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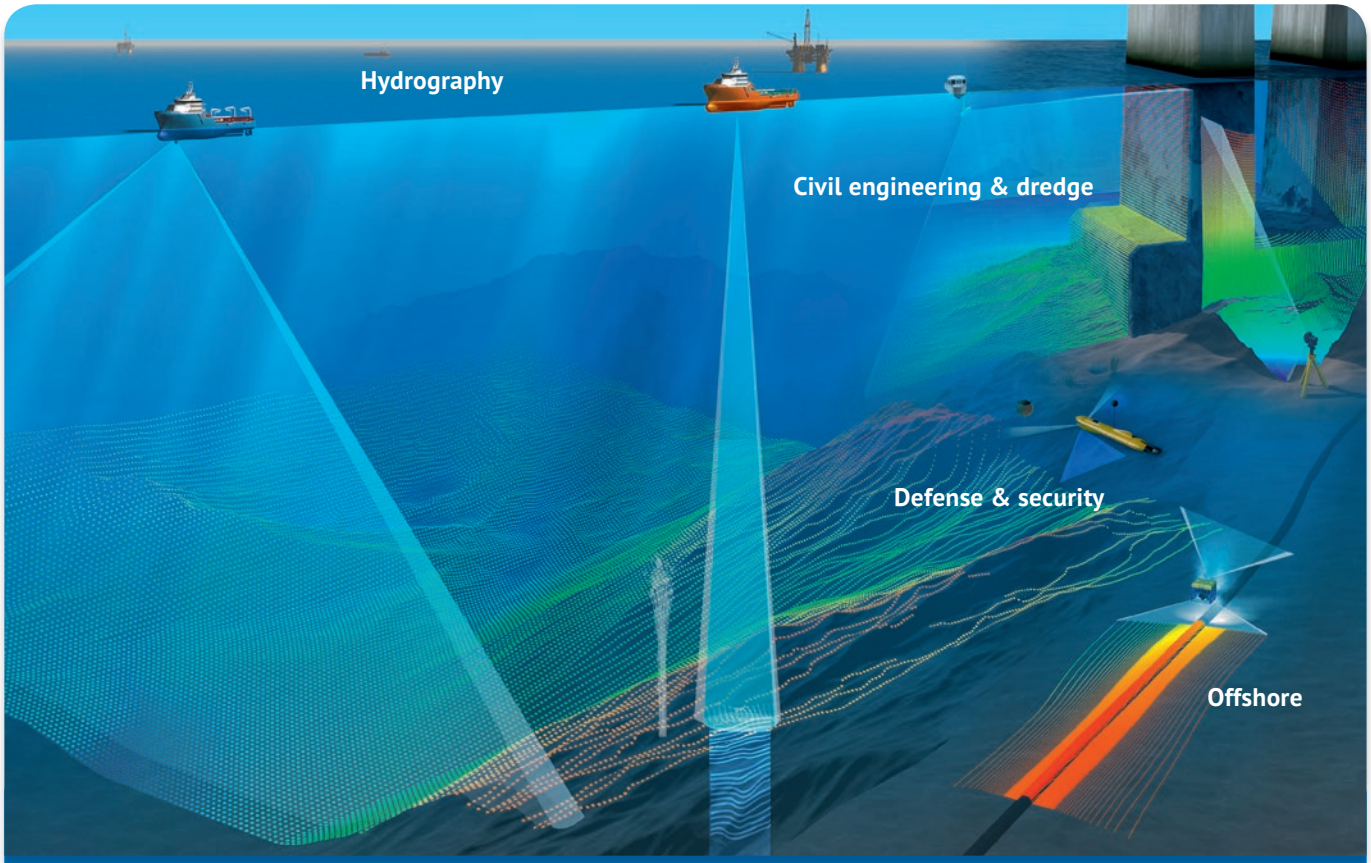

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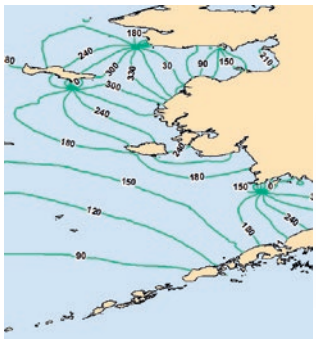

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Deployment of a Sabella tidal generator; example of renewable energy requiring hydrographic survey for construction and monitoring once in operation. Image courtesy: Sabella, France.

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PHOTOGRAPHY: ARIE BRUINSMA (WWW.ARIEBRUINSMA.NL)

Opportunities

I prefer to talk about opportunities and chances, rather than problems, difficulties and challenges. Realistically, I know it's often necessary to identify the problem before talking about the solution or an opportunity, a chance. The problem identified in the article 'Opportunistic Multibeam Surveying' by Shannon Hoy, Laura Robinson and Veerle Huvenne on page 24 of this issue of *Hydro International* is the fact that only ten to fifteen percent of the ocean floor has been mapped at resolutions of 100-metre pixel or better. Of course this problem is known to the hydrographic community, from the surveyor on a vessel to the International Hydrographic Bureau in Monaco, where Robert Ward identified the same problem, which he shares in this month's Insiders View on page 6 of this issue of *Hydro International*. Captain Ward even mentions the 'uncomfortable fact that there are higher resolution maps of the Moon and Mars than for many parts of our seas and coastal waters.' Ward advocates collection of bathymetry not as an activity in its own right, but as part of multi-disciplinary, multi-agency marine data gathering programmes. It is exactly this opportunity that Shannon Hoy et al. also see in their feature article, as the title already beholds 'Opportunistic Multibeam Surveying'. Making use of ships of opportunity could help contribute to optimised data collections in all areas in need of mapping – the Arctic, Antarctic and other remote areas of the world's oceans. Opportunistic surveying needs policymakers in hydrography that seek partnerships with leaders of research expeditions all over the globe, to be able to add multibeam surveying to the package of tasks the ships conduct when underway. Hoy names a few examples of cruises in the Drake Passage between Southern America and Antarctica and the lower latitude of the Atlantic where more than 100,000km² was surveyed, while this was not the primary goal of the cruise! It was therefore necessary to take indirect routes – requiring a flexible attitude and effective time-management within the research team. It's quite crucial that this flexibility is present. It's also necessary to tap into new markets outside of the research community. There are many more ships of opportunity out on the oceans, every day. If they had a multibeam echo sounder on board, the 100,000km² could easily be multiplied. But the hydrographic community would then also need to think about incentives. A commercial ship will not take a detour if they are not rewarded in some way. Risks of commercial loss are simply too high, as are higher costs. An opportunity for hydrography should also be an opportunity for the other party in the deal: the shipping company. This incentive will almost always be much cheaper than carrying out surveys ourselves and will always be quicker. Together with Hoy and Ward, I would like to agree that there certainly is a problem, but that there are reasons enough to also be very optimistic about the opportunities available for surveying all seas in the future!

Durk Haarsma durk.haarsma@geomares.nl

Our Seas and Waterways - Yet to be **Fully Charted** and Explored

The theme for World Hydrography Day 2015 – 'Our seas and waterways - yet to be fully charted and explored', highlights the uncomfortable fact that there are higher resolution maps of the Moon and Mars (and now some asteroids!) than for many parts of our seas and coastal waters. So, what can WE do at the practical level to improve this?

It seems to me that we need to turn our attention to better use of the resources that already exist - and that is what the IHO is looking to do. Crowdsourcing, satellite-derived bathymetry, participation in multi-disciplinary data gathering programmes and developing a more exhaustive inventory of the existing data are now all on the IHO agenda. These activities are not intended to replace highly accurate and thorough hydrographic surveys using specialist ships, aircraft and equipment, but they can provide useful depth information where otherwise we will have none.

We need to encourage the collection of bathymetry not as an activity in its own right, but as part of multi-disciplinary, multi-agency marine data gathering programmes. They say: 'Many hands make light work' - in this case, they can also make the money go further! The Mareano programme in Norway, the Infomar programme in Ireland and the north Atlantic seabed mapping initiative announced by Canada, USA and the EU in the Galway Statement are good examples.

Other keys to improvement are firstly to know what data already exists and secondly to be able to assess its accuracy or uncertainty to help us decide if it is fit for a particular purpose. In this regard, we should not be blinded into thinking that only the best is good enough. Good enough for who? Many maritime activities do not require chart or engineering quality data - especially where the alternative is no data at all! However, what is important is for a prospective user of data to know how good (or bad) the data really is, so that they can judge its fitness for their particular needs. The IHO crowdsourced bathymetry working group has recently been established to develop guidelines to do just this.

The IHO is also in the process of establishing a global open-source crowdsourced bathymetry collection programme. The existing IHO Data Centre for Digital Bathymetry and its web interface is being progressively reconfigured to become the world's open-data repository for crowdsourced bathymetry and principal bathymetric data discovery portal. This is building upon the well-established IHO-IOC GEBCO programme for mapping the oceans and will extend the data gathering effort from the deepest parts of the ocean right up to the coastline. In my view, this has the potential to dramatically improve the basic bathymetric coverage of the world's seas and oceans - and particularly the many unsurveyed coastal regions.

We also need to encourage everyone who may have collected bathymetric data, for whatever reason, to declare its existence - whether the data lies in the government or in the private sector. Where there is otherwise no data, it is likely to be useful to someone - regardless of its quality.

And finally, we know that work is continuing both in industry and academia to develop ever more refined methods to obtain depth data from multi-spectrum satellite imagery. The Holy Grail for this technology is to develop rigorous methods to calculate the uncertainty in the results. I am sure that this will come. We need this technology.
So, keep on sounding - and make sure that no sounding goes unaccounted!

PLA Catamaran Reaches Hull Milestone

Hull structures have been completed on CTruk's construction of a new 17m survey catamaran for the Port of London Authority (PLA). The two hulls were removed from the mould after several weeks of lay-up work and are now undergoing first stage fit out with fuel tank and ballast tank bulkheads at the company's River Colne facility in Colchester, while the deck is moulded at its Brightlingsea facility. The next stage will see the deck fitted to the hulls before the wheelhouse is added.

▸ ***http://bit.ly/1IWyXvz***

The first of the hulls of the PLA's new survey vessel is removed from the mould at CTruk's Essex yard.

Position Challenges Flying a UAV near North Pole Faced

Engineers on board the Alfred Wegener Institute's research icebreaker *Polarstern* have programmed a multicopter, allowing it to navigate despite the deviations produced by the Earth's magnetic field near the North Pole. The researchers recently celebrated the copter's first successful autonomous flight and landing on an ice floe.

▸ ***http://bit.ly/1J3NzXW***

Sascha Lehmenhecker preparing the UAV on the polar ice.

Large Hot Vent Site Discovery in Gulf of California

Germany's deep-sea research vessel *Sonne* is currently sailing in the Gulf of California in search of carbon release related to volcanic systems. Scientists, led by Professor Christian Berndt from the GEOMAR Helmholtz Centre for Ocean Research Kiel, have now discovered a previously unknown vent field with several black smokers. The field consists of at least four mounds up to 70 metres high.

▸ ***http://bit.ly/1IWAdin***

Black Smoker in the Gulf of California.

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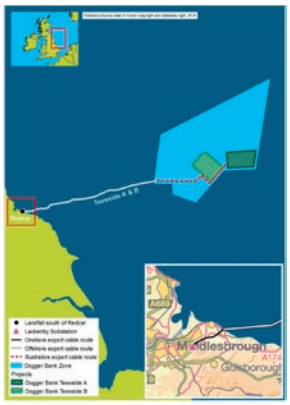
Large Hot Vent Site Discovery in Gulf of California - http://bit.ly/1IWAdin
Underwater Detection of Crashed Airplane - http://bit.ly/1IWAx0A
GAS to Provide Survey Services during Pipelay Installation - http://bit.ly/1IWACkS
Kraken Launches KATFISH High-resolution Sonar System - http://bit.ly/1IWAUYU

Dogger Bank Capacity to Increase to 4.8GW

Planning approval for offshore wind energy has been issued at Dogger Bank, taking the total of consented projects in the North Sea zone to 4.8 gigawatts (GW), almost equal to all the offshore wind capacity currently in operation in the UK. The consented development, Dogger Bank Teesside A&B, is part of the Dogger Bank Zone, the largest of the Round 3 zones and the farthest from shore. It is also one of the shallowest zones, with high wind speeds and seabed conditions ideally suited to offshore wind development.

▸ ***http://bit.ly/1IWDVbT***



Dogger Bank Teesside A&B.

Partnership for Tidal Turbine and Mammal Interaction

Ocean Sonics is entering into a partnership to install a tidal power turbine at the Emera-Cape Sharp site on the Bay of Fundy, Canada. The partnership will produce an improved software and user interface that notifies personnel in real-time of the presence of fish and sea mammals, giving stakeholders a better understanding of the interaction between the wildlife and turbines.

▸ ***http://bit.ly/1IWFK8z***

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Sontek CastAway-CTD	http://bit.ly/1JmtpOh

GAS to Provide Survey Services during Pipelay Installation

GAS (Geological Assistance & Services), Italy, has been awarded a long-term contract from SAIPEM to provide offshore survey services on board the dive-support vessel *Akademik Tofik Ismayilov*. The work will be performed during the installation of the export and infield pipelines for the Stage II development of the Shah Deniz field, which will ultimately deliver gas to Europe from Azerbaijan.

▸ ***http://bit.ly/1IWACkS***

Research Vessel Akademik Tofik Ismayilov.

Kraken Launches KATFISH High-resolution Sonar System

Kraken Sonar, Canada, has deployed KATFISH (Kraken Active Tow FISH), a sonar platform for military and commercial applications. KATFISH is a key development objective in delivering on the company's 'sensor-to-systems' strategy. At the moment, the KATFISH system has successfully completed proof of concept sea trials using Synthetic Aperture Sonar.

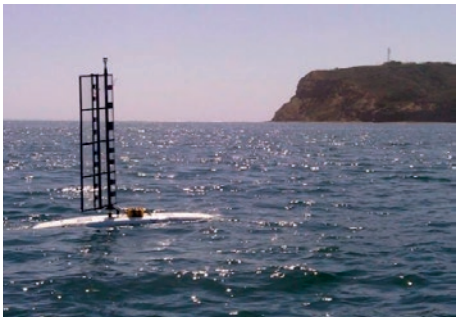
▸ ***http://bit.ly/1IWAUYU***

The SAS Sensor installed on the KATFISH.

Multi-million Dollar Deal for Ocean Aero

Ocean Aero (USA) has signed a multi-million dollar two-year contract with the Department of Defence under the Rapid Innovation Fund (DoD RIF) programme. Ocean Aero was selected to create a prototype Long Range Unmanned Underwater and Surface Vessel, similar to their current Submaran model. This contract is the result of a year of developing this exclusive concept, drafting and writing the proposal, as well as negotiating the contract with the DoD.

