation data across the coastal interface from land to seabed. The program aims to map approximately 40 percent of the nation's coastline, extending from 200 meters inland of Mean High Water Springs to depths of about 25 meters below sea level. These data are essential for understanding coastal processes, sea level rise, and climate resilience, and for supporting effective planning and adaptation along New Zealand's dynamic shoreline.

To help achieve this goal, NV5 Geospatial, in collaboration with LandPro Ltd. and TCarta Marine, is acquiring topo-bathymetric LiDAR data around Te Waipounamu / the South Island using a dual green laser system designed for complementary shallow and deep-water coverage. The integrated approach provides continuous, high-density mapping across the land–sea transition. LandPro's local knowledge, survey expertise, and in-country support have been vital to the project's coordination and operational success. TCarta provides water clarity reporting derived from satellite observations, informing flight planning and documenting environmental conditions throughout acquisition.

NV5 developed a secure online client portal that allows LINZ and project partners to view daily flight coverage and evaluate preliminary results, improving communication and enabling early decision-making on data acceptance and re-fly requirements.

Preliminary results show strong agreement between airborne LiDAR, ground survey, and sonar datasets. The resulting digital elevation models successfully bridge the long-standing data gap between terrestrial topographic LiDAR and vessel-based hydrographic surveys. This presentation will highlight the project's methods, results, and lessons learned, demonstrating how integrated hydrospatial technologies are shaping the future of coastal mapping and marine discovery in New Zealand.

Enhancing Coastal Lidar Efficiency: Leveraging PlanetScope Water Quality Information for the LINZ South Island Topobathymetric Survey

Kyle Goodrich

Airborne Topobathymetric Lidar (ATL) surveys represent the gold standard for high-resolution nearshore mapping, but their data acquisition efficiency and maximum penetration depth are highly susceptible to ambient water quality conditions, particularly turbidity, Total Suspended Solids (TSS) and downwelling radiance at 532nm. This presentation details an innovative, remote sensing-driven workflow developed by TCarta to significantly enhance the operational efficiency and reporting of the NV5 ATL survey executed for the LINZ 3D mapping initiative across the dynamic coastal environments of the South Island of New Zealand.

The approach leverages the high temporal and spatial resolution of PlanetScope multispectral satellite imagery to generate near real-time, targeted analysis of key water quality parameters and deliver the information in an interactive web mapping application. By applying advanced atmospheric correction and bio-optical inversion models to the PlanetScope and Sentinel 2 A/B imagery, TCarta derived continuous, reliable metrics for water clarity and light attenuation across the extensive survey area. This satellite-derived water quality (WQ) information was integrated directly into the NV5 mission planning framework.

This integration provided two critical operational advantages:

1. **Optimal Survey Scheduling:** The WQ maps enabled NV5 to identify and schedule acquisition flights during periods of peak water clarity, maximizing the effective penetration depth and data return of the ATL sensor.
2. **Dynamic Flight Line Optimization:** Areas with persistently high turbidity were identified pre-flight, allowing for the precise adjustment of flight line density and overlap, minimizing costly re-flights and maximizing the successful coverage of the challenging nearshore zones.

This case study demonstrates the substantial value of integrating high-frequency satellite monitoring into traditional hydrographic workflows. The use of PlanetScope-derived water quality metrics proved instrumental in transforming an otherwise complex and expensive ATL campaign into a highly efficient, data-driven, and cost-effective operation, setting a new benchmark for hydrospatial surveying in optically variable environments.

Bathymetric Lidar in New Zealand: Then and Now

Michael Christy, Daniel Kruimel, Jeff Lilycrop

In 1999 the JALBTCX (Joint Airborne Lidar Bathymetry Technical Center of Expertise) bathy lidar system (named SHOALS) was hired by Fugro to fly two areas in New Zealand for LINZ to produce data for nautical charts. Mark Brooks was the Fugro Team Lead and Jeff Lilycrop was the JALBTCX director. Both Jeff and Mark are now with Woolpert, who are one of the contractors selected by LINZ for the current 3D Coastal Mapping (3DCM) programme.

This presentation will discuss how bathymetric lidar technology and applications have evolved over the last 25 years, including advancement of JALBTCX in pioneering coastal mapping for coastal zone management and resilience. The presentation will also compare the 1999 bathy lidar survey with what is being achieved today under 3DCM.

3D Coastal Mapping – Data Assessment, Publication and Interpretation

Alysha Johnson

Toitū Te Whenua Land Information New Zealand (LINZ) is leading an effort to map 40% of New Zealand coastline, equating to over 10,000 km^2. From January 2025, high resolution Airborne LiDAR Bathymetry (ALB) has been collected along the coastal zone from 200 m inland of the Mean High Water Spring coastline, across the nearshore region, and seaward to 25 m water depth. This data is being collected by Woolpert across the North Island, and NV5 across the South Island. Seamless topographic and bathymetric DEM surfaces are produced, supported by a plethora of auxiliary information including aerial photographs, intensity and classified point clouds. This presentation will explore the steps taken to undertake quality assurance on the delivered data, as well as the publication pipeline to release the data upon the LINZ Data Service. A selection of highlights from the project so far will be showcased. This will include exhibiting use cases for the data within the fields of geomorphology and coastal monitoring. LINZ wish to use this opportunity to not only showcase the data already collected, but to invite the hydrographic and coastal community to utilise the data to support their own work and research.

Mind the Gap: 3D Coastal Mapping Infill Survey

Olli Rogers, Jimmy Van Der Pauw

As part of the Land Information New Zealand (LINZ) 3D Coastal Mapping Programme, Discovery Marine Ltd (DML) has undertaken nearshore infill surveys along the Otago coastline to enhance the existing coastal bathymetric model. The programme's objective is to deliver a seamless 3D elevation dataset that integrates airborne topographic-bathymetric LiDAR with vessel-based multibeam echo sounder (MBES) coverage.

This presentation provides an update on the 2025/2026 3DCM Otago infill campaign, outlining survey methodologies, field challenges, and preliminary outcomes. The Otago coastline represents a challenging nearshore survey environment, characterised by full exposure to the southern Pacific Ocean, turbid waters, intricate reef structures, and extensive bull kelp beds.

The resulting datasets will provide high resolution point cloud datasets of nearshore reef structures, sedimentary bedforms, and submerged hazards critical to navigation safety. These data sets continue to build on New Zealand's national 3D coastal dataset and provide a valuable foundation for coastal hazard modelling, marine habitat assessment, and sea-level rise analysis.

The Ins and Outs of Joining Land and Sea

Jennifer Coppola

LINZ's Joining Land and Sea (JLAS) project is the much-anticipated link between land- and sea-based datasets. The project will define relationships between vertical datums, allowing elevation (land) and depth (sea) datasets to be easily and consistently merged.

LINZ has completed several key pieces of work including partnering with NIWA to develop a new NZ tidal model and collecting additional sea level information around the coastline. This presentation will give an update on some of the challenges faced and the next steps.

JLAS is an important element of LINZ's 3D Coastal Mapping programme. The project will facilitate the merging of historic and future datasets, and land-based (e.g. LiDAR) and depth datasets. JLAS will also permit the collection of GNSS tides for reducing bathymetry to Chart Datum, which will lessen the dependency on shore-based short-term tide gauges for hydrographic surveys.

Leveraging Bathymetric Lidar and Sonar in a Coordinated Large-scale Multipurpose Mapping Campaign - Thunder Bay National Marine Sanctuary

Dave Bernstein, Colin Cooper, Nick Damm, Erin Cziraki

NV5 Hydrospatial has supported large-scale nautical charting efforts for NOAA's Office of Coast Survey (OCS) in the Great Lakes and recently applied a single, coordinated survey approach that combined aerial bathymetric lidar with vessel-based multibeam sonar to evaluate how these technologies can most effectively work together in a modern hydrographic mapping campaign. NOAA OCS, in collaboration with NOAA Sanctuaries and the Great Lakes Environmental Research Lab (GLERL), carried out this effort within the Thunder Bay National Marine Sanctuary, an area that supports interstate and international commerce along the St. Lawrence Seaway and benefits regional industries such as shipping, tourism, sailing, diving, and fishing.

The coordinated approach utilized NV5's in-house aerial bathymetric lidar and vessel-based sonar in a highly aligned manner to support the multipurpose mapping campaign. Bathymetric lidar provided efficient, cost-effective coverage of shallow areas and helped identify locations where sonar should focus for detailed mapping, infill, and feature verification. This allowed the multibeam effort to be directed where higher-resolution data were needed most. Throughout the project, special attention was given to understanding the efficiency, limitations, and relative performance of both bathymetric lidar and sonar in terms of coverage, quality, object representation, and cost-effectiveness. Feature detection, identification, and targeted recovery were central elements of the coordination, and the combined workflow offers valuable insight into how bathymetric lidar can support and complement sonar-based charting activities in future surveys.

