Intelligent Exploitation of the Blue Economy - A Hydrographic Perspective

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Abstract

How does one intelligently exploit the Blue Economy to benefit one's nation, one's company, one's agency, or oneself? From a hydrographic perspective, economic benefits derived through maritime trade are only really benefits when they arrive on land: at market. The success of vessel trade relies upon safe navigation and sustainable, resilient shore-side infrastructure. Not for the first time is it therefore emphasised that the land-sea interface is a critical component of any successful interaction between the Blue Economy and the terrestrial market which it serves. Land and sea data supporting the maritime activity upon which a Blue Economy is built have however, up until very recently, always been dealt with as separate entities, by separate agencies and industries, on distinct geodetic reference frames.

This paper will emphasise the importance of a holistic capture of marine and terrestrial terrain and the important additional data layers necessary to support successful, enduring maritime trade. A multi-faceted approach to data collection can be conducted to create a homogenous dataset which can be exploited by a greater number of stakeholders than can the mere sum of the component marine and terrestrial parts. These stakeholders include not only the traditional end data users but an increasing number of marginal stakeholder entities and other data managers.

Introduction

The Blue Economy is a term coined by several different initiators in their own fields:

For some, it is a review process introduced in a book of the same name by Gunter Pauli, examining current business, industrial and commercial modes of operation and how these can be improved upon. Interestingly, it is seen as the next potential development from the 'Green Economy', which is defined by UNEP as "one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities."

For others, such as the San Diego-based *Maritime Alliance*, the Blue Economy is "*....the sum of all economic activity associated with the oceans, seas, harbours, ports, and coastal zones.*", as quoted from the US' National Ocean Economics Program (NOEP)'s *The National Report: State of the US, Ocean and Coastal Economies, 2009.* The definition can therefore be taken to be an amalgam of the "Coastal Economy" and the "Ocean Economy" as described as separate entities in the NOEP Report.

For others still, such as the Maritime Affairs Department of the European Commission, the subject has tried to avoid the Pauli definition and has been subtly changed to focus on *growth* in the maritime business sector, entitled "Blue Growth". *Blue Growth* is "*a long-term strategy to support growth in the maritime sector as a whole.*" This is a very broad and all-encapsulating definition.

One therefore has to be very careful in describing what is meant by the term "Blue Economy". For the purposes of this paper, we are focussing on that definition promoted by the Maritime Alliance, IHO and an increasing field of protagonists who have declared an aim to support, develop or contribute to the Blue Economy in some way.

Blue Economy - Some Facts And Figures

From the material already written on the subject, it is clear that there has been a relatively recent recognition of the importance of maritime business, operations and trade from outside of the normal agencies and industries for whom the ocean is a direct link to their operations, welfare and existence. This recognition has highlighted the massive contribution by seaborne trade and offshore economic generators to regular terrestrial activities that the world's population has increasingly become reliant upon, particularly in the more consumerist societies of the West and in the developing world. There is often barely a thought given to where many goods come from or indeed how they arrived on the shelves of the superstore, or market, or neighbourhood shops. An improved awareness has helped focus on the maritime element of global trade, or the Blue Economy, and for those already engaged in the fuelling of this entity it has meant renewed recognition of one's services, practices and abilities. For the hydrographic surveying community this is good news as it spotlights the importance of accurate charting to ensure safe navigation for carriage of the goods and services which make up the Blue Economy.

The statistics involved in elements contributing to the Blue Economy are staggering. From data obtained from the IMO's *Maritime Knowledge Centre* 2011 publication "International Shipping Facts and Figures – Information Resources on Trade, Safety, Security, Environment", and from the 2012 data compiled by Equasis (www.equasis.org), the following are particularly noteworthy:

- World seaborne trade figures i.e. the amount of goods actually loaded aboard ships have increased considerably since the 70‘s (2.5 billion tons) to the present day where over 8.7 billion tons of goods were loaded (2012 figure) - more than a threefold increase.

- Developing countries continued to account for the largest share of global seaborne trade (61.2% of all goods loaded and 55 % of all goods unloaded).

- Developed economies‘ shares of global goods loaded and unloaded were 32.4 % and 44.3 % respectively.

