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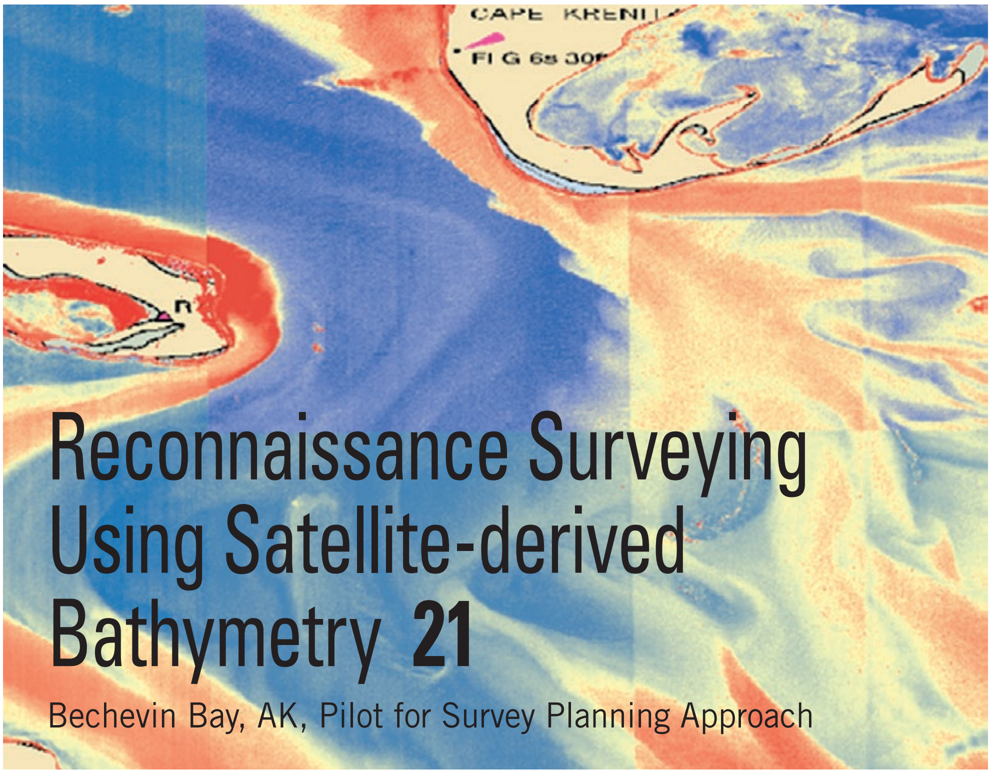
OCTOBER 2015 | VOLUME 19 NUMBER 7

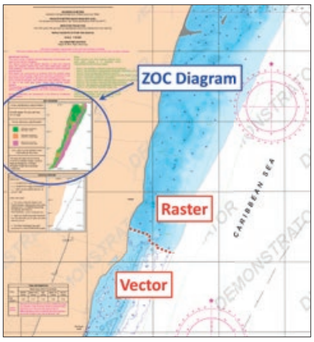
USING SATELLITE BATHYMETRY FOR SURVEY PLANNING

Reconnaissance Surveying

VERY SHALLOW WATER SURVEY — A NEW APPROACH

Satellite-derived Bathymetry Migration





October 2015 Volume 19 #7

Starting this summer, NOAA Ship Thomas Jefferson *will be deploying a Z-Boat by Teledyne Oceanscience to improve charting shallow areas close to the shores. Image courtesy: NOAA.*

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PHOTOGRAPHY: ARIE BRUINSMA (WWW.ARIEBRUINSMA.NL)

Looking Forward

Looking forward and determining a long-term strategy is one of the core fundamentals of good entrepreneurship. In magazine publishing we always live a few months ahead of the actual publishing date. Just after the summer holidays we started preparing our media planners for the following year, which means we already have to think about topics for all next year's issues, while the two last regular issues of the running year are being readied to go to the printers: the October and November/December issues and our yearly Buyers Guide are ready in August, always in ample time to be distributed at the conferences and shows taking place at that time of the year.

I believe that this process takes place at the same time in every company; after the summer holidays the year to come is not far away in the heads of forward looking managers. This issue will be distributed at quite a number of the autumn conferences and shows: Oceans 2015 in Washington, DC, Oceanology International in Shanghai, China and Hydro '15 in Cape Town, South Africa. We all know that this year has not been the easiest in the history of many companies. The low oil price resulted in hydrographic surveying being suddenly put on hold, while oil companies refrained from major investments in new oil fields and the geo-political circumstances in many regions made sales shaky. Nobody can predict the future, because there's nothing more volatile than the oil price or politics!

But a strategy, enabling you to respond to changing circumstances, is the least you will have to put in place, particularly when these volatile situations look like they are here to stay for a little longer. Keeping in mind next month's shows and conferences, I would say that looking for new business in new markets, be it geographically or field of application, should be one of them. The US, Africa and China present opportunities, while the situation in Europe continues to be slightly more gloomy. Growth in Africa is tremendous, although there are major differences between the continent and its surrounding seas; the same still goes for China and the adjacent Southeast Asian region. The US has always shown to have an economy that is able to bounce back at a pace unknown to, for instance, Europe. In all the aforementioned geographic regions a focus on sustainable energy, including wind and tidal, is part of the policy. There is a sea of opportunities for positive forward looking managers and entrepreneurs.

It is with great pride that I am able to announce the first issue of *Hydro International* in Spanish. Many of our regular subscribers, but also new subscribers in Latin America and Spain, will receive this first issue together with this issue of *Hydro International*. I invite others to visit www.hydro-international.com, to check out the digital edition. We very much believe in the future of the continent that seems slightly unexplored to date and the business it holds for hydrography. The Spanish version of *Hydro International* is also proof of our forward-looking approach.

Durk Haarsma durk.haarsma@geomares.nl

Senior Hydrographers and **Younger Generations**

Younger generations of hydrographers tend to be convinced that technological amenities, institutional development or company's positioning, to mention but a few and depending upon where young hydrographers are working, have been all achieved by a magic spell. They are the result of a sudden creation or have somehow always been there. They also do not take into account what previous generations have done to make these amenities available to them. They take little or no time to appreciate the extreme value of particular innovations as very soon it will be replaced by newer equipment, capable of better performance than the one they had just yesterday. In other words, there is not the same appreciation for instruments and equipment that we, the older hydrographers, had 20 to 30 years ago. We treasured and cared for a reliable single-beam echo sounder or a good EDM.

The outstanding development of hydrography over the past 30 years is no different from the changes other disciplines have experienced. They are the result of the advent into hydrography of devices capable of processing enormous amounts of data, developments in remote sensing, autonomous vehicles, GPS positioning, multibeam sonars, all sorts of processing capabilities, and much more.

Senior hydrographers have to keep abreast of the rapid scientific and technological developments in our profession and, at the same time remain connected with younger generations, not only because senior hydrographers have been in the field longer but essentially because this gap between younger and older generations could result in a lack of communication and understanding between the two. This could make the flow of instructions to executors, data processors and derivable producers more difficult, inefficient, vague and ambiguous, and could potentially damage the credibility of the product delivered.

Consequently, senior hydrographers face the challenge of keeping up-to-date with recent technologies, in order to take better advantage of these technologies. They also need to properly communicate with their younger colleagues, from time to time evaluate and quality-control their products and review their professional performance.

In addition to practical reasons for keeping up-to-date and connected, it is also healthy for the hydrographic profession to foster a solid bond between the younger and the older generations, as the latter have many stories to tell the youngsters. These will certainly help in making hydrography funnier and more attractive.

UXO Removed with Minimum Impact on Mammals

Bomb experts preparing to remove the unexploded Blockbuster, approaching the marking buoy.

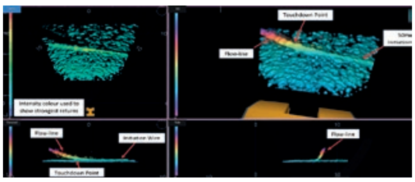
The Royal Netherlands Navy mine hunter HNLMS *Makkum* has cleared a so-called 'Blockbuster' from World War II, which was not mapped. It was found by fishermen at the Dogger Bank, about 200 miles offshore the Dutch coast in the North Sea. These types of bombs, 4,000lbs and 2.5m long, were designed to blast a living quarter away. Before clearing the bomb, marine mammals were stimulated to swim away from the place.

▸ ***http://bit.ly/1NAHetJ***

ROV Navigation Software Paired with Echoscope

The Coda Octopus Vantage ROV visualisation and navigation software can be used with all existing and new 3D sonar in the Coda Octopus family, the Echoscope 1000, the Echoscope C500 and Dimension. Users can now choose between Vantage or Underwater Survey Explorer (USE) depending on the requirements for the task in hand. Typically Vantage will offer more utility for the ROV pilot, while USE offers more survey capability for pole mounted and ROV applications.

▸ ***http://bit.ly/1NAHmtd***

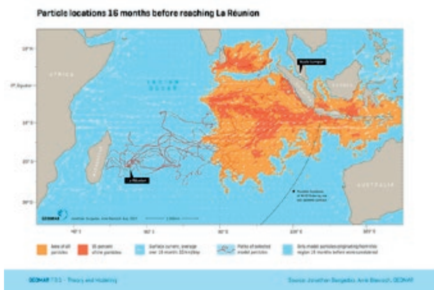


Screen print of the Vantage software.

German Oceanographers Provide Further Insights into MH370

For the past 16 months an extensive search has been underway for the missing Boeing 777 of Malaysia Airlines (MH370) in the Indian Ocean. Since a piece of debris was discovered a few weeks ago on the island of La Réunion, oceanographers in Kiel, Germany, have been attempting to trace the origin of the flaperon that is presumed to belong to the missing Boeing. The results of their recently completed computer model simulations show that the debris found on La Réunion probably originates from the eastern equatorial Indian Ocean. However, substantial uncertainties are making it difficult to pinpoint the area more specifically.

▸ ***http://bit.ly/1NAGVio***



Possible locations of model particles that originate from the eastern Indian Ocean and reached the island of La Réunion 16 months later. The areas with the highest probabilities are colour coded (click for enlargement). Image courtesy: GEOMAR.

CSEM Gas Hydrate Survey Completed

Ocean Floor Geophysics (OFG, Canada), in cooperation with Fukada Salvage and Marine Works (Fukada, Japan), has completed a high-resolution controlled source electromagnetics (CSEM) survey of near-surface gas hydrates in Japanese waters. The survey used the Scripps Institution of Oceanography Vulcan system for the National Institute of Advanced Industrial Science and Technology (AIST).

▸ ***http://bit.ly/1NAM7mu***

Total Saves Time with Sonardyne Fusion 6G

Together with its construction and survey partners, French oil company Total, operator of the Egina oil field offshore Nigeria, has successfully installed a Fusion 6G subsea positioning network to support its development of the USD15 billion project. Supplied by Sonardyne International Ltd, UK, the acoustic technology specified for Egina, which is still ongoing, included a field-wide array of Compatt 6 seabed transponders that were deployed and made ready for work eight days ahead of schedule.

▸ ***http://bit.ly/1NAJnWl***

A Sonardyne Compatt 6 transponder that forms part of the field-wide array of transponders at the Egina oil field is lowered in a frame down to the ocean floor.

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CEE Hydrosystems CEEPULSE	http://bit.ly/1OpLNXT

EMODnet Bathymetry DTM Further Expanded

The release in February 2015 of the EMODnet Digital Bathymetry (DTM) has been updated in the last 6 months and has now been published. Like the previous release, the Digital Terrrain Model covers all of the European seas. However, several identified anomalies have been corrected, considerably improving the overall product. The number of surveys datasets and composite DTMs used as sources has increased from circa 6,000 to circa 7,000.

