

THE NIPPON FOUNDATION-GEBCO

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NLA INTERNATIONAL

NLA International–Seabed 2030

Phase 2b: Benefits Analysis Workstream

Seabed 2030 Value Proposition Document

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SECTION ONE: VALUE PROPOSITION INTRODUCTION

Wind in the Sails (WITS) Project Background

The Nippon Foundation-GEBCO Seabed 2030 Project's vision to map the world's oceans by 2030 is insightful and ambitious setting a challenging timeline to address the 75% the oceans that have yet to be charted to the required gridded resolution. The "Wind in the Sails" (WITS) project supports the Seabed 2030 Project by providing empirical evidence to enable the development of a prioritised, targeted survey strategy. The aim of this three-phase project is to unite the global hydrographic community and operators within the marine and maritime domains around an agreed global seabed mapping priority list, underpinned by a robust evidence base that articulates the true need and value of mapping the seabed in its entirety to a defined gridded depth variable resolution.

WITS phases are: (Bold text current phase highlights the current phase of activity, Phase 3)

- Phase 1: Rapid evidence review and fast action priority list.
- Phase 2: Detailed modeling, benefit extrapolation and prioritisation of need.
- **Phase 2b: Benefits analysis and targeted community engagement to determine Prioritisation.**

This document is the Seabed 2030 Value Proposition Document, and a WITS Phase 2b benefits analysis workstream output.

Introduction to the Seabed 2030 Value Proposition Document

The Seabed 2030 Value Proposition document seeks to **convey a value proposition for Seabed 2030 mission**. The document starts by providing a high-level view on the Seabed 2030 mission and a key programme overview, including information on Seabed 2030's operating model and governance that demonstrates for readership that the programme is established, operational, and can expand to ensure global delivery. The document presents global ocean coverage to date and then provide some background on Seabed Mapping, what it is, how it generates value, and the range of entities involved in delivery. The Value Proposition then presents **the need for global ocean coverage seabed mapping and articulates the benefits of the Seabed 2030 mapping programme**. To achieve this, the benefits analysis workstream activity has followed the key stages of the benefits model developed in WITS Phase 2, notably, the work on a **Value Chain for Seabed 2030** (covered in Section 3), **Seabed 2030 Economic Impact Sectors** (Section 4), and the build of the **set of use case / case studies** (Section 5). **Together these elements clearly demonstrate and evidence the criticality and value of seabed mapping for key uses**. Seabed mapping uses referenced span global, regional, and local importance and for a range of key sector applications and / or purposes. Importantly, and in the last section, Section 6, **the Value proposition provides an executive overview on key Seabed Mapping and Seabed 2030 Mission benefits**.

As a document artefact, the Value proposition document is aligned with the **Seabed 2030 Executive Fact Sheet [Which is presented in Annex 2]** and is available for future business planning evidencing 'value' and 'benefit'.

All value commentary is evidence-based, with the value proposition developed **drawing on a set of key informing and evidential sources**, including:

- (i) **WITS Project Phase 2 and 3 benefits analysis workstream informing research and developed underpinning documentation** [as discussed above, and including, Document 2: Seabed 2030 Value Chain, Document 3: Seabed 2030 Economic Impact Sectors Document, Document 4: Seabed 2030 Executive Fact Sheet, and Document 5: Compendium of Seabed Mapping Use Cases].

- (ii) WITS Project Phases 2 and 3 **seabed mapping community workshops** [on benefits analysis, prioritisation, seabed mapping value chain, economic impact sectors and use cases assessment], **use case informing interviews with industry experts** bringing sector, and application use case knowledge, expertise, and experience, and the global - regional – national dimension through their guidance and advice.
- (iii) WITS project **Seabed 2030 community engagement survey questionnaires results and findings from across Phase 1, 2 and 3**, especially Community Engagement Survey 1 and 2 [Community: Bathymetric Data User and Practitioners Community, including Public, Private, and Science/Research, which received a total of 796 individual survey responses, drawn from 90 countries, providing a unique, comprehensive and timely global perspective on stakeholder requirements for mapping the world’s oceans], and Community Engagement Survey 3 [Community: International Hydrographic Organisation (IHO) Member States, IOC representatives, and National Bodies / Agencies with responsibilities for discharging hydrographic survey activities: which received a total of 198 returns drawn from 41 countries].
- (iv) **Seabed 2030 strategy, governance, and operations documentation**, ensuring alignment with programme delivery and operations, and
- (v) **Global reference base review spanning the Hydrographic / Oceanographic Industry Public, Private Sectors and Science and Research Published work on seabed mapping and its applications**. Including to **capture insights from key International Agencies and Bodies** such as those agencies with responsibility towards addressing three key marine challenges of our time: **climate change, marine pollution, and marine biodiversity**; the **Development Community / Government / Private Sector entities** that are enabling and delivering key programmes such as **coastal and economic development of nation states**, and leading the **regional and local response to disaster and crises events**, such as tsunami and storm surge, as well as **stimulating and enabling key areas of the blue / ocean economy management**.

The target readership for the value proposition includes Seabed 2030 management, decision makers, and practitioners. Additionally, this document is produced to inform the developing seabed mapping business case and with future donors / funding bodies in mind.

Finally, in the WITS project delivery context, the Value Proposition Document is being used going forward to directly inform the project Phase 3 prioritisation model development activities and is available to inform a full economic value assessment study in support of the Seabed 2030 global survey business case, should Seabed 2030 wish to commission such a study at any point going forward.

SECTION TWO: SEABED 2030 VALUE PROPOSITION – THE SEABED 2030 PROGRAMME

Seabed 2030 Programme and Background

Nippon Foundation-GEBCO jointly launched the Seabed 2030 project in June 2017, with the aim to facilitate the complete mapping of the global ocean floor by the year 2030.

This global project leverages the IHO-IOC GEBCO framework with the focused goal of producing the definitive, high-resolution bathymetric map of the entire World Ocean.

Seabed 2030 operates globally through a Global / Regional Center network and is supported in its mission through the global networks of GEBCO, and Hydrographic / Oceanographic Government Entities.

Seabed 2030 mission resonates with and actively supports UN Sustainable Development Goal 14 (SDG14) – a commitment to conserve and sustainably use the ocean, seas, and marine resources for sustainable development.

Seabed 2030 is endorsed by UNESCO IOC and recognised as a flagship program of the UN Decade of Ocean Science for Sustainable Development.

Seabed 2030 Mission

Seabed 2030 Mission is to inspire ocean mapping and deliver a complete seabed map for the benefit of people and the planet.

Formed by The Nippon Foundation and GEBCO, Seabed 2030 is a global initiative where industry, governments, researchers, and everyday explorers come together to help achieve the mission of mapping the entire ocean floor by 2030.

Seabed 2030 supporting UN Sustainable Development Goal 14 (SDG14), and a UN IOC Ocean Decade Project

The Seabed 2030 mission supports UN Sustainable Development Goal 14 (SDG14) – a commitment to conserve and sustainably use the ocean, seas, and marine resources for sustainable development.

In June 2021, Seabed 2030 was officially recognised and endorsed as a flagship programme of the **UN Decade of Ocean Science for Sustainable Development**.



As part of the global efforts to create a sustainable future, the United Nations declared 2021 to 2030 a Decade of Ocean Science for Sustainable Development, the overarching aim being to unify stakeholders around the world under a shared vision to improve conditions for the sustainable development of our oceans.

Seven pivotal outcomes serve as the compass points for the Ocean Decade: a clean, healthy, and resilient, productive, predictable, safe, accessible, and inspiring and engaging ocean. Bathymetric data is foundational as the topography of the ocean floor, and a cornerstone of our understanding that enables us to make progress toward these outcomes, recognition as such led to Seabed 2030 endorsement as a flagship programme of the UN Decade of Ocean Science for Sustainable Development.

Seabed 2030 Launch

In 2017, The Nippon Foundation and General Bathymetry Chart of the Ocean (GEBCO) came together to look at how ocean mapping might support the UN’s Sustainable Development Goal 14: ‘to conserve and sustainably use the ocean, seas and marine resources for sustainable development.’ This was at a time when the need to map the 70% of Earth’s blue surface was growing increasingly more urgent – and at the time, only 6% had been mapped to an adequate resolution.



Figure 1: Yohei Sasakawa, Chair of The Nippon Foundation, speaking at the Forum for Future Ocean Floor Mapping, Oceanographic Museum, Monaco, 15 June 2016. Taken by Rebecca Marshall.

The absence of detailed underwater topography, or bathymetric data, was hindering the capacity to manage marine resources sustainably and safeguard coastal communities worldwide. Recognising this, Yohei Sasakawa, Chairman of The Nippon Foundation, launched the ambitious Seabed 2030 Project in partnership with GEBCO at the inaugural UN Ocean Conference in New York.

Through Seabed 2030, the two organisations have committed to building the necessary technical, scientific, and management framework to compile all available seabed mapping information into a seamless digital map of the world’s ocean floor by 2030. In establishing Seabed 2030, The Nippon Foundation committed to provide 10 years funding of the Seabed 2030 program operational management and community outreach and engagement.



The Nippon Foundation mission is social innovation. By forging networks among citizens, corporations, nonprofit organisations, governments, and international bodies, The Nippon Foundation serves as a hub for the world’s wisdom, experience, and human resources, giving individuals the capacity to change society. For The Nippon Foundation, the Seabed 2030 initiative is driven by a strong motivation to empower the world to make policy decisions, use the ocean sustainably and undertake scientific research based on detailed bathymetric information of the Earth’s seabed.



Formed in 1903, General Bathymetric Chart of the Oceans (GEBCO) operates under the joint auspices of the International Hydrographic Organization (IHO) and the Intergovernmental Oceanographic Commission (IOC) (of UNESCO). GEBCO's aim is to provide the most authoritative publicly available bathymetry of the world's oceans.

Global Operating Model and Governance Delivering Seabed 2030 Mission

Seabed 2030 is recognised as **the authoritative initiative for synthesis of a World Ocean portrayal of the seabed from the coast to the deepest trenches**. The programme supports GEBCO in its aim **to provide the most authoritative publicly-available bathymetry of the world's oceans – the global ocean seabed map**. Four data products comprise the global ocean seabed map, including (i) The global bathymetric grid ('the data'); (ii) Web Map Services to access the grid, (iii) The GEBCO Gazetteer of Undersea Feature Names; the GEBCO world map, and (iv) The IHO-IOC GEBCO Cook Book, which is a reference manual on how to build bathymetric grids. For the purpose of value generation, we focus on the first product 'the seabed mapping grid.' Further details on the seabed mapping features and the grid specification are provided in Section 3 below.

The **operating model behind the Seabed 2030 global community engagement and outreach, bathymetry data collation, management, storage, and dissemination are established, implemented, and operational**. This operating model is expandable and can be scaled up to ensure global ocean coverage delivery, pending adequate investment being made available.

Seabed 2030 Programme is managed and coordinated through dedicated roles, providing programme direction, programme administration, partnership, engagement and development management and communications.

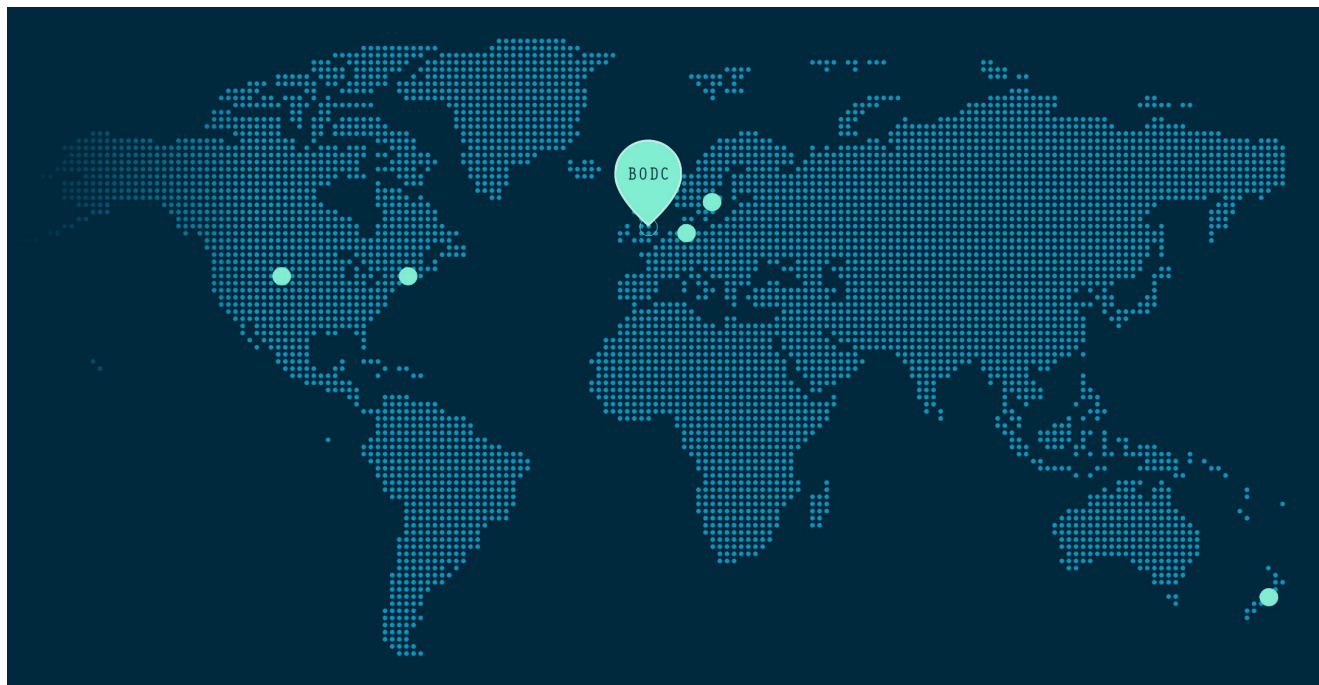


Figure 2: Seabed 2030 Global and Regional Centers.