To enhance operational transparency and decision-making, NV5 integrated the vessel-based Survey Information Management System (SIMS) with the lidar team's QAura platform. This created a unified web application that displayed live positions from vessels and aircraft, dynamic progress metrics, and simultaneous visualization of multibeam and bathymetric lidar rasters. The shared GIS environment supported collaborative annotation and real-time assessment and represents an innovative and scalable workflow for future multi-platform surveys.

This project provides new insight into how coordinated lidar and sonar operations can improve mapping outcomes, strengthen feature detection and confirmation workflows, and offer a practical model for future hydrospatial mapping and large-scale nautical charting programs.

The general bathymetric chart of the oceans (GEBCO) strategy 2024-2030

John Maschke, Geoffroy Lamarche

GEBCO was established in 1903 to bring knowledge about our planet's seabed to everyone through the production of free, open and complete seabed data and information for the world's oceans. The workforce behind GEBCO is mainly made up of a voluntary force of international scientists, hydrographers and representatives from industry under the umbrella of the International Hydrographic Organization. This presentation provides the general strategy for the compilation and production of GEBCO.

Coordinating Australia's Seabed Mapping Future – AusSeabed and the Survey Coordination Tool

Ryan de Wet

Australia's seabed spans vast and diverse marine environments, making comprehensive mapping a challenge requiring national coordination. AusSeabed is a collaborative initiative to improve the awareness, coverage, quality, accessibility, and usability of Australian seabed mapping through coordination, collaboration, and innovation. Over the past seven years, AusSeabed has established the foundation for this collaboration, delivering improved data accessibility, technical standards, and planning tools to support shared priorities.

The National Seabed Mapping Program (NSMP) is guiding the next phase of this work via a strategic framework for prioritising mapping activities and optimising resourcing. Central to this approach is the Survey Coordination Tool (SCT) — a digital platform designed to enhance collaboration, minimise duplication, and maximise investment in seabed mapping.

This presentation will outline AusSeabed's achievements to date, demonstrate how the SCT is impacting national coordination, and explore how these initiatives position Australia for the next generation of seabed mapping under the NSMP. Hydrospatial 2026 offers an opportunity to showcase how strategic coordination tools are shaping the future of seabed mapping in Australia.

Resourcing Australia's Prosperity: A 35-Year Vision for Offshore Mapping

Pip Bricher

Resourcing Australia's Prosperity is the Australian Government's 35-year, $3.4 billion precompetitive geoscience initiative, led by Geoscience Australia. The program aims to accelerate the discovery and development of critical minerals and other resources to support Australia's net zero transition and ensure the responsible management of all resources. This long-term investment will provide the foundational geoscience data required for informed decision-making across resource development, energy transition, and marine spatial planning.

A key focus of Resourcing Australia's Prosperity is Australia's extensive offshore marine jurisdiction. The initiative will deliver Australia-wide geoscience products that provide seamless datasets from offshore to onshore, underpinning a wide range of applications—from environmental modelling and infrastructure planning to offshore renewable energy projects. In addition to new data acquisitions, legacy datasets are being reviewed and reprocessed where necessary to add significant value to these integrated products.

This presentation will outline the objectives of Resourcing Australia's Prosperity for offshore mapping, highlight recent progress in offshore geoscience, and demonstrate its role in delivering the data required for Australia's transition to a low-carbon future. HydroSpatial 2026 provides an opportunity to showcase how this long-term initiative is enabling collaboration across government, industry, and research to achieve Australia's economic and environmental goals.

Seabed 2030 and Advancing Ocean Mapping: Project Updates and Goals for 2026

Sam Davidson, Kevin Mackay, Jenny Black, Sally Watson, Brook Tozer, Susi Woelz, Adam Greenland, Stuart Caie, Vaughan Stagpoole, Alysha Johnson

In 2017, the Nippon Foundation and General Bathymetric Chart of the Ocean (GEBCO) established the Seabed 2030 Project; tasked with building the necessary technical, scientific, and management frameworks to compile all available seabed mapping information into a seamless digital map of the world's ocean floor by 2030. Over the following 8 years, the Seabed 2030 Project has continued to accelerate our understanding of the world's oceans through the annual release of global bathymetric compilation grids and maps for public use. In 2021, Seabed 2030 was officially endorsed as a flagship programme of the UN Decade of Ocean

Science for Sustainable Development and in 2024 was selected as a Scale-up-Program (SCUP) by the Paris Peace Forum, highlighting the international impact of the project.

The Seabed 2030 project is now in its 9th year and has recently completed compiling data for the 2026 release of the GEBCO grid. Here we present an overview of the Seabed 2030 project, global seafloor mapping progress-to-date, and aspirations for potential future programs.

S-100 and e-Navigation in Australia: A national coordination effort

Alvaro Sanchez

This presentation aims at updating the audience with the latest S-100 developments and Australia's plans and initiatives to coordinate efforts at the national level.

Australia's S-100 stakeholders working group (S100WG) was stood up to take a leadership role in the creation, implementation and oversight of the introduction of S-100 based services in Australia by developing documentation, creating national guidelines and policies, defining roles, responsibilities and controls that will harmonize the e-Navigation data chain.

A working group under the Intergovernmental Committee in Surveying and Mapping (ICSM), the S100WG is responsible for coordinating and managing the timely and effective implementation of a broad range of S-100 products and services in the region. The IHO's S-100 Universal Hydrographic Data Model framework and its related products and services are key in enabling the International Maritime Organization (IMO) e-Navigation strategy.

Starting in 2026, mariners and other stakeholders will start having limited access to S-100 products and navigation system prototypes for familiarisation and testing purposes.

From 2029, Electronic Navigational Charts (ENCs) based on the new S-101 specification will begin to be integrated into the bridges of new ships, as type-approved S-100 Electronic Chart Display and Information Systems (ECDIS) are installed to meet IMO's mandatory carriage requirements. They will be accompanied by various other interoperable products developed by a diverse range of stakeholders, facilitating enhanced route monitoring and planning capabilities.

Additionally, S-57 ENCs will remain a valid navigational product for many years, coexisting with S-101 ENCs in a system referred to as Dual Fuel ECDIS (DF-ECDIS).

S-100: Integral to Future Marine Discovery

David Crossman, Peter Jensen

<u>Introduction:</u>

The transition to S-100 is one of the most significant developments in the maritime industry in contemporary history. This significant development is not only fundamental to the future of the entire maritime and marine industry, but is already upon us, with the official commencement date for the roll-out of IHO S-100 Phase 1 products occurring from January 2026! So what does that mean for our community, and what is the progress of this roll-out in this region?

<u>Situation:</u>

The S-57 data set that currently underpins the mariner's Electronic Chart Display and Information System (ECDIS) is primarily the bathymetric data utilised to support safety of navigation. However S-100 comprises multiple layers of stored and live data that will give the user an unparalleled depth and breadth of interoperable knowledge and information. However, it is not only mariners who will benefit from this development, in addition to safety of navigation, the S-100 data has direct application to the enablement of ocean management, streamlining port operations, protection and improvement of marine habitats, sustainability, coastal communities' assistance, national infrastructure, logistics efficiency, situational awareness, interoperability, marine traffic management, compliance and much more. As a result, there are significant economic, commercial, technical, risk, safety, and environmental benefits to be gained. And for us hydrographers, it will be a data source that we utilise for safety of navigation, for route and survey planning, and for the optimisation, efficiency and conduct of survey operations. It will also influence data that we gather are required to gather in order to feed this suite of S-100 specifications.

Summary:

Having undertaken over 100 S-100 projects, pilots and studies on behalf of National Hydrographic Authorities, the IHO, Coast Guards, and other appropriate authorities, IIC is arguably the world leader in S-100 development and support to organisations in their S-100 transition journey, and well placed to help shed further light on this subject. Therefore, this presentation will Provide an update on new developments in the S-100 space, give an indication of how the S-100 roll-out is progressing globally and within our region, and perhaps have a look at some of the specifications of particular interest to this community.

Towards S-100 for Australia: High resolution coastal model products

Roger Proctor, Alvaro Sanchez

This talk will focus on the high-resolution coastal hydrodynamic models which are a central component of Australia's transition to S-100–based navigational products. These models underpin new S-104 Water Level and S-111 Surface Current services, which will support real-time under-keel clearance management, enhanced route optimisation, and improved maritime safety information within next-generation onboard systems. This future interplay between products enables more efficient navigational decisions.