▸ ***http://bit.ly/1NAHCbF***

ROV Fills Gap between Economy and Professional

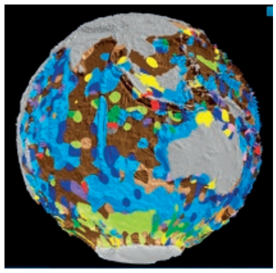
VideoRay, USA, recently announced the release of the Voyager ROV system. The Voyager is designed to bridge the power gap between the economy and professional ROV lines, while retaining the simplicity, portability and affordability of the economy-series ROVs. The Voyager features all the capabilities of the VideoRay Explorer, but with the added power of enhanced horizontal and vertical thrusters, which increase the submersible's maximum speed to 2.9 knots.

▸ ***http://bit.ly/1NAJBg5***

Ocean Floor Geology Revealed

Scientists from the University of Sydney's School of Geosciences, Australia, have led the creation of the world's first digital map of the seafloor's geology. The composition of the seafloor, covering 70 percent of the Earth's surface, has been mapped after the most recent map was hand drawn in the 1970s. Published in Geology, the map will help scientists better understand how our oceans have responded, and will respond, to environmental change. It also reveals the deep ocean basins to be much more complex than previously thought.

▸ ***http://bit.ly/1NAGYem***



Still shot of the seafloor's geology. Image courtesy: University of Sydney.

WaveSystem 200 for WTI Jack-up Vessel

Fred Olsen Windcarrier AS in Norway has bought Miros' new WaveSystem 200, which has been installed on the Bold Tern WTI jack-up vessel. This is Miros' first delivery of the WaveSystem 200. The WaveSystem 200 is a wave monitoring system utilised on jack-up vessels to give accurate wave parameters and draught data. The real-time wave and draught data gives valuable input to the operator during jack-up/down operations.

▸ ***http://bit.ly/1NAJj95***

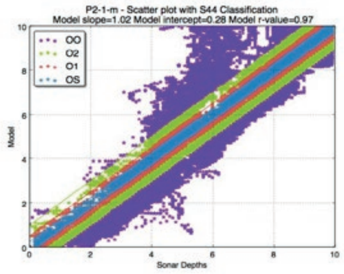
Allen Leatt.

IMCA Names Chief Executive

The International Marine Contractors Association (IMCA) has appointed Allen Leatt as chief executive. He will be joining on 1 October 2015 from Subsea 7 where he has been senior VP for Engineering and Project Management. Mr Leatt is a Fellow of the Royal Academy of Engineering, a Fellow of the Institution of Civil Engineers and a chartered engineer in the UK.

▸ ***http://bit.ly/1NAHM2E***

SDB Methods Put to the Test by SHOM



Classification of the raw differences (without any post processing) between a model and sonar depths soundings. Colours reflect the compliance of the model according to different hydrographic requirements: special order (OS), order 1 (O1), order 2 (O2) and out-of order (OO).

SHOM has undertaken studies in order to qualify new algorithms according to different cartographic usages. The first analysis conducted by SHOM produced promising results that indicate the huge potential of the new methods from satellite imagery, with an estimation of a confidence level based on the current hydrographic criteria.

▸ ***http://bit.ly/1NALdqf***

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NOC and WWF in Partnership for Marine Robotic Vehicle Trials — http://bit.ly/1NAH4me
USVs for NOAA's Shoaler-depth Nautical Chart Surveys — http://bit.ly/1NAH5X8
Live Streaming Video from the Ocean Floor — http://bit.ly/1IWCF8A

Underwater Positioning System for CPPM

iXBlue, France, has provided a full positioning system to the research centre based in Marseille, France, to meet its security and precision requirements during the deployment of underwater field structures. To meet the precision requirements, iXBlue provided CPPM with one low-frequency RAMSES 6000 for the acoustic positioning of the lines and ROV, one HYDRINS (INS) to enhance the vessel position, one MT391 transponder to position the ROV during the operations, four RTA61 releasable transponders to make up the LBL field, two RTA61 releasable transponders to control the deployment of the line, RAMSES REPLAY post-processing software and a remote control. Precise and reliable ROV positioning during the connection of the optical modules to the electro-optical subsea cable is critical as this is how they will be linked to shore to send data.

▸ ***http://bit.ly/1NALyJm***

Hydro International Interviews Dan Hook, ASV.

Being Able to **Look** and **Work Over the Horizon** is Important

ASV (headquartered in the UK) is a pioneer in the world of Autonomous Surface Vehicles. It discovered the potential of vessels that do not need man-power on board for various tasks. It was not until a few years ago that these kinds of platforms started taking off, also in the hydrographic survey profession. *Hydro International* interviews Dan Hook, ASV's managing director, on various aspects, including operating beyond the horizon, communication and collaboration and regulations.

What attracted you to the autonomous surface vehicles business?

I could see that this was an area of huge unrealised market potential in the defence, oil and gas and survey markets. There was also no one else doing it.

You have been with ASV for 14 years. What main difference do you see in the vehicles?

Reliability and capability. The size of the vehicles has not changed much at all but technology is advancing very quickly; these vehicles have become much more reliable and capable of completing a wider range of tasks. ASV's initial venture into the market came about by supplying and operating remote controlled target drones in the UK. Since then however, we have moved onto producing much more complex vehicles for use in scientific research, surveys and oil and gas work. These vehicles, such as our C-Enduro and C-Worker, are capable of being at sea for longer periods of time and can house a range of different sensors and payloads.

Dan with C-Enduro, the USV for oceanography built under an SBRI.

How did ASV enter the hydrographic/ocean science market?

Although there is some overlap, these are two different markets. Our first project in the hydrographic market was the development of a semi-submersible craft fitted with a side-scan and multibeam sonar suite for the US Navy. Our first venture into the ocean science market came later when we were awarded an SBRI (Small Business Research Initiative) to design and build a long endurance USV for oceanographic applications, the C-Enduro. This was an Innovate UK funded project initiated by a requirement from the National Oceanographic Centre, supported by NERC and Dstl.

What do you think is the greatest step to be taken by autonomous surface vehicles, for surveying, in the near future?

The ability to operate safely over the horizon and beyond the line of sight from a support vessel will be a huge game changer for autonomous surface vehicles. ASV has recently been awarded funding from an Innovate UK maritime autonomy call to develop and prove the capability to operate USVs over the horizon. ASV will be working with Cranfield University, D-RisQ and Frazer Nash Consultancy on this project. One of the main challenges currently faced when looking to achieve over the horizon communications is the lack of regulatory guidelines. This will be one of the issues addressed in the research project and something that ASV is actively working on.

Will autonomous surface vehicles be able to replace traditional vessels?

I believe that USVs have the ability to complete a huge amount of tasks currently carried out using a manned craft. This has many benefits including freeing up these larger vessels to complete tasks such as deploying large ROVs or bottom sampling equipment for example. USVs can be used to complete the dull, dirty and sometimes dangerous tasks that are currently being carried out by manned vessels and in some cases, putting operators at risk.

Which limitation for research ASVs do you aim to solve first?

As already mentioned, the ability to operate safely over the horizon is an important aspect to look at. This requires

▲ *USV designed and built for oceanographic applications under an SBRI funded by Innovate UK and supported by NOC, NERC and Dstl. Right: C-Worker.*

developments in situational awareness, collision detection and avoidance and satellite communications.

The ASV vehicles use propulsion systems that require some power supply (diesel, electric) – the most independent vehicle runs for 3 months. Will ASV extend this?

Currently we do not see the need to operate a USV for a continuous period longer than 3 months. The reason for this is that the sensors and equipment fitted to the vehicle will require cleaning and servicing. Having said that, the way the technology is advancing, this requirement may soon be extended to a longer period of time.

ASV operates in several ASV markets: defence, science, offshore. Which market shows the most growth?

We are seeing equal growth in all sectors. I think this is a reflection of how the technology is advancing and the steady wider adoption of the use of Unmanned Surface Vehicles. We are investing heavily in our offshore products and are expecting considerable growth in this area in particular.

How do you see autonomous vehicles developing further?

There is potential for collaboration between unmanned vehicles. In the not too distant future I expect to see ASVs transporting, deploying, supporting and recovering AUVs for deepwater work. There is also the potential for ASVs to interface with UAVs (Unmanned Aerial Vehicles).

What kind of (simple) M&R jobs would an offshore vehicle like the C-Worker be able to do in addition to surveying and inspection?

Our initial focus for C-Worker has been deployment of a USBL for subsea positioning, multibeam echo sounder for inspection work, ADCP for environmental data gathering, PAM (Passive Acoustic Monitoring) for cetacean tracking, and the deployment of an inspection class ROV (Remotely Operated underwater Vehicle). When carrying out such tasks, C-Worker operates autonomously, following pre-programmed missions. For purposes of launch and recovery, we also operate the vehicle on a remote controlled basis.

Are unmanned surface vehicles having an impact on how survey companies nowadays work?

It is still a little too early to say, although we are noticing a change in the way shallow water surveys are being conducted. Areas of shallow-water can often be in dangerous and hard to reach places, with vehicles like our C-Cat 2, surveyors are still able to complete their work but without risking the health and safety of their operators. Using a USV in these situations also gives a greater degree of operational flexibility.

Will the role of the surveyors and geophysicists change in the future?

I can foresee that surveyors may spend more time onshore with remote data links from ASVs but their role will not change.

How will USVs and AUVs operate with each other in the future?

We are seeing a need for ASVs and AUVs to work together for Mine Countermeasure (MCM) applications and we expect to see this requirement grow in the science and oil and gas markets in the next few years. ASV, along with the National Oceanography Centre, Sonardyne and SeeByte, has won funding from Innovate UK to combine ASVs with AUVs into an integrated survey system to create a lower cost solution to marine surveying.

We are developing a Maritime Autonomous Surface Systems code of practice for safe and responsible operations

How do you prevent collisions with regular merchant vessels or yachts? And should there be damage caused by a collision, how would you assess the liability?

This is a difficult area as there are currently no clear regulations– that is also why ASV is investing considerable time and effort into safe operations. A key element to this is collision avoidance. At such a pivotal time for the unmanned marine industry, I believe safe and responsible operations and practices are vital. We are developing a Maritime Autonomous Surface Systems code of practice for safe and responsible operations which is being shared and made available to any interested parties in the industry. We are also an active and contributing member of the MAS regulatory working group which is looking to develop a best practice regulatory framework for presentation to the Maritime Coastguard Agency (MCA). ◂

This article was originally written for and published in *Hydro International* Unmanned Systems Special, July-August 2015.

Dan Hook is ASV's managing director, with over 14 years experience in the unmanned marine industry. Dan is a qualified Naval Architect and Chartered Engineer. Under Dan's leadership, ASV has achieved a position at the forefront of Maritime Autonomy as the leading manufacturer of Unmanned Marine Systems. In just five years the company has grown from 3 to over 50 employees and recently opened an office and operational base in the US. In April 2015, Dan was awarded the AMSI Council Business Person of the Year.

✉ info@asvglobal.com

From Laboratories to Chart Production Routine

Satellite Derived Bathymetry **Migration**

Much has been said about Satellite Derived Bathymetry (SDB), but with the exception of SHOM, which led to the introduction of a number of SDB charts into the French chart series, next to nothing has been implemented within the international hydrographic community. This article aims to update readers with encouraging news as SDB, thanks to new generation satellites and modelling, is about to see the light at the end of a thirty years' tunnel.