- As at January 2013, the world fleet of propelled sea-going merchant ships of no less than 100 GT comprised 79,471 ships of 1,048,336,000 GRT with an average age of 20 years; they are registered in over 150 nations and manned by 1.5 million seafarers of virtually every nationality.

- The world's cargo carrying fleet in 2010 comprised 54,897 ships of 1,349.4 million Dwt (910.1million GT)) and the average age was 19 years. Completions during 2010 totalled 2,602 ships of 147.6 million Dwt (93.9 million GT). (Source: Lloyd's Register/Fairplay – World Fleet Statistics 2010). This figure was updated by the IMO on 1st July 2011 in recognition of the world merchant fleet exceeding one billion tonnes GRT (see above).

The United Nations Conference on Trade and Development (UNCTAD) Review of Maritime Transport 2012 stated that the world cellular container ship fleet stood at 10,066 vessels, with a combined total carrying capacity of 17.9 million TEU by the beginning of 2012. The 2011 data was compiled before the advent of the new Maersk *Triple E* class vessels, which are capable of carrying up to 18000 TEUs. To put this in perspective, 18,000 twenty-foot containers laid end to end would be some 108km (68.2 miles) in length; transport of this volume of materiel from just one ship is a staggering logistic issue for any national road and rail (intermodal) distribution network. Such ships are over 400m long, 59m wide and 75m high; this is sufficiently large to hide a 106,000 tonne *Nimitz* class aircraft carrier behind.

Figure Error! No text of specified style in document.**1: The Maersk *Triple E* class are amongst the world's largest ships and challenge the logistics of many of the world's ports**

Other equally massive ships of different designs are increasingly tasking the facilities and capacities of national port infrastructures. Royal Caribbean's *Oasis of the Seas* and *Allure of the Seas* each have a capacity of 6,360 passengers plus some 2,100 crew and, with a gross tonnage of 225,000 tons, makes them the largest passenger ships afloat and also makes Cunard's RMS Queen Mary, at 166,000 tonnes, appear quite modest by comparison.

Figure 2: ***Oasis of the Seas*** **presents huge challenges for small island nations to simply accommodate the potential trade these ships create (seen here berthed opposite the 70,367GT, 855ft** ***Carnival Sensation*****)**

As of 2010, there were 21,589 registered fishing vessels plying their trade across the world; even though this class of vessel is typically small they still amounted to over 9,400,000 GRT. A fleet of such size creates a huge element of the global food delivery chain and their need to deliver their perishable 'crop' to market in a rapid and efficient way is as - or more - crucial than that for their much larger counterparts in the containerized or bulk goods industries.

These figures are hard to comprehend but each and every way the above statistics are expressed highlights the sheer volume of only the bulk shipping and fishing trade elements of the Blue Economy. If one then starts to consider the value of the offshore petrochemical industry, the telecommunications network industries, long-distance power distribution, the rapidly-expanding renewable energy industry, and the recreational and private boating industries which themselves generate billions of dollars in trade and revenue, then one can see why something as fundamental as knowing you are safe and won't collide with anything is such a crucial element in the safe operation and delivery of a Blue Economy.

The Land-Sea Interface

Critical to the efficiency and safety with which the bulk of the Blue economy actually arrives at the global marketplace; which of course is overwhelmingly terrestrial, is the creation and maintenance of a reliable set of data which supports this sea-to-land transition; in other words the coastal environment. As surveyors and cartographers are all too well aware of however, this interface happens to be the most navigationally hazardous, technically challenging and cost-inefficient realm in which either terrestrial or hydrographic surveyors can acquire their data. It is therefore of paramount importance that a sound understanding of the ways and means to combat these challenges and still acquire data fit-for-purpose and to international standards is attained.

One of the main challenges facing progress towards a more inclusive and holistic approach to geospatial data capture and product design lies in the legacy approach to survey specification itself. The realm of the nautical cartographer and terrestrial mapper have for many generations been dealt with completely separately; encouraging the design of a survey polygon which fulfils the needs of not only these two realms but is inclusive enough to be of interest to other potential stakeholders is something that even the more progressive agencies still have to work hard to envisage. Traditional hydrographic survey polygons have always their inshore limits set where the cartographer perceives that the hydrographic surveyor can neither meet safe nor efficient operational progress; often a charted contour suffices as a guide to the survey limit. This is not necessarily what the cartographer wants; the challenge is to encourage the design of a survey polygon that is based on need, not assumed technological capability. The rapid advances in a variety of technologies renders this old approach obsolete and offers the cartographer an opportunity to fully capture all necessary data for update or renewal purposes of the final product or data layers. In such a way the land-sea interface is no longer the obstruction it once was to seamless data and this critical boundary is much better charted for all users.