Six global / regional centers are pivotal to Seabed 2030 mission operational delivery success, including:

1. **A Global Center based in the British Oceanographic Data Centre (BODC), UK**, is responsible for collating gridded bathymetric data sets from the Regional Centers to feed into the GEBCO ocean map.

2. The **IHO Data Center for Digital Bathymetry (DCDB)**, hosted by the US National Oceanic and Atmospheric Administration (NOAA) in Boulder, Colorado, is a central repository for raw bathymetric data and all data compiled by Seabed 2030. The DCDB archives and freely shares depth data acquired by vessels during surveys or while on passage.
3. The **Southern Regional Center** is based at the Alfred Wegener Institute (AWI) in Bremerhaven, Germany. The Southern Ocean Regional Center acts as the regional focus for data compilation and coordination activities in the Southern Ocean region and the South Atlantic, South Pacific, and South Indian Ocean south of 50°S.
4. The **Atlantic and Indian Oceans Regional Center** is based at the Lamont-Doherty Earth Observatory (LDEO) of Columbia University, Palisades, USA. This Center acts as the regional focus for data compilation and coordination activities for Seabed 2030 in the Atlantic and Indian Oceans.
5. The **Arctic and North Pacific Ocean Regional Center** is jointly hosted by the Center for Coastal and Ocean Mapping/Joint Hydrographic Center (CCOM/JHC) at the University of New Hampshire and the Department of Geological Sciences at Stockholm University, **Sweden**. This Center acts as the regional focus for data compilation and coordination activities for Seabed 2030 in the Arctic and Northern Pacific Ocean region.
6. The **South and West Pacific Ocean Regional Center** is based at the New Zealand National Institute of Water and Atmospheric Research (NIWA). This Center acts as the regional focus for data compilation and coordination activities in the South and West Pacific region.

The Regional Centers lead on and interact with **Regional Mapping Projects** to optimise the integration of regional available data / new data collection in the global ocean bathymetry model.

Advisory support to the Seabed 2030 programme is provided by the **GEBCO Guiding Committee**, the **Seabed 2030 Strategy Advisory Group**, and two GEBCO sub-committees provide thematic advice to the Seabed 2030, bringing knowledge and practice on (i) regional mapping efforts and (ii) underpinning technologies and innovation; **Sub-Committee on Regional Undersea Mapping (SCRUM)**: SCRUM's aims are to facilitate a closer collaboration with regional mapping efforts and coordinate, as well as encourage, the incorporation of their compilations into GEBCO, and **Technical Sub-Committee on Ocean Mapping (TSCOM)**: TSCOM serves the greater bathymetric, hydrographic, and maritime communities as authoritative source for technical expertise in seafloor mapping and forum for discussion on emerging technologies and applications of bathymetric and hydrographic data.

Seabed 2030 Partners - Cooperation in Mission Delivery

GLOBAL SUPPORT TO SEABED 2030 MISSION

Everyone with a link to the ocean can play a powerful role in helping to map the entire seafloor by the end of the decade:

Governments: Help to unleash the power of the Blue Economy by contributing hidden data and raising awareness of the mission.

Research: Support a key UN Ocean Decade action by contributing your data and sharing your insights on the intrinsic value of seabed mapping.

NGOS: Advocate for ocean floor mapping to promote conservation and safeguard the future of the planet.

Industry: Supercharge your ESG commitments and support healthy marine ecosystems by contributing essential data.

Individuals: Become an ocean champion by collecting data for the global map and helping to recruit more people to the mission.

Philanthropists: Support ocean mapping efforts by funding expeditions and technological innovation.

As of January 2024, the Seabed 2030 initiative has in excess of 200 partners, data contributors, and supporters drawn from across 50 countries and increasing. Partners, contributors, and supporters include Governments, Industry, NGOs, Research, Philanthropists, and Individuals, demonstrating the community breadth involved in mission success. Seabed 2030 partners are critical to mission delivery, providing their own data contributions, knowledge and support, and also through access to their own networks / wider ocean community, enabling access to other libraries of existing bathymetric data and also leverage new survey acquisitions to support and contribute data to the build up of Sebed 2030 global coverage.

The programme has had tremendous success in accessing both back catalogues of and new grid data through partners. One partner Fugro, provides a good example of how partners are supporting Seabed 2030 in this area. In Fugro's instance, they are supporting in three areas of data access support (1) provision of their own data [in-transit bathymetry], (2) working with their clients to investigate data sharing from client data back catalogue, and (3) a member of the Ocean Decade Corporate Data Group, seeking to further develop private sector data provision opportunities, arrangements, and efforts. Seabed 2030 is grateful for partner

In the last 12 months, Seabed 2030 established new partner arrangements with the following entities: planblue, SEABER, Memorial University of Newfoundland's Fisheries and Marine Institute, Marine Biodiversity Observation Network (MBON) and Marine Life 2030, Ocean Census, Society of Maritime Industries (SMI), NORBIT Oceans, Nigerian Navy, SEA-KIT International, ACUA Ocean, Saildrone, Orange Force Marine Ltd, ecoSUB Robotics – a subdivision of Planet Ocean, and Ministry of Information, Communications and Transport (MICT) for the Republic of Kiribati. The Seabed 2030 partner community is continually growing, with updates published on the Seabed 2030 website [Our Partner Section].

commitments and support, and look forward to onboarding new partners going forward. The Seabed 2030 partner community is continually expanding, with regular updates published on the Seabed 2030 website. [See here, 'Our Partner Section': <https://seabed2030.org/our-partners/>]

Seabed 2030 Seabed Mapping Programme Existing Coverage

The global oceans cover 70% of the earth. This is about 362 million square kilometres of the total surface area (Eakins and Sharman, 2010). In the last production year [ending May 2023], **~24.9% of the global ocean surface area** seabed mapping data has been acquired, processed, and made available for use. This equates to an ocean surface area of **~ 106 million Km²**, with a **further ~256 million Km² remaining to be acquired, processed, and made available for use**. This represents both a huge opportunity and challenge, with significant effort required to meet the target of 100% global ocean seabed mapping coverage by 2030.

Seabed 2030 ocean coverage has increased from 15% in 2019 to 24.9% in 2023, as announced in May 2023. In the year between 2022 and 2023 an additional 5.4 million square kilometres of new data – equating to an area twice the size of Argentina – was added to the definitive map of the world’s ocean floor.

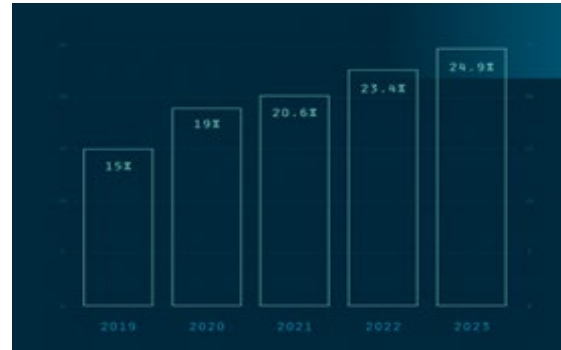


Figure 3: Ocean Coverage Year on Year Expansion, Source Seabed 2030

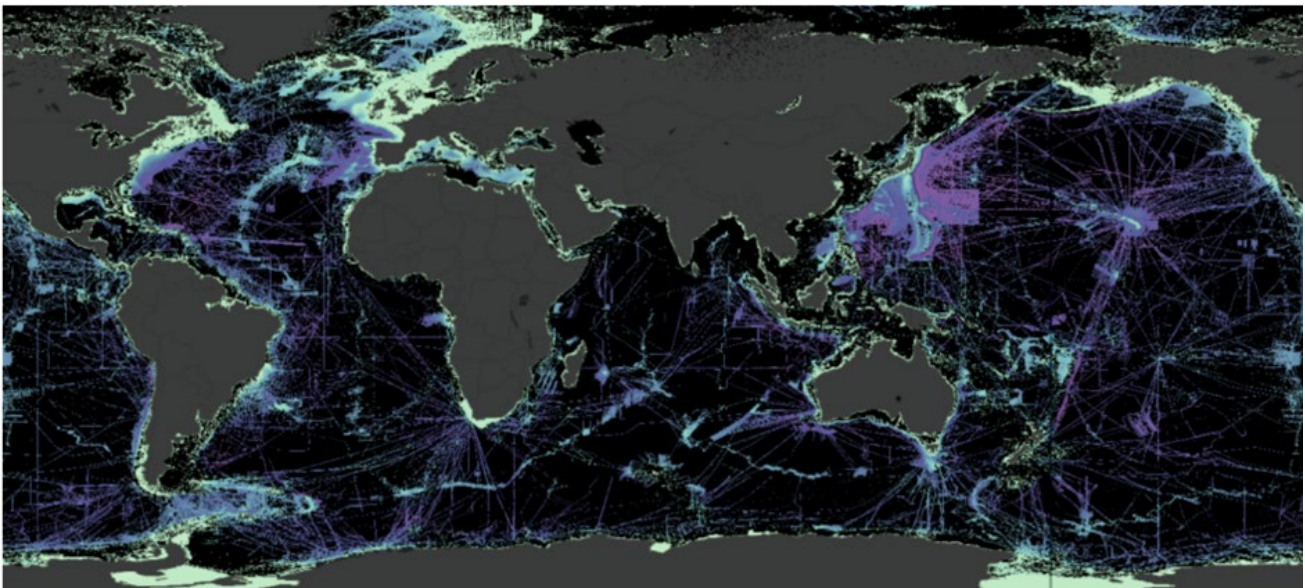


Figure 4: Seabed 2030 Ocean coverage map, showing 29.4% ocean coverage (Black /dark are areas with no depth data), May 2023, see here: <https://seabed2030.org/2023/05/02/hsh-prince-albert-ii-of-monaco-announces-a-quarter-of-the-ocean-now-mapped/>

Whilst Seabed 2030 is making good progress, it does remain the case that today [January 2024], it remains that there is no mapping or topographic understanding of 75% of the world’s oceans. This represents a huge gap in our global knowledge and understanding. Seabed 2030 mission will close this global knowledge and understanding gap.

SECTION THREE: SEABED 2030 VALUE PROPOSITION – WHAT IS SEABED MAPPING AND HOW DOES IT GENERATE VALUE

What is Seabed Mapping?

Seabed mapping is the study and visual representation of the ocean floor's shape, features, and habitats.

Bathymetry is the foundation of seabed mapping, and uses a range of technologies, including, sonar, multibeam echosounders, underwater vehicles, and more recently LIDAR and satellites (Satellite Derived Bathymetry (or SDB), and Synthetic Aperture Radar (SAR)), among others, to measure depth, identify objects, and investigate underwater terrain. Backscatter data compliments bathymetry data and provides further useful insight on the seafloor and water column, for instance providing information on seafloor surface texture (hardness / roughness), and the presence of hard rock or sediments. Other specialist data sampling may also be collected and used with bathymetry data to increase seafloor understanding. For instance, sub-bottom profiles can provide information on seafloor sediment thickness, and biological sampling can help us to further understand sea floor habitats and biodiversity.

Seabed 2030 is primarily concerned in the production and dissemination of global ocean coverage bathymetry data. Bathymetry data is foundational and provides the 2d and 3d geometry against which all other seabed sampling, survey, mapping, and monitoring may be planned, referenced, and visualised. Fundamentally, it provides a 3-dimensional map and an understanding of the seafloor depth and shape.

NOAA guided us that “bathymetry” originally referred to the ocean's depth relative to sea level, although it has now come to mean “submarine topography,” or the depths and shapes of underwater terrain. In the same way that topographic maps represent the 3-dimensional features (or relief) of overland terrain, bathymetric maps illustrate the land that lies underwater. Variations in seafloor relief may be depicted by colour and contour lines called depth contours or isobaths.

Figure 5 overleaf, presents an example bathymetry data (LHS image) in this instance for the East Flower Garden Bank [Source: NOAA]. The false colour represents different seabed heights providing a visual understanding of the seafloor topography. For context, the East Flower Garden Bank is a pear-shaped bank located 119 miles (192 km) south of the Texas / Louisiana border and approximately 13 miles east of West Flower Garden Bank. It has an area of 28 square miles (73 sq km), and a depth range of 62-446 feet (19-136 meters). Both East and West Flower Garden Banks are best known for the beautiful coral reefs located on the shallowest areas of each bank. These are the northernmost coral reefs in the Gulf of Mexico, thriving at the northern limits of coral survival. These are also the healthiest coral reefs in the greater Caribbean / Gulf region with over 52% coral cover, which is as much as 5 times the amount of hard coral as other reefs in the region. The corals have piled up on one another over thousands of years, creating high profile reefs that rise 15-20 feet (4.6-6.1 meters) above the nearest sand patches in some areas.

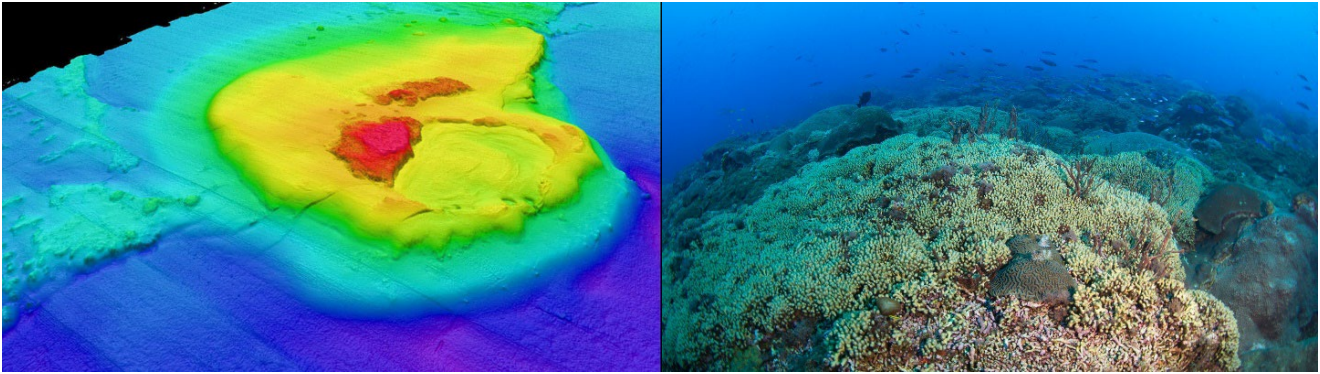


Figure 5: LHS Image - Bathymetry map of East Flower Garden Bank, Source; NOAA

<https://oceanservice.noaa.gov/facts/bathymetry.html>

RHS Image - Large patches of small branching corals (*Madracis auretenra*) are found in some parts of the reef at East Flower Garden Bank. Photo: G.P. Schmahl/FGBNMS, Source: NOAA Flower Garden Banks National Marine Sanctuary

<https://flowergarden.noaa.gov/about/eastflowergardenbank.html>

As referenced, **GEBCO, has a mandate to publish global ocean coverage bathymetry, producing and making available a range of bathymetric products**, including:

- **The global bathymetric grid ('the data').**
- Web Map Services to access the grid.
- The GEBCO Gazetteer of Undersea Feature Names; the GEBCO world map, and
- The IHO-IOC GEBCO Cook Book, which is a reference manual on how to build bathymetric grids.