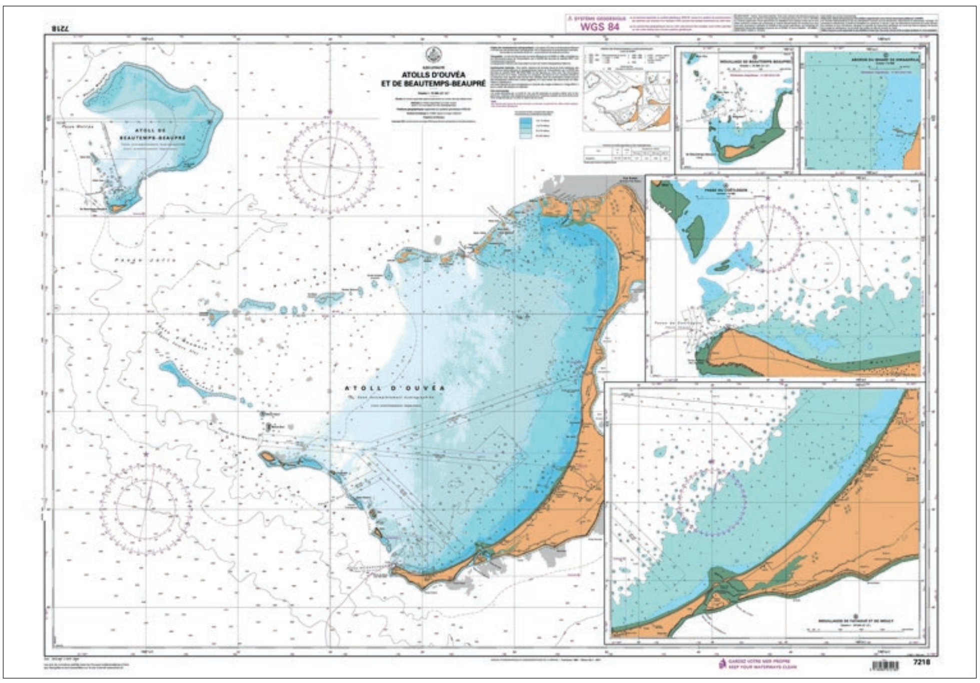
In 2014, detailed tests and analysis conducted by government hydrographers, cartographers and recognised satellite scientists operating for a number of projects initiated by the European Space Agency, the WWF and other stakeholders, were completed, extending the traditional research sites to several areas covering the South Pacific, the Indian Ocean, the Gulf of Mexico, the West Indies, the Eastern coast of Africa and as far North as the Shetlands.

Recently, SDB has even been used in the Gulf of Guinea to extract precise UNCLOS baselines out of the surfs bordering two adjacent African states.

In short, SDB has been confirmed; not as an overrated exploration tool, but as a new sensor capable of providing calibrated and validated depths to the marine cartographer.

Indeed, the method has limits; the vertical precision achieved presently is not much better than 10 to 15% of the depth; the validated reach of SDB, normally in the order of 15 to 30 metres, can be significantly truncated when the environmental conditions are poor, but the 2015 Hydrographer can now make an assessment of these factors and implement a new tool to charter shallow depths and their known uncertainties.

Given time, charting liability should follow, as with previous sensors. All that hydrographers need now are standards, but this could be resolved rapidly as a number of national hydrographic offices such as SHOM and the UKHO are willing to join forces with the IHO to give a framework to this very promising technology.



▲ *Figure 1: An early SDB chart (1990).*

Transmission of Light between Sea Bottom and Satellite Sensor

A possible reason for the disaffection of Hydrographic Offices with SDB may be caused by the paradoxically impenetrable equation of radiance that governs the transmission of light through a challenging environment characterised by many factors such as the height and direction of the sun, the wind and sea state, the satellite spectral bands, and three unknowns: the sea bottom albedo and the absorption and diffusion of light by the water column and the atmosphere.

Translated for laymen, the equation linking the 'brightness' or Luminance L, i.e. the quantity of energy received by the satellite sensor, and the depth is a function with a logarithmic declining shape, involving the absorption α, the scattering β, and the bottom reflectivity ρ: $L = f(Z_{\alpha,\beta,\rho})$.

▲ *Figure 2: The twelve steps of modern SDB processing. Steps 1 and 2 are relevant to the satellite system, 3 to 6 to the light propagation Scientist, 7 to 12 to the Hydrographer.*

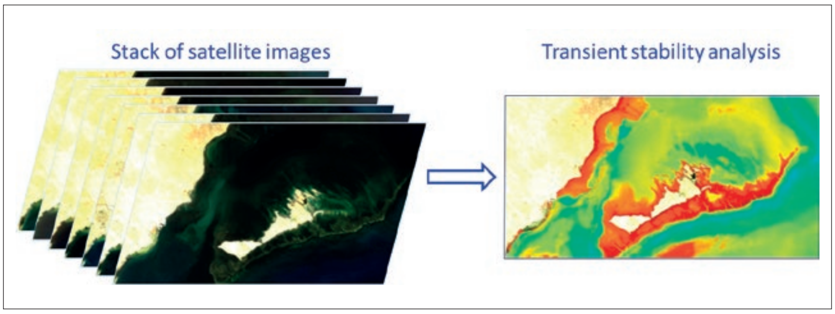
The Two SDB Methods in a Nutshell

There are two SDB methods based either on the empiric comparison of satellite images against selected field observations or, at a later stage, on the law of physics.

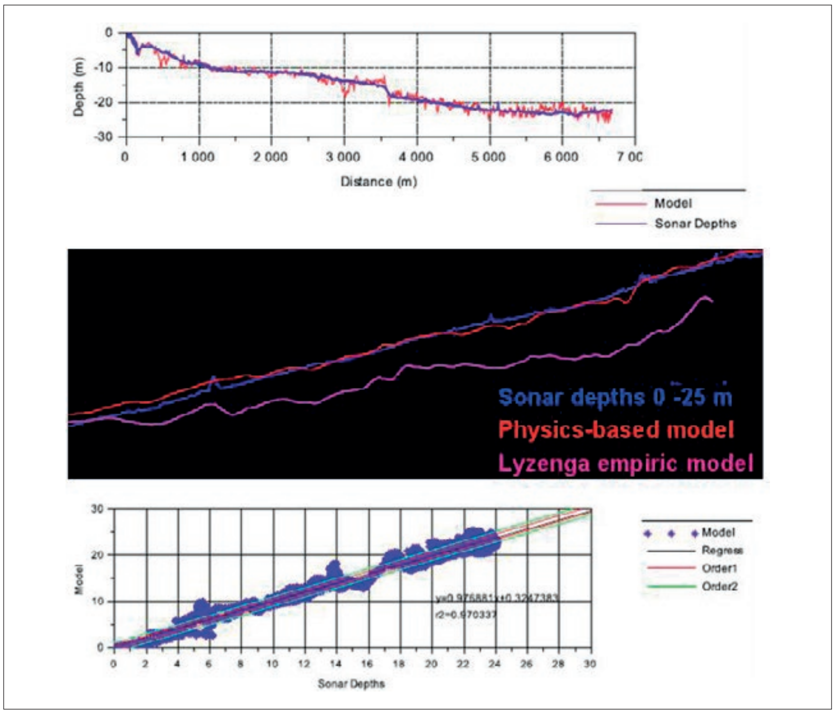
In early satellites, which had only one usable blue/green spectral band capable of seeing through the water, the empiric method consisting of producing a simple model by comparing a number of survey lines to satellite images was dominant. Assuming that the conditions prevailing in the atmospheric and water columns were unchanging, the model could be generalised to the whole image and depth layers could be produced with a reasonable level of confidence. However, this precluded mosaicing satellite images as the conditions would have been different, still required a bathymetric survey although limited, stringent selection of images, and outstanding experience of the analyst who had to cover no less than the three fields of hydrography, cartography and GIS. This early method has been used by SHOM since 1988, mainly to chart the atolls of French Polynesia and New Caledonia.

With the advent of the next generation satellites endowed with 5 to 6 usable bands such as Landsat 8 OLI and high-resolution systems such as Ikonos, KOMPSAT, Pleiades or WorldView 2, the sophisticated physics-based method, also called 'radiance inversion technique' could be introduced.

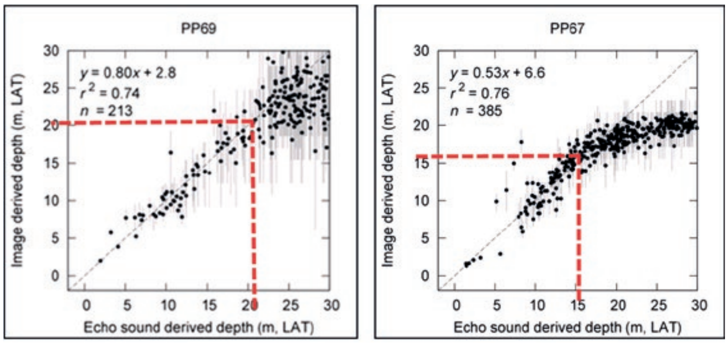
Still using the same principles mentioned above, but this time having access to all the unknowns thanks to the number of



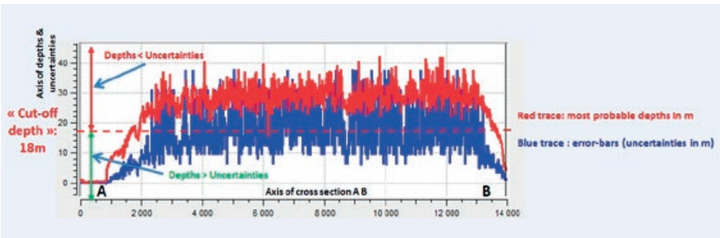
▲ *Figure 3: A sequence of satellite imagery can be used to monitor changes.*



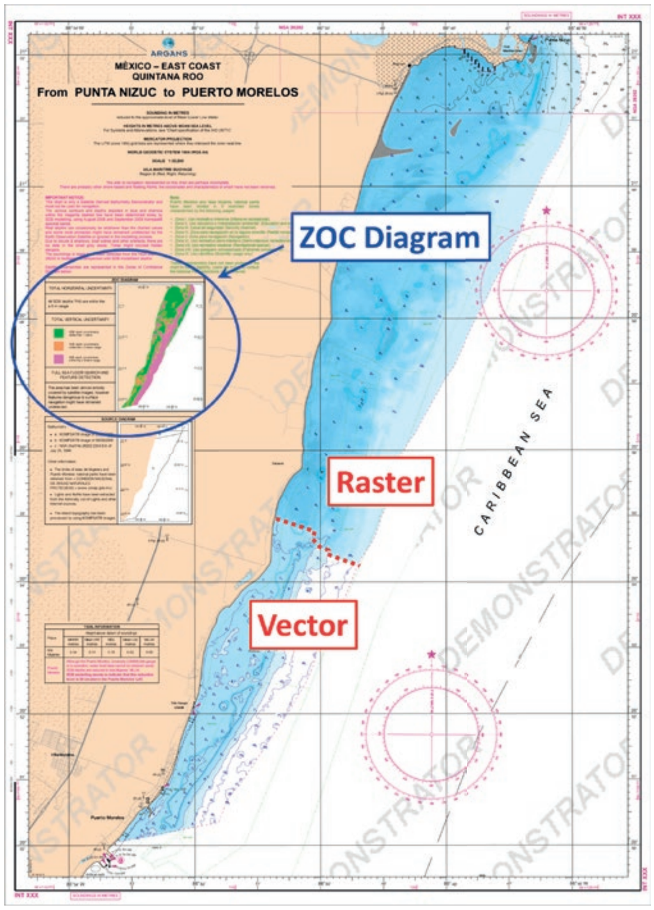
▲ *Figure 4: Comparison of sonar depths against SDB model (Beautemps-Beaupré test zone). Adequate filtering is expected to reduce the data dispersion and eventually fit the model into S-44 categories.*



▲ *Figure 5: Determination of cut-off depth by comparing the SDB model (y-axis) and the field survey (x-axis). Note the sharp increase of uncertainties depicted as grey error-bars below the cut-off depth.*



▲ *Figure 6: Determination of cut-off depth by observing a DTM cross-section. Note the sharp increase of blue uncertainties below the cut-off depth*



▲ *Figure 7: An SDB diagram of uncertainties: Ouvea test zone – South West Pacific.*

spectral bands and the development of sea floor libraries, the new method consists of computing depths by inverting the previous equation: $Z = f\text{-}1\ (L_{\alpha,\beta,\rho})$.
Needless to say, the 'radiance inversion technique', which processes each pixel individually, requires substantial computing capacity and good quality images, as free as possible from speckle and glint.
This method could be broken down into the twelve steps represented hereafter:

More progress should be expected with the ever increasing outpour of satellite images, bearing in mind that a decade ago, it could have taken years to select a single exploitable image.
Now, the satellite revisit frequency is such that images can be stacked and analysed in order to determine the zones of stability, free of plumes, transient and artefacts, therefore likely to yield more reliable SDB results (see Figure 3).