▸ ***http://bit.ly/1IWBhTw***



A prototype of the Ocean Aero Submaran.

New ENCs for Suez Canal

The Egyptian Naval Hydrographic Department (ENHD) has produced its first 12 ENCs (10 Harbour and 2 Approach) which seamlessly cover the waters of the Suez Canal. UK-based IC-ENC has been working closely with ENHD to assist in the production of these ENCs, both through attendance of the IC-ENC ENC Validation Training Course in February 2015 and through telephone and email support on a regular basis.

▸ ***http://bit.ly/1IWCcmV***

An aerial view of the Suez Canal extension.

Major Taiwanese Dredging Contract for Van Oord

Van Oord has been awarded the dredging contract for the Kaohsiung Intercontinental Container Centre Phase II in Taiwan. The client is the Port of Kaohsiung, Taiwan International Ports Corporation (TIPC). The contract value amounts to approximately EUR130 million. The preparations have already started and the execution period runs until January 2018.

▸ ***http://bit.ly/1IWBVjK***

Institute for Sustainable Coasts and Oceans Launched

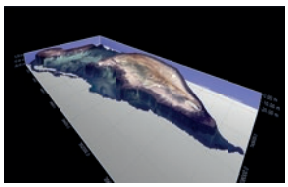
The National Oceanography Centre (NOC, UK) and the University of Liverpool have entered into a new strategic partnership creating the Institute for Sustainable Coasts and Oceans (ISCO). The ISCO is to provide improved connectivity between marine scientists, social scientists, engineers and economists in these different fields and thorough research will provide the knowledge needed to deliver sustainable management of the coast and the UK coastal seas, meeting the challenges that changes bring.

▸ ***http://bit.ly/1IWC079***

Fugro Expands Survey Services and Satellite Imagery Capabilities

Fugro has extended its integrated survey services to help improve efficiency in coastal management and enable more informed decision making. A new agreement with global specialist EOMAP enables the creation of integrated bathymetric survey products that comprise elements from Satellite Derived Bathymetry (SDB), Airborne Lidar Bathymetry (ALB) and traditional acoustic survey technologies. The integrated data and product solutions will provide clients with outstanding value and unmatched coverage.

▸ ***http://bit.ly/1IWBANS***



Heron Island topography and bathymetry. Image courtesy: EOMAP.

ENC Coverage for the Live Streaming Video from the Ocean Floor

From 10 July to 30 September 2015, NOAA ship *Okeanos Explorer* explores largely unknown deep-sea ecosystems in the Hawaiian Archipelago and offshore Johnston Atoll as part of the Hohonu Moana: Exploring the Deep Waters off Hawai'i expedition. Telepresence technology is being used to transmit data in real time to a shore-based hub where the video is then transmitted to a number of Exploration Command Centres located in the USA and the cloud. Access to the video and a suite of internet-based collaboration tools enable scientists on shore to join the operation in real time and allow the general public to follow the expedition online.

▸ ***http://bit.ly/1IWCF8A***

The remote video link visualised.

IMCA's 2014 ROV Stats

The International Marine Contractors Association's (IMCA) 2014 survey of remotely operated vehicle (ROV)s and ROV personnel reveals that in February 2014 a total of 3,369 ROV personnel (superintendents, supervisors, pilot techs and other offshore ROV support personnel) were working, and in August the total figure was 3,617. The total number of ROVs in February was 677 and in August 726. These figures compare with 3,663 personnel in February 2013 and 3,962 in August 2013; and 580 ROVs in February 2013 and 636 in August 2013.

▸ ***http://bit.ly/1IWCY3b***

Hydro International Interviews Jan-Bart Calewaert

Making **European Marine Geospatial Data** Available

For some years now EMODnet has been creating access to marine data sources. The long-term aim of EMODnet is to unlock the wealth of marine observations and data in Europe that are partly hidden and fragmented and make these easily available free of charge. On 20 October 2015, a conference will be organised in Oostende, Belgium, to discuss subjects such as data availability and governance of the EMODnet structure. *Hydro International* interviews Jan-Bart Calewaert, head of the EMODnet Secretariat.

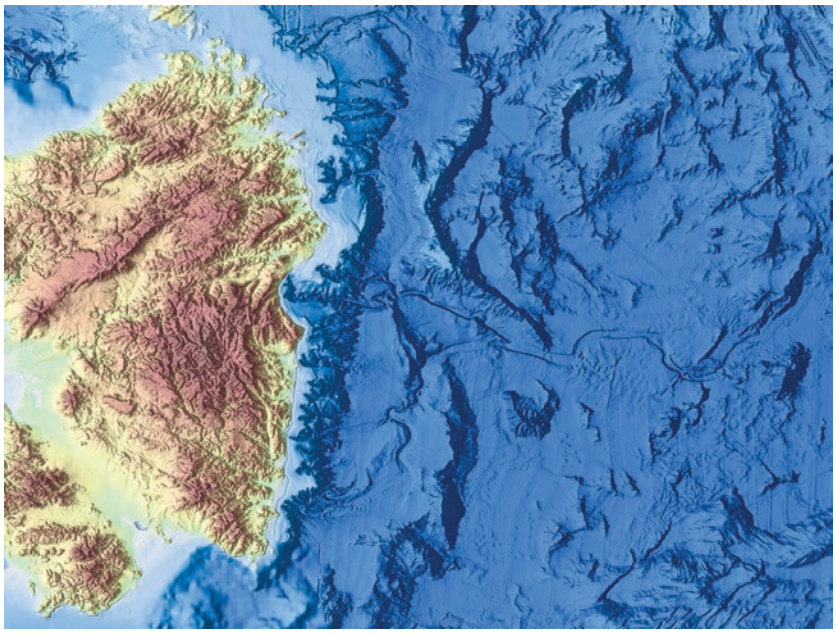
How big is the EMODnet Secretariat?
The EMODnet Secretariat was set up in 2013. Currently, there are three people working at the EMODnet Secretariat Office in Oostende and two colleagues based in the UK also provide support occasionally. However, EMODnet is much more than that: it is a growing network of organisations – now more than 110 – working together in thematic assembly groups since 2009. EMODnet thematic groups have been assembling and making available fragmented marine data, metadata and products through seven thematic data portals covering bathymetry, geology, seabed habitats, chemistry, biology, physics and, since 2013, human activities. Often more than one person in each of the partner organisations works on EMODnet and many more organisations provide data or user-feedback without being formal partners in the network.

▲ *Figure 1: Jan-Bart Calewaert.*

How is the EMODnet Secretariat structured?
The EMODnet Secretariat was set up by the European Commission to assist with the coordination of the network, to monitor the progress of the thematic portals and increase the visibility and profile of EMODnet. The Secretariat is administered by Seascape Consultants and located at the InnovOcean site in Oostende, Belgium, following an offer by the Flemish Government to host the Secretariat. This location is close to Brussels yet close to the coast and we benefit from being co-located with the European Marine Board, UNESCO's project office for its International Oceanographic Data and Information Exchange (IODE) programme as well as Flanders Marine Institute that leads the development of the central EMODnet portal and coordinates EMODnet Biology data portal.

What is the purpose of EMODnet regional activities or Checkpoints?
The EMODnet Sea-basin Checkpoints test if users can easily find and use data they need. This is done by assessing the data availability and quality from the perspective of a pre-defined set of user-functions or 'challenges' such as siting wind farms or assessing the fate of an oil spill after an accident or leak. Checkpoints evaluate how well the collected marine data and existing information systems address the needs of users, telling us something about how easy it is to find and use marine data. They also reveal how data systems could be improved or what kind of data is missing, unavailable or of insufficient quality to be useful for scientists and experts from industry, public authorities and civil society.
North Sea and Mediterranean Checkpoints have been running since 2013, contracts for the Arctic and the Baltic have just been signed and in the mean time, contracts for the Atlantic and the Black Sea Checkpoints have also been signed.

Why isn't there one web portal where all marine data is made available and users can search and download geographically?
The EMODnet Central Portal is being developed as a gateway to the thematic data portals and to provide a range of data services of its own for users interested in data and products from more than one discipline. Over time a GIS-based component will be built and embedded in the central portal providing access to the different thematic data products. Users will be able to perform a spatial query on different data products simultaneously and retrieve bathymetric, geological, seabed habitat, physical, chemical and biological information from the same location or an area,



▲ *Figure 2: Snapshot from the new EMODnet Digital Terrain Model (DTM) at grid resolution of 1/8 * 1/8 arc minutes showing the Tyrrhenian Sea east of Sardinia. The DTM is available from the EMODnet Bathymetry Portal at www.emodnet-bathymetry.eu Image courtesy: EMODnet bathymetry.*

at a specific moment in time. A first EMODnet Query Tool is now available for testing as a demonstration service on the central portal. Let's not forget that EMODnet is now only halfway along its development trajectory, so new tools, products and services are being developed and tested as we progress and portals are continuously improved and upgraded. This work includes reducing the descriptive, project-related background information on the thematic portal pages and instead providing a quicker and more intuitive access to tools for searching, downloading and visualising data and products. The focus on too much text was a result of the first phase when prototype portals were developed through fairly independent projects each with a strong need to communicate about the nature of their work and their achievements.

Does EMODnet make use of OGC standards for exchanging marine data?

Both the thematic data portals and central EMODnet portal actually work to implement geospatial standards from the Open Geospatial Consortium. The future EMODnet Central Portal data services will implement the Web Map Service specification and the Web Feature Service. They will also make use of the product metadata catalogue 'Sextant' from Ifremer, which is based on the standards of OGC and ISO TC211, implementing the Catalogue Service for the Web (CSW). The development of central portal data functionalities drives progress of the thematic portals in terms of openness and interoperability of the underlying data systems as this is a prerequisite to make these functionalities operational.

The EMODnet technical working group will meet in September this year to expand the OGC compliance rating system that had been used since 2013 to develop 'EMODnet Web Services guidelines' as the new standard for all issues critical to the further development of the Query Tool.

How can users easily obtain the data developed by EMODnet or others in open standards?

From the onset, EMODnet has made maximum use of what is already established both in terms of data systems, infrastructure and standards. EMODnet promotes the common adoption of international standards and only expands these or develops new standards if necessary to assemble and harmonise data within disciplines and to exchange data and products between the various thematic activities.

There are considerable differences between the thematic data portals in terms of organisations, infrastructure and the nature of the data and products which they make available. In some thematic areas standards still need agreement and implementation to realise EMODnet requirements. For example, each country generally has one reference point for archiving and distributing geological data and facilitating data assembly. However, before EMODnet there were no agreed standards to compile the geological data products which are being done at a scale of 1:250,000 during the current phase.

Which bodies are responsible for the data storage?

An important feature of EMODnet is that the data collection and storage remains the responsibility of local, national and regional actors. In most cases this means that data are collected and stored with Member States repositories, like national hydrographic offices for bathymetry data. The data are kept on their databases. EMODnet assembles the data and makes added value products such as the EMODnet Digital Terrain Model (DTM). These products are developed and maintained by the EMODnet partners themselves, which are not necessarily the same organisations as the data providers or holders.

EMODnet processes and validates data; what type of data is validated and how is this processed?

Quality checks and data validation are initially carried out at Member State level by those organisations responsible for collecting and storing marine data as they have the necessary expertise and maintain closest links to the data providers. However, data quality is very important when merging heterogeneous data from different sources so additional processing and validation may be necessary. For example, EMODnet Chemistry defined and implemented an additional data validation loop for their data and data products. In this loop, data is aggregated with unit conversions and a regional data quality control based on a common protocol at sea-basin level. Subsequently, reports are sent to the data collators to correct errors or anomalies in the master copy of the data and to guarantee the data quality upgrading. As a result, the official copy of the data available from the distributed

Funding

The European Marine Observation and Data Network (EMODnet) is financed by the European Union under Regulation (EU) No. 1255/2011 of the European Parliament and of the Council of 30 November 2011, establishing a Programme to support the further development of an Integrated Maritime Policy.

infrastructure is continuously updated and a set of products can be made based on the pool of aggregated and validated data.

How does EMODnet comply with INSPIRE? Does EMODnet cooperate with INSPIRE?

EMODnet and INSPIRE share the same objective, namely to improve access to environmental data. EMODnet data portals already implement INSPIRE principles and strive to become either fully INSPIRE-compliant or develop an understanding of why it is not desirable or feasible to do so. The main area where inconsistencies may occur are at the data model level as EMODnet thematic portals have adopted harmonisation models, but these are not necessarily INSPIRE data models. The cooperation is indeed there. On 30 June 2015, a dedicated workshop was organised with INSPIRE representatives at JRC (Ispra, Italy) to explore synergies and in October this year, EMODnet technical developers will meet with members of the INSPIRE technical team to consider what needs to be done by EMODnet portals to become fully INSPIRE compliant.

How is EMODnet being promoted to the marine industry (commercial and public)? And in the scientific world?

The EMODnet Secretariat has been informing potential users and contributors and increasing the visibility and profile of EMODnet since 2013. The EMODnet communication strategy is now being implemented together with partners as a joint responsibility. Firstly, all partners maintain strong links and engage with key actors within their network of scientists, policy advisors and experts from industry to make their portals better known and used. Secondly, the Secretariat has produced an EMODnet video, brochure, leaflets and posters to explain how important it is to improve access to harmonised marine data and products without restrictions and how EMODnet can contribute to support Blue Growth. All products are available from the EMODnet portal. We give demonstrations all over Europe, including at business meetings and conventions. Traditionally our community has better links with the scientific and policy stakeholders so we need to step up our efforts to connect to the commercial actors both as contributors and users.

How does EMODnet get funds? How does EMODnet guarantee its funding for the future?

EMODnet is financed and coordinated by the European Commission Directorate-General for Maritime Affairs and Fisheries to support its Marine Knowledge 2020 initiative and the Integrated Maritime Policy. The Member States continue to fund the collection, curation and long term storage of the data but the EU funds the development of EMODnet to create an over-arching, pan-European, sharing framework to make fragmented data resources more easily available in a harmonised way. EMODnet funds are intended to pay for the time and infrastructure needed to set up the necessary connections to feed data through EMODnet thematic portals. At this stage, funding for the final development phase from 2016 to 2020 has been secured, although the precise budget is not final. Once fully deployed, the resources required to maintain the system should be moderate. The funding and governance model to maintain EMODnet beyond 2020 is not yet cast in stone. We hope that the EMODnet Conference, which will take place on 20 October, may bring some more ideas to light.

How can EMODnet stimulate Blue Growth in Europe? Can the data be used by all free of charge?