The Seabed 2030 benefit analysis work focusses predominantly on the 'global bathymetric grid' product, understanding how the production and use of the grids provides value and benefit.

Seabed Mapping Grid Data Characteristics Driving Value

Key seabed mapping grid data characteristics enable and support users, including:

The data is spatially referenced and orientated to the latitude / longitude global coordinate reference system, with data grid points (X, Y (location) and Z (height) presented for the entire ocean areas based on the defined resolution (see below). Users can reproject the data to other coordinate reference systems for use in legacy systems and national /local adopted requirements.

The data target resolution is determined by water depth characteristics. GEBCO-Seabed 2030 has adopted the following target resolution by depth for the global ocean coverage products. This is a community agreed best level product specification and quality for the provision of **global** ocean coverage bathymetry:

- 1: Depth range 0-1500 metres, grid cell size 100m x 100m
- 2: Depth range 1500-3000 metres, grid cell size 200m x 200m
- 3: Depth range 3000-5750 metres, grid cell size 400m x 400m
- 4: Depth range 5750-11000 metres, grid cell size 800m x 800m

Data collection and production technology options are driven by both water depth and water physical properties. Different technological approaches are adopted to collect and produce seabed mapping grid data in coastal, shallow, and deep waters. For instance, airborne LiDAR and Satellite Derived Bathymetry are useful

supporting approaches in shallow and clear water settings, while in deep water the multibeam echo-sounder technology is required. *[For further details please see some additional overview details on emerging technologies and innovation further below, and as addressed in detail in Use Case 1, presented in Annex 1].*

Fundamentally, **the Seabed 2030 Digital Bathymetric Model will efficiently provide bathymetric information to end users and leave no features of the World Ocean floor smaller than 100m unmapped by the completion of the program.**

Global ocean areas may present other operational challenges for data acquisition and production, for example, ocean areas permanently under ice (where any new data acquisition requires use of ice breaker research vessel capabilities), difficult to access ocean areas for military / national security reasons, commercial sensitivity ocean areas such as oil and gas fields, among others.

Data Mandates / Responsibilities for the discharging Sovereign hydrographic survey responsibilities inform and drive (i) the first point of contact target in authorities / Agencies or Entities for seabed mapping authoritative existing data sourcing, and (ii) the feasibility and approach to undertaking new data acquisition. For instance, and as of November 2023, the IHO comprised of 99 Member States, National Hydrographic Offices (HOs) existing in many Nations globally, Primary Charting Authority (PCA) arrangements are well established, with for example UKHO providing PCA support to 63 nations, and in other Nations where neither National HO or PCA, a different Sovereign Agency may have the mandate or be executing seabed mapping and may be more difficult to engage. The location of the EEZ and any extension to Continental Shelf recognised boundaries established or in application, also determine data sourcing and acquisition strategies.

Significant coverage seabed mapping and bathymetry data has been acquired for science and research or commercial project purposes. In these instances, **existing data may be of variable specification, held / stored in multiple / disparate and federated archives, and there may be access / use constraints reflecting differing commercial, confidentiality, and / or security requirements.**

Finally, extensive coverage of seabed mapping and bathymetry data is available from other sources. These include **INGOs / NGOs, Philanthropists, among others**, and Seabed 2030 is investigating a **Crowd Sourcing approach** to play its part in the build up of global coverage.

Industry experts estimate as much as 40% of global ocean coverage may have already been acquired to date by a range of entities and for a wide range of different purposes. A significant part of Seabed 2030's current effort and engagement involves reaching out to entities to access and collate any available (suitable) data to build up the global ocean databank.

What is the Headline Purpose of Seabed Mapping?

Strategically, seabed mapping enables the world to make policy decisions, use the ocean sustainably, and undertake scientific research that is informed by a detailed understanding of the global ocean floor.

Tactically, seabed maps support a wide range of applications, ranging from ship navigation, resource management, scientific research, through to environmental conservation. This study has identified through industry expert and seabed mapping community engagement **twenty-four economic impact sectors** [see Section 4] and associated applications that are highly dependent on seabed mapping and have generated from these twelve separate use cases (see Section 5), that together demonstrate and evidence how seabed mapping is fundamental to and supporting global to local needs and requirements.

Technically, Seabed 2030 seabed mapping provides:

The authoritative map of the global oceans' sea floor (2d, 3d mapping and gazetteer).

All seafloor features of the World Ocean floor larger than 100m are being mapped.

All seamounts are being identified and located. NOAA states globally, it is estimated that there may be as many as 100,000 seamounts higher than 1,000m under our Oceans.

A bathymetry foundation in the form of a 2d and 3-dimensional geometry and topographic framework against and from which:

other ocean data and intelligence can be referenced and registered, [e.g., marine biodiversity, among others]

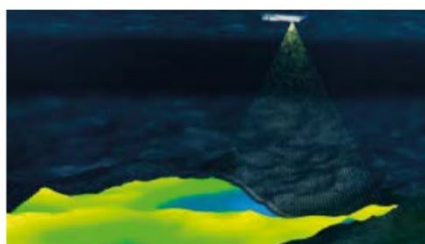
baseline, monitoring, and alerting can be supported, [e.g., tsunami early warning, among others]

specialist thematic modelling and analysis can be undertaken, providing seabed and water depth model components and intelligence where required [e.g., ocean climate models, among others].

a wide range of marine and maritime applications in high seas, EEZ and coastal waters can be supported, providing seabed topography and water depth intelligence where required. [e.g., seabed cables planning (see Figure 6 below), among *many* others]



Source: Fugro



Source: Seabed 2030



Source: OceanIQ

Figure 6: Future Market Insights estimates the Global submarine cable market is expected to grow from US\$ 3Billion to US\$ 4.38Billion by 2030, with a global market growth rate (CAGR) of 4.8%. Seabed mapping is critical for Subsea Cable Planning and Design, please see Use Case 003 – Subsea Cable Planning and Design, presented in Annex 1.

The importance of Emerging Technologies and Innovation to Seabed 2030 Mission Delivery

Emerging technologies and innovation have a significant role to play in Seabed 2030 mission delivery.

“To achieve global coverage seabed mapping requires a level of data acquisition and manufacture effort not seen before in the hydrographic survey community. Technology innovation and the adoption of some key emerging technologies are critical to achieving the Seabed 2030 mission” Jamie McMichael-Phillips, Seabed 2030 Director

The Seabed Mapping community has historically experienced steady rate adoption of sensor technology enhancements, bringing through associated software enhancements through close working with equipment and software manufacturers and suppliers. Further, the community has been able to and leverage wider mainstream ICT enhancements and advances in hardware / compute, and do this rapidly for onshore operation elements, whilst offshore operation elements typically take longer timelines reflecting lag imposed by operating circumstances, e.g., the dependency on performant communication networks, batteries constraints, among others.

More recently however, we are seeing key emerging technologies and innovations that are potential game changers for seabed mappers and anticipate that many of these will be mainstream and available to support Seabed 2030 mission timescales. Most impactful, we are experiencing the mainstreaming of cloud and maritime satellite communications which are fundamentally benefiting data processing, publication and data storage and dissemination. Industry Experts also identify two megatrends namely Autonomy and AI / Machine Learning that are now coming through from successful research and demonstrations into day-to-day operation. An abundance of niche innovations and developments are also significant, in areas such as battery capabilities and sensor miniaturisation. Together these present real opportunities for seabed mappers significantly reducing required effort, cost, and time, whilst optimising safety of operations, and ensuring data quality in line with required standards. Further realising scales of manufacture and efficiencies of operation not seen before.



Source: Saildrone



Source: SEABER



Source: SEA-KIT International and SEABED 2030, Seakit remote control of survey operations.

Figure 7: Seabed Mapping Emerging Technologies, examples from left to right **Saildrone, unmanned / uncrewed surface vessels, SEABER, Micro Autonomous Underwater Vehicle (AUV), and SEA-KIT International, remote control of survey operations.**

Table 1 below highlights example emerging technologies and innovations across different Seabed 2030 operating areas followed by industry expert guidance on mission impact.

Example Emerging Technologies and Innovations in selected Seabed 2030 operating areas providing mission delivery efficiencies	
Platforms	A portfolio of platform options is now at community disposal, including Satellite, Aerial, Surface, Underwater platforms, with key advances in power sources (Battery, Solar PV, and HVO Fuels), Autonomy and Communications.
Sensors	Advances in Satellite Derived Bathymetry (SDB), LiDAR, Synthetic Aperture Sonars, sensor miniaturisation, multibeam echosounders, (e.g., calibrated multibeams (backscatter) and new multibeam geometries, software defined sonars, among others).
Emerging Survey Strategies	Autonomous delivery systems, sparse arrays, and swarm (where a parent vessel coordinates a fleet of smaller vessels), and edge compute.
Data Processing / Data Production	Cloud storage and compute, better integration of Sound Velocity Profile (SVP) data, better estimates of uncertainty and automated processing tools.
Data Collation, Management and Publications	Cloud storage and compute, advances in marine data infrastructures and more infrastructure being implemented / available globally. Increasing standards mainstreaming and data fusion upon request and tailored to user needs. Also advances in satellite communications with enhanced bandwidth and availability, among others.

Table 1: Highlighted Emerging Technologies and Innovation in selected Seabed 2030 operating areas providing mission delivery efficiencies.

Seabed 2030 Industry Experts anticipate resulting operating / production efficiencies through emerging technologies and innovation adoption can provide significant savings / benefits in cost and time. They confirm that the **Seabed 2030 mission (i) is industrially and technically achievable where adequate initiative funding is made available**, and (ii) can induce significant cost and time savings. **By applying a hybrid manned / unmanned acquisition strategy approach, savings in the order of 40% time and cost can be achieved on the global programme, i.e., a Seabed 2030 initiative budget of US\$3 Billion, compared to an entirely manned vessel strategy / approach costing US\$5 Billion. [A resulting net saving of US\$2 Billion through emerging technology adoption for Seabed 2030 mission].**

How does Seabed 2030 Generate Value? The Seabed 2030 Value Chain

Seabed 2030 programme fundamental purpose is to ensure global ocean coverage of seabed mapping is available and accessible by customers / users globally.

A key output of the WITS Phase 2b project was the definition of a value chain for Seabed 2030. Essentially a Value Chain identifies the steps / activities an entity performs through which a valuable product is delivered to an end customer, it is a useful way of identifying where, how and by whom value is generated. The value chain also reflects and puts emphasis on the core purpose of an entity regards their operating model, e.g., to identify that all activities such as marketing, communications, among others, are identified and implemented in the day-to-day operational delivery.

The value chain was developed through a dedicated workshop with representatives drawn from the Seabed 2030 Global Community. The resulting Seabed 2030 Value Chain brings together and presents a value chain that combines seabed mapping data ‘production’ and ‘use’ supplemented with key ‘Ancillary Services’ as provided by the Seabed 2030 entity. This approach merges a ‘data ecosystem’ based value chain with key organisational ‘mandate’ services that are associated with the enabling or generation of value in a single unified Seabed 2030 value chain. The Value Chain also is tailored towards providing a strategic perspective and a strategic level tool, with the potential to inform economic value assessment (optional future study), as opposed to a tactical or technical operating perspective view and tool (*which would require a more detailed segmentation of steps and activities*). The Value Chain is presented in Figure 8 below followed by an overview explanation for reader interest.

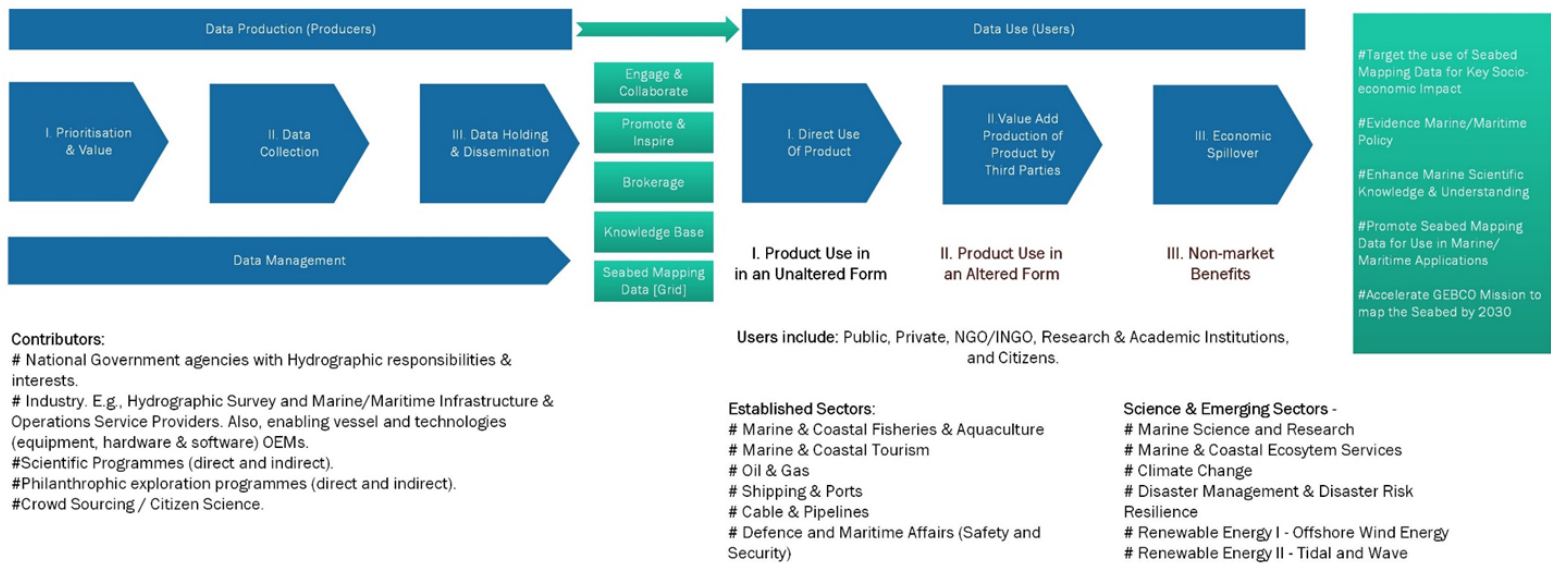


Figure 8: The Seabed 2030 Value Chain

The seabed 2030 value chain comprises value generating activities that build in sequence and are co-dependent, reflecting Seabed 2030 mandate as an organisation. Highlights of the Value Chain include:

Sequential Value Generating Activities:

These include **upstream data production (Producers) activities**, and **downstream Data Use (or Users) activities** that generate value. Data Production (Producers) and Data Use (Users) are described separately in turn below.