There is no need to calibrate the model against field surveys any longer although it is still necessary to have access to a limited number of proven depths to reduce the uncertainties that inevitably arise when no other in-situ knowledge of the site is available.

Bridging the Gap between Physics-based Methods and Practical Cartography

The practical difficulties start at the sixth step of the processing figure, when the Hydrographer receives a bathymetric model from the Satellite analyst containing several million pixels that must be uploaded into his GIS, transformed into a Digital Terrain Model (DTM) reduced to the chart datum, interpreted, validated and converted into a nautical chart.
Without going through fastidious details, we shall focus on the tenth step (validation & diagram of uncertainties), which determines entirely the capacity to produce IHO-compliant charts usable for navigation.
The physical model associates to each pixel a depth ranging in practice between zero and a maximum set value comprised between 30 to 50 metres. This value has to be analysed against an estimation of the range of the light propagation that can vary considerably depending on local environment, glint, turbidity, date and time of shooting, etc.
The main improvement brought by the physics-based method is that the uncertainty can now be calculated by analysing the various causes of errors affecting each pixel. Validation can then be achieved either by comparing the model against surveyed depths (Lyzenga empiric method) or by examining the structure of the depths recorded in the DTM.

One of the most exciting conclusions of the tests was to confirm that the model behaves like a Secchi disk and becomes ineffective after a certain depth, when the uncertainty is larger than the depth itself. In the various tests performed, 'cut-off depths' varied between 2 metres in the Shetlands and over 25 metres in New Caledonia, depending mainly on the glint and turbidity (Figure 6).

In the domain of validity thus determined, the precision of depths is better than 15%. Beyond the limit, the cut-off value itself guarantees a minimum depth comparable to those obtained by wire sweeps of the old and could be represented by a similar symbol where appropriate.

Diagram of Uncertainties and Zones of Confidence

Several questions arise when the wealth of physics-based information is depicted in the diagrams of sources and uncertainties: how many ZOC (Zones of Confidence) sections? Should uncertainties be depicted as absolute dZ or relative dZ/Z? Shouldn't colour codes be introduced? etc.

These questions point at the existing IHO standards that need not be changed fundamentally but must be adapted to cater for the SDB before the emergence of possibly conflicting national practices.

Outlook

After almost 30 years of semi-experimental cartography, the Satellite Derived Bathymetry is finally coming of age. Not only can Hydrographers now model visible depths with an acceptable degree of precision, but they can also qualify their data and enter zones of confidence whilst retaining the metric horizontal accuracy of modern satellites and capacity to provide full coverage of very large areas.

Conclusion

Unless local conditions preclude the propagation of light, modern SDB could finally mean an end to most of the uncharted shallow areas listed in the IHO C- 55 publication. However, this is not the end of history as better satellites endowed with better multispectral capacities will be launched and software will be improved to meet the growing demands of hydrographers turned into satellite analysts.

As SDB fundamentals are more or less under control, the priority is now to adapt the existing standards. This will need active engagement of the International Hydrographic Organisation, in line with the policy advocated by its current president.

Acknowledgements

The authors would like to thank the organisations that have supported the transition of SDB from R&D to hydrographic practice, i.e. GeoVille, METRIA, OceanWise, IGNFI, ESA, the World Bank, the WWF and SHOM, and to recognise the support provided by Dr F.R. Martin-Lauzer, (Eng. General, Armt. Corps), Chairman of ARGANS Ltd and other ACRI Group subsidiaries, for shedding light into the equations of radiance. ◀

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Bechevin Bay, AK, Pilot for Survey Planning Approach

Reconnaissance Surveying using Satellite-derived Bathymetry

False Pass, AK, USA, is the eastern-most passage through the Aleutian Islands between the Bering Sea and the Pacific Ocean and provides a passage for small to mid-size vessels. The passage is considered an alternative route to Unimak Pass, AK for vessels from mainland Alaska and is estimated to be shorter by 160 to 240km. False Pass is closed every winter due to sea-ice cover that freezes the inlet system around October-November and melts only towards the spring (around March). As a result, the soft sediment of the seafloor contains mud and sand that may change the path of the channel after the sea ice has melted. Preparation of False Pass for the Summer/Fall vessel traffic requires many resources in a narrow springtime window to identify the main channel and to delineate it with Aids to Navigation. The surveys are typically conducted by the US Coast Guard (USCG) buoy tenders using small boats and reconnaissance-style single-beam lines. This paper demonstrates the potential of using a turbidity map generated from a single-image Satellite-derived Bathymetry (SDB) to play a key role in the future of the survey planning and determination of survey priorities.

Bechevin Bay is a large tidal basin located at the southwestern end of the Alaska Peninsula (Figure 1). The south of the basin connects to the Pacific Ocean and the north side opens to the Bering Sea through a wide tidal inlet. The northern portion of Bechevin Bay is 2.7km wide and its bottom is shallow with abundant sand bars and mud flats. Most of the inlet cross-section is shallow with depths that range from 0.3 to 0.9m at mean lower low water (MLLW). Several natural channels pass through the northern part of the bay and eventually converge at Isanotski Strait, a 4.8km long channel with an average width of 0.8km. The currents in the strait at peak conditions range from 4 to 7knt.

Turbidity Maps

In many areas in the bay, sediment plumes generate false bathymetry in SDB results. Thus, it was hard to separate between true-bottom detection representing the bathymetry and water-column detection representing the sediment plume. The window of opportunity to find an appropriate image for SDB is only 3 months (March to May), and the presence of clouds and sun glint limits the number of available satellite images to one or two that can be used to calculate the bathymetry. As a proof of concept, two different band combinations were used to infer the location of the channels in Bechevin Bay, AK (the northern part of False Pass) using WorldView-2 (WV-2) imagery (Figure 2): once using derived bathymetry (blue/green band ratio), and once using a turbidity map (red/green band ratio).

Based on the optical properties of the water, it is possible to use the red band instead of the blue band and restrict the light penetration to only the top layer of the water. As expected, the derived bathymetry was limited to very shallow depths because of the sediment

▲ *Figure 1: Bechevin Bay Inlet System.*

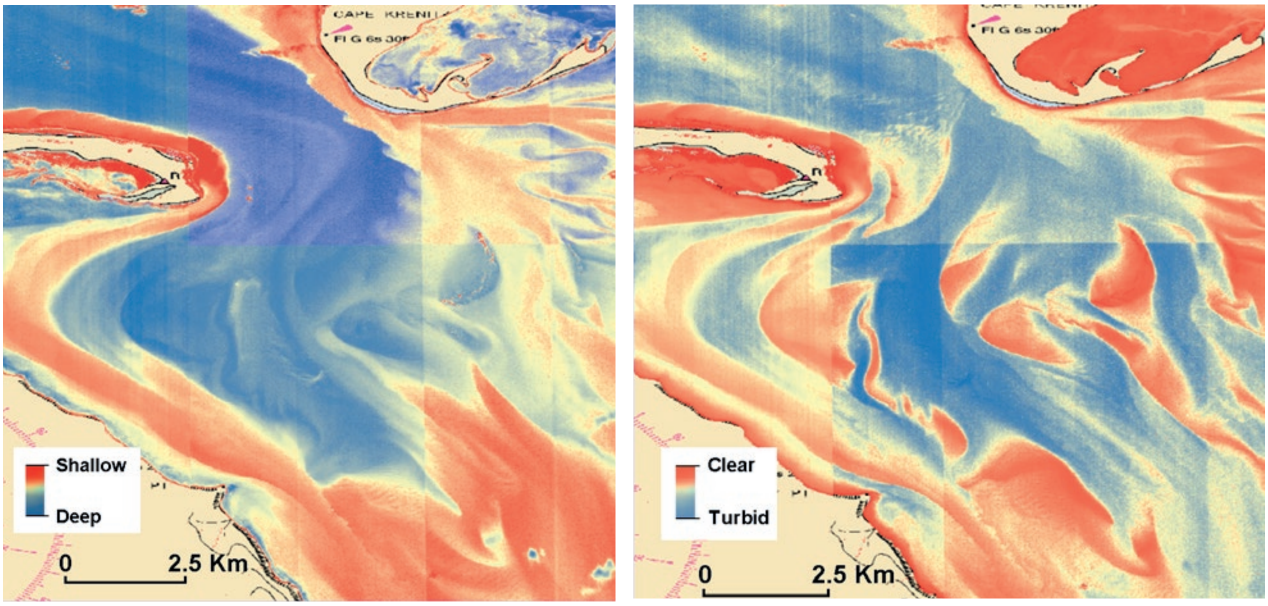

Figure 2: Bathymetric model (left) and turbidity map (right) using WV-2 imagery.

plumes that made the water turbid. However, it is possible to use the turbidity map to locate the channels within the bay based on the currents generated by Isanotski Strait. Assuming that most of the surface turbidity will be concentrated in the strongest currents, mapping the water surface layer (shallow water-depth penetration) will provide the horizontal location of the channel. Based on the preliminary results using WV-2 imagery, Landsat 8 imagery was used because of its large coverage (185km swath width) and its repeatability (every 16 days).

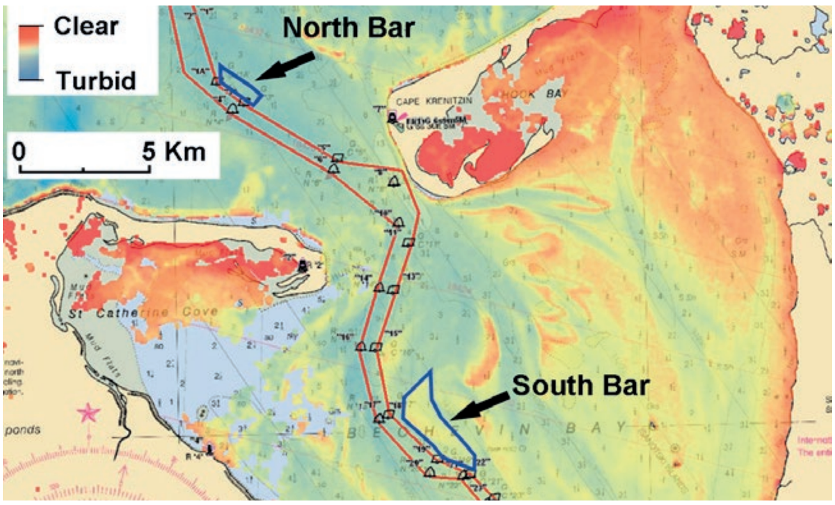

Figure 3: Turbidity map using a Landsat 8 imagery overlaid on NOAA Chart with the buoy locations from 2014.

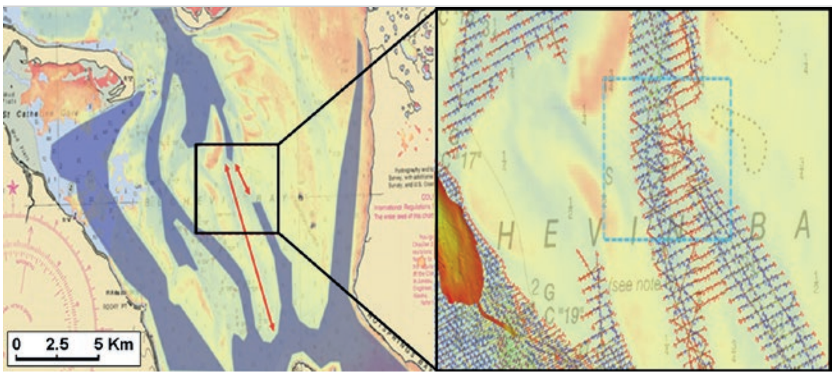

Figure 4: Terrasond investigation area (left) and completed sounding set (right).