To access these digital services, ships will need to update onboard systems. As an example, the International Maritime Organisation is writing new standards for the exchange of voyage plans and route information. New products that apply these standards in the ECDIS will be available as early as 2026. We know that there is a race amongst ECDIS suppliers to produce new hardware and software capable of meeting these new standards to capture new market share, and that port operations are gearing up for the use of S-100. These two groups and more will rely on both private enterprise and Hydrographic Offices for support and data. In the foreseeable future the high quality S100 data in Solas vessels will benefit the non solas sub ECDIS market with better data for smaller commercial and non commercial vessels.

In its S-100 Roll Out Plan the Australian Hydrographic Office has identified 22 focus areas around Australia to commence the release of S-101 (ENCs), S-102 (Bathymetric Surfaces), S-104 (Water Levels), and S-111 (Surface Currents) products from 2026. These focus areas will include major ports around the country, Antarctica, Papua New Guinea and Solomon Islands. The S-100 navigational products will be gradually released to the public until S-100 coverage replicates the S-57 portfolio.

We will discuss the development of high resolution hydrodynamic models for a number of these focus areas, and discuss some of the issues associated with the integration of S-104 and S-111 into the S-100 framework.

S-102 in the Port Environment: Technical Insights and Operational Impact

Annette Wilkinson, Dave Mundy

Hydrographic Offices and port operators are approaching S-102 from different operational realities, yet both increasingly rely on high-resolution bathymetry to support safe and efficient navigation. Pilots already use detailed gridded surfaces in PPUs and ECS tools, while Hydrographic Offices are preparing S-102 as a regulated, standardised product within the S-100 framework. This presentation brings both perspectives together to show how S-102 can bridge the gap between what pilots rely on today and what ships will carry on ECDIS tomorrow.

NZ perspective on S-100

Verena Bosselmann-Borsos, Marvin Espino

Abstract to be added

Your Secchi May Vary: An Exploration of Full-Waveform LiDAR Processing in the Topo-Bathymetric LiDAR Context

Eleanor Chandler-Temple

Topo-bathymetric LiDAR faces challenges its full-topographical equivalent does not – turbidity, refraction, and other complexities all factoring into the heavily-customized processing workflows required. In this study, we put multiple full-waveform processing strategies to the test in a complex braided river system, examining the influence of the environment on each available full waveform processing strategy.

Using RIEGL VQ-840-G data, the study evaluates noise levels, bottom detection density, processing time, and classification stability across contrasting aquatic environments within the river system – deep-channel, estuarine, and shallow lotic reaches. Processing strategies ranged from traditional, general-purpose waveform approaches such as system response fitting (SRF) to more bathymetry-focused surface-volume-bottom (SVB) routines, including deep learning-assisted exponential decomposition (dl-XDC).

If you're looking for a universally optimal workflow, this talk may disappoint. If you want to understand why your Secchi may vary – and potentially what to do about it – join me for a deep dive into full-waveform processing with an unapologetic bathy waveform nerd…

Addressing the challenges of Topo/Bathy LiDAR in the south west Pacific

Andrew Waddington

Airborne LiDAR Bathymetry (ALB) has the potential to contribute quickly to the knowledge of the nearshore environment in the Pacific Islands. Mapping is a key stage in understanding, monitoring and mitigating the effects of climate change, tourism and industry on Large Ocean States.

Any hydrographic survey work faces technological and environmental challenges but in the vastness of the Pacific these challenges can be dwarfed by those of logistics and support, infrastructure, and control. Coupled with financial constraints and sometimes on limitations of local expertise, bringing in an aircraft and the niche skills needed to carry out an ALB successfully can be severely restricted.

We will discuss the challenges of remote logistics (shipping, accommodation, fuel, access and connectivity), customs and immigration regulations, local aviation, and limitations in control networks as well as the more common ALB environmental issues.

In doing so, aspects of the specification and their impact on the cost of the survey will be highlighted alongwith suggestions on how these might be approached for other surveys.

Using a case study from a recent ALB survey carried out in French Polynesia for DCN and under the technical supervision of SHOM, this presentation will introduce some of these challenges, show how they were addressed and propose ways to minimise their impact on the survey and the cost in the future.

Autonomous Underwater Vehicles in Hydrographic Surveys: Opportunities, Challenges, and Charting Accuracy

Tim Garvan, Rhys Davies

Hydrographic surveys are critical for safe navigation, environmental monitoring and marine resource management. Traditionally, these surveys have relied on surface vessels equipped with sonar and supported by continuous GNSS positioning. In recent years, the advent of autonomous underwater vehicles (AUVs) has revolutionised the approach to marine data acquisition, for certain applications. This abstract presents a critical examination of AUVs in hydrographic surveys, focusing on their operational advantages, technological limitations, and the ongoing debate regarding their ability to achieve charting levels of accuracy.

AUVs offer several distinct benefits over conventional survey platforms. Their ability to operate close to the seabed enables the deployment of sensors in proximity to surveyed surfaces, markedly improving object detection and data resolution. The covert nature of AUV operations also allows surveys to be conducted discreetly, which is particularly valuable for defence applications and sensitive environmental assessments. Deploying multiple vehicles in coordinated missions can dramatically increase survey efficiency, enabling the rapid mapping of large expanses of seafloor with minimal human intervention. Furthermore, AUVs are largely unaffected by surface conditions such as sea state, swell, or daylight constraints, permitting surveys to continue uninterrupted in conditions that could otherwise halt traditional vessel-based operations. This resilience expands the operational window and offsets the relatively slow speed of AUVs, ultimately enhancing rate of data collection.

Despite these advantages, a critical question persists:

- Can AUVs deliver the positional and depth accuracies required for charting, as defined by international standards such as those set by the International Hydrographic Organization (IHO)?

Achieving charting-level accuracy entails precise positioning and robust sensor integration. AUVs must overcome challenges related to underwater positioning, where GNSS signals are unavailable, and rely on inertial navigation systems, acoustic positioning, or hybrid-fixing solutions. While recent technological advances have improved AUV accuracy, constraints remain. Factors such as sensor drift, environmental noise, onboard power limitations and the complexity of post-processing data can impact the reliability of survey results.

The presentation will address the following key points: the operational advantages that AUVs can bring to hydrography; the technological advancements that have enhanced AUV navigation and sensor performance; the constraints posed by current technology, including limitations in accurate positioning; and potential solutions to achieving efficient and accurate hydrographic surveys using AUV. Case studies using empirical and simulated data will illustrate how AUVs can meet charting standards under varying conditions. The discussion will also consider future developments, such as improvements in underwater localisation, real-time data validation, and collaborative swarming approaches among multiple AUVs.

In summary, while AUVs have transformed underwater operations with their versatility, coverage, and resilience to surface conditions, achieving charting levels of accuracy remains a complex challenge. The extent to which AUVs can meet these standards depends on technological integration, mission planning, and post-survey data management. This presentation aims to provide a balanced perspective on the current state of AUV-enabled hydrography, offering insights into both the opportunities and the constraints that define this rapidly evolving field.

The Challenges of Conducting Airborne Lidar Bathymetric Surveys in a Changing Climate

Mick Hawkins

Bathymetric LiDAR has emerged as a transformative tool for coastal zone topographic and bathymetric surveys. In areas once considered too challenging to survey, this technology enables safe and efficient acquisition of high-density point cloud data across extensive regions, particularly those vulnerable to climate change and rising sea levels. These datasets support critical research and analysis, informing effective coastal engineering decisions and the sustainable management of the marine estate. This advancement has spurred the development of innovative monitoring and modelling techniques, offering coastal managers unprecedented insights into coastal dynamics.

Despite its capabilities, bathymetric LiDAR systems face a persistent challenge: water clarity. Factors such as river runoff and breaking waves can significantly affect clarity, with seasonal variability adding further complexity. Fugro has addressed this issue by leveraging historical modelling through Satellite Analytics (SatAnalytics) and decades of project experience to identify optimal survey windows and deliver high-quality products to stakeholders. However, recent shifts in climate patterns have altered these trends. Cyclone seasons are expanding, cyclones are tracking further south, storm intensity is increasing, beach erosion is accelerating, rainfall volumes are rising, and dry seasons are becoming less predictable.

These evolving conditions have introduced new challenges to data acquisition. Even during historically reliable survey periods, weather unpredictability has increased, leading to extended project timelines and reduced ease of data capture. In response, Fugro has adapted its operating model to remain agile under changing environmental conditions.

In early 2025, Fugro strengthened its capabilities by acquiring EOMAP GmbH & Co. KG (EOMAP), a leader in satellite-based mapping and monitoring of marine and freshwater environments. Integrating Earth Observation (EO) technology into Fugro's existing suite of mapping solutions enhances flexibility throughout the project lifecycle.