Stakeholders

A recent and very effective IHO presentation, on a single slide of waterspace managers and interested parties, demonstrated how the management of a typical nearshore environment could very quickly become an extremely complicated matrix of overlapping areas of interest, prioritization and management considerations.

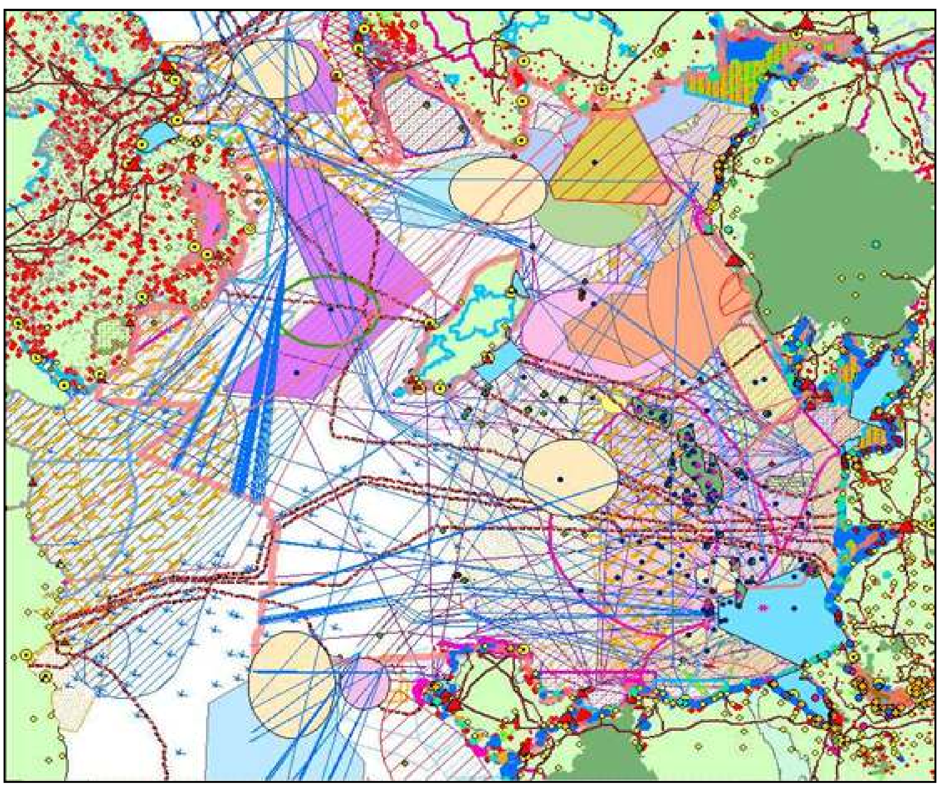

Figure 3: Irish Sea waterspace management issues with only 15 stakeholders represented (Source: DEFRA)

Conversely, it also highlights the typical grouping of potential stakeholders interested in the collection of nearshore data over and above the traditional main recipients (the national charting and mapping agencies). Inclusion of one or more of these parties in the deliberation stages of a nearshore/coastal hydrographic surveys can induce additional funding resource for a project, making the feasibility more affordable for the national government as a whole and amortising costs between the stakeholders. Such stakeholders might include but are not exclusive to the following:

- Cadastral (land usage and ownership) surveyors
- Nearshore oil and gas industry
- Tourism
- Aquaculture
- Cultural agencies
- Conservation and natural resource groups
- Renewable energy industry
- National security and defence agencies
- Cable route surveys for O&G, telecommunications and power
- Fishing agencies
- Recreation industry
- Nearshore mineral extraction activities (e.g. beach renourishment; sediment mining)
- Coastal engineering (construction etc.)