Ground Truth

As part of the annual channel inspection of Bechevin Bay, AK, the USCG Cutter *SPAR* conducted a single-beam hydrographic survey in May 2014. *SPAR* surveyed the charted channel and the surrounding areas to best mark the navigable channel. The USCG results were very similar to the SDB measurement inside the bay, including the identification of a shifting bar that rose to 3.6m at MLLW at the centre of the bay and east to the current channel (Figure 3). The USCG has observed this shoal ('South Bar') moving annually and recommends repositioning the buoys marking this shoal every one to three years. An additional shoal was identified at the entrance to the bay ('North Bar'). The additional shoal was not detected by the SDB approach, possibly because of weak currents surrounding the shoal.

Discussion

The formal incorporation of turbidity maps from satellite imagery into NOAA's workflows is still to be determined. NOAA's Hydrographic Survey Division (HSD), the group tasked with identifying and addressing the survey priorities throughout the United States, has already found SDB to be useful both as a reconnaissance and as a planning tool to assist with determining the accuracy of existing chart data and to assess the anticipated level-of-effort associated with a given project. In addition to the survey conducted by the USCG, HSD contracted Terrasond Limited to conduct a full bathymetric survey of Bechevin Bay and False Pass, AK. The position of a main channel and secondary channel through Bechevin Bay inferred from the turbidity map was validated by these surveys. The possibility for a secondary channel provides an alternative route characterised with fewer turns (thus being easier to navigate), and potentially being more geologically stable than the presently demarcated channel that is known to shift annually. The turbidity map result (Figure 3) was passed on to the field party to improve their surveying efficiency by focusing their efforts on the potential navigable channels, while simultaneously avoiding areas where they may risk grounding their vessel. Initial reconnaissance survey lines were planned based on the charted 4-metre contour limits and the inferred position of the channels. Ultimately, an alternative channel was identified; however, the depths were not as deep as those within the presently demarcated channel (Figure 4). That said, this alternate channel exists and can provide a navigation route for vessels with a shallower draft. This alternate channel would not have been mapped by the field party if the SDB turbidity map was not available.

Conclusions

The reconnaissance lines validated the channels suggested in the SDB turbidity map. The field party was able to strategically plan out the remainder of the survey with an emphasis on all the potentially deep channels, while carefully approaching shoal locations and avoiding non-navigationally significant waters. Executing the survey in this way is both more efficient and safer than the traditional methods for searching navigable waters using a single-beam sonar or half-stepping with a multibeam sonar.

Acknowledgement

The authors would like to thank Terrasond Limited for the ground truth survey data and permission to use Figure 4 in this paper and USCG's *SPAR* survey team for their feedback.

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Lieutenant Commander **Michael Gonsalves** has been working with NOAA's Office of Coast Survey for over ten years. He has served sea tours aboard the hydrographic survey ships *Rainier* and *Fairweather*, and is presently working in NOAA's Hydrographic Surveys Division as chief of the Operations Branch in Silver Spring, MD.

Multibeam Echo Sounder and Terrestrial Laser Scanner Data Comparison

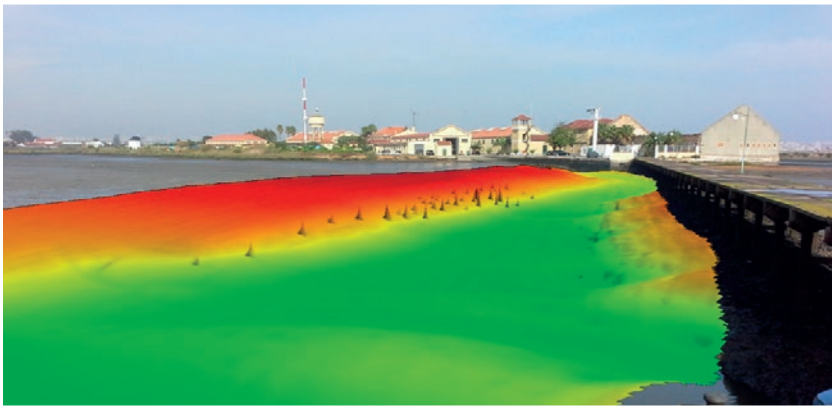
Very Shallow Water Survey - a **New Approach**

Hydrographic surveys in very shallow waters can have several applications such as nautical chart updating, performing environmental monitoring and characterisation, determination of dredged volumes, establishing navigational channels or defining general coastlines. When full bottom search is required, surveys in such areas will involve many hours of work, require several specialised technicians and, in most cases, the use of expensive equipment. Therefore, in order to gather coastline altimetry data, many hours can be spent conducting survey lines with GNSS equipment, sometimes in unfriendly and rough terrain. In order to find a way to optimise these tasks, Leica Geosystems Portugal (LG) and the Portuguese Hydrographic Institute (IHTP) carried out a joint survey to gather bathymetric data at an intertidal zone using a Leica ScanStation P20. Data from the Kongsberg EM 2040C was used to evaluate the Laser Scanner survey.

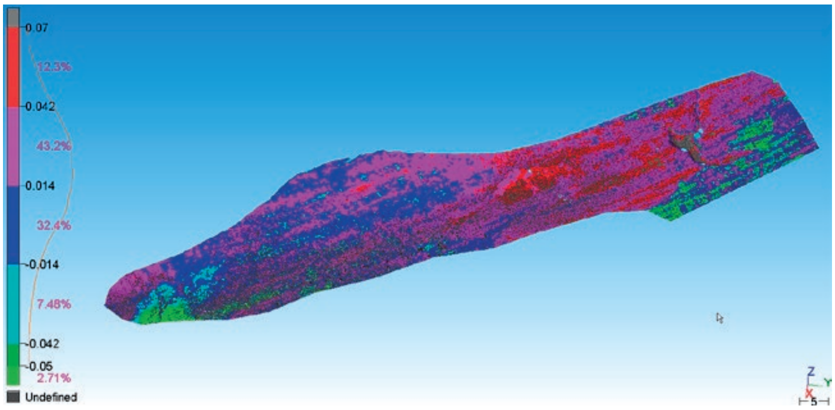
Leica's ScanStation P20 is an ultra high-speed pulsed laser scanner with capacity to scan up to 1 million points/second with an accuracy of 3mm at 50m distance. This system is mainly used to capture 3D images of objects, buildings and landscapes.
The echo sounder used for this comparison was the Kongsberg EM 2040C. It is a shallow-water multibeam echo sounder for high-resolution mapping and inspection applications. It has a wide frequency range from 200 to 400kHz, short pulse lengths and large bandwidth. It uses Frequency Modulated (FM) chirp to extend range and provides a beam width of 1° x 1° at 400kHz.

▲ *Figure 1: Survey area.*

▲ *Figure 2: Leica ScanStation P20 Survey (Point Cloud).*



▲ *Figure 3: CUBE surface with 25cm resolution created using Kongsberg EM 2040C data.*



▲ *Figure 4: Laser scan and multibeam surface differences by 3D Reshaper.*

Can now be considered to be less challenging and risky activities

A muddy shallow-water area (Figure 1) was selected to gather the data. Two surveys were carried out: one with Leica ScanStation P20 during a low tide period and another one with the multibeam echo sounder during a high tide period.

To guarantee an accurate and reliable comparison of the surveys, vertical and horizontal references should be shared. Therefore, a common reference frame based on local bench marks was established, previously surveyed using GNSS, that was used for Laser Scanner orientation and GNSS reference station set-up for the hydrographic survey.

During a low tide period 6 full dome scans were conducted from 6 different bench marks, where point clouds were acquired with a 6mm resolution at 10m distance (Figure 2). Each scan took about 2 minutes, and it was decided that no photos should be taken if radiometry information was not relevant. It was possible to apply topographic methodologies for laser scanner orientation (Resection and Known Backsight) due to ScanStation P20 dual axis compensator. As mentioned earlier, the hydrographic survey using the Kongsberg EM 2040C took place during a high tide period with average depths of 3m. For positioning and attitude integration a Seapath 330RTK system with Differential Global Navigation Satellite System (DGNSS) was used based on Real Time Kinematic (RTK) corrections.

Methodology

Multibeam data was processed by IHPT on CARIS HIPS and SIPS v.8.1.9. To obtain tide reduction RTK information was used together with geoid undulation. All other corrections were applied during data acquisition. The final product was a CUBE Surface with 25cm resolution (Figure 3) and an ASCII file (.xyz). Leica Cyclone software was used to process ScanStation data. A very simple task of point cloud cleaning and mesh creation was enough to calculate the laser scanner final surface that was exported as an ASCII file (.xyz).

Afterwards, both ASCII files were exchanged between institutions. LG created a mesh from the multibeam ASCII file and compared it with the mesh created from the ScanStation data. The comparison between both meshes was done using 3D Reshaper (www.technodigit.com), where both surfaces were imported (Figure 4).

Simultaneously on CARIS HIPS and SIPS, the depth layer from the 25cm resolution CUBE surface created with EM 2040C data, was compared with a 25cm resolution average depth surface generated by the laser scanner ASCII file.

Because of the different technical features of the systems (sound propagation vs electromagnetic emission), the different methods of positioning and data processing, and the nature of the bottom, which was

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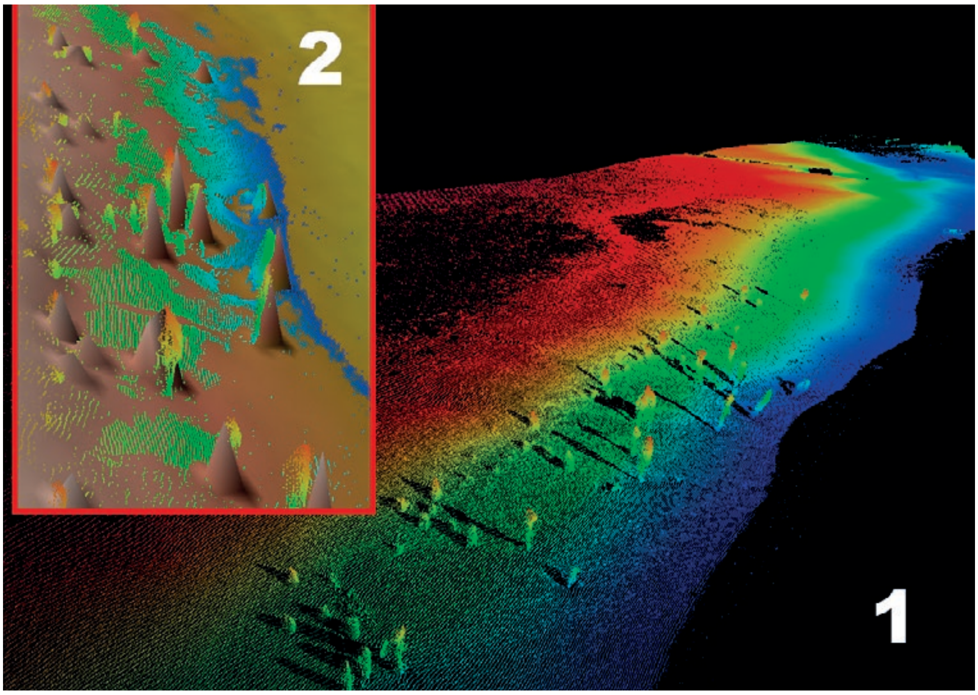

▲ *Figure 5: 1.Highly detailed features from Leica ScanStation P20 point cloud. 2. Multibeam CUBE Surface vs Leica Laser Scanner point cloud. Although with less detail, minimum depths of these small structures are shown by Kongsberg EM 2040C.*

highly inadequate for laser detection (muddy, dark in colour with water plants and clams), as well as other factors, it was not really expected to get very good results.