EMODnet can save costs to offshore operators as they spend less to access and process existing data or collect new data. Secondly, better access to harmonised and quality assured marine data is expected to stimulate competition and innovation critical to underpin Blue Growth. Thirdly, better access to data will reduce uncertainty in our knowledge and ability to forecast the behaviour of the sea, which will be beneficial for all involved in maritime activities, coastal defence and long-term planning.

Currently, EMODnet data and products are freely available without restrictions on most thematic portals. Some of the datasets that can be found via the bathymetry and chemistry portals have restrictions and may require negotiation with the data providers. Restrictions may be in place to allow scientists to publish research outputs, to protect economic interests or for security reasons, but the duration of these restrictions should remain as short as possible. The portal developers preferred to include these datasets in the searchable metadatabase so that users would be aware of their existence. We are currently debating the options on how to deal with these restrictions and underlying data policies. One option could be to only provide access to fully open and free data and products to be fully in line with our principles. This would not prevent other underlying data systems from continuing to make these resources visible via their own tools and platforms. This is on the agenda of the EMODnet Conference to be held on 20 October 2015 in Oostende, Belgium. Everyone interested is more than welcome to join.

▲ *Figure 3: EMODnet aims to serve maritime sectors with access to marine data and information products, but also provides spatial data and information about maritime activities such as offshore wind farm constructions via the recently launched EMODnet Human Activities data portal. Image courtesy: Alpha Ventus/DOTI 2009.*

Acknowledgement

Mr Calewaert would like to extend a special thanks to the EMODnet Coordinators and key partners of the thematic and regional activities for their relentless efforts and support without which this interview and contribution would not be possible. ◀

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The Need for a Survey Strategy

Managing UXO Risk in Offshore and Renewables Projects

With the increase of offshore marine projects over the decades, demand for a cost-effective and efficient risk-based approach for the mitigation of UXO (Unexploded Ordnance) has become a priority for offshore construction teams. From the numerous projects for the offshore renewables and major gas distribution projects in North West Europe it was learned that offshore UXO mitigation is mostly a survey issue, as the survey industry can provide the tools to locate, identify and manage potential UXO. This article suggests a best practice strategy coming from experience gained with offshore marine project management and modern survey methods.

Figure 1: Example of a defused former UXO.

In the more recent years, offshore renewables projects have raised awareness of the UXO threat to marine construction teams. The toll of many dead and injured makes it an important HSE risk [1] and delays caused by dealing with unexpected UXO bring a cost increase of tens of millions of euros to the project as well as discussions about the responsibilities during the project [2]. Also, manipulation of the seafloor during the survey and construction work may trigger detonation of the ammunition that may or may not be directly touched.

There is a requirement to mitigate the UXO risk situation in projects with a pragmatic approach that is both efficient and cost-effective.

Requirements for a Strategy

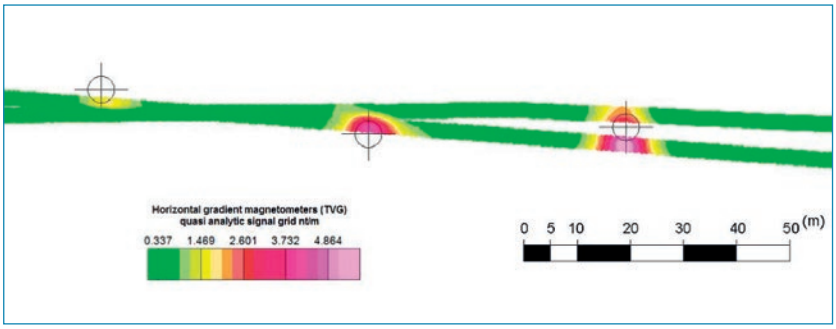
Traditionally, the UXO risk was met in the installation phase of projects once all route and position decisions had been already made. Nowadays, design processes for offshore marine projects are approached with a so-called project initiation stage or Front End Engineering and Design (FEED) stage. During this stage, initial designs, for instance, on cable routes, potential production platform or turbine locations, form part of the early design studies. If no recent survey data is available for the area, a survey campaign should be organised and studies initiated that support the consenting process as well. The surveys should ideally be combined and undertaken in a multidisciplinary approach so as to have a more cost effective project organised and enable various related datasets to be interpreted both on- and offshore in order
to choose, for instance, the geotechnical survey stations.
The typical survey programme:

1. Geophysical survey;
2. Geotechnical survey;
3. Benthic survey.

Further relevant studies include:

1. UXO desk top study;
2. Sediment mobility study;
3. Marine archaeological assessment;
4. Environmental impact assessment.

When bottom intrusive surveys such as geotechnical vibrocoring or CPT (cone penetration test) are required, data from the geophysical surveys should be examined to identify potential UXO hazards. In the project preparation, stringent Safe Job Analyses shall be carried out with all project team members and procedures provided to manage the UXO risk. Where applicable, safety counter measures and kits should be supplied in case of potential chemical UXO.
The generic UXO desk top studies make use of historical and other public domain sources, to identify the possible types of UXO in the construction area. Further, a risk-based evaluation shall be made, taking into account the proposed installation tool and methods together with the expected occurrence of specific UXO in the construction area.
The desk top study could also provide the procedures for notification and cooperation with the relevant authorities and procedures in dealing with UXO. They can vary from country to country and it is relevant to identify the differences within, for example, the North Sea EEZ and territorial waters at an early stage.



▲ *Figure 2: Typical results of Surrogate trials. Image courtesy: MMT.*

As Low as Reasonably Practical

As Low as Reasonably Practical (ALARP) is a term often used in the context of safety-critical processes. The ALARP principle is that the residual risk after mitigation shall be minimised. For a risk to be ALARP it should be demonstrated that the cost involved in further reducing the risk is disproportional to the benefits gained.

An ALARP UXO risk mitigation can be sub-divided into five phases:

Phase 1: Review of the Desk Top Study and Risk Identification

Based on the chosen construction methodology and selected location or route of the project, identified risks must be reviewed and survey mitigation revised as necessary.

Relevant survey specifications are

- Minimum survey line spacing and sensor flying height;
- Width of the survey corridor for a route or the extent of the construction site including, if necessary, anchor patterns for a heavy lift vessel;
- Minimum iron content (kg) the surveys should be looking for;
- Most importantly, testing and proofing of the survey sensor package capabilities by a so-called surrogate trial. The desk top study should provide the surrogate weights and dimensions as identified for the specific areas.
- Furthermore, a start should be made to evaluate all existing survey data assembled to highlight potential geology that could upset magnetometer readings due to the higher iron content found, for example, in clays or boulders.

The outcome of this interpretive study should be used for the detailed design of the UXO survey plan.

Phase 2: Investigation Surveys

This phase is the geophysical sensor package survey, comprising of sensitive magnetometer/gradiometer, high-frequency side-scan sonar and, preferably, a multibeam echo sounder to identify surface contacts or sub-surface anomalies. This is also an opportunity to investigate the construction area using a parametric sub-bottom profiler that could assist identification of potential geology acoustically shaded by cover sand in the FEED phase survey and matched with potential magnetic anomaly readings.

The survey should start with so-called surrogate trials, using cylindrical objects with iron content resembling UXO potentially expected in the area. These surrogate targets are temporarily placed on the seafloor and magnetic data recorded from different survey lines and various flying heights to demonstrate sensitivity and detection capabilities of the sensors (see Figure 2).

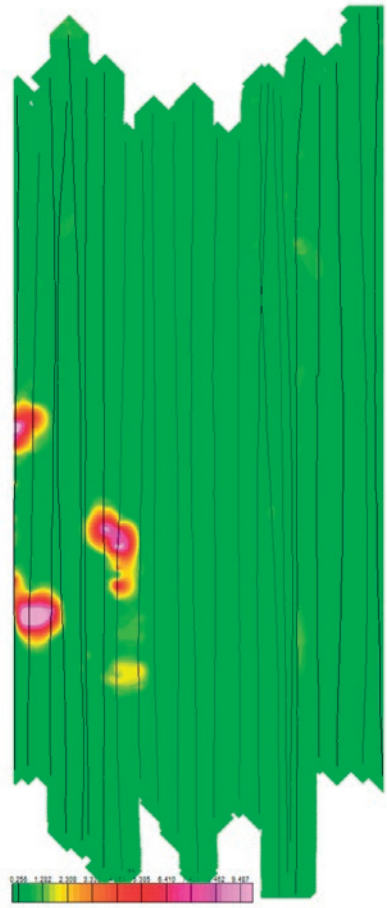
In order to maintain an even flying height over the survey lines a remote operated towed vehicle (ROTV) could be considered.

The typical outcome of this phase is a contact list resulting from gridding and detailed interpretation of all anomalies and contacts using modern software analysis.

Further project risk can be eliminated by removing interpretational bias by providing data to two independent parties and then arranging a discussion to derive a final inspection list for the identification phase.

Phase 3: Identification Surveys

The anomalies listed are the result of the changes of the earth's magnetic field caused by a piece of iron. However, the presence of such anomalies is not actual proof that UXO has been identified. A combined survey and ROV team, advised by Explosive Ordnance Disposal (EOD) experts is required to positively identify each anomaly. A workclass ROV equipped with a heavy-duty dredge facility and various survey sensors and cameras will be used to physically investigate each anomaly location.

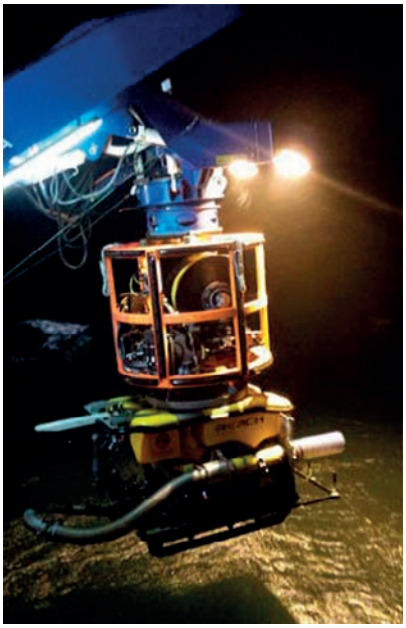


▲ *Figure 3: Typical anomalies gridding result of an area. Image courtesy: MMT.*

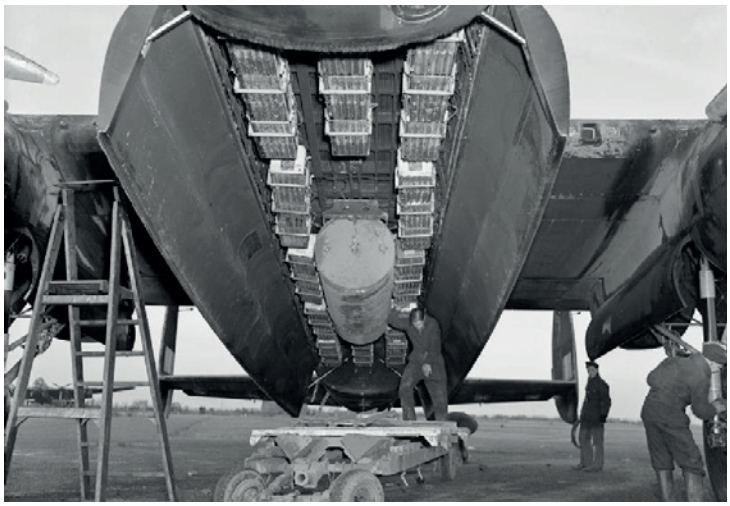
Any such project should be started again with stringent Safe Job Analyses and procedures on the intrusive dredging and identification of an area with potential UXO.

The ROV will mainly be deployed to relocate the identified anomalies and supplemented by a dredging plan designed jointly by the EOD experts and the ROV team. The nature of the object should be identified from real-time observations and acoustic cameras. Before starting any of these investigations the accompanying surface vessel should be kept at a safe distance from the potential UXO threat. It is relevant that precise underwater positioning control be provided by a combination of USBL, INS and DVL aided package.

In most cases, some form of debris will be found and, depending on type and its proximity to the work areas, it is useful to have a workclass ROV that can be equipped with grinders and cutters to help reduce the



▲ *Figure 4: Workclass ROV for dredging and survey. Image courtesy: MMT.*



◀ *Figure 5: Top: Identified British ground mine. Image courtesy: MMT. Below: Bombs being loaded in a Lancaster plane. Image courtesy: Wikimedia.*

impact of the object or assist with removal. Occasionally UXO are found and these range from small mortar to ground mines or bombs requiring further intervention.

Phase 4: UXO Removal and /or Construction Rerouting

After identification of the UXO by the EOD expert and properly documenting the object according to prepared procedures, relevant authorities should be informed to arrange for a notice to mariners and to declare a safety zone. The removal and detonation of an UXO is a dangerous and costly operation and it could be considered an option to leave the UXO and reroute or reposition the construction. A risk-based assessment should be organised with the project team in consultation with the EOD expert. This assessment will consider the distance from UXO to construction activity, installation methodology and tools, positioning uncertainties and the extent of localised disturbance.

In case of UXO removal, a proper project and HSE plan should be provided by the EOD contractor to identify and mitigate any risk for the project, depending on the legislation of the country concerned, as already identified in the desk study.

After UXO removal or rerouting, installation can take place based on the survey results and ALARP standards. EOD companies in the sector are able to provide so-called sign off certificates, which could provide an additional insurance for the remaining residual risk to the installation.

Phase 5: Installation

It is typical that UXO mitigation surveys are organised close to the installation phase of a project. Although the ALARP principle has been met, a residual UXO risk can remain in the installation phase, and from the HSE point of view a safe job analysis should include UXO awareness training for the project personnel.

Conclusion

A UXO strategy should be started and implemented in the project initiation/FEED phase of an offshore marine project. As UXO are widespread within the EEZ of European states it would make sense for legislation and guidelines to be provided for a pan-European approach for an offshore UXO risk mitigation strategy based on the ALARP principles.