Data Production (Producers): include seabed mapping data acquired and produced and to be made available for use as a specified product / service, comprising:

Prioritisation & Value: including Seabed 2030 prioritisation of areas of the seabed to be mapped, and the benefits and economic value assessment activities with regard for attaining global ocean coverage of seabed mapping by 2030.

Data Collection: including the collection / acquisition of seabed mapping input data (both enabled or facilitated by Seabed 2030 entity, and/or delivered through the Seabed 2030 partner community, (e.g., hydrographic survey data acquisition etc.).

Data Holding & Dissemination: including the hosting and distribution of seabed mapping data for use, and in various formats as applicable.

Data Management: including seabed mapping data management crosscutting all areas of data production. This is assumed to include data QC as an inherent function of data management.

Note data processing is not a Seabed 2030 entity mandate activity and typically resides in the Seabed 2030 partner community. Consequently, it is proposed this sits outside of the Seabed 2030 Value Chain and can be considered a delivery function supporting the production of seabed mapping wherever this resides in GEBCO community and / or wider contributor networks.

Contributors to Data Production and the enablement of Value Generated through Data Production activities include:

1. National Government agencies with Hydrographic responsibilities & interests. *These include national or sovereign survey activities and wider Nation support through Primary Charting Authority (PCA) arrangements.*
2. Industry. E.g., Hydrographic Survey and Marine/Maritime Infrastructure & Operations Service Providers. Also, enabling vessel and technologies (equipment, hardware & software) OEMs, and Private Sector commissioning, such as seabed mapping surveys for Subsea Cable or Oil and Gas Companies, among others.
3. Scientific Programmes (direct and indirect).
4. Philanthropic exploration programmes (direct and indirect), such as exploration expeditions, and philanthropic support to NGOs among others.
5. Crowd Sourcing / Citizen Science.

Note, there are instances where contributors cooperate, examples including Regional Mapping Programs such as Atlantic Ocean Research Alliance (AORA), among others, and major marine infrastructure projects such as subsea cable programs, where public and private interests form consortia to commission and deliver \$multi-million subsea cable infrastructure investments.

Development Banks funding may also be drawn down to commission seabed mapping survey to stimulate ocean economy / coastal development (Port infrastructure planning and design, hydrographic survey for safety of navigation, tourism, climate change mitigation, among others).

Data Use (Users*): include any user of seabed mapping grid data (direct use (e.g., of published seabed mapping data in its readily available format) / indirect use (value add data processing) and economic spillover value generation, comprising:

Direct use of product, including use of seabed mapping product in its unaltered form [Published Grid].

Value add production of product by third parties, an indirect use of the seabed mapping data product, centred on the use of seabed mapping product use in an altered form [Published Grid+ processed / modified].

Economic spill over, including non-market benefits, where the use or existence of seabed mapping results in value benefit being generated in other areas of the economy, areas of the economy away from the intended purpose or original use of seabed mapping.

*Users include Public, Private, NGO/INGO, Research & Academic Institutions, and Citizens.

Users can be grouped by sector which for the purposes of Seabed 2030 economic value assessment can be grouped and presented potentially as: [Further details on the identified economic impact sectors are presented in Section 4]

Established Sectors:

- Marine & Coastal Fisheries & Aquaculture
- Marine & Coastal Tourism
- Oil & Gas
- Shipping & Ports
- Cable & Pipelines
- Defence and Maritime Affairs (Safety and Security)

Science & Emerging Sectors:

- Marine Science and Research
- Marine & Coastal Ecosystem Services
- Climate Change
- Disaster Management & Disaster Risk Resilience
- Renewable Energy I - Offshore Wind Energy
- Renewable Energy II - Tidal and Wave

Enabling Value Generation Activities:

Towards the middle of the proposed value chain and at the point of intersection between data production and data use we see a set of key activities undertaken by Seabed 2030 that enable the generation of value. We are terming these Enabling Value Generation Activities.

These activities can be crosscutting the Value Chain but primarily are positioned between data production producers (upstream) or 'supply' and data use 'users' (downstream). These activities reflect Seabed 2030 entity activities to enable and facilitate seabed mapping towards achieving global ocean coverage of seabed mapping by 2030. Enabling Value Generation activities include:

Engage & Collaborate: including Seabed 2030 Engagement and Collaboration with the seabed mapping stakeholder community (including stakeholders involved in seabed mapping data provision and data use, and wider stakeholders such as those involved in seabed mapping investments and funding, and philanthropic organisations, among others).

Promote & Inspire: including Seabed 2030 'promotion' of seabed mapping activities and the promotion of the Seabed 2030 mission, and 'inspiring' new and expanded use of seabed mapping e.g., in emerging sectors, among others, as well as 'inspiring' the finding of solutions to seabed mapping challenges (for instance the challenges associated in achieving global coverage seabed mapping data in time for 2030, and the global scale ramp up challenges this mission presents).

Brokerage: including Seabed 2030 working towards and accommodating the needs of users to access, understand and be able to use seabed mapping data, as well as brokering in a financial sense, for

example investigating, identifying, and pursuing new funding streams towards ensuring Seabed 2030 mission success.

Knowledge Base: including Seabed 2030 provision of informing documentation and to be an industry point of reference as a source of knowledge on seabed mapping. For instance, this may include the provision of seabed mapping reference case study details, grounding evidence and generation of information guidance documentation on the use of seabed mapping and the Seabed 2030 mission.

Seabed Mapping Data [Grid]: This is the supply of or provision of seabed mapping grid data to users and is coordinated through the cooperation of Seabed 2030 Regional and Global Centers, and GEBCO e.g., the “Web Map Services to access the grid”, among others.

Objective-orientated Value Generation Activities.

This area of the Value Chain represents the ‘end result’ or the ‘key target areas for Value Generation’ enabled by or supported by seabed mapping data. For the purposes of the proposed value chain at this time, and the Seabed 2030 WITS economic value assessment work these include:

Target the use of Seabed Mapping Data for Key Socio-economic Impact.

Evidence Marine/Maritime Policy.

Enhance Marine Scientific Knowledge & Understanding.

Promote Seabed Mapping Data for Use in Marine/Maritime Applications.

Accelerate GEBCO Mission to map the Seabed by 2030.

This result / target set is not exhaustive and can be expanded to include strategic review of resulting / target benefits presented in Section 5 of this document.

Why is Global Ocean Coverage Seabed Mapping Needed?

Seabed 2030 founding principle, and the basis for the Seabed 2030 roadmap states: The Nippon Foundation-GEBCO Seabed 2030, global program is focused on the goal of compiling a high-resolution openly available Digital Bathymetric Model (DBM) portraying the World Ocean seabed at the highest resolution possible from the coast to the deepest trenches by the year 2030. This DBM provides bathymetric information to end users and essentially leaves no feature of the World Ocean floor smaller than 100m unmapped by the completion of the programme.

This mission and programme are needed, as of **today, there is no mapping or topographic understanding of 75% of the world’s oceans. This represents a huge gap in our global knowledge and understanding. Seabed 2030 mission will close this global knowledge and understanding gap.**

Seabed 2030-collated seabed mapping data is fundamental to our understanding and sustainable use of our ocean. This data:

- **Enhances our understanding of the World’s Ocean and our subsea world.**
- **Underpins a wide range of Ocean and Marine Scientific Research.**
- **Supports our preparation for and mitigation of global and regional scale crisis, including climate change, sea level rise, and volcano, tsunami, and tide surge flood disaster events; and**

- **Enables socio-economic development and growth of the Blue Economy.**

As one indicator of potential for value generation that Seabed 2030 can support, in 2015, the WWF assessed the value of key Ocean assets at over US\$24 trillion, with two-thirds of that based on assets that require healthy productive oceans. The total global value of the Blue Economy is currently around US\$2.5 Trillion and is predicted to rise to US\$3 Trillion by 2030 and employ 40 million people. [Source OECD, 2016. The Ocean Economy in 2030].

Sections 4, 5 and 6 of this document presents details on actual Seabed 2030 value generation and benefit, through the identification and analysis of twenty-four economic impact sectors (Section 4), the preparation and publication of twelve Industry Expert informed, real world seabed mapping use cases (Section 5) and concluding with an executive summary of Seabed 2030 programme resulting benefits (Section 6). Together demonstrate and evidence the value and benefit case for Seabed 2030 programme.

SECTION FOUR: VALUE PROPOSITION – SEABED MAPPING ECONOMIC IMPACT SECTORS, SECTOR APPLICATIONS, SECTOR DEPENDENCY ON SEABED MAPPING AND COMMUNITY HIGHLIGHTED REGIONAL SECTOR MAPPING PRIORITIES

In line with the benefits analysis model approach, the WITS project team provided a sector review to (i) identify seabed mapping key economic impact sectors to form a view on their level of dependency on seabed mapping, (ii) identify within each sector key applications or uses for seabed mapping (especially uses that generate most value), and (iii) to prepare links and intersection points for any future, more detailed seabed mapping economic value analysis study, should this be required or helpful to inform the Seabed 2030 business case. Further, sector related insights drawn from the WITS Phase 1 community engagement survey are reported.

Sector Logic: Seabed mapping underpins, supports, or enables key areas of global, regional, national, and local economic activity. Whilst the **acquisition, production and dissemination of seabed mapping data** can be considered a **quaternary sector activity**, i.e. an information service activity, **seabed mapping activities are commissioned or executed by a wide range of entities drawn from public / state sector** [national hydrographic offices, among others], **private sector** [oil & gas companies, subsea cable companies, and hydrographic survey companies, among others, **and voluntary or not for profit sector entities** [including International NGO / NGO, and we can also include non-governmental science and research entities here].

The **use of seabed mapping data benefits key economic sector activities associated with marine, maritime and coastal settings**, including '**Primary sector**' [Raw Materials, such as oil and gas, mineral and fishing], some **Secondary Sector** [Manufacturing and Construction, such as Marine / Maritime / Coastal Infrastructure Construction], **Tertiary sectors** [Services, including financial services and IT / communications] and **Quinary sector** [which are essentially Human Services, including tourism].

Further, the **use of seabed mapping data benefits both established and emerging sector economy activities** as well as **key areas of the Blue / Ocean Economy** [the Blue Economy being associated with the sustainable economic use marine resources]. **Twenty-four economic impact sectors** were identified, engaged on, and assessed with Seabed 2030 and GEBCO representatives in a 'sector review' dedicated workshop, followed by validation by **survey questionnaire engagement across global Hydrographic Offices and IOC community** representatives, [which received 199 survey returns drawn from 58 countries].

Table 2 overleaf provides a highlight overview on the identified twenty-four seabed mapping economic impact sectors, including details on:

- Blue / Ocean Economy Sector Name [See Table Column 1]. To provide fuller sectoral coverage, a merge of definitions used by United Nations, World Bank Blue Economy ProBlue Programme, OECD Blue Economy, and EU Marine Sector categorisation was adopted, acknowledging that no single set of definitions covered all the sector areas where seabed mapping is used and generates value.
- Sectors are grouped together as being ‘established sectors,’ ‘science and / or emerging sectors or ‘other’ sector class. This is helpful as an emerging sector may need a different market approach, for instance the provision of support to sector early-stage pilots or demonstrations, among others.
- Sector assessment on the level of dependency the sector has on seabed mapping [See Table Column 2]; applying 3 criteria levels: High dependency [where seabed mapping data is critical to the sector or ‘must-have’], Medium dependency [where seabed mapping provides an enhancing value to the sector or ‘good to have’], or Low dependency [where seabed mapping has ‘limited’ relevance or ‘no’ relevance to the sector].
- Community highlighted sector seabed mapping applications / uses are also presented for each sector [See Table Column 3], these being application or uses where seabed mapping has most impact / value.
- We also identify the application or uses that were identified for use case production [See Table Column 4]. These are covered in more detail in Section 5 and Annex 1.