Results

The results obtained from data comparison were quite good. The average difference between the depths given by both systems was less than 0.015m with a standard deviation of approximately 0.03m.
In addition to the depth difference analysis, we were also able to compare the capacity of object detection and characterisation. Because of its exceedingly high resolution, it was not surprising that the small wooden pillars visible on Figure 1 were detected and very well defined by the ScanStation P20. In addition, the multibeam system revealed great object detection. Considering the inherent limitations of sound propagation in the water and the physical resolution of echo sounders, EM2040C showed good performance and despite the fact that these structures were represented as cones, all minimum depths of the wooden pillars seem to have been detected (Figure 5).

Conclusions

This experiment makes it possible to consider the use of Laser Scanning technology in hydrographic surveying. It has been shown to be a proven solution in very shallow waters, particularly when full bottom search is needed on intertidal, small and confined areas where other Lidar systems or drones are too expensive. Its efficiency and high-quality results proved to be an added value in those arduous survey conditions.
However, these types of sensors cannot achieve water penetration, so in deeper zones an echo sounder must be used. Multibeam or interferometric echo sounders should prove to be effective.
In the near future, IHPT will strive to use laser scanner technology for two different tasks: surveying in dry areas at low tide and the acquisition of coastline altimetry data for later inclusion on nautical charts.
Looking ahead, this technology can also provide innumerous solutions when, for example, we consider its integration with unmanned aerial vehicles, giving us the remarkable advantage of easily reaching remote areas and quickly sweeping an entire zone.
In short, the most positive outcome of the study is that another solution for hydrographic surveying was found. From now on, tasks like gathering coastline altimetry data or achieving full bottom search on intertidal areas can be considered to be less challenging and risky activities. ◀

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George Davidson

Pioneer Surveyor

George Davidson, whose name is indelibly connected with the survey of the West Coast of the United States, spent most of the sixty-one years between 1850 and 1911 in service to the citizens of California, Oregon, Washington, and Alaska. He was born in Nottingham, England, on 9 May 1825 and emigrated with his parents to the United States in 1832. They settled in Philadelphia where a few years later he became a student of Alexander Dallas Bache, then principal of the Philadelphia Central High School. In 1843, Bache was appointed second superintendent of the United States Coast Survey. Two years later he selected Davidson to become his personal clerk in the Washington, D.C. office of the Coast Survey. Davidson was not happy with such a sedentary existence as he modified his address on many letters home with the notation 'Washington D(reary) C(ity)'. It was obvious he was ready to head for the field.

In 1846, Bache sent him to serve with Assistant Robert Fauntleroy on the Gulf Coast of the United States. Fauntleroy befriended the young man and taught him the techniques of geodesy in the field. During the winter months he took Davidson to his home in New Harmony, Indiana, a colony of intellectuals and social experimenters seeking a utopian society. Here Davidson met his future wife, Ellinor Fauntleroy, although they did not marry until 1858. In 1849, Fauntleroy died of yellow fever while working on the Texas coast leaving George grief-stricken for his mentor. The same year, the Coast Survey had sent survey crews to California. Because of the gold strike, no labour was to be found on the West Coast, and the first crews to arrive accomplished little work. Because of this, Superintendent Bache decided to send a crew of young men of great energy with 'record to make' to the West Coast. These men would undertake "for one year to do any duty, however hard or manual, incident to the survey on the western coast." George Davidson, James Lawson, and two others volunteered for this arduous assignment.

They arrived in San Francisco on 19 June and within three weeks were headed back south to begin their work. Point Conception, known as 'The Hatteras of the Pacific' was selected as their first location for which to determine an accurate astronomic position. Over the next year, he made astronomic observations near Monterey and San Diego in California, then north to Cape Disappointment at the Columbia River entrance. On the return from Cape Disappointment, Davidson was left off at Port Orford, Oregon Territory, where he conducted observations and remained until January 1852. While there he was "living on lean salmon until you feel scaly, turn colour and wag your tail." When returning to San Francisco he was assigned to the party of Lieutenant James Alden, USN, on the Coast Survey Steamer *Active* and proceeded south landing at nine locations to determine their astronomic positions. Upon return to San Francisco, he and Lawson, who had been working in the vicinity of San Diego, proceeded on the *Active* north to Neah Bay, near Cape Flattery in Washington Territory. The seeds of dissension between Davidson and Alden were sown on these trips and they came to hate each other over the next year, each heaping invective upon each other's heads in letters to the Superintendent of the Coast Survey. This resulted in Davidson acquiring a vessel which he named the *Robert H. Fauntleroy* in 1854. After the *Active* discharged Davidson and his party of nine men at Neah Bay, his survey party encountered hostility from the Makah tribe and their relatives across the Straits of Juan de Fuca on Vancouver Island. Although the Makahs were afraid of retribution from the United States government if they attacked the survey party, their neighbours from across the strait did not share the same fear. A fleet of large canoes containing at least 150 Indians came across the strait and anchored in the kelp off Neah Bay. The Coast Survey party

▲ *Figure 1: George Davidson*

built breastworks and loaded all available weapons such that each man could shoot 60 rounds without reloading. No attack ensued as the Indian scouts always found an armed guard.

That Davidson and other members of the party were crack shots and courageous to a fault, sometimes exceeding foolhardiness, is illustrated by the following story told by James Lawson. A few years after the Neah Bay incident and when Davidson and his party were engaged in helping survey the

Figure 2: *Coast Survey sounding operations in Strawberry Harbor. Coast Survey Ship* Fauntleroy *in background. Watercolour by James Madison Alden, nephew of Lieutenant James Alden. Lt. Alden commanded the Coast Survey Steamer Active.*

boundary between Canada and the US in the Puget Sound area, he was in Victoria, British Columbia. While there they took to bragging about American marksmanship to the British colonial officials. The following day, while on a hunt with the British, an American shot and wounded a mountain lion. Davidson, who had been running ahead, dropped a rifle cartridge in his shotgun, and, as the lion was dropping from the first shot, he shot it through the heart. In the elation of the moment, he took off his stovepipe hat and , placed it on the barrels of his shotgun, and then placed this in front of his face so that the brim of his hat just touched the crown of his head. He shouted to his fellow American to shoot at the hat. The other fellow did, piercing the hat and spitting the barrels of the shotgun about two inches above Davidson's head. Lawson reported that the "astonishment of the Englishmen was inexpressible" and upon coming up to Davidson "forgetting he was a superior officer" called him a "d____d fool."

Besides the dangers of hostile natives and one's own foolhardiness, the work was dangerous. Davidson made over 40 small boat surf landings on a rock bound stormy coast during his career in spite of never learning to swim. Besides sounding out many of the channels and entrances to the small harbours of the West Coast, he also spent months in mountain triangulation work packing into places that had hardly been seen or visited by anyone prior to his work. All of this work had the potential for serious accidents as illustrated by at least six men drowning as boats overturned and were swamped between 1852 and 1867. Concurrent with this dangerous work, Davidson chose the sites for many Pacific coast lighthouses and in 1858 wrote *The Directory of the Pacific Coast*, the forerunner of the Coast Survey Coast Pilots. His 1889 edition of the *Coast Pilot of California, Oregon, and Washington* became the authoritative list of sailing directions for West Coast mariners as well as tracing the origin of numerous feature names on the coast and recording the history of exploration since the early Spanish adventurers. It also contained over 400 coastal views prior to the encroachment of civilisation. This document is considered one of the great historic works detailing the geography and early exploration of the western margin of North America.

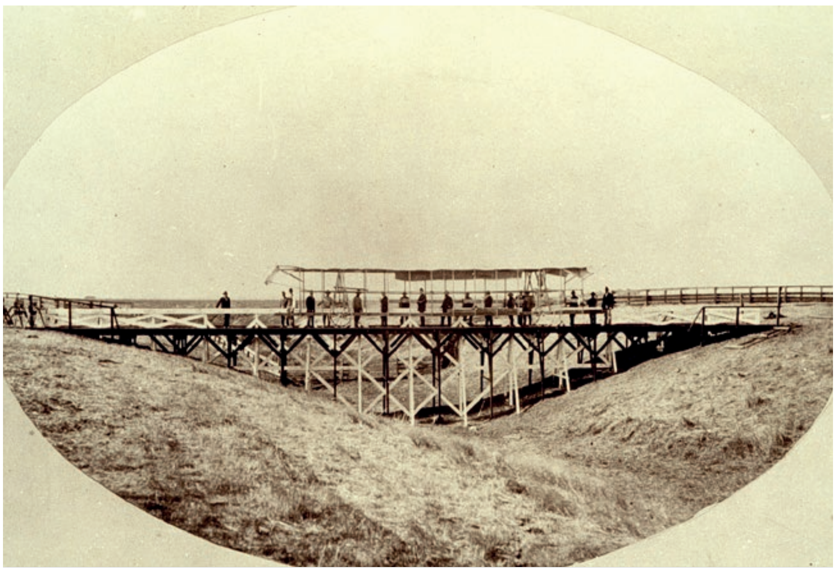

Figure 3: Yolo Buggy used to transport and shade base measuring instruments. Yolo Base Line, one of the most accurate measured in the nineteenth century. Base Line party of George Davidson.

Many consider the measurement of the Yolo Baseline in the Sacramento Valley and the Los Angeles Baseline to have been Davidson's crowning achievements. Both were over 11 miles in length and measured to the then unprecedented accuracy of better that one part in a million. The Yolo Baseline served as the starting point for the great geometric figures on the surface of the earth that became known as the Davidson Quadrilaterals upon which the primary triangulation of the Pacific coast states was based. This work overshadowed Davidson's earlier direction of the West Coast beginnings of the 39th Parallel Survey. The great triangle bounded by Roundtop in the central Sierra Nevada to Mount Shasta to Mount Helena had some of the longest lines ever measured in classical geodetic work including the 192 mile line from Mount Shasta to Mount Helena.

Davidson led an extraordinarily active


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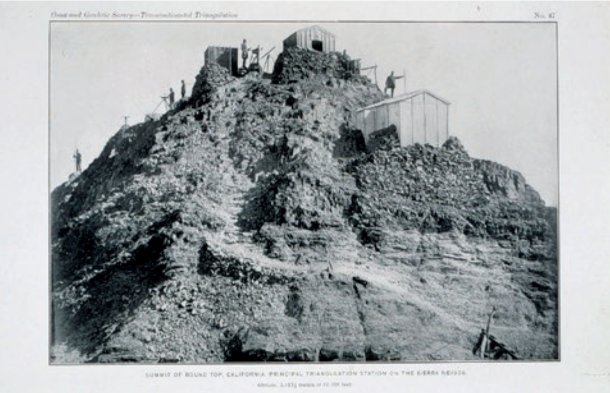


Figure 4: Summit of Round Top, CA, Principal Triangluation Station on the Sierra Nevada. Altitude 3,165m or 10,386ft.

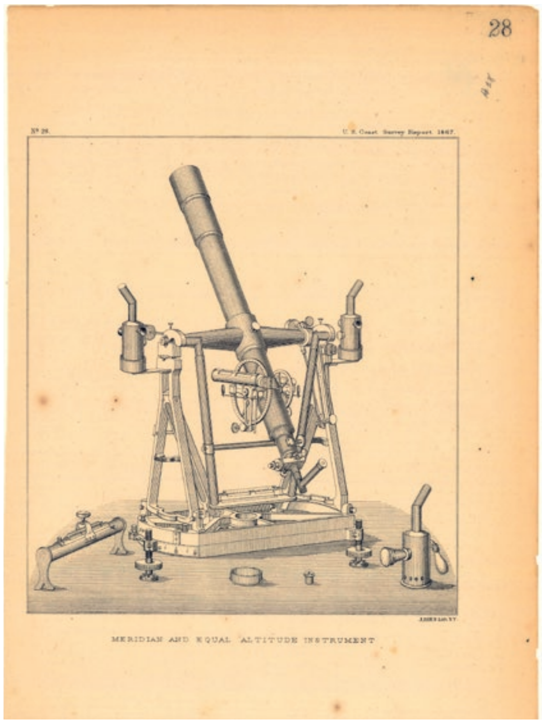


Figure 5: Instruments designed and used by Davidson.

professional life. He was associated with the University of California from 1870 until his death in 1911. He served as Honorary Professor of Astronomy and Geodesy, a Regent of the University from 1877 to 1885, Professor of Geography from 1898 to 1905, and Professor Emeritus until his death. He received an honorary degree of LLD from the University in 1910. He was elected president of the California Academy of Sciences in 1871 and served in that capacity for sixteen years. In 1867, he headed the party making a geographical reconnaissance of Alaska and his report helped sway Congress to purchase 'Russian America'. In 1872, he was appointed one of three Commissioners of Irrigation of California and became recognised worldwide as an authority on irrigation problems. He was instrumental in helping establish the Lick Observatory. He survived the San Francisco earthquake of 1906 and helped found and became the first president of the Pacific Seismological Society. Davidson became the most honoured American for his scientific work in the nineteenth century. He was elected to membership in such societies as the Royal Astronomical Society, the American Philosophical Society, the Bureau des Longitudes of France and the United States National Academy of Sciences.