Acknowledgement

The author would like to thank the staff of MMT for the provision of copyright material to illustrate this article. ◀

More information

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Improving Correctors to Hydrographic Survey Soundings

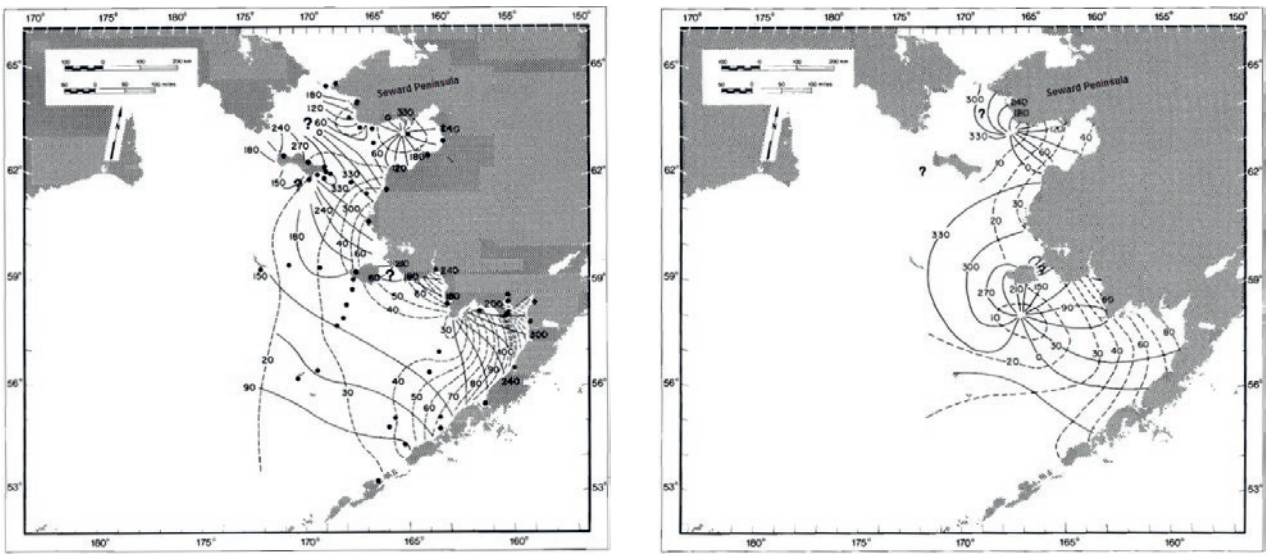
Integrating **Offshore Tide Model Output** with Onshore **Observations**

The National Oceanic and Atmospheric Administration (NOAA) develops tide correctors for reducing hydrographic survey soundings to Chart Datum by using the Tidal Constituent and Residual Interpolation (TCARI) software to interpolate harmonic constituents (HCs), tidal datum elevation relationships and water level residuals from observations. Due to the complex tidal regime and limited coastal observations in the Bering Sea, the error associated with tide correctors generated from the TCARI interpolation exceed the 45cm National Ocean Service standard in some offshore areas. In an effort to develop a higher quality tide corrector, a method of blending offshore HCs from high-resolution tide models and the onshore observations was explored.

This paper presents the general concept and operational feasibility of this approach. A regional tide model was used to provide the offshore HCs in the Bering Sea. The main objective of this study was to evaluate if the integration of offshore, modelled harmonic constituents with onshore observations improves the accuracy of tide correctors in the Bering Sea.

The Limitation of Current Zoning Scheme in the Bering Sea

TCARI is a method of interpolation to derive water level correctors that reduce hydrographic soundings to Chart Datum (MLLW). The accuracy of TCARI largely relies on the spatial distribution and availability of data. Currently, there are only four permanent NOAA operating water level stations along the Bering Sea coastline up to the Bering Strait and 20 additional stations with published HCs. Given the 2,000km shoreline along the Bering Sea coast, the geographic distribution of observed data is very sparse, resulting in high TCARI errors.



▲ *Figure 1: The amplitude and phase contours for M2 (left) and K1 (right) constituents (Pearson et al., 1981).*

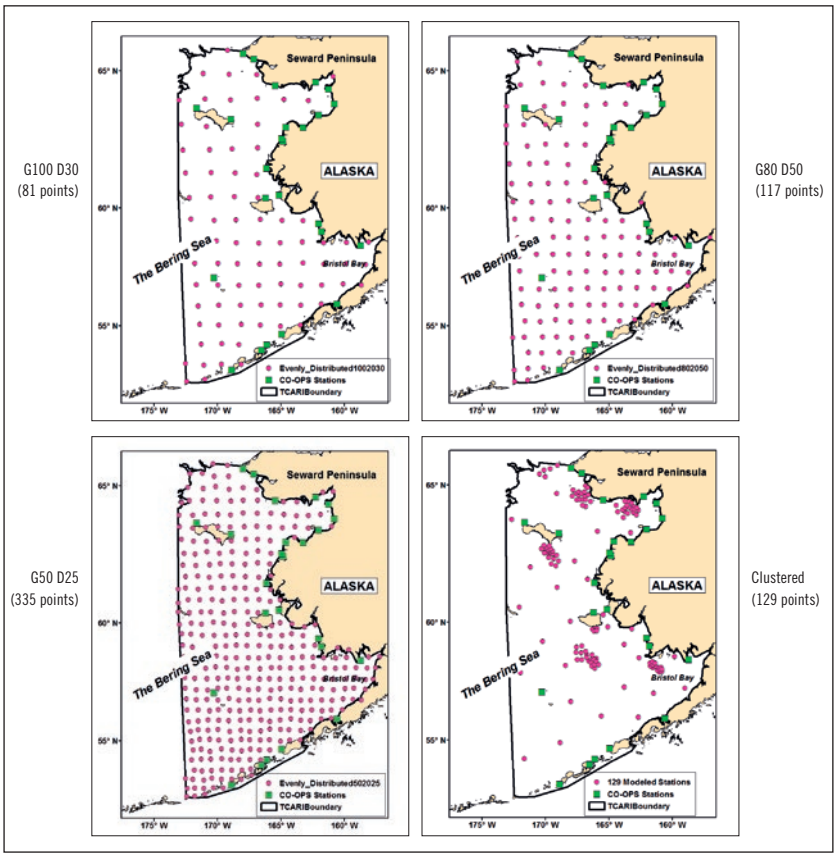


Figure 2: Each of the four 'blended' scenarios combining NOAA stations (green square) with different model output distributions. The grid spacing in kilometres (G) and the distance away from stations in kilometres (D) are shown to the left or right of each scenario.

In addition, the interpolation accuracy is impacted by the tidal complexity as interpolation across complex tidal regimes increases the uncertainties of the solution. The tides in the Bering Sea are complex for several reasons; the first is the existence of several diurnal and semidiurnal amphidromes. An amphidromic point is a point of zero vertical displacement of one harmonic constituent of the tide. The amplitude of that harmonic constituent increases with distance away from this point and the phase of the constituent changes continuously around the central point (Figure 1). The direct interpolation of observations from coastal stations results in offshore solutions that have errors greater than the 45cm specification.

Tide Model Evaluation

A regional tide model developed by Foreman et al. (2006), which assimilated satellite altimetry data, was used to provide additional HCs. Before being incorporated into a TCARI solution, the modelled HCs were evaluated by comparing them with the published HCs at NOAA stations. For this evaluation the principle semidiurnal constituent, M2, and principle diurnal constituent, K1, were used for comparison.

An error was computed for each constituent at each location which combines the amplitude and phase differences. The

The geographic distribution of observed data is very sparse

relative error (%) was calculated by dividing the error by the observed amplitude of the constituent, which provides a measure of the relative performance of the model for each constituent. However, it should be noted that for constituents with minimal amplitude, any discrepancy will result in a large relative error. The error values for M2 ranged from 6mm to 35cm and K1 ranged from 6mm to 16cm. The relative error values for the M2 constituent ranged from 2.4% - 180% of the observed amplitude, and from 3.8% - 90% for the K1 constituent. Given these discrepancies, tide reductions derived from the tide model alone would not meet NOAA's hydrographic survey specifications.

Tide Model Integration

The output from selected offshore model output points were combined with the observations from onshore stations for TCARI interpolation so that the model results contributed more to the interpolated HCs in the offshore regions and the onshore observations contributed more to the interpolated HCs in the nearshore regions. Two ways of selecting model points were investigated. One method used a programme that automatically selects evenly distributed model points throughout the TCARI domain. The other involved a manual selection of model points based on spatial distribution of modelled amphidromes.

Four different scenarios of integrating model points were evaluated in this study. They are described by a parameter G for the grid spacing, and a parameter D for the minimum distance between model points and tide stations. Three evenly distributed scenarios are: 100km grid spacing and 30km tide station distance (G100 D30); 80km grid spacing and 50km tide station distance (G80 D50); 50km grid spacing and 25km tide station distance (G50 D25). The fourth scenario is 129 model points clustering around the locations where there are suspected amphidromes (Figure 2). Combining these four blended scenarios, the solution using only data from operating tide stations, and the tide model output itself, a total of six scenarios were used for comparison with data collected offshore in the 1980s.

Comparison of Errors among 6 Scenarios

As part of two Pacific Marine Environmental Lab (PMEL) studies in the Bering Sea, pressure gauges were deployed from the tip of the Seward Peninsula south to the end of the Alaskan Peninsula (Pearson et al., 1981 and Mofjeld, 1986). The HCs derived from the data of 24 of these gauges were used as ground-truth information for comparison between six scenarios.

The results for the M2 and K1 constituent comparisons are shown in Table 1. Table 1 indicates that the addition of model output into a TCARI solution significantly reduced the error for M2 from 37.9cm to 3.4cm and K1

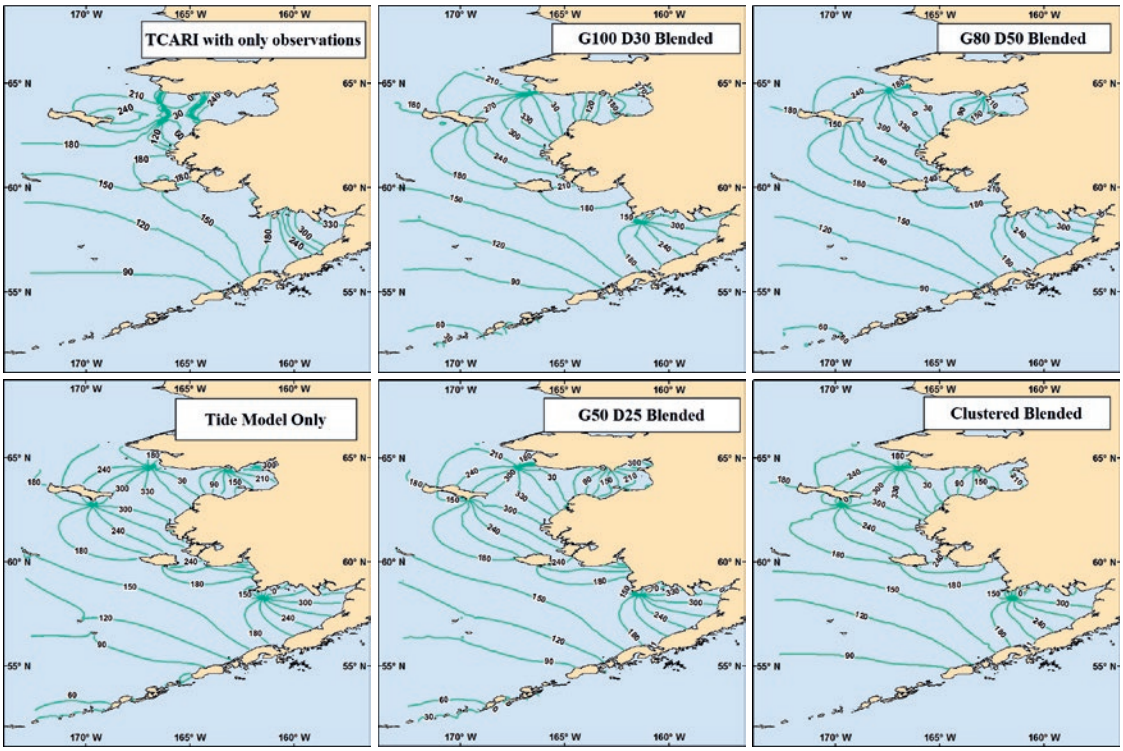


Figure 3: Phase contours of the M2 constituent generated from each of the six scenarios.

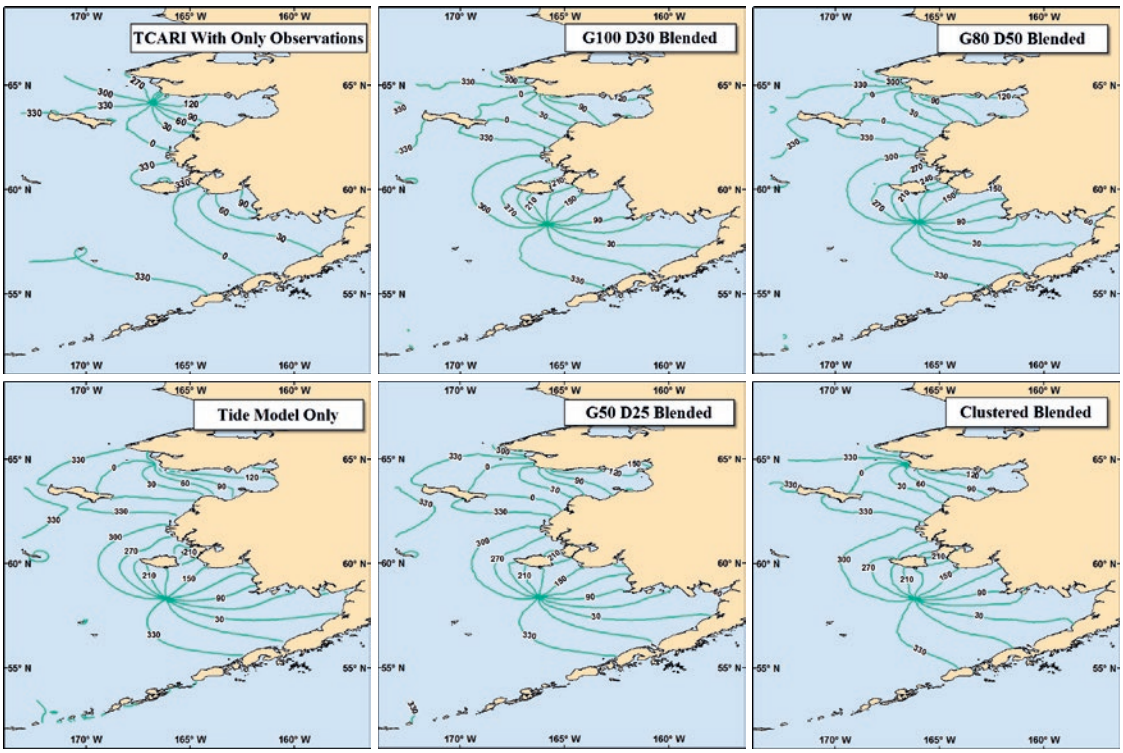


Figure 4: Phase contours of the K1 constituent generated from each of the six scenarios.

constituents from 11.9cm to 2.1cm, in the best cases. Accordingly, the relative error for M2 was reduced from 167.3% to 24.6% of the observed amplitude and from 84.6% to 18.4% for K1.