Economic Impact Sector <i>Twenty-Four Economic Impact Sectors, identified through community engagement</i>	Sector Assessment [Level of Dependency on Seabed Mapping] #High #Medium #Low	Community Highlighted Sector Seabed Mapping Applications / Uses	Seabed Mapping Use Case Produced Reference (see Section 4 and Annex 1)
Established Sectors [7 Sectors and 41 Seabed Mapping Applications]			
Government [Our focus here is towards Policy Development, e.g., MPAs]	High	<ol style="list-style-type: none"> 1. UNCLOS Coastal State Continental Shelf Application & Review. 2. Resources Leasing / Licensing. 3. Evidence to inform marine challenges policy development, e.g., climate change, marine biodiversity, marine pollution, among others. 4. Policy boundary designation/delineation, e.g., MPAs, Fisheries Control Areas, among others. 5. Foundation data for MSP, ICZM, and Seascape Management. 6. Seabed mapping data is presented for user access as a foundation data, (Bathymetry Theme Data) through Data Infrastructure Services, e.g., EMODNet, among others. 	Use Case 010 – Government Policy
Marine and Coastal Fisheries and Aquaculture (Mariculture)	Low in a High Seas setting High in an EEZ setting, (e.g., SIDS)	<ol style="list-style-type: none"> 7. Fisheries Management Policy boundary designation/delineation, e.g., Fisheries Control Areas, among others. 8. Fisheries Management, e.g., for both Marine Fisheries and Marine Aquaculture. Especially important for Small Island Developing States (SIDS). 9. Marine Biodiversity & Fisheries, understanding special habitat sites such as coral (e.g., associated with fish nursery). 10. Grounding evidence informing the decision-case towards the banning of bottom trawling. International Requirements e.g., In the Mediterranean Sea, and since 2005, bottom trawling is banned at depths below 1000m / 3281 feet depths. 11. Sea Mounts distribution in relation to bottom trawling. 12. Drive fisherman behaviours. Seabed mapping allows fishers to be more efficient in finding their fish, leading to 	

		increased Landing Per Unit Effort (LPUE) outcomes, and potential environmental benefit where better targeting of fishing reduces disruption in surrounding environment. 13. Aquaculture / Mariculture site planning and design.	
Marine and Coastal Tourism	Low in a High Seas setting High in an EEZ setting, (e.g., SIDS)	14. Cruise Ships etc., operation via High Seas: Navigation and Safety at Sea. 15. Blue economy marine and coastal tourism enablement through hydrographic survey for SOLAS. Enabling tourism to operate (such as cruise vessel access and use of Port, etc.). The survey may be a key enabler introducing new economic activity for developing coastal nations/SIDS, among others. 16. Underwater interesting marine habitats and marine heritage sites of touristic interest. 17. Sea mounts discovery and consideration of proportion of shallow water in high seas exists.	
Oil and Gas	Medium [And predominantly in EEZ]	18. Oil and gas exploration. 19. Oil and Gas Extraction facilities planning, design, build and operations. 20. Deeper water - leasing in national waters. 21. Subsea Oil and Gas Cables and Pipelines Planning and Design. 22. Shipping safety at sea and navigation for Oil and Gas vessels and operations. 23. Planning for high resolution surveys. Note, Most Oil and Gas companies download EMODNET data for planning purposes.	
Shipping and Ports	Medium High within EEZ	24. Shipping Navigation and Safety at Sea. 25. Shipping Route Planning. 26. Shipping Accident at Sea, including incident investigation and vessel recovery. 27. Shipping Recovery of Cargo at / over Sea. 28. Port Infrastructure Planning and Design. 29. Port Operations – new hydrographic survey commissioning e.g., on 3-to-5-year cycle basis to inform dredging activities, among others.	
Cables and Pipelines	High	30. Subsea Cable Route Planning and Design. 31. Subsea Cable Asset Management, including Condition Monitoring, Inspection and Security. 32. Subsea Pipeline Route Planning and Design.	Use Case 003 – Subsea Cable Planning and Design

		33. Subsea Pipeline Asset Management, including Condition Monitoring, Inspection and Security. <i>E.g., Subsea cable route planning including route optimisation, and the identification of suitable seabed attachment points, cable junctions, spurs, cable cross-over point and landing areas, among others.</i>	
Defence and Maritime Affairs (Safety & Security)	High	34. There is a link to the maturity of National Defence and Security capabilities – notably, some Nations are more advanced in subsea activity c.f. to others. 35. Seabed mapping support to claims for sovereign rights and increase the marine jurisdiction of a nation. 36. Operations in High Seas including operations planning, navigation, and safety at sea, etc. 37. Search & Rescue in High Seas. 38. Accident at/over Sea, including incident investigation and aircraft / vessel recovery. 39. National Security Border Security including EEZ navy monitoring adjacent to EEZ high sea area, coast guard operations to enforce EEZ, etc. 40. Commissioning of Hydrographic Survey for SOLAS. 41. Primary Charting Authority (PCA) Services Provision.	Use Case 002 – EEZ Seabed Mapping in the Absence of a National Hydrographic Office
Science and/or Emerging Sector [7 Sectors and 31 Seabed Mapping Applications]			
Ocean Discovery	High	42. Expedition planning, supporting route planning, informing target mobilisation / demobilisation, and optimising vessel time in exploration areas of interest. 43. Map base upon which discoveries and findings can be spatially referenced and presented in their 2D and 3D context. 44. Future expedition targeting / decision-making. 45. New seabed mapping surveys are generally acquired as part of an ocean exploration expedition.	Use Case 011 – Ocean Discovery & Ocean Exploration
Marine Science and Research	High	46. Foundation data for Marine Science and Research 47. Support to Marine Science and Research to understand and address marine challenges such as Climate Change, Marine Biodiversity, and Marine Pollution. 48. Support to Marine Science and Research in a number of fields of interest: plate tectonics, geological, biological, chemistry, among others.	Use Case 006 – Climate Change Ocean Models

		<p>49. Support to specific models, such as the Improvement of Global Ocean Models, including location and identification of deep-water overflows, pathway and changes, and climate models, among others.</p> <p>50. Underpinning Seabed discovery for science purposes generally.</p>	
<p>Marine and Coastal Ecosystem Services (Including Marine Biodiversity)</p>	<p>Low – High pending application area <i>[Higher for Marine Biodiversity. Tidal modelling is highly dependent. Geology highly dependent]</i></p>	<p>51. Marine Biodiversity Mapping and Monitoring, e.g., mapping of areas around MPA and case study identification of suitable areas for MPAs, Deep Coral Areas, among others.</p> <p>52. Tidal modelling.</p> <p>53. Seabed Geology.</p> <p>54. Foundation data for habitat survey planning, analysis, and visualisation.</p> <p>55. Coastal Protection / Mitigation Natural-Based Solutions Planning.</p>	<p>Use Case 008 – Marine Biodiversity</p>
<p>Climate Change</p>	<p>High</p>	<p>56. Improvement in Global Ocean Model, including location and identification of deep-water overflows. Pathway and changes, and climate models.</p> <p>57. Improved Climate Modelling.</p> <p>58. Polar Region Bathymetry: Critical Knowledge for the Prediction of Global Sea Level Rise.</p> <p>59. Sea Level Rise and Coastal Inundation Modelling, Resilience, and Adaptation.</p> <p>60. Carbon Sequestration, e.g., the baling and sinking of sargassum bales to the ocean floor.</p>	<p>Use Case 006 – Climate Change Ocean Models</p> <p>Use Case 007 – Small Island Developing States (SIDS) Sea Level Rise and Coastal Inundation</p>
<p>Disaster Management and Disaster Risk Resilience</p>	<p>Medium</p> <p>High for Tsunami and Storm surge modeling / coastal inundation</p>	<p>61. Tsunami Propagation Modelling.</p> <p>62. Seabed landform regarding earthquake and underwater volcano activity to inform Disaster Preparedness and planning.</p> <p>63. Storm Surge Modelling [e.g., The Netherlands].</p> <p>64. Coastal Inundation / Flood Modelling.</p> <p>65. Inform development planning and design and build of infrastructure and nature-based adaptation solutions.</p>	<p>Use Case 004 – Tsunami Propagation and Storm Surge Modeling</p>
<p>Renewable Energy I - Offshore Wind Energy</p>	<p>Medium</p> <p><i>High in an EEZ setting.</i></p>	<p>66. Offshore wind energy site suitability strategic assessment <i>[Regional and Nation overview – e.g., see offshore wind geospatial analysis – Figure 9 above]</i>.</p> <p>67. Engineer analysis of seabed environment for location planning, seabed anchor points, site, and export cable routing options review.</p>	<p>Use Case 005 – Renewable Energy Offshore Wind Energy</p>

		68. Wind farm subsea cable route planning including route optimisation, and the identification of suitable seabed attachment points, cable junctions, spurs, cable cross-over point and landing areas, among others. <i>Note: Offshore wind is more mature sector and at scale c.f. tidal / wave renewable energy (see below).</i>	
Renewable Energy II - Tidal and Wave	Medium <i>High in an EEZ setting.</i>	69. Offshore tidal and wave energy site suitability strategic assessment [Regional and Nation overview]. 70. Engineer analysis of seabed environment re location planning, seabed anchor points, site, and export cable routing options review. 71. Subsea cable route planning including route optimisation, and the identification of suitable seabed attachment points, cable junctions, spurs, cable cross-over point and landing areas, among others. 72. Tidal / wave modelling, including water depth and seabed roughness and obstacles, among others. <i>Note: Offshore wind is more mature and at scale c.f. tidal / wave (see above).</i>	
Other Sectors [10 Sectors and 39 Seabed Mapping Applications]			
Hydrographic/Oceanographic Survey <i>Also, a cross-cutting sector</i>	High	73. Hydrographic / Oceanographic Survey, including Primary Charting Authority (PCA) Services Provision, and the informing of new surveys planning. 74. Seabed 2030 driving technology innovation and industrial enhancements, e.g., autonomous vessels, ML, sensor improvements, among others. 75. Seabed 2030 driving industrial expansion and growth: resulting in economic value benefits (esp. direct benefits, e.g., increased employment and new skills in workforce). 76. Seabed 2030 potential to increase the customer base for survey companies with associated economic impact and industrial / community benefits. 77. Ability to fuse Seabed 2030 with other data – concept of Seabed 2030 / GEBCO as more than seabed knowledge, in the context of enabling added value through combining Seabed 2030 data with other ocean data.	Use Case 001 – Seabed Mapping Innovation Use Case 002 – EEZ Seabed Mapping in the Absence of a National Hydrographic Office Use Case 012 – Seabed 2030 Driving Hydrographic Industry Expansion and Human Capital Benefits
Human Capital <i>Also, a cross-cutting sector</i>	Low <i>[Impact is high in a global survey context]</i>	78. Seabed Mapping Industry Employment Opportunities Growth and Capacity Building, resulting from the production of global ocean seabed mapping [Scale up to realise Seabed 2030 mission].	Use Case 012 – Seabed 2030 Driving Hydrographic Industry Expansion and Human Capital Benefits

		<p>79. Seabed 2030 driving workforce development, expansion and growth, e.g., across all steps of the value chain from hydrographic survey technologies manufacture (OEM), through to data users and the end user wider communities. Resulting in economic value benefits such as direct benefits, e.g., increased employment and the introduction of new skills in workforce, among others.</p> <p>80. Seabed 2030 driving inclusion at global community level.</p>	
<p>Marine and Coastal Development</p>	<p>Medium</p> <p><i>High EEZ setting (e.g., SIDS), also development in response to sea level rise has a high level of dependency.</i></p>	<p>81. Foundation data for marine and coastal development strategy and planning. Contributing to the delivery of a Nation's (and SIDS) priorities and interests, and the Nation response to major threats such as climate change and sea level rise.</p> <p>82. Supporting / enabling the development of nation ocean/blue economy, including contributing to Maritime and Coastal Infrastructure development and expansion, and the growth of a variety of sectoral priorities and interests, maritime transportation, capture fisheries, tourism, among others.</p> <p>83. Foundation data for marine and coastal environmental planning and management, including supporting a Nation's response to major challenges such as biodiversity, conservation and informing the set up and management of MPAs and other special sites.</p>	<p>Use Case 009 – Small Island Developing State (SIDS) Marine and Coastal development, and the Use of Seabed Mapping as a Foundation Data for Marine Spatial Planning.</p>
<p>Marine Aggregates and Marine Mining</p> <p>[Especially resource evaluation and preservation]</p>	<p>High</p>	<p>84. Marine Aggregates and Marine Mining (Including for Resource Evaluation and Preservation),</p> <p>85. UNCLOS Coastal State Continental Shelf Application & Review</p> <p>86. Inform the deep-sea mining community with a need to survey to understand seabed status, condition, and what is there, ahead of proceeding with mining activities.</p> <p>87. Resources exploitation Leasing / Licensing.</p> <p>88. Marine Aggregates and Marine Mining exploration.</p> <p>89. Marine Aggregates and Marine Mining Extraction facilities planning, design, build and operations.</p> <p>90. Subsea Marine Aggregates and Marine Mining Cables and Pipelines Planning and Design.</p>	

		<p>91. Shipping safety at sea and navigation for Marine Aggregates and Marine Mining vessels and operations.</p> <p>92. Planning for high resolution surveys for resources management.</p>	
<p>Biotechnology Inc. Pharma Industries</p>	<p>High <i>[Biotechnology / Pharma case by case dependent]</i></p>	<p>93. Support to biological / ecosystem research on seabed locations and features (e.g., Hydrothermal vents), and the linking of marine species, seabed locations and environment elements for biotechnology / pharma uses.</p> <p>94. Future biotechnology / pharma solutions.</p>	
<p>Insurance <i>Also, a cross-cutting sector</i></p>	<p>Medium</p>	<p>95. Support to insurance services in parametric insurance for crisis and disaster, informing decision-making.</p> <p>96. Input to insurance policy and claims review. E.g., new ports, cruise / shipping routes planning, among others, e.g., see https://london-marine.co.uk/</p> <p>97. High Seas cable / pipeline infrastructure insurance.</p> <p>98. Maritime infrastructure decommissioning insurance, e.g., provision of evidence that oil / gas field end of life commitments is delivered on.</p> <p>99. Support to Aircraft / vessel recovery.</p> <p>100. Insurance has growing involvement – in areas such as coastal and shallow water natural capital, etc., and climate change aspect of insurance.</p>	
<p>Investment <i>Also, a cross-cutting sector</i></p>	<p>Medium</p>	<p>101. Support to business cases and informing decision-making associated with:</p> <p>102. Investments supporting ocean discovery.</p> <p>103. Investments in specialist thematic areas, e.g., Monitoring carbon capture (Climate) Investment supporting ocean discovery.</p> <p>104. Investments to enable / expand nation ocean/blue economy activities, e.g., new ports, cruise / shipping routes, coastal infrastructure, among others.</p>	
<p>Ship Building, Ship Breaking, and offshore (structures) decommissioning</p>	<p>Low <i>[Not applicable in high seas setting. Applicable in an EEZ near shore / coastal setting]</i></p>	<p>105. Decommissioning of offshore structures need draft clearance and the identification of any unmapped obstacles etc.</p> <p>106. Marine Pollution Risk Assessment and Marine Pollution Dispersion Analysis, as an input to propagation modelling.</p>	
<p>Desalination</p>	<p>Low <i>[Not applicable in high seas setting.]</i></p>	<p>107. Input to water / tidal models and details on seafloor features to inform desalination location suitability. #Desalination Infrastructure planning and design.</p>	

	<i>Applicable in an EEZ near shore / coastal setting]</i>		
Marine Archaeology / Heritage	Low <i>[Can be high pending site-specific case by cases]</i>	108. World Marine Heritage Site Evidence for Policy, site delineation, inventory, and management. 109. Marine archaeology / heritage discovery expedition planning and use of GEBCO data as an input to new survey commissioning. 110. Marine archaeology / heritage area inventory, and ancillary data referencing. 111. Seafloor context site publication and promotion for media, PR purposes.	