Surprisingly, and to the shame of those involved, Davidson was dismissed from the Survey in 1895 by William Ward Duffield, an ignorant political appointee who was made head of the Coast and Geodetic Survey during the second administration of Grover Cleveland. The uproar that ensued from the scientific community forced Duffield's resignation in 1897.

George Davidson combined the skills of hydrographer, geodesist, geographer, astronomer, seismologist, civil engineer, hydrologist, historian, native American ethnographer and teacher for the citizens of his adopted land as well as the world scientific community. In 1900, at the age of 75, he commented "… I continue ceaselessly to work because I love it, because I have the constitution to stand it, and because I believe that I can add something to human knowledge and especially benefit the young." His services to the western coast are commemorated by Davidson Seamount off the California coast, the first undersea feature to be named with the generic term 'seamount'; Mount Davidson in San Francisco; Mount Davidson, Nevada; and Mount Davidson, Davidson Mountains, Davidson Inlet, Davidson Bank, and Davidson Glacier, Alaska. He was an extraordinary man, the likes of which few of us will ever see in our lifetimes.

Coalition of Geospatial Organizations (COGO)

Hydrography Data in the US **Require Attention**

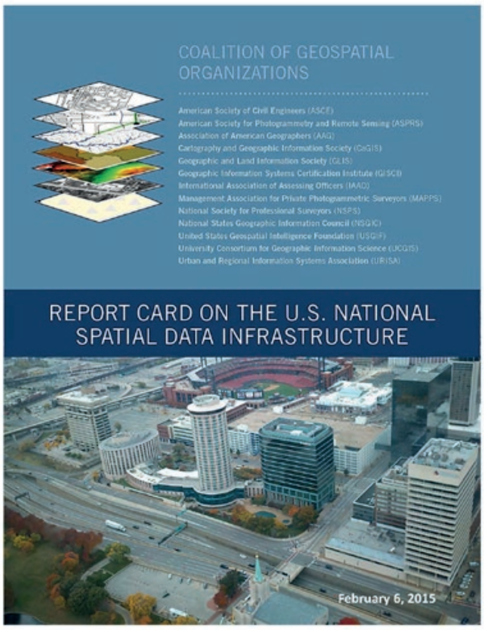
An extensive Report Card on the US National Spatial Data Infrastructure (NSDI) was published earlier this year by the Coalition of Geospatial Organizations (COGO). One of the seven data themes assessed, the Hydrography Data theme, scored a mediocre grade of C. More work needs to be done to efficiently coordinate data collection and to improve quality control. But the overall picture is rather positive.

The National Hydrography Dataset (NHD) is the surface-water component of the National Map of the United States. This dataset encompasses oceans and coastlines, and it is the primary national hydrography data product for the US. Hydrography is valuable to many applications; many users need hydrographic features as reference or base map data. Other applications, particularly environmentally oriented analyses, need the information to analyse and model water supply, pollution, flood hazard, wildlife and land suitability.

Coordination

Federal leadership for the collection, production and distribution of hydrography data has been provided by the US Geological Survey (USGS) and the Environmental Protection Agency (EPA). "There has been good coordination among the federal agencies that require these data for their program and mission needs and with non-federal entities", states the Report Card's panel of experts. But because hydrography data are consistently identified as a critical dataset for a wide variety of uses at all levels of government and within the non-governmental sectors, the panel emphasises that this data theme requires attention. "More work needs to be done to better leverage budgets, coordinate data collection efforts, and collaborate across levels of government."

There are numerous possibilities to leverage and coordinate data collection efforts. For example, the lead agencies at the Federal level, including both the USGS and EPA, coordinate their efforts with the Spatial Water Data Subcommittee, which has the responsibility to develop water resource components of the NSDI. This subcommittee is sponsored by the Federal Geographic Data Committee, responsible for the National Spatial Data Infrastructure of the US. The Spatial Water Data Subcommittee is also part of the Advisory Committee on Water Information (ACWI), which has to coordinate Water Resources Information. ACWI represents the interests of water-oriented organisations, and has 35 members who are appointed by the Secretary of the Interior. Via the ACWI, these organisations coordinate their programmes and advise the federal government on their activities and plans. Members are selected from among



▲ *Figure 1: Report Card.*

GRADE REPORT OF: National Spatial Data Infrastructure (NSDI) **SEMESTER:** Fall 2014

Subject	Dept.	Grade	Subject	Dept.	Grade
CADASTRAL DATA	DOI	D+	CAPACITY	FGDC	C
GEODETIC CONTROL	DOC	B+	CONDITION	FGDC	D
ELEVATION DATA	DOI	C+	FUNDING	Various	D
HYDROGRAPHY DATA	DOI	C	FUTURE NEED	FGDC	D
ORTHOIMAGERY DATA	DOI & USDA	C+	OPERATION & MAINTENANCE	FGDC	C
GOVERNMENT UNITS DATA	DOC	C	PUBLIC USE	FGDC	C
TRANSPORTATION DATA	DOT	D	RESILIENCE	FGDC	C
OVERALL DATA GRADE		C	COMPREHENSIVE GRADE		C-

TO: Federal Geographic Data Committee
590 National Center
Reston, Virginia 20192

FROM: Coalition of Geospatial Organizations (COGO)
http://www.cogo.pro
See the full report for an explanation of each grade.

▲ *Figure 2: The scores in the Report Card fit in a range from A to F.*

Figure 3: Part of the National Hydrography Dataset. Polygons are used to represent area features such as lakes, ponds and rivers. Points represent point features such as stream gages and dams. Lines represent linear features such as streams, canals and smaller rivers, and show the water flow through area features. The combination of lines is used to create a network of water and transported material flow so users can trace movement in downstream and upstream directions.

Evaluation

This year, the Coalition of Geospatial Organizations (COGO) in the US published a Report Card that is intended to address the condition of the US National Spatial Data Infrastructure, and to spur future progress. The completeness and suitability of data on the basic themes – from cadastral to transportation – was evaluated during 2014 by a seven-member expert panel chaired by former Governor of Wyoming James E. Geringer, who is currently the director of policy and public sector strategies with Esri. The panel also included vice-chairs Dr. David Cowen, Professor Emeritus of the University of South Carolina, and John J. Moeller, former staff director of the Federal Geographic Data Committee.

a wide variety of organisations including federal agencies, professional water-related associations, state and county water-related associations, academia, private industry, water utility associations, civil engineering societies, watershed and land conservation associations, ecological societies, lake, coastal, and ocean associations, and environmental and educational groups. Less is more?

Access and Exchange

The NHD provides consistent accessible hydrography data across the nation. Most datasets are publicly available through the National Map, EPA data portals, federal government clearinghouses and other web portals. Further information and downloadable data are available at nhd.usgs.gov. The NHD is also accessible through the NSDI Clearinghouse at the Geoplatform.gov portal.

In 34 states hydrographic data are available through a public state-maintained web mapping service, but only in 17 states are these data publicly available for re-use without restrictions.

US and international standards are accommodating the exchange and integration of hydrography data with other data of the NSDI framework. The Federal Geographic Data Committee has developed the Geographic Information Framework Data Content Standard, endorsed in 2008, and hydrography is one of the parts of this standard. The standard defines the components of networked and non-networked surface water features, and enhances data sharing and applications development when used with standards-based web services or file transfer.

The standard anticipates that multiple representations of hydrographic features exist within specific application communities, and accommodates the exchange of these multiple representations. A Framework Standards Guidance Document is available on the FGDC website to facilitate the process of creating new standardised data or to harmonise and transform existing data to match standardised content.

Quality

The NHD is available nationwide in two seamless datasets. One of these datasets is based on 1:24,000-scale topographic mapping, known as the high-resolution NHD, and the other is based on 1:100,000-scale topographic mapping, known as the medium-resolution NHD. It is also becoming available in select areas based on larger scales such as 1:5,000 mapping.

The National States Geographic Information Council (committed to efficient and effective government through the prudent adoption of geospatial information technologies) did a geospatial maturity assessment in the US and included questions about hydrography data. Of the 50 states in the US, 29 have 96% or greater completeness, but 17 have less. Five states have no programme for developing statewide hydrography data.

The US Geological Survey did some research in 2009 comprising hydrography data. In its 'National Map Customer Requirements' hydrography was ranked as the fourth highest requirement. The NHD provides a network that supports the analysis of any type of movement by surface waters, such as navigation, sediment transport and effluent dispersion. However, the level of accurate integration with the National Elevation Dataset was not sufficient to meet analysis or basic mapping needs. The panel of experts stipulates that the National Hydrography Dataset is one of the datasets most often cited as needing better quality control.

To complete the picture, it should be mentioned here that since 2013 the US Geological Survey is indeed providing national management to facilitate the overall maintenance process because "users demand greater accuracy," as stated on the USGS website. A 'stewardship' agency in each state manages the maintenance activities within that state, trained by and under quality assurance of the USGS. Updates to the National Hydrography Dataset are made by the stewards, and processed by the USGS for national distribution.

About COGO

The Coalition of Geospatial Organizations (COGO) is a coalition of 13 national professional societies, trade associations, and membership organisations in the geospatial field, representing more than 170,000 individual producers and users of geospatial data and technology.

More information

www.cogo.pro

IHO **Capacity Building** Update

Capacity Building (CB) is one of the strategic objectives of the IHO. It aims to assist countries, especially IHO Member States, in better meeting their international obligations in hydrographic surveying, nautical charting and maritime safety information. This is done through identifying the needs in each region and countries, providing technical advisory visits, and the provision of workshops, seminars, training and education programmes held around the world. Funding comes from the IHO Member States' annual contributions with significant additional funding from the Republic of Korea and the Nippon Foundation of Japan. This additional funding enables several high-level training and education programmes.

In the last ten years, more than 1,200 individuals from 66 IHO Member States and 68 non-Member States have benefited from activities sponsored by the IHO CB programme.

Recent Programmes

Three students sponsored by the Republic of Korea funding completed the FIG-IHO-ICA Category A level Master of Science Programme in Hydrography held at the University of Southern Mississippi, USA in 2014-2015. A total of six students successfully graduated in 2014 and 2015. Four more students are participating in the 2015-16 programme.

The Republic of Korea also sponsors a three-phase marine geospatial information programme in Busan, Republic of Korea. Five students attended Phase 1 of this Category B level nautical cartography course in March and April this year. Phase 2 will begin in March 2016.

In addition to its ongoing support of Category A training in ocean mapping at the University of New Hampshire, USA, the Nippon Foundation of Japan supports Category B nautical cartography training under the IHO CB Programme. The 7th IHO - Nippon Foundation Cartography, Hydrography and Related Training (CHART) course started at the UK Hydrographic Office in September. 36 students have graduated from the previous six courses conducted between 2009 and 2014.

In addition to financial assistance from Member States, the IHO CB programme benefits from significant input and cooperation with international organisations such as the IMO and IALA, and key industry partners, who regularly provide in-kind support through the loan of equipment or by providing instructors at little or no cost at CB workshops and courses that have a practical content. Recent examples include regional courses in multibeam processing in Bangladesh and Sri Lanka and practical hydrographic surveying training in Fiji.