M2 and K1 Contours in the Bering Sea

Phase contours of the M2 and K1 constituents from the six scenarios were exported from TCARI to allow for the comparison of the different solutions in the Bering Sea (Figure 3 and 4). The tide-stations-only plot did not reveal any single M2 amphidromic point, while the other five solutions, including the tide-model-only solution, show several amphidromic systems. The M2 contours (Figure 3) from the clustered-model-points scenario were most consistent with those from the tide model. The G50 D25 evenly-distributed scenario was similar to the clustered solution, but the significant increase in the number of points would present an operational limitation. The G100 D30 and G80 D50 evenly-distributed solutions did not resolve all of the suspected M2 amphidromes that the Foreman tide model shows.

Plots of the K1 phases in Figure 4 suggest that the clustered solution most similarly

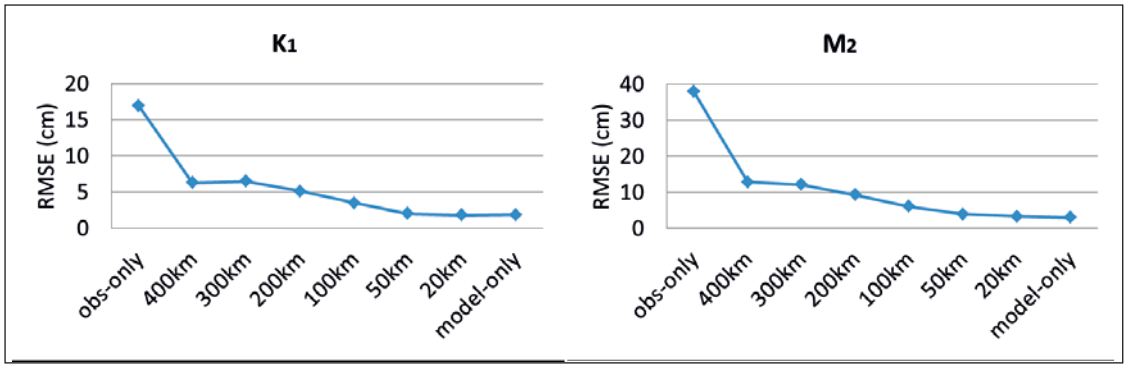


Figure 5: Model output sensitivity test with different values for the gridding distance parameter G but the same tide station distance parameter D. The error is expressed as the RMSE.

	M2		K1	
Scenarios	**Average absolute error (cm)**	**Average relative error (%)**	**Average absolute error (cm)**	**Average relative error (%)**
Tide stations only	37.9	167.3	11.9	84.6
G100 D30	4.9	35.1	3.1	25.5
G80 D50	4.6	37.2	2.8	25.7
G50 D25	3.4	28.0	2.1	18.4
Clustered model points	4.7	24.6	3.5	24.1
Tide model only	3.0	19.8	1.9	14.7

Table 1: Average absolute error (cm), and average relative error, expressed as the absolute error divided by the observed amplitude (%), for 6 scenarios.

reproduced the two suspected diurnal amphidromic points. The tide-stations-only solution resolved a full amphidromic point off of the south-western tip of the Seward Peninsula, which is consistent with Pearson (1981) (see Figure 1), while the model only identified it as a partial amphidromic point. The tide-stations-only solution did not show the amphidromic point in western Bristol Bay that was captured by the Foreman tide model, as well as all four blended solutions.

A total of six scenarios were used for comparison with data collected offshore in the 1980s

Discussion and Future Work

An additional sensitivity test was performed using the evenly distributed model points (Figure 5). The goal was to test the sensitivity of the gridding distance parameter G by setting it to 6 different values: 400km, 300 km, 200km, 100km, 50km, and 20km. Additionally, the tide station distance parameter D was fixed at 50km. The average error reduced significantly when model output spaced at 400km was included in the TCARI solution. This improvement was less dramatic when reducing the density parameter further. The trend was the same for both the M2 and K1 constituents. These types of sensitivity tests are important to maximise results while minimising computer processing time. For the Bering Sea, the use of model output at the 400km grid level (8 model points) provided an error within the specifications for NOAA hydrographic surveys, despite not resolving all of the complex tidal features.

This method will continue to be evaluated in regions of well-understood tidal physics such as Chesapeake Bay and then implemented for tide reduction operations in the near future.

Acknowledgements

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Deep-sea Research Expeditions Expand Multibeam Bathymetric Map of Seafloor

Opportunistic **Multibeam Surveying**

Currently only ten to fifteen percent of the ocean floor has been mapped at resolutions of 100-metre pixel size or better and the vast majority of this mapped area is within territorial waters. One way to significantly increase seafloor coverage is to outsource data collection to non-hydrographic vessels or ships of opportunity. However, data currently being collected by these vessels are largely unmanaged, leading to possible redundant coverage and/or inconsistent quality. It is a good idea that the scientific and hydrographic communities make effective use of ships of opportunity in order to optimise data collection in the immense areas in need of mapping in the planet's remote waters.

Three expeditions set sail to collect and image cold-water corals on bathymetric highs for palaeoceanographic and biogeographic research (led by authors Laura F. Robinson and Rhian G. Waller). This research required operation in areas beyond national jurisdiction (ABNJ), where multibeam bathymetry data are sparse. In order to effectively collect scientific samples, maps of the seafloor in higher resolution than the existing altimetry grids were needed. Collection of bathymetric data was ancillary to the primary cruise goals but by optimising opportunistic surveying, 125,300 square kilometres of multibeam data were collected, processed and published.

▲ *Figure 1: The* RVIB Nathaniel B. Palmer *docked in Punta Arenas, Chile. Photo taken by Shannon Hoy.*

The Cruises

During 2008 and 2011, the *RVIB Nathaniel B. Palmer* (Figure 1) navigated the Drake Passage, the 500-mile-wide swath of the Southern Ocean between Antarctica and South America, performing scientific operations such as trawling, dredging, coring, and utilising a towed-camera system. Little multibeam bathymetric data were available for cruise planning or operations. Therefore, bathymetric reconnaissance was necessary during the 2008 cruise in order to locate ideal sites for sample collection. In 2011, bathymetry data were collected to add coverage to the maps created in 2008 and to explore new areas. In total, 49,500 square kilometres of seafloor were mapped in the remote Drake Passage (Figure 2). These maps greatly improved upon the existing altimetry data in detail and location, increasing the ability to sample safely and effectively (Figure 3).

Planned routes must maximise data coverage without increasing transit time

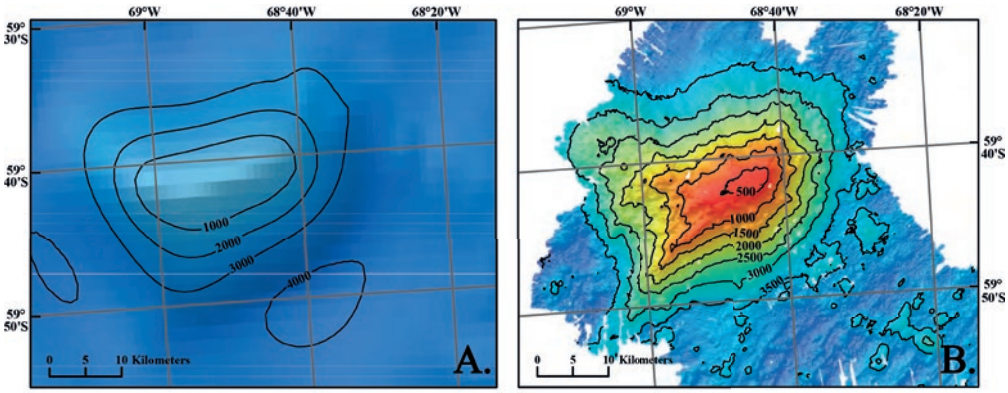
In 2013, the *RRS James Cook* (Figure 4) traversed infrequently-travelled areas of the low latitude Atlantic Ocean (Figure 5). Similar to the *Nathaniel B. Palmer* expeditions, prior available multibeam bathymetric data were scarce in the intended sampling locations. Again, it was necessary to dedicate ship time to mulitbeam surveying to effectively plan scientific operations, such as sampling and diving with a remotely operated vehicle. These surveys yielded 75,750 square kilometres of 100-metre pixel size multibeam bathymetric data.

Optimising Opportunistic Surveying

Effective time management and the flexibility to take slightly indirect routes between work sites were key to optimising bathymetry collection during these non-bathymetric-focused expeditions. Minimising the time spent on surveying while maximising the coverage without jeopardising quality were critical elements of survey planning. To maximise the efficiency of all operations, surveying was carried out during gear turn-around, transits to sampling areas,

▲ *Figure 2: The* RRS James Cook *docked in Tenerife, Canary Islands. Photo taken by Shannon Hoy.*

and sub-optimal weather windows.
To ensure quality data collection and effective survey planning, trained mapping personnel covering the 24-hour work day were necessary. We found that 2 trained technicians were able to process all of the acquired multibeam data while at sea and produce maps for scientific operations. With careful recruitment, the mapping specialists can contribute to other scientific operations on board, hence maximising their input to the expedition. This is a critical argument for allocating berths, a limited resource during scientific expeditions.



▲ *Figure 3: Example of the level of resolution of seafloor data on Sars Seamounts that existed before (A) and after (B) the 2008 and 2011 expeditions in the Drake Passage.*

Why Collect Remote-water Bathymetry

The majority of the 125,300 square kilometres of bathymetric data collected during these three cruises were not critical to the primary scientific operations. Data were collected and processed continually, even during transits, throughout each cruise, for the purpose of expanding the available multibeam bathymetric map of the seafloor. Ships operating in these remote waters provide opportunities to collect data necessary for making reliable bathymetric maps required for scientific research. These same maps support commercial exploration and exploitation of seafloor resources and provide a basis for effective marine management. Scientific research today is being carried out across all ocean depths around the world in an effort to understand how our planet works, how humans are impacting it, and to mitigate the effects of hazards such as tsunamis, earthquakes and the effects of climate change. This knowledge is a valuable contribution to ensure safety, to minimise the loss of expensive over-the-side equipment, to ensure the selection of the best sites for the purpose at hand, and for a complete understanding of the environment.

Challenges in Collecting Remote-water Bathymetry

Our experience has made us aware of three important issues associated with collection of multibeam bathymetric data in remote waters. First, data collected in remote waters by non-hydrographic vessels vary in quality because they are often unmonitored. Operating procedures and processing techniques vary from ship to ship or even technician to technician. This lack of standardisation could cause inconsistent and unreliable data to be produced. Second, some vessels, although equipped with modern multibeam echo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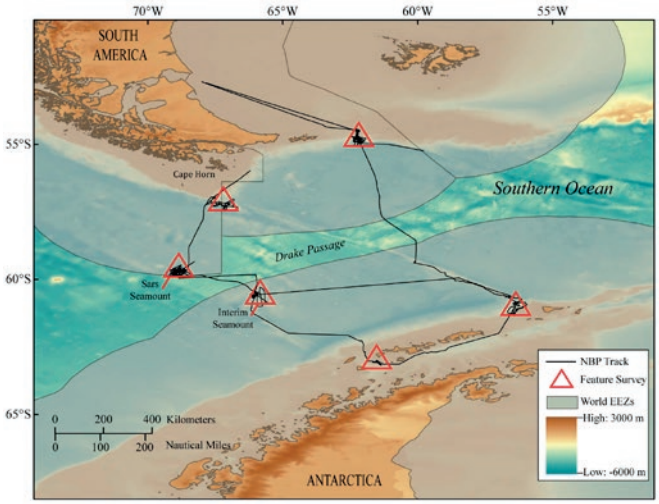
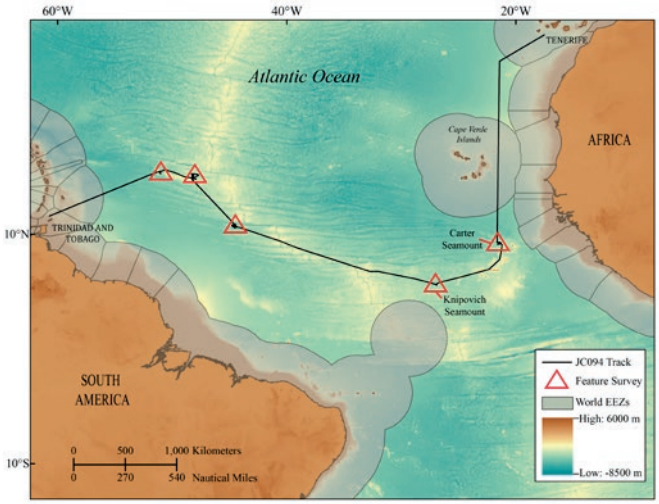


▲ *Figure 4: The 2008 and 2011 cruise track of the* RVIB Nathaniel B. Palmer. *The red triangle indicates an area where a seafloor feature survey was conducted.*



▲ *Figure 5: The 2013* RRS James Cook *expedition track. The red triangle indicates where a seafloor feature survey was conducted.*

sounders, only collect data for a small fraction of their at-sea time, or do not collect it at all, probably due to lack of funding and personnel and/or lack of knowledge that the data may be of use. Third, international data collected in remote waters might not be shared with the wider scientific community. This lack of sharing promotes redundant data collection, which is a waste of time, money and resources.

More Discussion Needed

In order to promote collection of bathymetry by ships of opportunity or non-hydrographic vessels, a system must be in place that efficiently catalogues and makes available the locations of existing data, the quality of that data, and the most effective route for one of these vessels to take. These planned routes must maximise data coverage without increasing transit time. If each time a vessel transited to and from its destination they made slight parallel adjustments to their tracks, then large swaths of seafloor could be mapped over time. If you expand that model to all of the ships of opportunities, think of how efficiently remote areas could be mapped. The goal is for this system to be used by not only hydrographers, but also by scientists and mariners. Therefore, it is critical that this be easy to use and not reliant on expensive software. It is possible to contribute to creating an efficient mapping system by joining the discussion in the Hydro International LinkedIn group (search for *Opportunistic* in the group).

Conclusions

Our experience has shown that it is possible to collect and process large swaths of useful bathymetry during research cruises where collection of bathymetric data is a secondary goal. Having more readily available quality bathymetric data would save both time and money for future scientific expeditions. We believe there is considerable support in the marine science community to standardise and share bathymetric data if it can be done with low cost and without a large impact on the primary operations of the expedition. Clearly, more discussion is needed to develop protocols and international standards that provide a reasonable compromise between efficiency and quality, but the marine science community would be a logical place to begin those discussions.