Table 2: Twenty-four seabed mapping economic impact sectors, including circa 111 applications supported / enabled by seabed mapping.

Twenty-four economic impact sectors are identified and within these 111 seabed mapping applications or uses identified, as guided and / or validated with the representatives drawn from across the global seabed mapping community.

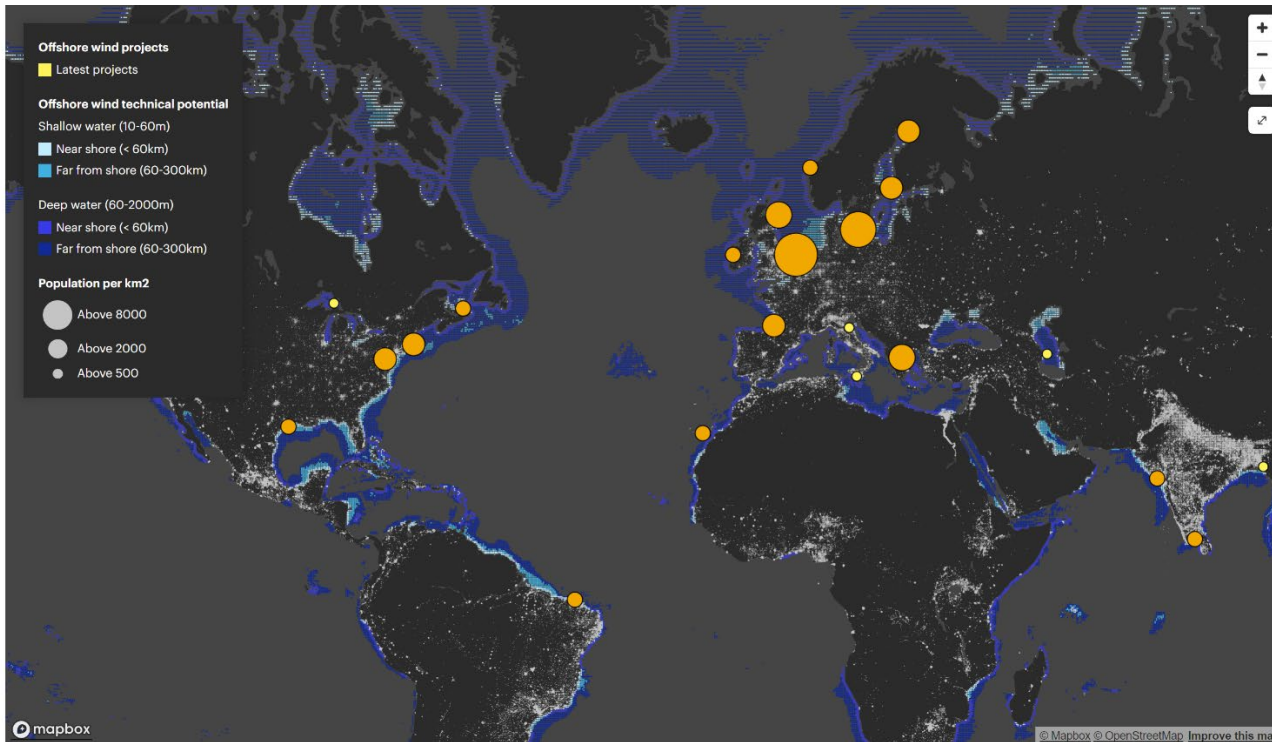


Figure 9: An Example Seabed Mapping Sector Orientated Application - Offshore Wind Geospatial Analysis, Source: IEA commissioned Imperial College London geospatial analysis study 'A detailed analysis of global offshore wind potential created as part of the Offshore Wind Outlook 2019' example UI and interactive map view. See here: <https://www.iea.org/data-and-statistics/data-tools/offshore-wind-geospatial-analysis>.

The WITS Project Phase 1 Project community engagement survey investigated initial sector priorities by regional ocean / sea settings, provided useful insight for both the Seabed 2030 Value Proposition sector assessment and Seabed 2030 seabed mapping prioritisation review (the WITS Phase 2b Objective 7 activity currently underway). The survey outcome (overview), followed by these initial Ocean Regional / Sea Setting sector priorities findings are presented below.

Survey Outcome Overview: From across the global seabed mapping community 796 individuals responded to the survey, drawn from 90 countries, providing a unique, comprehensive, and timely global perspective on stakeholder requirements for mapping the world's oceans.

There was good cross-sectoral representation, with respondents identifying themselves as coming from government (28%); industry (27%); academia (22%); the not-for-profit sector (7%); Defence (3%) and 'other' (12%). The main benefit of mapping the world's oceans was overwhelmingly considered to be 'To advance scientific understanding of seabed characteristics' (40%), followed by 'To monitor environmental changes over time' (13%) and 'To understand and protect national economic interests' (12%).

Ocean regional / sea setting geographies sector findings: Twelve ocean / sea settings were adopted providing whilst not a complete ocean / sea coverage nevertheless a useful segmentation of the global picture, including; Arctic Ocean, Atlantic North, Atlantic South, Baltic Sea, Black Sea, Indian Ocean, Mediterranean Sea, Pacific North, Pacific South, South China Sea, Southern Ocean and “Multiple” (Multi). The multiple category incorporates results where respondents had preferences across multiple ocean regions and did not state a preference to either inshore or offshore as a priority for seabed mapping.

The key sectoral findings from the quantitative analysis were as follows:

- **Arctic:** The largest sector response was from **government** organisations, the greatest need for **seabed mapping came from science and research** organisations and the (limited response) **industrial** requirements came from **cables / communications** and **renewable sectors**.
- **Atlantic North:** The largest sector response was **industry** and within this by far the leading **industrial** requirements came from the **renewable energy** companies. The leading need for seabed mapping came from the **science and research** communities.
- **Atlantic South:** The largest sector response was **academia** with the **oil & gas** companies showing the leading **industrial** requirement for seabed mapping. Like many ocean regions, the greatest need for seabed mapping was for the **science and research** bodies.
- **Baltic Sea:** With a limited number of respondents (6) the largest sector need was **government**, and the leading **industrial** requirements were to support **defence**. Again, the predominant need was to support **science and research**.
- **Black Sea:** With the smallest number of responses (4) the leading sector response was **government**, and the seabed mapping needs were equal for both **economical and safety** perspectives.
- **Indian Ocean:** The **government** was the leading sector response, and the majority **industrial** needs came from the **fishing, aquaculture, and oil & gas** sectors. Once again, the primary need to map the seabed was **science and research**.
- **Mediterranean Sea:** **Government** was the leading response sector with **industrial** needs being the most significant call **consultancy, research, science, fishing, and tourism**.
- **Pacific North:** The largest sector response was from **academia**, with **industry** needs equally reflected by **consultancy, research, science, fishing, aquaculture, and tourism**. Of note, the fishing, aquaculture, and tourism calls for seabed mapping were the largest across all 12 ocean regions.
- **Pacific South:** This region saw the highest number of responses of the whole survey (127) and **government** was the leading sector. The leading requirement for seabed mapping needs came from **science and research** bodies.
- **South China Sea:** Industry was the leading response sector and the largest across all 12 ocean regions. The most significant **industrial** call was for **hydrography, mapping and surveying** and the priority need was from a **safety** perspective. Note the South China Sea region was the only region to show that the greatest interest for seabed mapping was to understand and protect **national economic interests**.

- **Southern Ocean:** The results showed similar trends to the Arctic region. The leading response sector was **academia** while **industrial** calls were largely from **consultancy, research, and science**. The overwhelming need for seabed mapping was from an **environmental perspective** and this was the most significant call across all 12 ocean regions.
- **Multiple Ocean Regions:** For those respondents who expressed interests and preferences for multiple ocean regions, the leading sector was **government**, with leading **industry** requirements laying within **consultancy / research / science** and the greatest need was from an **environmental perspective**.

SECTION FIVE: VALUE PROPOSITION - SEABED MAPPING USE CASES

A WITS Seabed 2030 Benefits Analysis Workstream Workshop in Q1 2023, provided Seabed 2030 Community representative guidance on economic impact sector seabed mapping applications and use cases that would usefully demonstrate, evidence and articulate seabed mapping benefits / value. [See Table 2 in Section 4 for the resulting lengthy list set of identified applications / use cases]. In subsequent project meetings with Seabed 2030 management an initial concise list of priority thirty Use Cases was selected, then merged and condensed into a set of twelve Use Cases to be developed and documented by the WITS project team.

In summary, twelve identified Use Cases were selected to provide coverage and a focus on:

- (i) **Key marine challenges of our time**, notably climate change, marine biodiversity and disaster management, and how seabed mapping supports these areas.
- (ii) To **exhibit Seabed 2030’s international dimension and global relevance in mind**, responding to needs reflecting the Global North, Global South and Small Island Developing States interests and concerns.
- (iii) Ensuring provision of seabed mapping use case coverage in both **established and emerging Ocean / Blue Economy sector interests**, and
- (iv) Highlighting Seabed 2030 relevant **Hydrographic industrial and technological (innovation) developments and associated human capacity building interests and missions**.

A standardised Use Case content approach and reprographic layout was agreed with Seabed 2030 management, and up to five Industry Experts for each Use Case application subject area nominated and approached. Informing interviews with these industry experts were held across a 4-month period, supplemented with desk study and wider use case production work by the WITS project benefits analysis workstream team. In parallel the Use Case subject areas were engaged on and validated with wider international community representatives through the Seabed 2030 Prioritisation Engagement Survey rolled out across the IOC and International Hydrographic Office membership in mid-2023, receiving strong validation and valuable feedback through the 199 survey returns received.

Each use case, presents details on:

- Use Case title
- Use Case introduction
- Challenge addressed
- Description of seabed mapping support / contribution
- Seabed mapping value added
- Benefits
- Seabed mapping value impact: Economic, Social, and Environmental,
- Industry Experts and Seabed 2030 Supporting Statements

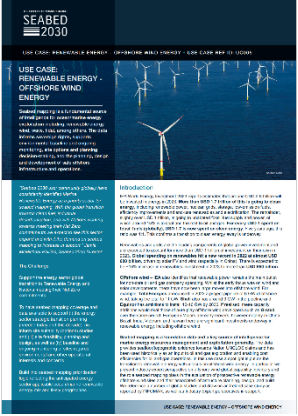


Figure 9: Seabed 2030 Use Case Reprographic Production, see Annex 1 the Compendium of Seabed Mapping Use Cases

Table 3 below identifies the Twelve Use Cases produced with highlighted Value Context guidance for each (*How seabed mapping supports and available Global Economic Value Perspective Benchmarking*), with the Compendium of Seabed Mapping Use Cases presented in Annex 1.