Satellite-derived turbidity data now plays a pivotal role in project planning and execution. This data provides a reliable, cost-effective overview of turbidity variability over time. Historical satellite imagery enables analysis of turbidity levels and sediment transport patterns, offering insights into environmental impacts across large or dynamic areas. Near real-time access to daily satellite images empowers field teams to assess current conditions and adjust survey plans, improving responsiveness and operational efficiency.

Recent innovations in GeoData delivery is transforming how clients engage with and act on coastal survey insights. Platforms like Fugro's **VirGeo** now enable stakeholders to access, share, and interact with airborne LiDAR and Earth Observation (EO) datasets in near real-time, fostering transparency and collaboration across project teams. By integrating satellite-derived products from EOMAP and other providers, users can independently monitor turbidity, environmental conditions and the progress of data collection dynamically throughout the survey lifecycle. This shift from static reporting to interactive, allows decision-makers to respond faster, plan more effectively, and align survey outputs with broader climate resilience goals.

This presentation will explore recent project challenges in Western Australia and Queensland, highlighting how Fugro is leveraging EO data to enhance data acquisition strategies and deliver robust outcomes in increasingly complex coastal environments.

Multi-Source Coastal Bathymetry for Hydrospatial Resilience using Sentinel-2, ICESat-2 and SkyTEM in Northland, New Zealand

Salman Ashraf, Brooke Tozer, Gokul Anand, Tusar Sahoo

We present a multi-technique framework for shallow water bathymetry retrieval, using a range of remote sensing methods including optical Satellite-Derived Bathymetry (SDB), Wave Kinematic Bathymetry (WKB), ICESat-2 space-based LiDAR and Airborne Electromagnetic surveying (SkyTEM data). Our goals are twofold: 1) To assess the applicability of these remote sensing methods in differing New Zealand coastal environments for supporting hydrospatial planning and hazard resilience, in alignment with the National Adaptation Plan (NAP) and targeted surveying campaigns such as Land Information New Zealand/Toitū Te Whenua's 3D LiDAR Coastal Mapping project; and 2) Provide improved bathymetric datasets to underpin modelling of inundation, sediment transport, dynamic wave behaviour, and tsunami simulations to enhance understanding of hazards and risks in vulnerable coastal regions. We present optical SDB results from Sentinel-2 imagery calibrated using ICESat-2 LiDAR tracks across three environmentally favourable sites located on the east coast of the Far North of New Zealand (e.g., Fig. 1). The empirical spectral ratio method yielded reliable results in the 3-10 m depth range, with high correlation values ($R^2 \approx 0.94$) and Mean Absolute Deviations of ~0.7-0.8 m relative to "ground-truthed" multibeam data (Fig. 2). However, performance degraded in optically complex environments, particularly below 2 m or over rocky seabed. In Great Exhibition Bay, SDB revealed ~4 m discrepancies in the dynamic Parengarenga Harbour mouth compared to LINZ's navigational chart, highlighting its potential utility for change detection (Fig. 3).

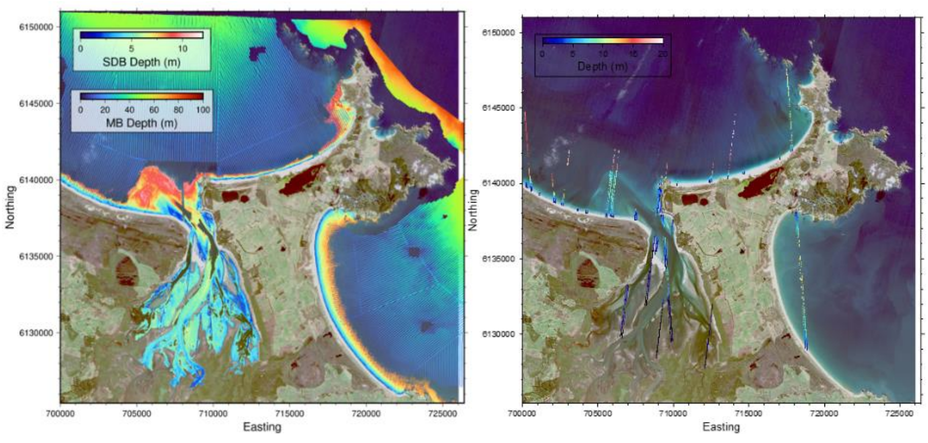

Figure 1: Comparison of SDB results with multibeam data and ICEsat-2 tracks in Rangaunu Bay and Doubtless Bay, Northland

As an alternative to optical SDB, we utilised recently acquired SkyTEM airborne resistivity data to assess the utility of the electromagnetic source for mapping the seafloor. SkyTEM successfully delineated the seawater/seafloor interface to ~20 m depth, with strong correlation to multibeam (fig. 4). While its spatial resolution is 5-10 times lower than SDB, SkyTEM proved effective in turbid and wave-affected areas where optical methods fail.

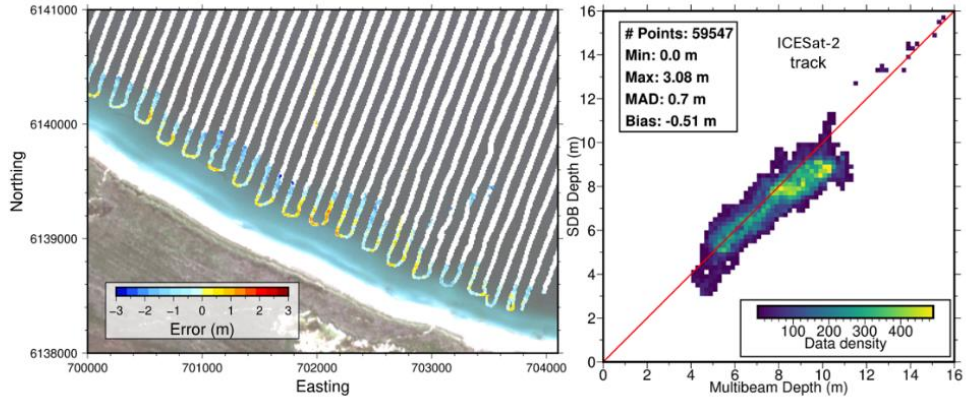

Figure 2: An example of validating SDB results with multibeam data in Western Rangaunu Bay, Northland

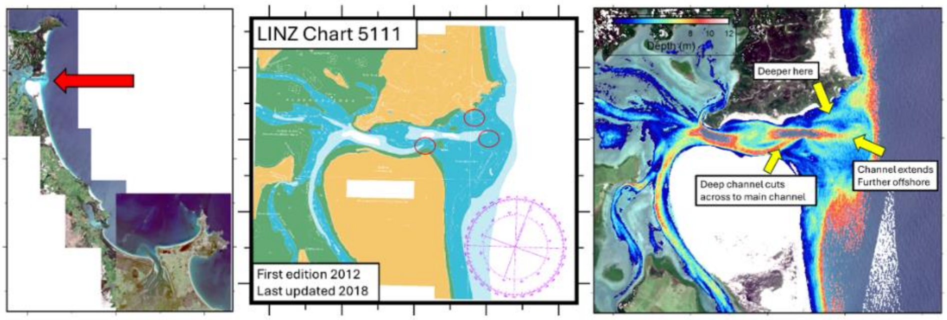

Figure 3: Comparison of SDB with LINZ navigational chart, highlighting its utility for change detection in the Parengarenga Harbour in Great Exhibition Bay, Northland

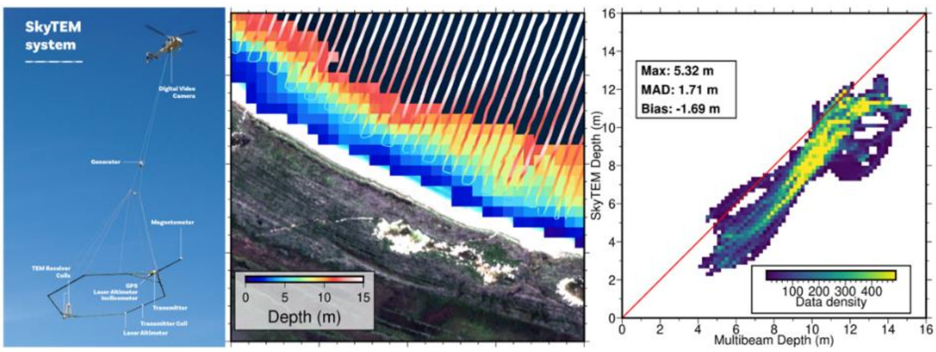

Figure 4: An example of comparing SkyTEM airborne resistivity derived bathymetry with multibeam data in Western Rangaunu Bay in Northland

Similarly, we have performed WKB using the S2Shores framework, extending bathymetric retrieval further offshore, into optically deep areas. In Doubtless Bay bathymetry is derived to a maximum ~25 m depth. Extending recovery 15 m deeper than optical SDB, albeit at a spatial resolution degraded by a factor of five (50 m). We assess both the SDB and WKB results against recently acquired marine LiDAR to inform national standards for coastal bathymetry integration.