Acknowledgements

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Tide and Current Monitoring for Navigation and Maintenance

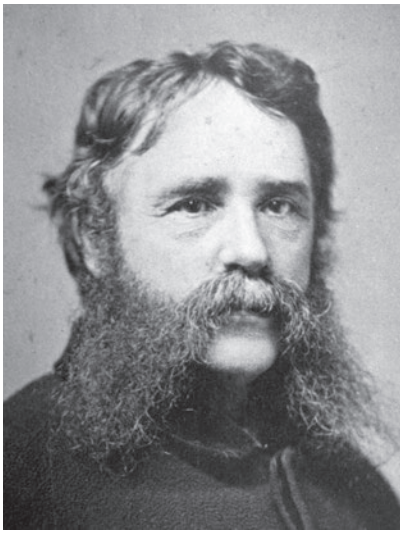
New York Harbour

The greatest of the Coast Survey mid-nineteenth century harbour studies was that of New York Harbour. In 1855, the Commissioners on Harbor Encroachments of New York requested that new hydrographic surveys of New York Harbour be conducted. The first surveys had been conducted twenty years earlier and considerable changes had occurred.

Following the completion of the new hydrographic surveys of New York Harbour, an advisory council, consisting of Coast Survey Superintendent Alexander Dallas Bache, General Joseph Totten, and Commander Charles Henry Davis, produced a report for the Commissioners detailing the changes that had occurred. They also recommended a physical survey of the harbour be conducted to determine the causes of the changes. They recognised that "… when it comes to those of improvement nothing less than a physical survey will answer. A few thousand dollars thus expended, by determining the minute actions of the tides and currents and their causes, may save hundreds of thousands in expensive tentative works of improvement."

The council's report noted extensive changes. Between the Hudson and East Rivers alone, 1,220 acres of land had been made "upon which, formerly, the tide rose more than four and a half feet, removing thus a tidal space of nearly nine millions of cubic yards from this part of the harbour." Although many of the changes were beneficial, in many instances harm had been done to local channels and commercial areas. The nature of the problem as described by the council was: "It is not sufficient to know the changes and their extent. The causes which have produced them must be ascertained. In this way alone can they be regulated and controlled …. We cannot too often repeat, that whatever changes the direction and velocity of the current, must change the regimen of the harbour for good or evil." The council went on to suggest that New York Harbour would have been better off "had the shore-line been regulated years ago according to a systematic plan."

Recognising that the force behind the encroachments on the harbour was the high value of real estate, the council blunted potential charges that they were against private property rights by advocating use of an additional 1,840 acres for dock space and the filling-in of 2,840 acres of tidelands amounting to 34,000,000 cubic yards of harbour volume. But, this was to be "done according to systematic plan, which will avoid the dangers we have observed or have been able to foresee…"



▲ *Figure 1: Henry Mitchell.*

Contained within the New York Harbour report is the concept of finite resources and the need to conserve economic resources. The council recognised that: "New York Harbour, like all other tidal harbours, must principally depend on the ebb and flood to keep its approaches and channels in navigable condition. For this reason it is necessary to preserve jealously, the water area of the harbour, so as to permit the greatest possible quantity of tide-water to enter it and by its efflux to scour the channel and bar."

As a result of the report, the state legislature of New York requested that the Coast Survey "complete the physical survey of the harbour, so that the results might not only be adapted to purposes of navigation but to the study of the changes in progress." Accordingly, Bache assigned Assistant Henry Mitchell to the physical survey. Mitchell had just finished a major study of the tides and currents of Nantucket and Vineyard Sounds and had worked part of the past year conducting tidal observations in support of hydrographic surveys in New York Harbour. He differentiated between studying tides and currents for purposes of navigation and for studies of harbour improvements and realised that:

"The study of tides and currents must be regarded in a two-fold relation: first, as affording the means of constructing prediction tables for immediate use in navigation; second, as an inquiry into a class of agencies whose ceaseless activities are gradually altering the configuration of our harbors and seacoasts …."

Working from shore stations and the Coast Survey Schooner *Madison* in the Hell Gate area in 1857, Mitchell established self-registering tide gauges and two manually observed box gauges. The box gauges were observed every 15 minutes, night and day, during the course of the survey. Showing an increased level of sophistication over earlier tidal surveys, he connected the permanent stations "by lines of levels, so that we are able to refer all the observed heights to a common zero and ascertain the disturbance of sea level at each stage ...." He also noted that "The changes in the mean water level, caused by long continued gales of wind, are among the most striking characteristics of this region…."

The *Madison* occupied long-term stations and its boats were employed in locations where a single day's work would suffice. Observations were made in the axis of the stream; and, by judicious use of the boats, as many points as possible were occupied simultaneously. The primary instrument for observing

▸ *Figure 2: Hell's Gate.*

currents was the 'ordinary log', a weighted pole with a graduated line used to measure the velocity of the current. Velocities and directions of currents were recorded at half hour intervals while on station, as well as the time of slack water. Most of the major stations were occupied with an unbroken series of observations for 7 to 9 days.

Within New York Harbour, it would seem that the work would not be dangerous. However, Mitchell considered the difficulties in the Hell's Gate area to be "almost insurmountable" particularly in observing maximum flood currents off Hallet's Point. At this locality "the flood streams are gathered together into a single torrent, in which no boat can lie at anchor. We repeatedly tried ... to secure a boat in this place during the flood current, and in each case it was either run over by drifting vessels or by the stream itself."

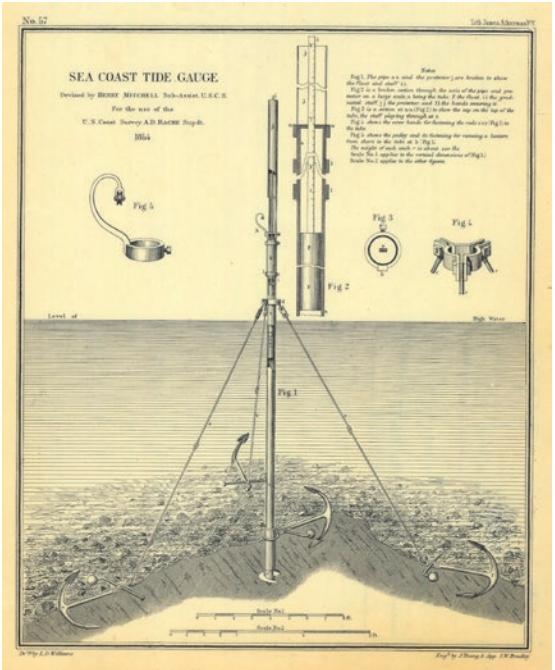
The box gauges were observed every 15 minutes, night and day

Mitchell abandoned the use of boats in this area and then attempted using "free floats and noting the time of their passage across certain ranges." However, as each float tended to follow a different path, this method was a failure. In spite of this, Mitchell succeeded in examining "the whirls and counter currents in the vicinity of Hell Gate...." and discovered that, "Many of the more remarkable of these are confined to fixed limits, and regularly recur with each ebb or flood current."

In 1858, Bache instructed Mitchell to study both surface currents and "the motions of the waters below." The goal of studying the sub-surface regime was to define the factors affecting sedimentation and erosion in the tidal basin. Mitchell invented an "ingenious apparatus" to observe the sub-surface currents. This device consisted "of two large copper globes, as floats, connected by a slender cord, one weighted so as to float when immersed to the depth of four feet, and the other so as to sink to different depths in the currents which it may be desired to investigate. The motion of the apparatus will depend, of course, upon the difference of movement at four feet, the nearly superficial current, and below…"

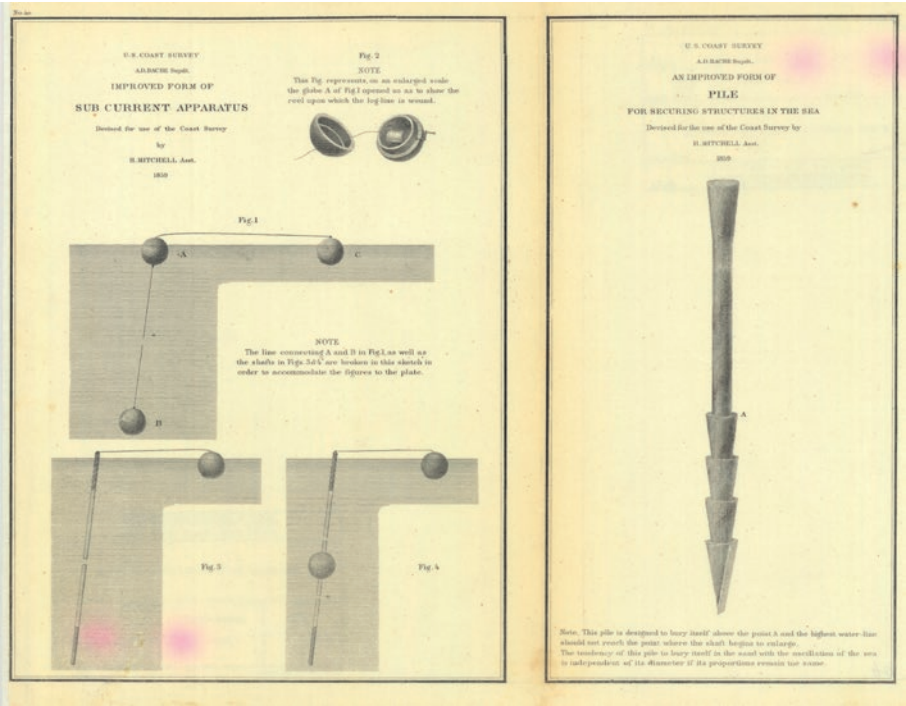
By means of his floating copper globes, Mitchell "ascertained that, instead of uniform gradation of velocities from surface to bottom, there often occurs in deep channels a counter drift, or even distinct streams, at different depths. …. At some of our stations phenomena of this character never fail to repeat themselves daily, on the recurrence of certain tidal phases…." Mitchell's discoveries were totally unexpected; and, if not unprecedented, certainly were among the earliest to determine the nature of the movement of water masses in estuarine environments.

In spite of Mitchell's studies and the exhortations of the advisory council, mindless practices continued to dominate the use of New York Harbour. Unauthorised filling of wetlands was commonplace as was the extension of construction beyond the lines allowed by law. These were not only the acts of private citizens but were also done under the authority of the city government.



▲ *Figure 3: Sea coast tide gauge devised by Mitchell for use in offshore waters.*

Sewage was also a source of damage to the harbour. In the mid-nineteenth century



▲ *Figure 4: Improved form of sub-current apparatus for current stations occupied in Sandy Hook Bay and off the entrance to New York Harbour.*

there were few concerns with public health or damage to the environment. However, there was great concern with the potential commercial damage to New York Harbour. Sewage filled the slips in the harbour at "nearly eighteen inches each year" and that out of one hundred and ten sewer outlets, only four discharged at the outer end of the piers with the rest discharging into the still waters of the slips or basins where sewage accumulated.

Paralleling the sewage problem was the dumping of street cleaning dirt into the waters of the harbour which also filled up the slips, from the practice of heaping it up on the piers and bulkheads. At least one pier gave way from the accumulation of dirt upon it, and 3,000 cart loads (approximately 3,000 tons) were dumped in the river. Considering that much of the 'dirt' was horse manure, it takes little imagination to visualise what a cesspool New York Harbour must have been.

To remedy the evils affecting the capacity of the harbour, the Commissioners requested that the legislature of New York enact stiffer penalties for encroachments and the power to remove the encroachments at the cost of the offending parties. Concerning the sewage and dirt, "All new sewers should be carried to the outer ends of the piers ... and, where practicable, the termination of those now built should be changed so as to empty in like manner with the new ones.... No dumping should be permitted upon or near the piers or bulkheads, under a penalty; and the city inspectors should be required to have scows or other vessels provided and ready to receive the dirt from the carts, there being no good reason why dirt should have a preference over all other articles in the use of our piers and bulkheads."

Change and encroachments continued. Henry Mitchell conducted major studies of New York Harbour again in 1866-67, 1872-1873, 1876, 1880, and 1887. Following the initial physical survey of the harbour, a flurry of similar studies were undertaken at Boston Harbour, Mobile Harbour, and the site of a proposed canal between Cape Cod Bay and Buzzards Bay, Massachusetts. The object of these surveys was generally the preservation of the waterways "by preventing dangerous encroachments on the water in the rapid progress of buildings and of improvements on land, by ascertaining the changes caused in the water space by the changes in the land, and the causes of these changes." These pioneering studies were landmarks in both conservation and estuarine science and, although the technology and methods have changed, still serve as models for similar studies and policy decisions today. ◀

Saab Seaeye

ROVs in **Use for Renewables**

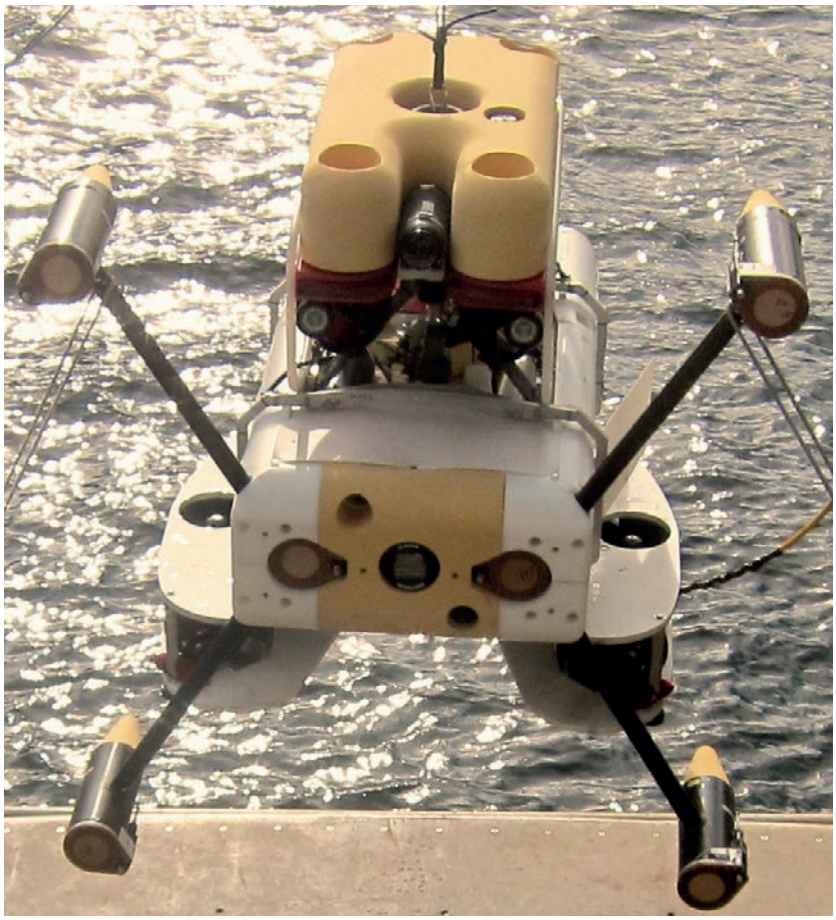
The renewable energy sector is a significant user of Saab Seaeye underwater vehicles. Already the world's largest manufacturer of electric ROVs, Saab Seaeye also has a range of autonomous and tethered AUV/ROV hybrid systems that will extend the potential for remote inspection and monitoring in the renewable sector.