Integrated Geospatial Data Acquisition

Modern survey companies have excellent tools at their disposal to ensure that various types of geospatial data can be collected by different technologies and to varying degrees of accuracy and data density on a single common spatial reference frame. Providing the translation parameters are known to refer the common dataset to a different datum or reference frame preferred by each stakeholder, a single product can satisfy the needs of all recipients. This has been delivered on more than one occasion to a growing number of hydrographic agencies whose requirement to fulfil the needs to the nautical chart and terrestrial map products can be met with the one survey dataset.

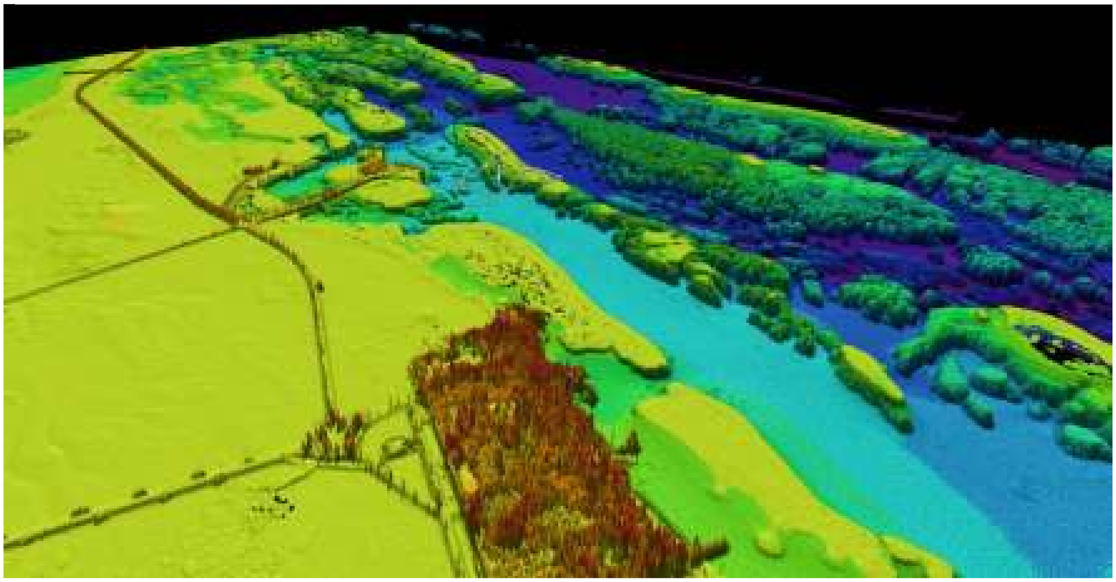

Figure 4: Charting agencies are increasingly looking for datasets which seamlessly integrate the land-sea interface; this image includes coastal topography, complex nearshore reef structures and deeper navigable channels fused into one deliverable

Data collected from non-surveying third parties (so-called 'crowd sourcing'), although usually collected using active sensors, needs to be very carefully assessed against other more rigorously appraised data. The veracity of data therefore depends not just on the mode of collection but very much who has collected it.

Tools Of The Trade

Current technology allows the hydrographic survey industry to meet the demands of efficient data capture on the land-sea interface with a combination of technologies and techniques; these include sensors fitted to both airborne and waterborne platforms that cover a much broader band of the energy spectrum than previously employed. Data can be acquired from a number of sources; these can be broadly grouped into active and passive sensors. Active sensors provide a degree of control input and accuracy verification which is not available to passive sensor data acquisition, but are generally more expensive to run, process and deliver information from. Active sensors might include but are not limited to the following:

- Multi-beam and single-beam echosounders
- Sidescan (interferometric) sonars
- Bathymetric and topographic LiDAR systems
- Horizontal laser linescanning systems (deployed from both boats and terrestrial vehicles)
- Magnetometers
- Gravity meters
- Shore-based Doppler radar
- Airborne Synthetic Aperture Radar

Passive sensors tend to be cheaper to operate and obtain data from, but the lack of additional sensory input (including a human element of assimilation, particularly in assessing the environmental conditions present when the data was acquired), means that a heightened risk of use is involved without alternative means of data validation. For this reason it is always preferable to augment any passive data with overlapping 'active' data for which accuracy and resolution have been very carefully monitored and deliberated. Passive sensors might include but are not limited to the following:

- Aerial cameras (visible spectrum)
- Hyperspectral imagers
- Multispectral imagers
- Satellite imagery

These are just some of the main active and passive sensors available with which to determine the nearshore and onshore environment.