Use Case No.	Use Case Title	Value Context <i>How Seabed Mapping Supports (Normal Font) and provision of any available Global Economic Value Perspective Benchmarking (Italic Font)</i>
Use Case 1	Seabed Mapping Innovation	<p>Seabed 2030 Industry Experts anticipate resulting operating / production efficiencies through emerging technologies and innovation adoption directly leading to savings benefits in cost and time, confirm that the Seabed 2030 mission (i) is achievable where adequate initiative funding is made available, and (ii) can induce significant cost and time savings.</p> <p><i>By applying a hybrid manned / unmanned acquisition strategy approach savings in the order of 40% time and cost can be achieved, i.e., a Seabed 2030 initiative budget of US\$3 Billion, compared to an entirely manned vessel strategy / approach costing US\$5 Billion. [A resulting net saving of US\$2 Billion through emerging technology adoption for Seabed 2030 mission].</i></p>
Use Case 2	EEZ Seabed Mapping in the Absence of a National Hydrographic Office	<p>Coastal Nations without Sovereign Hydrography capabilities reap benefits using GEBCO seabed mapping data, often as the only source of ocean depth data within their territorial waters. Primary Charting Authority (PCA) arrangements enable nation economic development through opening maritime transport routes and the development of Maritime and Coastal Infrastructure based on hydrographic survey and the production of navigation charts for SOLAS, among others.</p> <p><i>A Nation 'Economic Value ROI' of between 1:8 and 1:10 occurs for every US\$ spent on PCA hydrographic surveys / good bathymetric data acquisition.</i></p>
Use Case 3	Subsea Cable Planning and Design	<p>Submarine Cables as a sector generally and specifically route planning and design is highly dependent on seabed mapping, including for foundation data purpose, providing 3-dimensional contextual reference, and as data intelligence to inform the optimal route locations and geometries, and to identify and mitigate key risks associated with seabed morphology (e.g., seafloor terrain, slopes, structures, obstacles, and type). Seabed mapping feeds into the planning and identification of the optimal subsea cable route, delivering cost efficiencies optimisation, and contributing to risk reduction and risk mitigation planning.</p> <p><i>Future Market Insights estimates, the global submarine cable market is expected to grow from US\$ 3Billion to US\$ 4.38Billion by 2030, with a global market growth rate (CAGR) of 4.8%. Key drivers include: Power: movement towards green energy (wind, wave, and tidal energy generators).</i></p>
Use Case 4	Tsunami Propagation and Storm Surge Modeling	<p>Seabed mapping is a critical input to tsunami propagation modeling, tsunami early warning and storm surge modeling, supporting better disaster preparation and planning, and enabling timely forecast of landfall locations and magnitude for individual events. The propagation speed of a Tsunami is controlled by depth and when the Tsunami goes to coast it will increase in amplitude linked to depth and slope. Bathymetry backscatter 'roughness' informs energy dissipation in the model at coastal areas. Seabed mapping also informs the network planning and location of Tsunami Warning System Sensors. Seabed mapping is critical for storm surge modelling, providing depth and determining acceleration at basin level and determining channel water movement at coastal areas and dynamics into river system propagation. This determines the arrival time and height and volume of water at landfall, to, and when applicable the model informs the operation (open / closure) of flood barriers and other engineering operation decisions.</p>

		<i>UNISDR references US\$280 billion due to tsunamis out of recorded economic losses for earthquakes and tsunamis of US\$661.5 billion for the period 1998-2017. A total of 264 confirmed deadly tsunamis have resulted in over 544,000 known (or confirmed) deaths globally, with damages and cost of running into US\$ 100's millions to a US\$ few billions of US\$ for a single crisis event. In a SIDS context Tsunami can have devastating impact on Nation GDP.</i>
Use Case 5	Renewable Energy - Offshore Wind Energy	Seabed mapping is a fundamental source of intelligence for ocean / marine energy exploitation including, renewable energy wind, wave, tidal, among others. The data informs sovereign rights, supports environmental baseline and ongoing monitoring, site options and planning decision-making, and the planning, design and development of safe offshore infrastructure and operations. <i>IEA World Energy Investment 2023 reports estimates that around USD 2.8 trillion will be invested in energy in 2023. More than USD 1.7 trillion of this is going to clean energy, including renewable power, nuclear, grids, storage, low-emission fuels, efficiency improvements and end-use renewables and electrification. The remainder, slightly over USD 1 trillion, is going to unabated fossil fuel supply and power, of which around 15% is to coal and the rest to oil and gas. For every USD 1 spent on fossil fuels (globally), USD 1.7 is now spent on clean energy. Five years ago, this ratio was 1:1. This confirms a transition to clean energy is underway. Renewables and grids are the leading components of global power investment and are expected to account for more than USD 1 trillion of investment on their own in 2023. Global spending on renewables hit a new record in 2022 at almost USD 600 billion, driven by solar PV and wind (especially in China). There is expected to be ~10% increase in renewables investment in 2023 to more than USD 650 billion.</i>
Use Case 6	Climate Change Ocean Models	Seabed mapping and bathymetry provides data intelligence on water depth, seabed features, seabed surface texture, and 3-dimensional profile / geometries, which collectively support a range of climate related modeling requirements from ocean to the local level. Further, and as reported in this and wider use cases, seabed mapping is also key input to other specialist models including sea level rise and coastal inundation, and models associated with extreme weather events cyclones and storm surge among others, which are becoming more frequent as a result of climate change. As a data input to climate ocean modeling, providing enhanced intelligence on sea-level rise, sea-ice models, nearshore and coastal models (for mitigation and adaptation planning), seabed mapping/bathymetry has a key supporting role informing climate change response today and going forward. <i>Deloitte's Global Turning Point Report, released during the Davos World Economic Forums Annual Meeting, 23 May 2023, finds that if left unchecked climate change could cost the global economy US\$ 178 Trillion over the next 50 years, or a 7.6% cut to global gross domestic product GDP in the year 2070 alone. However, with global leaders uniting in a systematic net-zero transition, the global economy could see new five-decade gains of US\$ 43 Trillion, a boost of global GDP of 3.8% in 2070.</i>
Use Case 7	Small Island Developing States (SIDS) Sea Level Rise and Coastal Inundation	Seabed mapping is a key input to coastal inundation and flood modelling. It also supports the mapping of baseline position [reference mapping] for disaster management, and for mitigation/adaptation provides 3-dimensional intelligence, and details on seabed / coastal features to inform the planning, design, and construction of hard infrastructure and nature-based adaptation solutions. <i>UNCTAD [May 2022] reported that SIDS' geographical conditions make them highly vulnerable to natural disasters, particularly those caused by climate change. In the Caribbean alone, the damage</i>

		<p><i>caused by climate-related and earth-related hazards is estimated at US\$12.6 billion per year. In the context of one Small Island Developing State, Kiribati, IMF, in June 2023, referenced a World Bank (2017) estimation that adaptation costs exclusively for coastal protection in Kiribati—protecting the low-lying atolls from rising sea level through sea dike construction and port upgrade—could reach US\$54 million (equivalent to 11 percent of GDP per year) in the 2040s.</i></p>
Use Case 8	Marine Biodiversity	<p>Seabed mapping is a foundation data and an important source for 2d and 3d geospatial referencing of biodiversity and habitat intelligence. Seabed mapping provides detailed on water depth, and a range of seabed characteristics useful for marine biodiversity, and wider marine and coastal ecosystem services purposes. The existence and sustainability of Marine biodiversity hotspots are highly dependent on water depth and a range of seabed characteristics including, geomorphology, slope, and texture, among others. Seabed landscape features determine habitat opportunities, e.g., coral, seamounts, abyssal plain, trench, hadal zone, among others. Five key areas of seabed mapping support to marine biodiversity includes, among others: 1. The enablement and advancement of our knowledge and understanding of marine species, habitats, and ecosystems. 2. Supporting the mapping and monitoring of marine biodiversity hotspots, habitats, and areas of ‘biodiversity’ interest. 3. Aiding ocean discovery/exploration, enabling new ecosystem and species discovery. 4. Supporting the modelling, analysis, and assessment of marine biodiversity ‘threats’ and ‘risks’, including climate change, habitat and ecosystem destruction, natural resources management, among others, and 5. Informing policy and regulatory boundary delineations, e.g., Marine Protected Areas, among others.</p> <p><i>Marine biodiversity provides significant economic value. Examples include World Economic Forum, reported in August 2021, that Worldwide, mangroves reduce risk to more than 15 million people and prevent more than US \$65 billion in property damages each year. Smithsonian state that, one hectare of seagrass (about two football fields) is estimated to be worth over US\$19,000 per year, making them one of the most valuable ecosystems on the planet. And NOAA Office for Coastal Management state that the total economic value of coral reef services for the U.S., including fisheries, tourism, and coastal protection is over US\$3.4 billion each year, and that annually, U.S. coral reefs provide flood protection benefits of US\$1.8 billion in averted damages to property and economic activity.</i></p>
Use Case 9	Small Island Developing States (SIDS) Marine and Coastal Development, and the Use of Seabed Mapping as a Foundation Data for Marine Spatial Planning	<p>Seabed mapping is a foundation data for and an enabler of SIDS marine and coastal development. As a foundation data seabed mapping supports Marine Spatial Planning (MSP), providing ocean geographic context and insight, and a visualisation backdrop and context to aid MSP stakeholder engagement and communication. Seabed mapping is an enabler of key Marine and Coastal Infrastructure Development, underpinning major maritime / coastal infrastructure works such as the planning and design of Ports / Port expansion, and the opening of Maritime transportation routes. The data is fundamental to delivery in international SOLAS commitments which in turn underpin the movement of trade and passengers by sea. Further, the data informs decision-making and work in a number of Ocean / Blue Economy sector areas, ranging from fisheries through to natural resources management.</p> <p><i>It is difficult to assign an economic value on the contribution Seabed Mapping makes to a SIDS economy, without dedicated investigation in the specific nation context, but it can be said that without access to seabed mapping marine and coastal development can be impeded, delayed, or not</i></p>

		<i>occur. Further, we know from PCA industry expert engagement that typically a Nation 'Economic Value ROI' of between 1:8 and 1:10 occurs for every US\$ spent on PCA hydrographic surveys / good bathymetric data acquisition.</i>
Use Case 10	Government Policy	<p>Seabed mapping provides topography detail of the ocean / seafloor, a map base reference, through which ocean policy can be considered, formulated, and presented geographically in 2 or 3 dimensions for public consumption. Seabed mapping is also a foundation data and provides geographic reference and context upon which other ocean information and intelligence can be geographically referenced and/or presented, e.g., administrative boundaries, policy delineations / boundaries, habitat mapping, among others. Seabed mapping provides support to policy implementation and monitoring and as an input to planning and implementation of ocean economy programmes and projects, including human activity areas of the ocean economy such as cable and pipelines planning and design, and renewable energy planning and design, through to the marine science programme design such as benthic habitat monitoring planning among others. Seabed mapping has a significant role to play towards our understanding and response to three global ocean challenges of our time: climate change, marine biodiversity, and pollution, including: Climate change: as an input data for global ocean and sea level rise models. Marine biodiversity: as an input to aid habitat survey and mapping work, the monitoring and conservation of vulnerable marine habitats and ecosystems. Marine pollution: as an input to planning, design and environmental impact assessment associated with marine / maritime infrastructure work and energy resources in a marine environment context.</p> <p><i>It is difficult to assign an economic value on the contribution Seabed Mapping makes through government policy context without dedicated investigation. In a Policy context and recognising the importance and relevance of seabed mapping data, key institutions do however include and require the use of seabed mapping data in their respective Regional and National Data Infrastructure. For instance, the World Bank Integrated Seascape Management approach for Marine Spatial Planning and Blue Economy, identifies bathymetry as foundation 'physical category data.' European Marine Observation and Data Network (EMODnet) is recognised as a best practice approach providing an effective pan-European marine data infrastructure. EMODnet provides access to European marine data across seven discipline-based themes: including a Bathymetry theme (alongside Biology, Chemistry, Geology, Human Activities, Physics and Seabed Habitats themes).</i></p>
Use Case 11	Ocean Discovery and Ocean Exploration	<p>Ocean exploration is highly dependent on seabed mapping data, technologies, and processes. Seabed mapping informs and supports exploration planning, expedition operations, and provides a map base upon which observations can be spatially referenced and presented in both 2 and 3 dimensions. Seabed mapping where available, is a critical input to expedition / mission planning, supporting route planning, informing target mobilisation / demobilisation, and optimising vessel time in exploration areas of interest. It is important to map and be aware of major seafloor features and anomalies for expedition success. The data may be the only data available to provide geographic insight on an area of interest exploration location, providing key detail on site context, it is geomorphology and ultimately aiding explorer decision-making.</p> <p><i>Downstream value and resulting benefits can be significant, including in the marine sciences, enhancing our understanding, and making discoveries including in geology, physics, chemistry, and biology fields. Marine archaeology brings a human dimension providing cultural and heritage</i></p>

		<p><i>downstream value. Overall, Ocean Exploration, supported by seabed mapping aids the marine community to maintain ocean health more effectively, sustainably manage marine resources, accelerate areas of the ocean economy, and build knowledge and understanding of the value and importance of the ocean. Explorers and Marine Researchers also have identified spillover value where Ocean Exploration, for instance the Ice-covered Arctic has been a bridge and informed space science and space exploration and the search for life in space.</i></p>
Use Case 12	Seabed 2030 Driving Hydrographic Industry Expansion and Human Capital Benefits	<p>Seabed 2030 mission represents a tremendous opportunity for hydrographic industrial development and growth, while driving human capital outcomes. Delivery of the Seabed 2030 mission on schedule will stimulate and accelerate hydrographic industrial development and growth. It also provides a golden opportunity to focus attention and enhance human capacity concerns such as the build up of developing nation capacities, and furthering other human capital interests such as inclusivity and gender. Three key areas of significant thematic value generation include: 1. Global Data Production Capacity Building Ramp Up, Industrial Development and Growth. Seabed 2030 is a global delivery effort and outcome, driving and enabling the global ramp up of seabed mapping delivery capacity across all areas of the data production value chain: from data prioritisation and planning through, data collection, data processing and production to data holding and dissemination. 2. Global Multi-Sector Use and Value Global Ocean coverage leading to significant expansion of sector uses globally, in both established sectors and scientific and emerging sector areas [See section 4], and 3. One off Set of Human Capital Opportunities. Seabed 2030 presents a huge opportunity to build capacity globally, accelerate capacity and competency building in new skills, accelerate operating model enhancements such as remote working with inclusion benefits, and focus attention on gender elements, among other human dimensions.</p> <p><i>It is difficult to assign an economic value on the contribution Seabed Mapping makes in this theme area without dedicated investigation. However, three key sources are usefully signposted by Industry Experts, including: 1. Market intelligence by IMARC Group confirms the Global Hydrographic Survey Equipment Market is exhibiting strong levels of growth (5.78% CAGR) and is forecast to reach US\$ 4.1 Billion by 2028. 2. The Seabed Mapping community estimate the cost of Seabed 2030 Mission delivery as between US\$3 and 5 Billion, with the lower number integrating autonomy approaches where sensible, and the higher number based on a traditional survey approach, and 3. The value of Australian seabed mapping data to the blue economy, [Deloitte Access Economics Study commissioned by Geoscience Australia], provides a useful Nation focus study. This study estimated (for a single year 2018-19), that the activities directly involved in producing seabed mapping data directly contributed \$51 million to the Australian economy and created 500 jobs. Further, that the use of seabed mapping data also directly contributed over 56,000 jobs (FTEs) to the Australian economy in 2018-19, and the direct economic contribution of seabed mapping data use being \$9 billion in the same year. This clearly demonstrates social benefit in a Nation context and provides a useful reference model for other coastal nations.</i></p>

Table 3: Seabed 2030 Use Cases - How Seabed Mapping Supports and a Global Economic Value Perspective Benchmark.