Since its foundation in 1986, the Fareham, UK-based company has pioneered many innovations that have set standards for electric vehicles across the ROV industry. Leading-edge technology has created systems capable of fulfilling highly specific operational needs in various industries, the renewable energy sector being a clear example.

In this sector underwater vehicles must master the particularly challenging environments in which renewable energy installations are set. Typically they are built in shallow waters where high currents and wave action demand powerfully swimming vehicles that will hold steady whilst undertaking precise tasks or making accurate observations. They must also operate in poor visibility and manoeuvre deftly in tight spaces.

The underwater vehicle technology needed for such conditions has been developed and refined over the years by Saab Seaeye who have created a wide range of vehicles able to cope with severe environments whilst undertaking an extensive spread of tasks.

By introducing intelligent behaviour-based architecture, called iCON, and also designing vehicles with the maximum thrust power, operators in the renewable sector benefit from the resulting control and power that provides them with a stable platform from which to handle an array of sensor systems and tooling options whilst remaining on station in strong tides.



▲ *Figure 1: Washington University monitoring package mounted under a Saab Seaeye Falcon ROV ready for deployment at a tidal energy installation.*

Such technological advances are meeting the challenges presented by the renewable sector that are both broad and varied, some examples of which follow.

Renewable Energy Installations and Marine Animals

The long-term effect of renewable energy installations on marine animals is to be investigated by researchers at Washington University. A specially designed underwater monitoring system with a detachable instrument pod deployed by a Saab Seaeye Falcon ROV will gather information on how marine life interacts with renewable installations used to harvest wave and tidal energy.

The instrument pod can monitor marine mammals and detect fish tags. It also has a sonar system, sensors to gauge water quality and speed, and a stereo camera to collect photos and video. A fibre optic cable connection allows for real-time monitoring and control.

The system can attach to most types of underwater infrastructure, with the instrument pod delivered to its docking station by the Falcon ROV.

▲ *Figure 2: Workboat deploys Falcon ROV to check integrity of floating turbine moorings off the coast of Japan.*

▲ *Figure 3: Cougar XT Compact, fitted with Innovatum's Smartrak system, brings power to inshore survey work in strong currents and tidal flows.*

Actuators on the Falcon latch the monitoring instruments onto the docking station before the ROV disengages, leaving the instruments in place and travelling back to the surface.

Despite the monitoring package being almost twice the size of the Falcon (Figure 1) the researchers were able to fit an off-the-shelf Falcon with five extra thrusters on an external frame to move the mass of the instrumentation package against turbulent currents.

The University sees the system as key technology for the future of monitoring tidal energy systems that will increase the rate of progress in environmental studies, including research into other structures that form artificial reefs like oil and gas rigs.

Securing Floating Turbines

After Japan's 50 nuclear reactors closed, following the Fukushima disaster, wind is now seen as an important alternative energy source. But in a crowded and mountainous country, floating turbines in the deep waters off the rugged coastline was the only option.

With many turbines to be installed at a depth of 100 metres or more, sure-footed anchorage to the seabed is a vital necessity. To monitor the integrity of chained mooring points the Japanese Government uses a Saab Seaeye Falcon ROV to assess anchor holding, analyse anchor drag and check for twist and entanglement.

The Ministry chose the Falcon because it can be deployed from a small workboat at a low operating cost and can handle strong currents (Figure 2).

Finding Cables in Offshore Wind High Current Sites

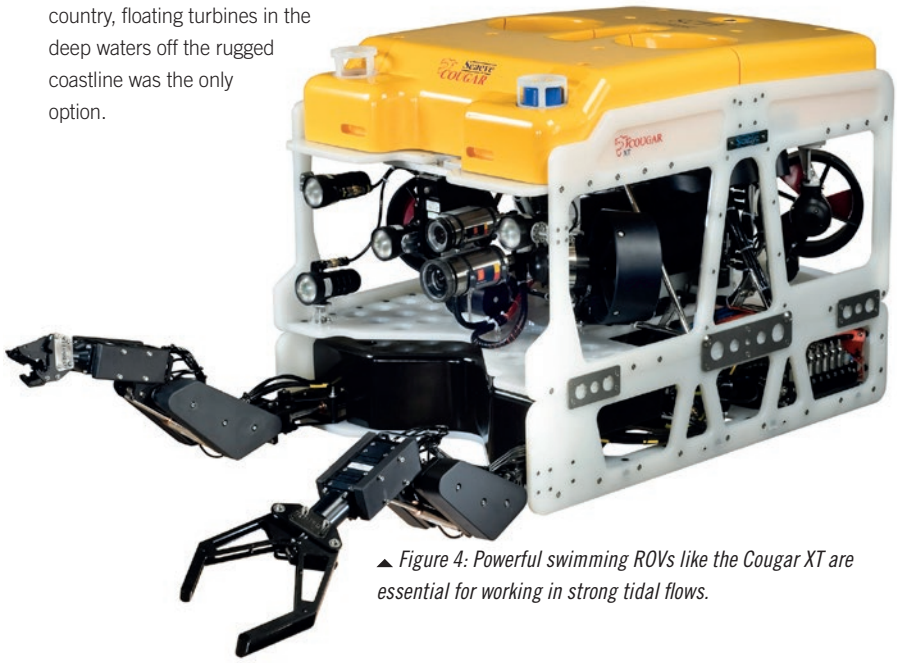
UK-based Innovatum has created the world's smallest package for the location, tracking and survey of inshore and coastal pipelines and cables. To handle the six-metre wide gradiometer array in the strong currents and tidal flows of the southern North Sea, the company has opted for the compact version of Saab Seaeye's Cougar XT with its six-strong thruster power, advanced systems and low profile.

Innovatum has also fitted the ROV with a high-resolution imaging sonar and dual-headed scanning profiler for mean seabed level measurement. For survey work, the Cougar has the advantage of a low electrical and acoustic noise signature for optimum survey sensor data.

The Innovatum system is said to be the only one in the world that can sense cables carrying either AC or DC current; and cables carrying no current or signal at all. It can also undertake passive tracking of steel pipelines.

Mastering Strong Currents

Extending the working window offers significant operational and cost advantages say Keynvor MorLift who opted for Seaeye Cougar-XT systems (Figure 4) to undertake their installation and maintenance work at tidal energy sites where exceptionally strong tidal currents occur.◀



▲ *Figure 4: Powerful swimming ROVs like the Cougar XT are essential for working in strong tidal flows.*

More information
www.saab-seaeye.com

NORCOWE

Measurement for **Offshore Wind Farms**

The Norwegian Centre for Offshore Wind Energy (NORCOWE) is a research centre with partners from science and industry. NORCOWE is part of the FME scheme, set up by the Research Council of Norway (RCN) to support development of environmentally friendly energy. Met/ocean measurements for offshore wind energy are a major topic within NORCOWE.

Offshore wind deployments have rapidly developed during the last decade. Both the size of the individual turbines and the extension and density of wind farms have increased and the sites have moved further offshore. These developments pose new challenges with respect to meteorological and oceanic measurements and modelling.

Over the last few years, several large turbines (6-8MW) have been introduced to the market. These turbines have a rotor diameter of 150 metres or more, and a tip height of at least 160 metres when installed at site.

The development of large turbines (5-10MW) implies that we need reliable information on the Atmospheric Boundary Layer (ABL) up to 250-300 metres. At this altitude all our well established surface-layer theories are no longer valid. Recent research shows that information on the wind field and stability (i.e. the temperature profile) over the whole ABL, including the capping inversion, is required to understand and predict wind shear and turbulence conditions in the lowest 300 metres. The situation is further complicated by the poorly understood air-sea exchange processes at the wave-atmosphere interface. These processes seem to modify the wind profiles and the turbulence structure under certain atmospheric conditions, resulting in non-monotonic or even inverted wind profiles. There is a need for improved design basis to optimise turbine and foundation construction. Currents, waves and turbulence parameters are important input for that purpose. Measurements focused on the determination of turbulent parameters are crucial for the estimation of structural loads.

Single turbine wake effects are the main factor in limiting the density of turbines in a wind farm, due to downstream power production losses as well as increased maintenance requirements. Wind turbine wakes are complex and highly turbulent structures with large spatial and temporal variability. The state of the art models are capable of predicting average position and extension of turbine wakes, but they still have large problems with representing the instantaneous structure and dynamics (e.g. meandering) that are crucial for accurate load and fatigue estimations. Consequently, there is a need for offshore measurements of wakes in combination with the sea state and the related air-sea exchange processes to understand and document the complex interaction of wakes with the wave-affected marine atmospheric boundary layer.

Figure 1: A variety of wind turbines. Image courtesy: NORCOWE.

Wind farm wakes can extend several tens of kilometres downstream

Observations, e.g. from satellites and model simulations, indicate that wind farm wakes can extend several tens of kilometres downstream. A more precise characterisation of wakes from large offshore wind farms is crucial in the planning process, in particular in the North Sea due to space restrictions.

▲ *Figure 2: Wind turbines seen in a Lidar scanner. Image courtesy: Benny Svendal.*

▲ *Figure 3: An unmanned sailing vessel. Image courtesy: Christian Michelsen Research.*

NORCOWE initiated and realised the OBLEX-F1 campaign (Offshore Boundary Layer Experiment at FINO1) at the German research platform FINO1 to address some of the challenges. OBLEX-F1 started in May 2015 and is expected to last until June 2016. It is being carried out by Christian Michelsen Research (CMR) and the Geophysical Institute, University of Bergen (GFI/UiB) in close cooperation with other NORCOWE partners and German institutions and consortiums. See the NORCOWE website for a detailed description.

The key purpose of the campaign is to improve the knowledge of the marine atmospheric boundary layer with respect to the interaction of wind shear, turbulence and stability, the influence of air-sea interaction processes and to describe the structure and dynamics of wind turbine wakes and wake propagation offshore. The collected observational dataset will be used to validate and improve numerical models and tools for, among others, weather forecasting, marine operations, power performance and wind farm layout. Additionally, the campaign scope will cover research on motion correction techniques for floating sensor platforms.

In order to provide unique datasets for the study of boundary layer stability in offshore conditions, simultaneous measurements of wind, temperature and humidity profiles in the Marine Atmospheric Boundary Layer (MABL) are being taken. This is the first time a microwave radiometer has been installed offshore. By employing both microwave radiometer and Lidar remote sensing technology, we are able to map the boundary layer conditions continuously up to an altitude of several kilometres. Two scanning Lidar systems have been installed on the FINO1 research platform, enabling characterisation of both wind inflow conditions and correlated wake effects at the nearby Alpha Ventus wind farm.

The first microwave radiometer to have been installed offshore

Instruments measuring the currents, temperature, salinity, surface gravity waves and turbulence were deployed in June 2015. The focus is on the upper ocean turbulence characteristics in the presence of surface gravity wave-related processes. The oceanographic instrumentation at FINO1 will be deployed until October 2015.

In recent years we have seen the introduction of many new innovative measurement solutions based on remote sensing technology. Examples are Lidar anemometers, hydroacoustic doppler profilers and microwave radiometers. NORCOWE expects this development to accelerate as the core technology matures rapidly and size, power consumption and complexity of the instruments drops. Successful integration of remote sensing technology on robust platforms suitable for rapid and maintenance free deployment offshore is the key to meet the demand from the wind industry.

In particular floating Lidars are an important step forward to improve the wind resource assessment and to bring down site and resource survey costs. The pull from industry to develop better solutions in this area is exemplified by the commercialisation roadmap initiative launched by Carbon Trust. In addition to site surveys, such solutions will be of great value for improved forecasting of maintenance access windows and short term production planning.

NORCOWE expects further development and increased use of Remotely Piloted Aircraft Systems (RPAS) and unmanned ocean vessels of different size and endurance. Comprehensive met/ocean measurement platforms will likely also be more common in the future. The integration of different met/ocean remote sensing technologies on a single floating platform would enable simplified mapping of wind resource combined with collection of data for turbulence, wave, current and environmental conditions from a single deployment. ◀

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World Hydrography Day (WHD) 2015

Celebration in Monaco with Japanese Coast Guard

This year, the International Hydrographic Bureau Directing Committee organised the celebration of the WHD on 30 June so as to take advantage of the presence in Monaco's harbour of the Japanese Coast Guard training ship *Kojima*. This ship (115m length, 2,950 gross tons, 18 knots cruise speed) was carrying out the usual around the world cruise with 39 young Midshipmen on board.

The IHB president Robert Ward gave them an extended speech about the importance of the hydrography and the tasks of the IHO at the IHB headquarters. In particular, it was pointed out that the Japanese Hydrographic Department is one of the branches of the Japanese Coast Guard. "One of you", President Ward said, "may one day become the head of the Hydrographic Department".
The celebration of the WHD took place that evening on board of the *Kojima* in the presence of Prince of Monaco HSH Albert II, who was welcomed on board by the Commanding Officer, Captain Tetushi Mitsuya. Other personalities present were His Excellency the Ambassador of Japan Mr. Ichiro Ogasawara, His Excellency Mr. Tonelli, Monaco's Minister of Foreign Affairs and Dr. Vladimir Ryabinin executive secretary of the Intergovernmental Oceanographic Commission.
The IHB President gave a very interesting speech. He pointed out the continuous support that the Principality of Monaco has given to the IHO and to the IHB in particular for almost 95 years. He then explained the theme chosen by the IHO Member States for the WHD this year 'Our seas and waterways — yet to be fully charted and explored'.
As a possible measure to fill out this gap the IHO recently adopted the concept of crowdsourced bathymetry in which depth data can be collected by any ship or boat using its regular navigation echo sounder as part of a normal voyage across the sea and along the coastline. This data will then be included in the IHO Data Centre for bathymetry, making it not only a data store but also the world portal to upload and download crowdsourced bathymetry.
The project of the General Bathymetric Chart of the Oceans (GEBCO) will benefit from this initiative. GEBCO was initiated by Prince of Monaco Albert I and now continues as a project shared by IHO and IOC. The presence of Dr. Ryabinin in the celebrations reinforced the concept expressed by the IHB president.
The ceremony was also attended by the members of the working group 'Nautical Information Provision (NIPWG)' (the successor of the previous Nautical Publications) who were in the IHB for the first meeting. This working group aims to develop and maintain guidance, resolutions and specifications to provide shipboard users with necessary and up-to-date information in a timely manner to allow for the planning of a safe route for the intended voyage and the safeguarding of the ship's navigation throughout the voyage. The participants included representatives of the IHO MS and representatives of industry, such as Jeppesen.
After the speech of president Ward, the Captain of *Kojima*, the Ambassador of Japan and the representative of the Midshipmen addressed the audience.
Drinks with typical Japanese food were served after the speeches.
The visit by *Hydro International* to this significant IHO yearly event was the perfect occasion to demonstrate the vitality of the IHO and of the IHB Directing Committee and staff. The services provided to the maritime community are improving and are proceeding at a fast pace. The number of new Member States is also growing significantly (when the author joined the IHB late 1992, there were 58 IHO MS; now there are 85 with new members pending). All this is due to the intense efforts of the IHB Directors supported by a strong nucleus of several collaborators (a total of 19 people are active in the IHB, including the Directing Committee) and by good cooperation of the IHO MS hydrographers and the representatives of the industry from all over the world.