This integrated approach offers a scalable, cost-effective solution for filling national bathymetric data gaps and supports policy goals for climate adaptation, hazard resilience, and hydrospatial data infrastructure. Future work will focus on refining wave-based methods, validating SkyTEM corrections, and developing regional bathymetry strategies tailored to geographic coastal conditions and end-user needs.

Innovating Hydroacoustics: New Tools for Shaping the Future of Marine Discovery

Henry Johnson

As an OEM, Kongsberg Discovery draws on decades of in-house expertise to develop and deliver world-leading technologies that advance our understanding of the marine environment and address complex operational challenges.

Our technologies are deployed globally across research, government, and commercial sectors—empowering users to shape the future of marine discovery.

This presentation will highlight recent innovations in hydroacoustic instrumentation designed to enhance maritime domain awareness and support cutting-edge oceanographic research.

EM 2042 – Next-Generation Shallow Water Multibeam Echosounder
The EM 2042 is Kongsberg's latest shallow water MBES, featuring multi-transmitter architecture and full 4D motion compensation. Engineered for portability and ease of use, it introduces two groundbreaking features:

- PredictivePitch
- QuadSwath

Together, these capabilities significantly improve survey efficiency and data quality, even in challenging conditions.

Single Beam and Scientific Echosounders
Advancements in EK80 broadband split beam transducers and ADCPs are unlocking new insights into ocean dynamics—from fine-scale measurements to novel data interpretation. Key topics include:

- Vertical current profiling with ADCP
- Mapping physical properties of the water column
- Generating bathymetry from split beam data with multiple soundings per ping ("swath") - a technique that could be retroactively applied to existing datasets, supporting initiatives like Seabed 2030 and AusSeabed.

Unfolding Vertical Structures: Enhancing Port survey workflows with 3D Coordinate Transformations

Dan Morash, Travis Hamilton

The latest enhancement to CARIS's software introduces a new workflow for processing data from vertical structures in the marine environment, such as quay walls, dams, and bridge piles. Traditionally, ocean mapping workflows focus on horizontal data acquired from sonar and lidar, primarily targeting the ocean floor. This new functionality addresses the unique challenges posed by vertical structures imaged in the marine environment, offering a transformative approach to data processing.

The workflow begins with the creation of an engineering alignment that follows the shape of the vertical structure in the x/y plane. This alignment serves as the foundation for a subsequent 3D coordinate transformation, where the alignment is utilized as the destination coordinate system. Through this transformation, complex vertical data is effectively unfolded into a strip, akin to a film strip. This process allows the data to be perceived in a horizontal plane, simplifying the complexity of vertical structures.

By converting vertical data into a horizontal format, existing processing and analysis tools within CARIS can be seamlessly applied. This new workflow significantly enhances processing efficiency and enables more detailed analysis of data from vertical marine structures.

Multi-frequency multibeam in Fiordland

Emily Tidey

Multi-frequency multibeam is of interest to marine habitat and geophysical researchers, as the differing seabed returns from each frequency that is used may indicate environmental or seafloor sediment differences that are not possible to determine with only one frequency. The use of this technique comes with in-field challenges in balancing the multibeam settings such as the absorption, power, pulse width, gain and swath width as well as office factors when processing the data.

The University of Otago has been experimenting with the multifrequency settings available in our R2 Sonic 2026 which has an operational range of 90-450kHz. In late 2025 we ran some lines in Fiordland to ascertain the considerations to make when this multibeam method is used for deep water operations (>200m). Here we share the results of our sounding data, the next steps for us in using this data and future multi-frequency multibeam field trials.

Bathymetric and Terrestrial Survey Innovation for Ports and Harbors

Daniel Kruimel

Woolpert is a global leader in geospatial and engineering services, delivering advanced bathymetric and terrestrial survey solutions that empower ports and harbors to operate safely, efficiently, and sustainably. With over six decades of innovation and a team of certified hydrographers, geophysicists, and licensed land surveyors, Woolpert combines cutting-edge technology with rigorous quality standards to address complex maritime and coastal challenges.

Technologies and Methods
Our bathymetric capabilities leverage **multibeam and single-beam echosounders**, **side-scan sonar**, and **sub-bottom profilers**, integrated with **RTK GNSS positioning** and motion systems for precise depth and positional accuracy. For terrestrial and structural mapping, Woolpert employs **Terrestrial Laser Scanners (TLS)**, **total stations**, and **GNSS receivers**, complemented by **airborne LiDAR** and **photogrammetry** for seamless integration of land and marine datasets. Autonomous and crewed platforms, including **Uncrewed Surface Vessels (USVs)**, enable rapid deployment in challenging environments, while vessel-based LiDAR enhances nearshore and infrastructure detail.

Woolpert have recently pioneered an **innovative SLAM** methodology for mapping underwater infrastructure in GPS restricted environments. Instead of using SLAM directly with the acoustic data, our solution was to use a SLAM LiDAR system on the survey vessel as a navigation device in lieu of GNSS. While the most visible result of a successful SLAM survey is a cohesive point cloud, the relative position and orientation of the LiDAR sensor is also calculated. By extracting and formatting this position and orientation data to simulate a post-processed trajectory file (i.e. SBET) it can be applied to multibeam or any other sensor on the vessel in an otherwise standard workflow.

This presentation will share methodology, results of a survey, and the lessons learned. We'll also discuss the accuracy and repeatability of the data, the time synchronization considerations, and the applicability of this method to different GNSS-denied environments.

Applications and Business Impact
These technologies solve critical operational and planning problems for port authorities and maritime stakeholders:

- **Navigation Safety**: High-resolution bathymetric data identifies shoals, obstructions, and sediment build-up, ensuring safe vessel passage and compliance with international standards.
- **Dredging Optimization**: Pre- and post-dredge surveys provide accurate volume calculations, enabling cost-effective material removal and channel maintenance.
- **Infrastructure Management**: TLS and LiDAR surveys deliver precise as-built documentation of wharves, piers, and coastal structures, supporting asset management and engineering design.

- **Environmental and Regulatory Compliance**: Integrated geophysical and topographic datasets inform habitat mapping, sediment analysis, and coastal resilience planning, meeting IHO and NOAA specifications.

- **Future-Proof Planning**: Unified bathymetric and terrestrial datasets underpin hydraulic modeling, shoreline development, and long-term port expansion strategies.

Woolpert's ISO 9001:2015-certified processes and adherence to IHO S-44 standards guarantee data integrity and interoperability. Trusted by international governments, port authorities, and private-sector clients, Woolpert delivers actionable insights that reduce risk, optimize operations, and enable sustainable growth for ports and harbors worldwide.

Update on HIPP in Fjord

Steve Duffield

Reach Subsea launched the Reach Remotes with a Pilot Project in April 2025 where the Reach Remote undertook several user activities, including a Hydrographic survey to HIPP standards.

Reach Remote 2 arrived in Australia in October 2025. It will undertake an initial project, followed by an HIPP project, starting in January 2026.

This presentation will provide a recap of the pilot project, with an update of current activities.

Scratching the Surface: Human Impacts Across NZ's Marine/Freshwater Environments

Sam Davidson, Sally Watson, Scott Nodder, Grace Frontin-Rollet, Susi Woelz, Tilmann Steinmetz, Joshu Mountjoy, Alan Orpin

The people of Aotearoa New Zealand have a close connection to the awa (rivers), roto (lakes), and moana (ocean) with ~65% of all residents living within 5 km of a coastline. Although multiple agencies and institutions have been actively researching and surveying the shallow marine and lacustrine environment across Aotearoa, each of these surveys has involved a variety of different acquisition techniques (e.g., towed cameras, multibeam echosounders, sub bottom profilers, etc…) and survey output requirements (e.g, hydrographic surveys vs. ecological habitat assessment). Many surveyed marine/freshwater settings around New Zealand have shown a broad range of anthropogenic features in processed bathymetric surfaces. Although quickly detected in real-time, many of these features can be quickly 'smoothed' out due to their relatively fine scale (< 10 m), resulting in either a lack of ability to reconcile features, or the mischaracterization of features as other natural phenomena (e.g., rock outcrops or other rugose features). Additionally, even if human impacts are detected in one dataset type (e.g., multibeam echosounder), it may not be evidently clear how these features are modified or preserved through time. As such, it is essential that the ability to extrapolate out identified instances of detected human impact can be undertaken.

Here we present an overview of observed human impacts across New Zealand, synthesized from multiple research/hydrographic multibeam echosounder surveys in both marine and freshwater environments. We discuss how reprocessing hydrographic multibeam data, where possible, may be required to best identify anthropogenic features and how incorporation of other data processing techniques, such as structure-from-motion photogrammetry, may provide additional information outside of conventional morphometric analysis.