Data Layers - Present And Near-Future

Current data layers which typically need to be populated are based on the structure of paper, raster and electronic nautical charts (ENCs); most of these seek to comply with IHO standards for nautical charting and suggested structures as laid down in IHO Publications S-4, S-52, S-57 and the new S-100 standards. These layers of information follow historic protocols for the prioritization and hierarchy of data essential to the mariner to assist in the safe conduct of navigation within the charted area. A similar methodology has always been employed to provide structure to the hydrographic tasking for surveyors to follow when collecting hydrographic data. Whilst this is not necessarily deficient in fulfilling the needs of the nautical cartographer in the design and build of the databases necessary to create a modern chart folio, it does not address the needs of a number of interested secondary stakeholders for whom data collection could be vital and, in increasingly tight fiscal circumstances, necessary for more holistic governmental budgetary propriety. Inclusion of a number of additional stakeholders during the planning and consulting phase of a coastal hydrographic survey will not only assist in the overall budgeting equation, it will most likely adjust the initial survey area and data collection parameters so that a more inclusive data collection mission is fulfilled for the benefit of all stakeholders.

Some examples of additional or heightened priority on a typical hydrographic survey can be simply illustrated by exploring the needs of a few topical stakeholders. These are not listed below in any particular order or level of importance and are not exclusive but serve to demonstrate how the typical outlines of a hydrographic survey can become more inclusive.

Stakeholder	Interests	Prime Deliverables
Charting Agency	Nautical Charting	Bathymetry; Navigational Aids; Tidal Information; Seabed Composition
Aquaculture	Marine Habitat; Biomass	Seabed Composition; vegetative growth; water column information; water quality; tides, human impact in vicinity; bathymetry

Coastal Engineering	Ports and Coastal Infrastructure	High-resolution geospatial structural surveys; land-sea interface; tidal datums and levels; change detection modelling; bathymetry; immediate nearshore topography
Habitat Mapping	Coastal environmental protection	Land-sea interface; backscatter, hyperspectral and/or reflectance imagery above and below water; ground truth sampling for definitive soil/seabed classification
Cadastral/Land Utilization	Land usage; boundary information	Tidal datum and associated levels; legal boundary definition and baseline establishment; hyperspectral imagery defining land/seabed type and current usage/vegetative layers present; bare earth deliverables; land usage maps
Ports and Coastal Cities	Port and terrestrial Transport infrastructure	Bathymetry; coastal topography; cadastral and bare earth deliverables; high-resolution geospatial structural surveys

It is the evolution of this conceptual approach to coastal survey planning which this paper seeks to foster and to make the reader take heed of the necessity of incorporating the requirements of the greater Blue Economy stakeholder community into the vital hydrographic survey planning necessary to support the 'to market' land-sea interface.

Conclusion

Within the last three decades there has been a huge increase in our collective reliance on the sea as a means of transportation; as a source of energy of various types; as a source of food and nutrients; and as the carrier medium for the globally vital Blue Economy input to the world's overall trade volume. As seaborne trade, goods and services has increased, so has the importance of overcoming the historic shortfalls in effective geospatial data collection across the land-sea interface. Growth both in trade and the size of vessels now carrying this trade has been alarming, particularly in the last 10-15 years, which has placed increasing pressure on the existing infrastructure and logistic operations of even the largest port complexes. Hydrographic surveys need to be planned therefore to support this level of business, to overcome the traditional land-sea boundary issues and to meet the needs of a greater number of stakeholders. This can be achieved with appropriate use of today's technology and utilized more effectively by the cartographer with a greater awareness of potential stakeholder investment and adoption of a more holistic survey planning paradigm.

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Biography

Don Ventura is a Charge IHO Category A Surveyor with Fugro and has been engaged in hydrography for almost 30 years. His experience includes 22 years service as a hydrographic survey officer in the British Royal Navy and US Navy, 3 years employed with SAIC and 7 years with Fugro Pelagos Incorporated.