Figure 1: Briefing to Japanese midshipmen.

Figure 2: HSH Prince Albert II with the trainees and IHB directors.

Figure 3: The Kojima *moored in Monaco.*

First NOAA **Chart Adequacy** Workshop

The key objective of the NOAA Chart Adequacy Workshop was to demonstrate techniques to evaluate the suitability of nautical chart products using chart quality information and publicly-available information. The three-day workshop was held in Silver Spring, Maryland, USA, from 14 to 16 July 2015. The attendees were cartographers, hydrographers and potential chart producers from hydrographic offices and government agencies around the world. The nations of the participants in the workshop included: Indonesia, Israel, Japan, Kenya, Malaysia, Philippines, South Korea, Sri Lanka, United Kingdom, United States and Venezuela.

The workshop began with a general overview of chart adequacy procedures, emphasising that the focus of the workshop was quality management (as opposed to uncertainty management where risk is calculated based on potential consequences by different users and vessels in different marine settings). NOAA's Lt Anthony Klemm stated the three main goals of the workshop: 1) Train an international group of hydrographers and cartographers; 2) Discuss and review a procedure for assessing chart adequacy based on the depth, main traffic routes and the last available survey in the area, and; 3) Present different publicly-available datasets and their usage for charting.

Through instructor presentations and GIS laboratory exercises (provided by Dr. Shachak Pe'eri and Lt Anthony Klemm), the participants generated the key layers that are involved in the NOAA procedure. A vessel traffic layer was generated by classification of navigational routes using Automatic Identification Systems (AIS) information. A bathymetric difference layer was generated by identifying areas that showed significant bathymetric changes identified by comparing Satellite-Derived Bathymetry (SDB) or other surveys of opportunity, with the existing chart. A hydrographic characteristics layer was generated by classification of chart quality information. Chart data (including the smooth sheet sounding sets) for the procedure were provided in a vector format with the appropriate metadata according to IHO S-57. Raster Navigational Charts were also used as a background and as a reference for the Bathymetric Difference layer.

The participants' interaction with the presenters, during both the workshop and the networking events, was very positive. The interest of the students included the understanding of the procedure, the mechanics of purchasing or receiving AIS data from different vendors, and the different satellite imagery that can be used for SDB. A Chart Adequacy Evaluation cookbook was provided to attendees. This document will also be added this year to the IHO-IOC GEBCO Cookbook. This will widen the network of users who can access this material. The chart adequacy procedure is a low-cost tool that that can be applied at HOs abroad, including in developing nations. An additional benefit of the workshop will be strengthening international relationships between HOs around the world, thus aiding capacity-building efforts. Future workshops are planned based on this first pilot workshop and the feedback received from the participants.

Figure 1: The attendees of the workshop.

Australasian Hydrographic Society

World Hydrography Day Event – South Australia

Each year the International Hydrographic Organization (IHO) celebrates World Hydrography Day (WHD), an opportunity to increase public awareness of the vital role that hydrography plays in everyday life. This year marks its 94th anniversary, and Precision Hydrographic Services (PHS) was pleased to host an Adelaide event at the Arkaba Hotel on Friday 19 June to celebrate the occasion.

The Adelaide event attracted over fifty people representing hydrographic surveying service companies, equipment/software suppliers and students who are studying towards their surveying diploma/degree. Delegates heard presentations from CARIS, Pilbara Ports Authority, Coda Octopus Products, Bureau of Meteorology (Tidal Unit), Fugro LADS, Surveying and Spatial Science Institute (SSSI) and Precision Hydrographic Services (PHS).

This year's WHD theme 'Our seas and waterways yet to be fully charted and explored' concentrates on the fact that much of the world's seas, oceans and navigable waters remain unsurveyed. Many people do not know that less than 10% of the world's oceans have been systematically surveyed and that coastal waters are far from being fully charted. Figures specific to Australia include: 35% of Australian coastal waters have been adequately surveyed, 20% need to be re-surveyed to modern standards, and 45% have never been surveyed at all.
This event would not have been possible without the support from PHS, HydroSurvey, FugroLADS and SSSI.

Australasian Hydrographic Symposium 2015

The Australasian Hydrographic Society will be hosting the Australasian Hydrographic Symposium 2015 and Trade Exhibition at Cairns, Queensland, Australia from 4 to 7 November 2015. Cairns is the gateway to the Great Barrier Reef and is a beautiful, tropical city in northern Queensland – a great to place to be, particularly for anyone in wintery northern climates….. we look forward to seeing you later this year. The organisers are now calling for papers, speakers and trade exhibitors.

▲ *Frans Schlack, Pilabra Ports Authority.*

The Symposium's theme, 'Harnessing The Blue Economy Through Hydrography In The Asia—Pacific Region' focuses on the importance of hydrography to the region's economies, and the opportunities for hydrographic surveying and maritime-related activities. While the 'Blue Economy' is acknowledged in Europe and America, the Australasian region is lagging. Therefore, the Symposium is timely in promoting issues affecting both developed and developing states' economies within the region, potential opportunities and the availability of current equipment and technology.

The Symposium brings together speakers and delegates from varying maritime fields including specialist hydrographic streams, maritime transport, marine and environmental science, resource exploration, maritime heritage, defence, tourism, coastal development, ports and harbours and government. Up to 90% of the world's trade is carried by sea or river and hydrography fundamentally affects our lives. This symposium seeks insight regarding the effects and opportunities that may arise, and seeks to provide a platform to show the importance of hydrography and the 'Blue Economy' to the Asia—Pacific region, including our region's rich maritime heritage.
The Symposium provides a baseline to promote the International Hydrographic Organization World Hydrography Day (WHD) 2015 theme of: 'Our seas and waterways - yet to be fully charted and explored'. The WHD theme identifies the fact that much of the world's seas, oceans and navigable waters remain unsurveyed, particularly in the Asia-Pacific region where charting is relatively poor and the 'Blue Economy' is essential for the region's economic well being. The WHD theme encourages supplementary data gathering initiatives, including crowdsourcing and satellite imagery, to help obtain more useful depth data. These methods cannot replace highly accurate and thorough hydrographic surveys using specialist ships and equipment, but will provide useful depth information where otherwise we have none.
Cairns is a truly beautiful and relevant venue due to its very close proximity to the Great Barrier Reef and one of the major shipping routes within Australian waters. It is hoped you will be able to attend and we are calling for papers through the Symposium linkage found in the Australasian Hydrographic Society's website: www.ahs.asn.au.
A detailed description of the Symposium can be found at: https://consol.eventsair.com/QuickEventWebsitePortal/australasian-hydrographic-symposium-2015-and-trade-exhibition/ahsweb

Hydrographic Society Benelux

Workshops for 2nd Half of 2015

The Hydrographic Society Benelux (HSB) [1] is organising a workshop on 11 September 2015 with the theme Underwater Positioning. The event will be held in a special venue: an old fortification that has been turned into a conference venue. The fortification has been renamed GEO fort [2] as particular attention was paid to Geomatics in preparing the fortification for its new role.
A workshop will be organised In October at the same location as and in cooperation with Offshore Energy (this exhibition and conference in the RAI premises in Amsterdam runs from 13-14 October 2015 [3]).
The HSB workshop focuses on Wide area positioning/PNT and is to take place on the first day of the event, i.e. 13 October.
The last workshop in 2015 is scheduled in Belgium on 11 December 2015, with the theme Climate XChange and Hydrography.

More information

1. www.hydrographicsocietybenelux.eu
2. www.geofort.nl
3. offshore-energy.biz/exhibition

SEPTEMBER

Shallow Survey 2015
Plymouth, UK
→ 14-18 September
For more information:
www.shallowsurvey2015.org

World ECDIS Day
Hamburg, Germany
→ 16 September
For more information:
www.world-ecdis-day.com

VideoRay International Partner Symposium (VIPS)
Pottstown, USA
→ 16-18 September
For more information:
www.videoray.com/vips-2015.html

OCTOBER

Teledyne Marine Technology Workshop
San Diego, CA, USA
→ 4-7 October
For more information:
www.teledynemarine.com

European Dredging Summit
Antwerp, Belgium
→ 7-8 October
For more information:
www.wplgroup.com/aci/conferences/eu-mdr1.asp

Kongsberg HiPAP Survey Engineer Training Course
Aberdeen, UK
→ 9-10 October
For more information:
km.training.aberdeen@kongsberg.com
www.km.kongsberg.com/training

Offshore Energy 2015
Amsterdam, The Netherlands
→ 13-14 October
For more information:
www.offshore-energy.biz

OCEANS '15 MTS/IEEE
Washington DC, USA
→ 19-22 October
For more information:
www.oceans15mtsieee-washington.org

PLOCAN Glider School
Telde, Gran Canaria, Spain
→ 19-24 October
For more information:
www.gliderschool.eu

8th ABLOS Conference
Monaco
→ 20-22 October
For more information:
www.ablosconference.com

Nortek Pulse-Coherent User Symposium
Karlsruhe, Germany
→ 22-23 October
For more information:
www.nortek-as.com/en/news/nortek-user-symposium-22-23-october-2015

IADC Dredging Seminar
Singapore
→ 27-31 October
For more information:
www.iadc-dredging.com

NOVEMBER

The ECDIS Revolution
London, UK
→ 3 November
For more information:
www.ecdisrevolution.org

Oceanology International China
Shanghai, China
→ 3-5 November
For more information:
www.oceanologyinternational.com/en/Exhibiting/Oceanology-China-2013/

Australasian Hydrographic Symposium
Cairns, Australia
→ 3-7 November
For more information:
bit.ly/1KPQcyi

CEDA Dredging Days
Rotterdam, The Netherlands
→ 5-6 November
For more information:
www.cedaconferences.org/dredgingdays2015

International Subsea Event China International Underwater Intervention
Xiamen, China
→ 6-8 November
For more information:
www.subseaevent.com

Calendar Notices
For more events and additional information on the shows mentioned on this page, see www.hydro-international.com. Please send notices at least 3 months before the event date to: Trea Fledderus, marketing assistant, email: trea.fledderus@geomares.nl.

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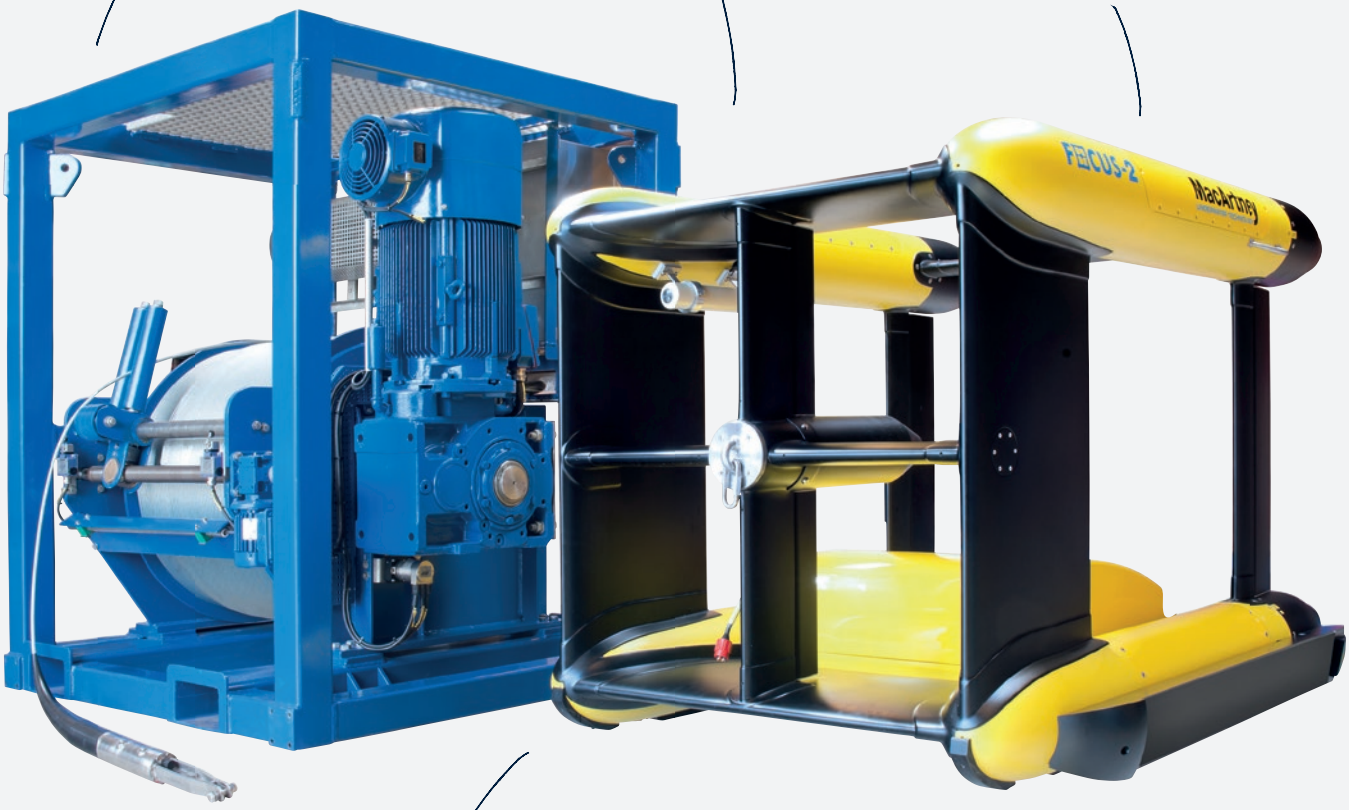

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