Reshaping Reserves: Exploring the Gaps in Marine Reserve Boundaries Through a Past-Present-Future Approach

Georgia Pendred

Marine Reserves mark spaces of protection, yet their boundaries reveal more than lines on a chart. They represent spatial expressions of how societies define, divide, and care for the ocean. In Aotearoa, boundary creation has been shaped by scientific practice and statutory requirements, but collaboration across disciplines, cultures, and communities has not always been consistent.

This Honours research examined how marine reserve boundaries have been defined and understood through a past, present, and future case study approach, focusing on Goat Island, Banks Peninsula and the South-East Marine Protection (SEMP) planning and implementation processes.

Five key metrics guided the analysis: surveying methods and data, legal frameworks, iwi inclusion and mātauranga Māori, stakeholder participation and scientific purpose. Using qualitative interviews and thematic analysis, the research showed that effective marine reserve boundaries depend on both on technical precision as well as social and cultural legitimacy. Boundaries that were clearly defined in both space and intent benefited from strong collaboration, transparent decision making, and engagement with local knowledge systems.

The findings demonstrated the central role hydrography and the surveyor in shaping the future of marine reserve creation and management. Hydrographic practice supports not only the precision of boundary placement but also the communication of their meaning and purpose. By translating multiple disciplines and voices into clear spatial form, hydrography acts as a connector between ecological data, legal certainty, and community values.

The research concludes that future boundary design would benefit from guiding principles that positions the surveyor as a mediator between worlds, translating data into meaning, and coordinates into collective understanding. Rather than prescribing a singular method, the study proposes principles for inclusive boundary design that reframe surveying as an act of connection between people, place, and protection. These insights support enduring marine guardianship in Aotearoa's waters and offer pathways for strengthening marine reserve management from the outset of their creation, enhancing the role of hydrospatial professionals as technological capabilities expand and the blue economy evolves.

Beyond bathymetry: Diving into the world of multibeam water column data and seep detection

Alicia Maurice

Multibeam echosounder systems (MBES) have been providing geospatial data with high resolution and accuracy for decades.

In addition to the acquisition of bathymetric data, acoustic returns from scatterers in the water column, if collected, can also provide invaluable information. While this type of data is commonly collected by split-beam echosounders for fisheries for example, the applications of MBES water column data are still falling behind their seafloor backscatter counterpart. This discrepancy can mostly be explained by the data storage challenge that the collection of MBES water column data represents. Yet, MBES water column data can provide key complementary information, especially when faced with elusive targets. They can contribute to enhancing bathymetry with quantitative information but also enable a more complete understanding of the underwater world.

In this presentation, we dive into some of the applications of multibeam water column data with a focus on how these data can be a strong ally in seep detection.

SmartCoast2 and Net Ecosystem Value: A Digital Twin Approach to Climate Resilience in the Torres Strait

Paul Seaton, Mick Hawkins

Digital twins of the ocean are emerging as a cornerstone of the UN Ocean Decade initiative, transforming how we integrate and interpret vast ocean science datasets to understand risks and design mitigation strategies. By combining historical and real-time geo-data with advanced modelling, these tools enable evidence-based decisions for sustainable management and stakeholder collaboration.

The **SmartCoast project** exemplifies this approach through the development of a Digital Twin for the Torres Strait—a region between mainland Australia and Papua New Guinea experiencing some of the fastest recorded sea-level rise globally. Led by **Fugro**, in partnership with **James Cook University (JCU)**, **Queensland University of Technology (QUT)**, **EOMAP**, and supported by the **Queensland Earth Observation Hub (EOHUB)**, SmartCoast applies a co-design process with local communities to create a digital coastal zone management platform for Horn and Thursday Islands.

This region's **natural capital**—particularly mangrove and seagrass ecosystems—provides critical nature-based solutions for coastal protection, carbon sequestration, fisheries productivity, and biodiversity. Yet, baseline data on the health and extent of these ecosystems is scarce, and monitoring systems are absent, limiting the ability to safeguard these assets. SmartCoast addresses this gap by leveraging **hydrospatial products**—integrating Earth Observation, LiDAR, bathymetric mapping, and high-resolution imagery—to deliver uninterrupted sea-to-land surveys focused on mangrove and seagrass habitats. These datasets underpin the SmartCoast platform, enabling robust ecosystem management and resilience planning. In doing so, the project expands the traditional use of **hydrography and ocean science data beyond navigation and safety**, applying it to climate adaptation, ecosystem valuation, and community resilience.

The platform offers dynamic visualisation of complex natural processes, environmental hindcasting and forecasting under multiple climate scenarios, and user-friendly interfaces aligned with FAIR data principles. Verification of ecosystem data is conducted with local habitat rangers, supporting advanced inventory classification (e.g., healthy, threatened, transition zones) and risk assessments for coastal inundation.

A key innovation is the integration of the **Net Ecosystem Value (NEV) framework**, which quantifies the ecological, social, and economic contributions of mangrove and seagrass systems. By monetising ecosystem services—such as shoreline protection, fisheries support, and carbon storage—NEV enables stakeholders to evaluate trade-offs, prioritise interventions, and justify investments in restoration and conservation. Coupling NEV with digital twin capabilities creates a powerful decision-support tool that visualises environmental change, forecasts climate impacts, and strengthens adaptive management strategies.

SmartCoast demonstrates how valuing natural capital alongside technological innovation can drive climate resilience, safeguard livelihoods, and support sustainable development in vulnerable coastal regions.

Evaluating Seabed Pressure from Merchant Vessel Anchoring in New Zealand

Hendra Febriawan, Sally Watson, Marta Ribó, Sam Davidson, Simon Thrush, Jenny Hillman, Eva Leunissen, Geoffroy Lamarche

Shipping underpins both international trade and domestic freight in New Zealand. In 2024, merchant vessels, including container ships, bulk carriers, fuel tankers, and cruise ships, accounted for the majority of port visits. The highest number of ship arrivals was recorded at Tauranga, Auckland, Lyttelton, Napier, and Wellington. Collectively, these five major ports handled about 65% of all ship visits, with the remainder distributed among smaller ports nationwide. Anchoring is a routine and essential procedure for vessel safety and efficiency when awaiting port access. However, anchoring exerts physical pressure on the seabed and benthic habitats, with the intensity of seafloor disturbance influenced by vessel size, anchoring frequency, and substrate type (e.g., soft mud vs. rocky substrate). Anchoring may also affect water-column habitats by agitating and suspending sediments during anchor deployment and recovery. This issue is particularly concerning where anchorages occur near marine reserves or restoration sites. Despite its potential ecological impact, anchoring has generally been excluded from cumulative pressure assessments, making this investigation essential. This study aims to investigate the spatial extent, intensity, and frequency of merchant vessel anchoring activities at primary ports and anchorage sites in New Zealand using bathymetric and vessel tracking data. It also seeks to develop a cumulative pressure framework by integrating these variables to evaluate anchoring pressures on the seabed.

This study utilises Automatic Identification System (AIS) data collected from 2020 to 2024 to identify anchoring events using pre-processed search filters. Using spatial analysis, anchoring clusters and boundaries will be delineated for all ship anchor events at each port. Broad-scale regional bathymetry from Land Information New Zealand (LINZ) will be used to estimate water depth and infer potential anchor chain length. Where available, high-resolution bathymetry data will be used to validate visible anchor marks on the seabed in relation to AIS-derived anchoring locations. Cumulative anchoring pressure will be modelled by combining variables such as anchoring footprint, anchoring event density, bathymetry, impacted benthic habitat, and proximity to marine reserves.

This study will improve understanding of where and to what extent anchoring pressure on the seabed and habitats accumulates. AIS data offers a potential use in supporting assessments by identifying anchoring activities nationwide for the first time. The findings will enable examination of aggregated anchoring pressures across broad spatial and temporal scales, highlighting areas of high pressure and non-compliance. Incorporating quantitative and spatial analysis will support accurate estimation of actual conditions and enable suitable management decisions.

High-Resolution Bathymetric Evidence of Bedforms Indicative of Caldera Water Exchange at Hunga Volcano

Hannah St. Louis, Marta Ribó, Rebecca Carey, Christopher Yuleridge, Peter Harris, Vanessa Lucieer, Phil Van Den Bossche

The January 2022 eruption of Hunga Volcano in the Tonga Arc was one of the most powerful volcanic events in modern history, reshaping the submarine caldera and surrounding seafloor. Pre- and post-eruptive bathymetric mapping provided a rare opportunity to quantify material loss and gain surrounding the volcano. Bathymetric surveys revealed that the caldera deepened by more than 850 m and that large-scale depth changes across the mapped area reflect the removal of approximately 6.85 ± 0.05km^3 of material from inside the caldera and a further ~2 km^3 from its outer flanks. Much of this erupted material, approximately 6.3 km^3, settled on the seafloor within a 20 km radius of Hunga Volcano.