In 2014, the IHO capacity building programme reached a new level of achievement with double the funds available compared to 2013. This enabled eight technical visits to take place and 22 different training activities. Eight technical visits and 25 training activities have been scheduled for 2015.

The IHO CB programme has been in operation since 2005. It began with limited funds but this has grown so that more than half a million euros were available in 2014. However, the requirements continue to outstrip resources. For this reason, the IHB Directing Committee strives to raise global awareness of hydrography and to engage external stakeholders, international partner organisations, funding agencies, academia and industry - all of whom can help in the CB effort - either through coordination of initiatives, direct financial assistance or in-kind support. ◂

More Information
www.iho.int > Capacity Building

Figure 1: Graduates of the IHO-USM CAT A Programme receive their certificates of recognition.

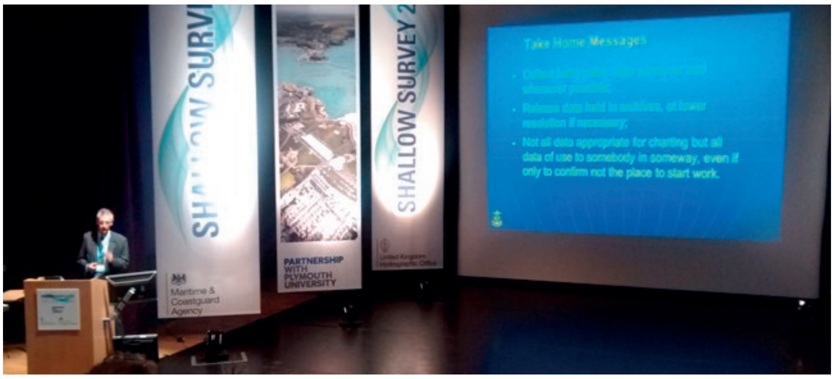
Figure 2: 6th CHART Course at the UKHO.

Shallow Survey 2015 in Plymouth, UK

More than the Common Dataset

The biennial event Shallow Survey was held in Plymouth, UK, from 14-18 September 2015. The Roland Levinsky building of the university hosted the conference, welcoming over 300 delegates. The trade show with 45 stands was spread over three floors. In addition to the papers focussing on the common dataset, there was much attention for other subjects like satellite bathymetry, data management and quality control.

In the time running up to Shallow Survey, multibeam surveys using equipment of various suppliers were conducted in the waters of Plymouth and the common dataset was made available for analysis. This time, specific line patterns had to be run over a number of objects like a 2m cubic object and a wreck. Also vessel speed, swath angle and offline tolerance were made compulsory so as to create comparable datasets. Presentations focussed on this theme were given on the Monday. After a first description by Andy Talbot (UKHO) on the dataset, Peter Hogarth (Kongsberg Maritime) reflected upon the effects of sound velocity variations on the different datasets. Tim le Bas continued on object based image analysis (OBIA) and applied this principle to the datasets.



▲ *Figure 1: David Wyatt (IHO) shared take-home messages for crowdsourced bathymetry.*

More Than just Datasets

The conference continued by treating a wide range of other survey-related subjects like backscatter analysis, wreck survey, satellite derived bathymetry and bathymetric Lidar, crowdsourced bathymetry, geographic information systems and data management, visualisation and quality control, resurvey policies and survey planning and autonomous vehicles (surface and sub-surface). This conference clearly had a broader orientation than just the datasets and multibeam surveying. Especially the attention given to satellite derived bathymetry throughout the conference was impressive and insights shared were valuable.

▲ *Figure 2: The Shallow Survey foghorn reminded the attendees to attend the sessions.*

Workshops

Active involvement was possible during the workshops on Monday and Friday. Various suppliers such as Chesapeake Technology, Fugro, Caris and QPS provided hands-on training opportunities. Demo cruises were also organised throughout the week by Teledyne RESON, demonstrating their new T50-P multibeam sonar.

Social Events

Networking with colleagues is also important during events like Shallow Survey. To facilitate a good chat, the organisers put a welcome reception on the agenda for the Monday evening for the early arrivals, an icebreaker reception on Tuesday and on Wednesday evening delegates were able to get a taste of the West – ciders, ales, wines and regional food were available throughout the exhibition area. The gala dinner took place on Thursday evening in the marquee on Plymouth Hoo, overlooking the Plymouth Sound.

▲ ***Figure 3: During the Taste the West event on Wednesday, CARIS demonstrated a survey taking place at that moment on the Mississippi river in the USA.***

The next edition of Shallow Survey will take place in 2018, in St John's, Newfoundland, Canada. ◄

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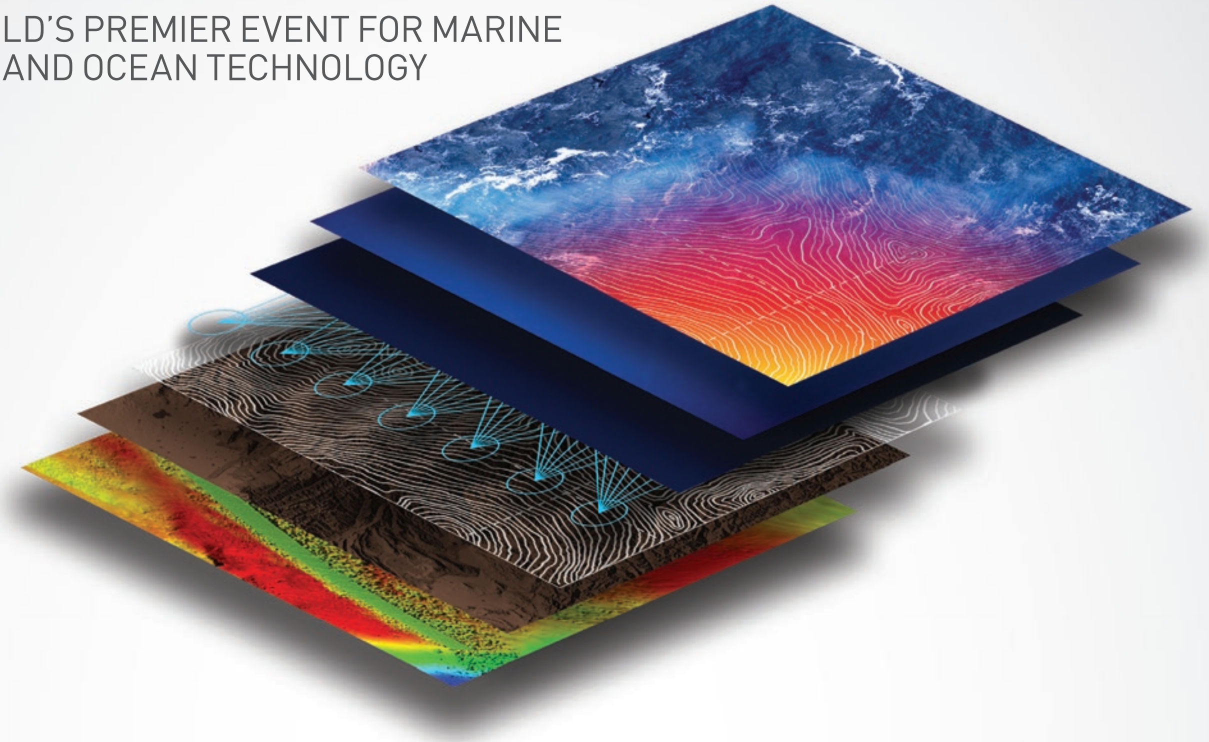

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Australasian Hydrographic Society

New Zealand Region - World Hydrography Day Event – Annual Seminar

It's getting bigger each year! The New Zealand Region ran its annual Seminar and AGM to celebrate World Hydrography Day in Wellington this year. To support students carrying out hydrographic surveying studies at Otago School of Surveying, the Society arranged for 11 students to attend. The NZ member organisations covered their costs. They all gave short presentations that are available on the website http://www.hydrographicsociety.org.nz/events.htm

▲ *Figure 1: Students from Otago University School of Surveying attending the NZR Annual Seminar.*

▲ *Figure 2: D. Crossman presenting the Education Award to T. Rutter.*

Thomas Rutter, from the School of Surveying, was awarded the Australasian Hydrographic Society (AHS) Education Award. This award was presented by the AHS president, Commander Dave Crossman, RNZN during the Seminar and he was commended on his research investigating the performance and operation of ROSVs using multibeam echo sounders (MBES) for nautical charting surveys to national and international standards. Associated research also involved cost and operations benefit analysis to commercial hydrographic survey firms.

Bruce Wallen also received a Career Achievement award from the Society.

West Australia Region AGM

The WAR held its AGM on 19 August with a technical presentation by Acoustic Imaging and the evening was sponsored by QPS. The WAR has seen a pleasing increase in membership over the past 12 months from 75 to 94. During the year the WAR held six organised events.

▲ *Figure 1: AHS Career Achievement Award presentation by Peter Ramsay to Paul Kennedy (Fugro Survey).*

Australasian Hydrographic Symposium 2015

The AHS will be hosting the Australasian Hydrographic Symposium 2015 in warm, sunny Cairns in November 2015. Cairns is the gateway to the Great Barrier Reef and is a beautiful, tropical city in northern Queensland – a great place to be, particularly for anyone in wintery northern climates….. We look forward to seeing you later this year.

More information
AHS website: www.ahs.asn.au/AHS.html
Symposium details: https://consol.eventsair.com/QuickEventWebsitePortal/australasian-hydrographic-symposium-2015-and-trade-exhibition/ahsweb

OCTOBER

Teledyne Marine Technology Workshop
San Diego, CA, USA
➔ 4-7 October
www.teledynemarine.com

RenewableUK
Liverpool, UK
➔ 6 October
bit.ly/RenewableUK2015

European Dredging Summit
Antwerp, Belgium
➔ 7-8 October
www.wplgroup.com/aci/conferences/eu-mdr1.asp

Kongsberg HiPAP Survey Engineer Training Course
Aberdeen, UK
➔ 9-10 October
www.km.kongsberg.com/training

Offshore Energy 2015
Amsterdam, The Netherlands
➔ 13-14 October
www.offshore-energy.biz

OCEANS '15 MTS/IEEE
Washington DC, USA
➔ 19-22 October
www.oceans15mtsieee-washington.org

PLOCAN Glider School
Telde, Gran Canaria, Spain
➔ 19-24 October
www.gliderschool.eu

8th ABLOS Conference
Monaco
➔ 20-22 October
www.ablosconference.com

Advances in Ocean Wave Measurement
London, UK
➔ 21 October
www.rsaqua.co.uk/events

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

IMCA Annual Seminar
Abu Dhabi, UAE
➔ 27-28 October
www.imca-int.com/events/annual-seminar-2015

Hydroacoustic Workshop
Seattle, USA
➔ 27-29 October
www.biosonicsinc.com/services-training.asp

IADC Dredging Seminar
Singapore
➔ 27-31 October
www.iadc-dredging.com

NOVEMBER

The ECDIS Revolution
London, UK
➔ 3 November
www.ecdisrevolution.org

Europort
Rotterdam, The Netherlands
➔ 3-6 November
www.europort.nl

Oceanology International China
Shanghai, China
➔ 3-5 November
www.oceanologyinternational.com/en/Exhibiting/Oceanology-China-2013

Australasian Hydrographic Symposium
Cairns, Australia
➔ 3-7 November
bit.ly/AHS-2015

CEDA Dredging Days
Rotterdam, The Netherlands
➔ 5-6 November
www.cedaconferences.org/dredgingdays2015

International Subsea Event China International Underwater Intervention
Xiamen, China
➔ 6-8 November
www.subseaevent.com

Sustainable Ocean Summit
Singapore
➔ 9-11 November
www.oceancouncil.org

FEMME
Singapore
➔ 17-19 November
bit.ly/FEMME15

Hydro15
Cape Town, South Africa
➔ 23-25 November
www.hydrographicsociety.org

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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