Together the Use Cases provide a seabed mapping industry and community body of evidence to inform the developing Seabed 2030 seabed mapping benefits analysis model, evidence the evolving Seabed 2030 business case, and to be available to support ongoing Seabed 2030 knowledge sharing activities, PR, and communications. The use cases will also inform the Seabed 2030 prioritisation toolkit design, the WITS Phase 2b Objective7 activity underway in 2024.

SECTION SIX: GLOBAL OCEAN COVERAGE SEABED MAPPING BENEFITS

This section provides an executive summary of the benefits that can be realised through the implementation of and achieving the Seabed 2030 Mission. The benefits are highlighted benefits not a full / exhaustive list.

All presented benefits are evidence based and informed through either industry expert engagement or authoritative guidance as published by relevant competent authorities.

Seabed 2030 Missions Benefits

Technically, Seabed 2030 seabed mapping provides:

1. **The authoritative map of the global oceans' sea floor** (2d, 3d mapping and gazetteer).
2. **All seafloor features of the World Ocean floor larger than 100m are being mapped.**
3. **All seamounts are being identified and located.** *NOAA states globally, it is estimated that there may be as many as 100,000 seamounts higher than 1,000m under our Oceans.*
4. **A bathymetry foundation in the form of a 2d and 3-dimensional geometry and topographic framework against and from which:**
 - **Other ocean data and intelligence can be referenced and registered**, [e.g., marine biodiversity, among others].
 - **Baseline, monitoring, and alerting** can be supported, [e.g., tsunami early warning, among others].
 - **Specialist thematic modelling and analysis** can be undertaken, providing seabed and water depth model components and intelligence where required [e.g., ocean climate models, among others].
 - **A wide range of marine and maritime applications in high seas, EEZ and coastal waters can be supported**, providing seabed topography and water depth intelligence where required. [e.g., seabed cables planning (see Table 2 below), among *many* others].

Strategically, Seabed 2030 is bringing together all available bathymetric data to produce the definitive map of the world ocean floor by 2030 and make it available to all. This data is fundamental to our understanding and sustainable use of our oceans. This data:

1. **Enhances our understanding of the Worlds' Ocean and our subsea world,**
2. **Underpins a wide range of Ocean and Marine Scientific Research,**
3. **Supports our preparation for and mitigation of global and regional scale crisis, including climate change, seal level rise, and volcano, tsunami, and tide surge flood disaster events; and**
4. **Enables socio-economic development and growth of the Blue Economy**

Global Highlight (Example) Benefits, include:

1. **Closing the sea floor mapping gap** - Whilst we are making good progress towards achieving global ocean coverage of seabed mapping, it does remain the case that today [January 2024], we have no mapping or topographic understanding of 75% of the world's oceans. This represents a huge gap in our global knowledge and understanding. **Seabed 2030 mission will close this global [seabed mapping] knowledge and understanding gap.**

2. **Is the Authoritative Global Bathymetry Foundation Data, (GEBCO bathymetry grid / topography, and Gazetteer), used for the 'global to local' referencing, exchange and communication of global ocean data, interests, and concerns.**
3. **Provides a topographic evidence base for policy international marine policy development, supporting agreements and boundary delineation, including for UNCLOS Coastal State Continental Shelf Application & Review, Marine Protected Areas, World Heritage Sites, among others.**
4. **Supports the preparation for and mitigation of three global marine challenges of our time: (i) Climate Change, through enhancing global ocean models and models that inform our knowledge and understanding of sea level rise (esp. glacier dynamics driven by seabed models, among others) and global ocean warming models, (ii) Marine biodiversity, through introducing 2d/3d topographic framework to support other biodiversity survey planning and data referencing, habitat inventories as well as the identification of candidate locations for important marine habitat / biodiversity ocean locations and (iii) Marine Pollution, through enhancement of pollution propagation / dispersion models through introducing the sea floor dimension, understanding potential for sensitive habitat environments towards pollution threats, among others.**
5. **Supports the global community understanding of the subsea world, informing, and enabling globally important marine science and research, exploration, and discovery activities.**
6. **Enables a global perspective and level of inventory to inform the sustainable exploitation of marine resources such as oil and gas, marine aggregates, and marine mining minerals, and especially being able to understand context to inform decision-making where ocean / subsea location are of global importance.**
7. **Global Sector Example - Subsea cables planning and design, where seabed mapping is critical for subsea cable route planning and design and support global digital telecommunications and transactions.** One example cable system is the Southeast Asia - Middle East - West Europe 3 system (SE-ME-WE-3), with a total installed length including branches) of almost 40,000 km, Source ICPC. Subsea cables are critical to everyday quality of life, with telecommunications subsea cables supporting global digital communications and transactions, ranging from security to banking transactions. Such transactions underpin global GDP, value US\$ trillions.

Regional Highlight (Example) Benefits, include:

1. **The Go To 'Regional' Bathymetry Foundation Data, e.g., for use in Regional – mut-nation interests around MSP, ICZM, and Seascape Management, and typically presented for user access through regional data infrastructure services such as EMODNet and Pacific Data Hub, among others.**
2. **Support to National Operations in (Regional / Global) High Seas including operations planning, navigation, and safety at sea, etc., Search & Rescue in High Seas, and Accident at/over Sea, including incident investigation and aircraft / vessel recovery.**
3. **Enhancement of regional ocean models for climate change, sea level rise and ocean warming (see global benefit 2 above).**
4. **Enhancement of Regional Tsunami Propagation Models, enhancing model accuracy and landfall prediction, optimising mitigation, and disaster preparation, planning and response. Regional Ocean seabed mapping is critical for accurate tsunami propagation modelling.**
5. **Enhancement and Operation of Storm Surge Early Warning to inform storm barrier operations. In specific coastal geographic locations, e.g. The Netherlands, the national response to storm surge**

threats requires a regional coverage of seabed mapping in the prediction model. Leading to more efficient / optimised operation of coastal protection measures such as flood barrier operations.

6. **Regional Sector Example - Subsea cables planning and design, where seabed mapping is critical for subsea power cable route planning and design.** *Subsea cables disseminate power from source to point of use, provide levels of energy resilience and security for and between Nations.*

In the Context of a Nation / Sovereign Perspective, Seabed 2030 Mission Highlight (Example) Benefits:

1. **Seabed mapping supports claims for sovereign rights and increase the marine jurisdiction of a nation, and the associated exploitation of ocean resources.**
2. **Support to National Defence and Security capabilities** – notably, some Nations are more advanced in subsea activity *c.f.* to others. **National Security Border Security** including EEZ navy monitoring adjacent to EEZ high sea area, and support to coast guard operations to enforce EEZ, subsea cable security, among others.
3. **Support the planning of and execution of Hydrographic Surveys for SOLAS.**
4. **Support the transition to / expansion of Offshore Renewable Energy (RE) / clean energy and reduction of dependency on fossil fuels.** *Seabed mapping is critical for offshore wind energy site suitability strategic assessment. Further, Seabed mapping data supports environmental baseline and ongoing monitoring of RE sites, RE site options and planning decision-making, RE farm cable to on-grid routing and connections, and the planning, design and development of safe offshore infrastructure and operations.*
5. **Protect and Mitigate Coastal Threats such as Storm Surge and coastal inundation modeling,** (see Regional Benefit item 4 above), supplemented with the further need for channel seabed mapping in coastal and estuary areas to predict and respond to storm surge and coastal inundation (flooding) threats.
6. **Optimise fisheries management, and the targeting of fishing activities through fisher access to seabed mapping data.**

Additionally, and in the context of Small Island and Developing States (SIDS) and/or Developing Coastal States Context, Seabed 2030 Mission Highlight (Example) Benefits:

1. **GEBCO Grid may be the only available data source for the marine area within a Developing Nation EEZ and in these instances is the go-to source and critical for Nation decision-making on Marine / internal EEZ interests and concerns.**
2. **Support the planning of and execution of Hydrographic Surveys for SOLAS through Primary Chart Authority Arrangements.**
3. **Seabed mapping as a foundation data supporting Developing Nation Marine Spatial Planning (MSP),** providing ocean geographic context and insight, and a visualisation backdrop and context to aid MSP stakeholder engagement and communication internal to nation and between neighbouring States where a joined up marine management approach is helpful.
4. **Critical data source to plan for and mitigate climate and disaster threats, including such as sea level rise, support coastal inundation understanding (flood risk and risk to local fresh water supplies, among others), support the planning and design of nature-based solutions for climate change using bathymetry grid and backscatter data, among others.**

5. **An enabler of key Marine and Coastal Infrastructure Development, underpinning major maritime / coastal infrastructure works such as the planning and design of Ports / Port expansion, and the opening of Maritime transportation routes, leading to new economic activities such as tourism, among others.**
6. **Feasibility study and identification of new area of Ocean/Blue Economy for Nation/State exploitation, such as aquaculture (mariculture) site location, sustainable fisheries management, sustainable / ecotourism, bio pharmacy, oil and gas and minerals resources management.**

Seabed 2030 Mission Economic Benefits include:

1. Support to hydrographic survey industry expansion and growth [Market intelligence by IMARC Group confirms the Global Hydrographic Survey Equipment Market is exhibiting strong levels of growth (5.78% CAGR) and is forecast to reach US\$ 4.1 Billion by 2028].
2. **Providing a direct economic contribution to a [Coastal] Nation's economy through 'data production.'** In the example case of Australia, this centered on the production of seabed mapping generating a direct contribution of \$51 Million to the Australian economy and creation of 500 jobs for a single year (2018-2019). [Source: The value of Australian seabed mapping data to the blue economy, [Deloitte Access Economics Study commissioned by Geoscience Australia].
3. **Providing a direct economic contribution to a [Coastal] Nation's economy through 'data use.'** In the case of Australia this centered on the use of seabed mapping directly contributing generating 56,000 jobs (FTE) to the Australian economy in 2018-19, and the direct economic contribution of seabed mapping data use being \$9 Billion in the same year. [Source: The value of Australian seabed mapping data to the blue economy, [Deloitte Access Economics Study commissioned by Geoscience Australia].
4. Industry Experts identified that Primary Charting Authority support enables **A Nation 'Economic Value ROI' of between 1:8 and 1:10 occurs for every US\$ spent** on the PCA hydrographic surveys / good bathymetric data acquisition.
5. **Supporting a full range of Ocean /Blue Economy activities, including 24 economic impact sectors for which 111 seabed mapping applications / uses have been identified, including 7 Established Sectors (41 applications / uses), 7 Science and / or Emerging Sectors (31 applications / uses), and 10 Other Sectors (39 applications / uses),** The Economic Value of these 24 sectors ranges between few US\$Billions per annum to US\$Trillions in global context (see Section 4 and 5 of this document).

Seabed 2030 Mission Socio-Benefits include:

1. Delivery of the Seabed 2030 mission on schedule will stimulate and accelerate hydrographic industrial development and growth.
2. **Global Data Production Capacity Building Ramp Up, Industrial Development and Growth. Seabed 2030 is a global delivery effort and outcome, driving and enabling the global ramp up of seabed mapping delivery capacity across all areas of the data production value chain:** from data prioritisation and planning through, data collection, data processing and production to data holding and dissemination. Including the introduction of new jobs and roles in support as well as global / regional footprint.
3. **Global Multi-Sector Use and Value Global Ocean coverage leading to significant expansion of sector uses globally,** in both established sectors and scientific and emerging sector areas, including **the introduction of new jobs and roles in support.**

4. **One off Set of Human Capital Opportunities through Mission Delivery.** Seabed 2030 presents a **huge opportunity to build capacity globally, accelerate capacity and competency building in new skills, accelerate operating model enhancements such as remote working with inclusion benefits, and focus attention on gender elements, among other human dimensions.**
5. By **applying a hybrid manned / unmanned acquisition strategy to Seabed 2030 Mission delivery,** savings in the order of 40% time and cost can be achieved, i.e., a Seabed 2030 initiative budget of US\$3 Billion, compared to an entirely manned vessel strategy / approach costing US\$5 Billion. [\[A resulting net saving of US\\$2 Billion through emerging technology adoption for Seabed 2030 mission\]](#). **Also enabling remote working, and more inclusive delivery approach.**

Seabed 2030 Mission Environmental Benefits include:

1. Provide support to **key environmental sectors and associated ocean / marine activities, including Marine and Coastal Ecosystem Services (Including Marine Biodiversity), Ocean Discovery and Exploration, and Marine Science and Research,** among others.
2. Supports the **preparation for and mitigation of three global marine challenges of our time: (i) Climate Change,** through enhancing global ocean models and models that inform our knowledge and understanding of sea level rise (esp. glacier dynamics driven by seabed models, among others) and global ocean warming models, **(ii) Marine biodiversity,** through introducing 2d / 3d topographic framework to support other biodiversity survey planning and data referencing, habitat inventories as well as the identification of candidate locations for important marine habitat / biodiversity ocean locations and **(iii) Marine Pollution,** through enhancement of pollution propagation / dispersion models through introducing the sea floor dimension, understanding potential for sensitive habitat environments towards pollution threats, among others.
3. Support the global to local **transition away from fossil energy sources to clean energy through supporting the development of offshore renewable energy** as described in nation benefits above.
4. Supporting the **discovery of new specialist species and specialist seafloor habitats (ranging from deepwater corals through to hadal zone communities, among others), through seabed mapping support to Ocean Discovery and Exploration.** Raising both our understanding and knowledge of the Subsea environment and raising the profile of the subsea environment with the wider general public.
5. By applying a hybrid manned / unmanned acquisition strategy to Seabed 2030 Mission delivery, in addition to the socio-benefits presented above, **enabling carbon savings (Levels TBD) using autonomous vessels (e.g., solar powered) and reducing the use of fossil fuels where applicable.**

ANNEX 1: Compendium of Seabed Mapping Use Cases

Annex 1 presents the Compendium of Seabed Mapping Use Cases as prepared by WITS Phase 3 benefits analysis workstream for Seabed 2030, and as described in Section 5 of this document.



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ANNEX 2: Seabed 2030 Executive Fact Sheet

Annex 2 presents a copy of the Seabed 2030 Executive Fact Sheet, prepared by WITS Phase 2b benefits analysis workstream for Seabed 2030.



SEABED executive
summary document.