Building on this large-scale reconstruction, this study focuses on newly identified fine-scale geomorphic features along the rim of the caldera identified using high-resolution (5 m resolution) multibeam bathymetry data collected during the 2025 VEERI-HOT voyage on board the RV Investigator. A series of distinct bedforms, channels, and breaches in the caldera rim appear to represent active pathways for water and particle exchange between the caldera interior and the surrounding ocean. Many of these bedforms were newly recognized in the 2025 bathymetry dataset and were not clearly identifiable in the lower resolution 2022 multibeam survey; it therefore remains unclear whether they were generated by the 2022 eruption or by subsequent mass wasting events.

By integrating the analyses of these geomorphological features with hydrographic data, our results indicate that particle-rich water is actively being exchanged between the caldera basin and the ambient ocean. Conductivity-temperature-depth (CTD) vertical profiles from the 2025 voyage show a sharp contrast between the water masses inside and outside the caldera. Numerous temperature profiles indicate an anomaly within the caldera, where deep waters remain notably warmer (18°C), compared to just 4°C in the surrounding waters at equivalent depths. Turbidity data similarly shows two strikingly different water bodies, revealing high particle concentrations trapped within the caldera basin, suggesting limited vertical mixing. However, a pronounced highly turbid layer within the caldera appears to extend outwards through a breach in the north-eastern caldera rim, marking a clear alignment between geomorphological rim structure and hydrographic water column properties at this location.

Deep-towed camera footage revealed fine-scale bedforms such as ripples and scours, which were too small to have been detected in multibeam data. Near the north-east channel, the footage also revealed high abundances of several marine species, indicating early biological recovery potentially associated with water column conditions following the January 2022 eruption.

This study uses a synthesis of bathymetric mapping, backscatter interpretation, deep-towed camera imagery, and water column observations to demonstrate how high-resolution seafloor morphology can reveal physical exchange processes in a submarine volcanic environment. Hunga Volcano presents an exceptional opportunity to study the interaction between geomorphology and oceanography in a recently restructured volcanic system. This work highlights the importance of coordinated geospatial and oceanographic surveys in capturing both the physical structure and dynamic processes shaping submarine volcanism in the Southwest Pacific.

Jamming of GNSS in the European and Mid East marine environment - and what can we expect in Australasia

Gary Chisholm

Even though GNSS operation in Australiasian waters seldom suffers from jamming it is a matter of time before this problem becomes more common.

Jamming and spoofing of marine GNSS has ramped up especially in the Baltic Sea and the Middle East. Real examples in 2025 from those regions will be presented to explain how this affects marine operations. Then methods to detect and mitigate the problem will be presented.

Shaping the Future of Marine Discovery Through Sustainable Hydrospatial Capability in the Pacific

Christopher Saili, Neville Benson

Marine discovery in the Pacific is increasingly influenced by decisions made well before any survey vessel mobilises. While technology continues to improve, the long-term value of hydrographic data is often determined at the planning, approval, and specification stages of development. As coastal infrastructure and maritime activity expand across the region, the quality and consistency of data collected today will directly affect navigation safety, operational efficiency, and public responsibility for many years to come.

This presentation draws on practical experience from the Kahuto Blue and BlueSpatial Australia partnership, which was established to deliver standards-driven Hydrospatial services while progressively building local, in-country capability. Rather than focusing on specific tools or survey techniques, the discussion looks at how outcomes are shaped by early decisions, coordination between stakeholders, and the clarity of survey requirements.

Key issues explored include the ongoing challenge of inconsistent spatial reference frameworks, where legacy geodetic systems coexist with modern GNSS-based approaches, and the impact of layered consulting structures that can separate decision-making from applied expertise. The presentation also reflects on market signals from private-sector developments, where hydrographic survey is often specified at minimum compliance levels under tight budgets. In these cases, unclear requirements can shift risk downstream into operations, navigation, and, ultimately, public agencies.

Rather than proposing prescriptive solutions, the presentation positions clear hydrospatial standards as a practical enabler of marine discovery. Well-defined requirements support safer navigation, reduce the need for costly remedial surveys, and ensure data remains useful beyond individual projects. The presentation concludes by emphasising the role of partnerships, training, and locally anchored capability in shaping a sustainable and trusted future for marine discovery in the Pacific.

Discovery through collaboration – RV Investigator's contributions to mapping volcanoes in the Pacific Region

Christopher Yuleridge, Jill Brouwer, Amy Nau

Australia's dedicated ocean research vessel (RV) Investigator facilitates a broad range of multidisciplinary marine science research in Australian and international waters. RV Investigator is equipped with a full suite of acoustic instruments for continuous underway collection of full ocean depth seafloor topography, backscatter, sub bottom profile and bioacoustics data. These comprehensive, integrated datasets are used for real-time support of marine science voyage objectives. Post-voyage, the data are made publicly available with further applications to understanding climate change, geological hazards, biodiversity, sovereignty and natural resource and infrastructure management. In this presentation, we showcase the value of this capability for international marine science collaboration, with a focus on volcanoes and their impacts in the Pacific region.

RV Investigator has surveyed the Hunga-Tonga Hunga-Hapai (in 2022, produced the most powerful eruption in over 110 years), Macauley, Havre and Healy volcanoes near Tonga and New Zealand along the Tonga-Kermadec volcanic arc. Datasets acquired include: multibeam bathymetry, backscatter, sub-bottom profile, seismic, bioacoustics, sediment cores, deep towed camera, benthic sled samples, and CTD data. These datasets are utilised by scientists and governments to help determine:

- Eruption mechanics for improved eruption predictions.
- Sedimentary processes including submarine landslides to measure tsunami hazards.
- Improved understanding of plate tectonics and volcano orogenesis.
- Habitat identification and post-eruption recovery.
- Infrastructure planning such as deep-sea internet cabling.

Collection of fundamental geophysical datasets by RV Investigator has supported marine science activities in the Pacific, building relationships with governments in areas of operation, and public engagement including education in those areas. Recently in October 2025, in collaboration with the University of Tasmania, the Geological Survey of Tonga and the University of the South

Pacific, RV Investigator successfully completed a 53-day voyage over the Hunga-Tonga Hunga Hapai volcano including a full survey of the volcano utilising 3 multibeam echosounders. Scientific outcomes from other voyages in the Pacific region include data collected near New Caledonia, providing insights of local tectonics and fracture zones of Zealandia to assist in earthquake modelling. Additionally, oceanographic data collected along the 170 W parallel from the ice edge to Fiji has contributed to local and global climate models that can be used to inform climate hazards and strategies. A future voyage will be repeating the 170 W parallel transect to identify oceanographic and biological changes in the region over the last decade.

RV Investigator will continue surveying in the Pacific region with upcoming voyages aiming to maximise scientific impact for Pacific Island nations as well as Australia, and Australian researchers and their collaborators.

Marine AI from a Hydrographer's Perspective: Enhancing Watchkeeping and Wildlife Observations with Technology

Dillon Shields

As marine exploration evolves, the integration of artificial intelligence is reshaping traditional vessel-based roles, particularly in watchkeeping and ecological monitoring. This paper explores the transformative impact of a Software based, cutting-edge AI-powered situational awareness platform, from the perspective of an online surveyor.

This software enhances operational safety and efficiency by automating visual detection tasks, enabling real-time identification of vessels, marine mammals, and environmental hazards. For onboard survey vessels, this could mean a shift from traditional manual watchkeeping to intelligent oversight, where AI augments human decision-making and reduces fatigue-related risks.

A key application discussed is AI-assisted Whale monitoring, which enables non-invasive tracking and behavioural analysis of cetaceans. This not only supports conservation efforts but also opens new avenues for data-driven marine research and Marine Mammal Observations potentially reducing permitting for work in whale migration areas.

The presentation explores the future of Marine AI, highlighting its potential to enable autonomous survey missions, enhance remote marine mammal monitoring, and improve data fidelity through closer collaboration between humans and intelligent systems.

Building an Innovation Ecosystem for Shaping the future of Marine Discovery in the Asia-Pacific

Chris Kennedy

The changing geo-political and environmental landscape of the Asia–Pacific is reshaping how we observe, map, and understand our oceans. From the ambitious HIPP objective to map Australia's Exclusive Economic Zone within 50 years, to the urgent need for resilient coastal communities facing rising sea levels, to Australia's need to secure sea lines of communication in an increasingly contested region - national demands for hydrospatial intelligence are accelerating. Meeting these demands will depend not only on new sensors and platforms, but on our ability to innovate systematically, collaboratively, and at scale.

This presentation explores the idea that innovation in the marine domain should not be a fortunate by-product of creative individuals working in isolation, but the predictable outcome of innovation processes aligned with organisational strategy. Drawing on well-established innovation models and frameworks, it outlines how governments, industry, and research organisations can build the innovation ecosystems that will be required to improve sector-wide productivity and enable the achievement of our urgent national objectives.

Through practical examples across marine science and technology, this presentation will demonstrate how an organisational environment that prioritises structured experimentation and exploration based on intuition can accelerate the pace and impact of marine discovery. This presentation argues that shaping the future of hydrography, and the broader hydrospatial sector, will require transforming how we design, govern, and sustain innovation itself, so that the ocean can be understood with the urgency that our national interest demands.

The Fourth Dimension in Coastal Management: Monitoring Seafloor Dynamics from Space

Emily Twiggs

Approximately 73% of the world's seafloor remains unmapped, with most efforts focused on discovery rather than monitoring bathymetric change. While seafloor evolution is often gradual, dynamic coastlines undergo rapid shifts driven by natural processes such as sediment transport and storm events, and human interventions like dredging and artificial bypassing. These changes have far-reaching implications for infrastructure, coastal protection, benthic habitats, cultural heritage, surf quality, and maritime safety, underscoring the need for continuous monitoring.

Effective management of these areas requires accurate, frequent, and spatially comprehensive data, alongside a clear understanding of sand movement between beaches, surf zones, and estuary systems. Traditional bathymetric surveys provide essential data but are costly, logistically challenging across large areas, and impractical for rapid deployment before and after major storm events, such as Tropical Cyclone Alfred. Surveys also cannot retrospectively capture historical changes. Satellite-Derived Bathymetry (SDB) offers a viable alternative, delivering high-resolution, spatially continuous data in the challenging nearshore zone, with the unique ability to travel back in time over four decades.

While uptake is increasing, SDB remains relatively under-used in coastal management applications. In Queensland, however, there has been a notable shift from baseline SDB mapping to monitoring the morphodynamic evolution of vulnerable coastlines. Case studies include:

- Maritime Safety Queensland (MSQ): Sand bar monitoring for navigation safety (example in Figure).
- Gold Coast Waterways Authority (GCWA): Mapping navigation channels and entrance deltas to assess sedimentation patterns.
- SmartSat CRC, City of Gold Coast, Griffith University: Long-term monitoring of the Gold Coast Seaway entrance since the 1980s, to understand sediment movements and severe storm impacts on navigation, coastal protection, habitats, and surf quality.

An update will also be provided on remote-sensing and modelling-based coastal resilience tools, including COASTS, developed for monitoring coastal change, erosion hazards, and beach safety for Noosa Council.

Rapid advances in satellite sensors, cloud-based processing (e.g., SDB-Online) and AI capabilities are transforming coastal management. These innovations deliver cost-effective, actionable insights to support resilience strategies and sustainable decision-making in dynamic coastal environments.

Bridging Sea Level and Vertical Land Motion: A Low-Cost GNSS Approach

Joe Eu Heng, Chien Zheng Yong, Robert Odolinski, Christina Hulbe

Rising sea levels and coastal subsidence pose increasing challenges to communities and infrastructure. Continuous coastal monitoring is essential for understanding the impacts of climate change, planning adaptation strategies and protecting vulnerable infrastructure. However, geodetic stations and traditional tide-gauge networks are often expensive and limited in spatial coverage, particularly in remote regions. This study investigates the capabilities of utilising two low-cost GNSS antennas and receivers for both positioning and sea-surface changes simultaneously.

In this configuration, two low-cost dual-frequency GNSS antennas are mounted in a L-shape arrangement. One zenith antenna is used for positioning, and the sideway antenna is used for reflectometry. While signal-to-noise ratio (SNR) is logged by both receivers, the side-facing antenna's orientation allows multipath interference to generate variations from which sea-surface changes can be derived. This technique is known as GNSS-Interferometric Reflectometry (GNSS-IR). Meanwhile, the zenith antenna provides a stable reference for Vertical Land Motion estimation through long-term positioning monitoring through Precise Point Positioning (PPP) or baseline processing.

By combining these measurements, the experiment shows that VLM and sea-surface change can be decoupled and quantified with the same geodetic reference frame. Therefore, confirming that combining positioning and GNSS-IR techniques within a dual-antenna configurations can capture both VLM and tidal variability. This approach provides a practical and scalable alternative to traditional tide-gauge networks, particularly in remote or data-sparse coastal regions. By utilising the low-cost GNSS receivers, it provides a more equitable and sustainable coastal monitoring.

The use of Unmanned Surface Vessels and AI to remove data bottlenecks

Richard Dowdeswell, Cory Brooks

The commercial use of Unmanned Surface Vessels (USVs) for applications covering inland waters, coastal and offshore environments has proliferated over the last 5 years. Although these types of solutions offer significant CO_2 emission savings, lower risk and reduced costs, compared to traditional crewed vessels, challenges still remain.

In the majority of cases the control of these types of vessels are undertaken from a Remote Operations Centre (ROC) where humans retain overall control. Pre-programmed survey lines are created in advance, based on historical survey data, with limited communication capability to adjust these lines on the fly for any variations in the seabed that have occurred since the last survey. In virgin areas, survey planning is often more difficult and when combined with large tidal variations gaps is data coverage can often appear requiring additional infill lines being required.

Separately, and due to the data processing 'bottle neck' resulting from data bandwidth limitations on communications to these types of vessels, work has been underway for a number of years in applying Artificial Intelligence and Machine Learning approaches to the onboard processing of bathymetric sonar data.

This proposed paper will discuss and present work which has been conducted using real time vessel AI data processing to generate 100% coverage of the survey area with Quality Assured (QA) data. This new capability maximises the survey efficiency and provides onsite Quality Control (QC) before the vessel departs the survey location. In addition, the advances in recent high bandwidth communications now allows for this quality processed data to be automatically uploaded back to base so that the onshore surveyor can review the processed data resulting in rapid turnaround and customer delivery.

Taking your pressure logger to new depths

Iain Francis

Accurate water level measurement is fundamental to hydrographic surveying where pressure loggers are widely used as tide gauges to support sounding reduction, tidal analysis and vertical reference modelling. Although pressure measurement is a mature technology in oceanographic instrumentation different sensor technologies exhibit distinct performance characteristics that can influence the quality and stability of hydrographic observations. Two sensing approaches dominate modern oceanographic pressure loggers: piezoresistive pressure sensors and quartz resonant pressure sensors. Understanding the differences between these technologies is important when selecting instrumentation for hydrographic applications that require stable measurements over long deployments.

Piezoresistive pressure sensors measure pressure through deformation of a silicon diaphragm which alters the electrical properties of strain gauges within the sensor structure. These sensors are widely used in oceanographic instruments because they are robust, compact and available across a wide range of pressure ranges. Typical specifications provide accuracies around ±0.05% of full scale which is sufficient for many hydrographic and oceanographic deployments. Their combination of cost effectiveness, small size and reliable performance makes them the most commonly deployed pressure sensors in compact oceanographic loggers. However because the measurement relies on mechanical strain within the sensor structure these devices can exhibit long term drift as materials relax over time or respond to temperature cycling.

Quartz resonant pressure sensors operate on a different principle where applied pressure alters the resonant frequency of a quartz crystal. Because frequency can be measured very precisely quartz sensors provide extremely fine resolution and excellent long term stability. Paroscientific quartz sensors commonly used in oceanographic pressure loggers typically exhibit average drift of around 30 parts per million per year with a specified maximum of approximately 140 ppm per year. This level of stability makes quartz sensors particularly useful for long deployments where small changes in water level must be resolved with confidence.

These differences become particularly relevant in hydrographic surveys requiring continuous water level observations over many months or even years. During long deployments sensor drift can appear as a slow bias in the pressure record which can propagate into tidal reductions and vertical uncertainty estimates. Choosing between piezoresistive and quartz sensors is therefore often a balance between deployment duration, stability requirements and practical considerations such as instrument cost and availability. Piezoresistive sensors remain the versatile workhorse for many deployments particularly where multiple instruments are required or where deployments are relatively short, while quartz sensors are often preferred where long term stability is critical.

Pressure loggers are routinely deployed as tide gauges within the Hydrospatial Industry Partnership Program in Australia. RBR has supplied pressure loggers to a number of HIPP panel surveyors where they are used to support tidal reduction and hydroid modelling during survey operations. Advances in compact oceanographic loggers have also improved deployment practicality through increased memory capacity, flexible sampling strategies and improved power efficiency. Understanding the performance characteristics of these sensor technologies helps hydrographic practitioners choose instruments that best match the stability and uncertainty requirements of their surveys.