



5 July 2022

Mr Yohei Sasakawa
The Chairman
The Nippon Foundation
1-2-2 Akasaka, Minato-ku
Tokyo, Japan

Dear Mr Sasakawa

I respectfully submit the proposal for Year 5 of The Nippon Foundation – GEBCO Seabed 2030 Project for your consideration.

Yours sincerely

A handwritten signature in blue ink, located below the 'Yours sincerely' text. The signature is stylized and appears to read 'Jamie McMichael-Phillips'.

Jamie McMichael-Phillips
Project Director

THE NIPPON FOUNDATION-GEBCO SEABED 2030 PROJECT

Year 6 Programme of Work
Application to The Nippon Foundation

Submitted by
Jamie McMichael-Phillips, Project Director
5 July 2022

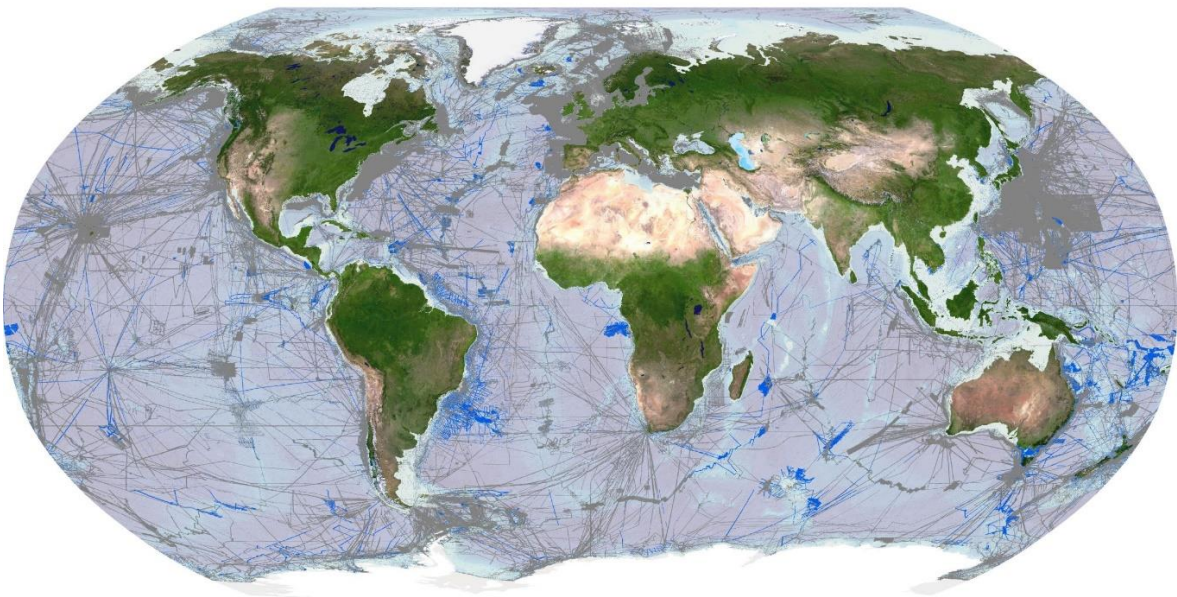


Figure 1: A view of the GEBCO Grid 2022 release showing, in blue, new data added in the preceding year courtesy of Pauline Weatherall. National Oceanography Centre, UK

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1. EXECUTIVE SUMMARY

The application for Year 6 funds for The Nippon Foundation GEBCO Seabed 2030 Project (Seabed 2030) is for the period 1 August 2022 to 31 July 2023. As is the norm, the proposed activities are structured into 5 Work Packages that broadly conform to The Nippon Foundation-endorsed Seabed 2030 Business Plan.

The budget plan is based on enhancing the core Project Team and 5 Centers in delivery against ongoing and new Work Package deliverables, continuation of a number of Special Projects from Year 5, and introduction of a new Special Project for:

- **Multi Resolution Grid Development:** building on the complex work undertaken in previous years in development of a multi-resolution grid and to operationalize this new generation GEBCO product.

Year 6 activity will run in parallel with the entirely separate bidding and grant processes for Ocean Frontier Mapping. The latter being to identify candidate science expeditions during which we may consider funding extra mapping days and/or using placing alumni onboard to augment data gathering and processing activities.

The total amount of funds requested for Year 6 is **US\$2,999,724**

2. PROGRAMME OF WORK

The Programme of Work (POW) is presented as a summary table in Appendix II. The Year 6 activities are structured into 5 Work Packages (WP).

2.1. WP 1: Data

WP1 focuses on continued ingestion of data into the GEBCO Ocean Map and the publication of the next version of the product: GEBCO 2023. Incorporated within the 2022 version of the GEBCO global product are two key regional maps, namely: International Bathymetric Chart of the Arctic Ocean (IBCAO) 2021 and International Bathymetric Chart of the Southern Ocean (IBCSO) 2022. We plan to collaborate closely with the BedMachine project team to innovate ways of ingesting under-iceshelf topography into these two polar compilations.

Thereafter work is planned in Year 5 to publish a new version of IBCAO and to continue routine updates to IBCSO: changes will be included within the 2023 Grid.

Bedmachine is the name of a project that creates gridded compilations of the topography underneath the Greenland and Antarctic ice sheets. The under-ice topography is derived by measuring the ice thickness, mainly with airborne radar, and interpolation. The under-ice topography is then connected to the fjord bathymetry, to create a seamless map from land topography to the seafloor. So this means that in order to create the Bedmachine products, they need good bathymetry around Greenland and Antarctic, and in order to create the IBCAO, IBCSO and GEBCO grids (which are products of IBCAO and IBCSO in the polar regions) we need the under ice topography. Hence, we started a collaboration to exchange data and help each other.

The Bedmachine project team, led by scientists at Dalhousie University, is searching for bathymetry as well, and they have a very good connection to the glacial community that do measurements underneath the ice shelves, or close to the outlet glaciers' margins. NASA has funded a programme called "Ocean Melting Greenland" (OMG) which systematically collected bathymetry in Greenland fjords to make Bedmachine better, since the bathymetry in front of the outlet glaciers is key for climate change questions and the dynamics of the Greenland ice sheet.

Through our collaboration with Bedmachine, we have had a first hand in these data, even before they are placed in public domain. We are now exchanging data lists to make sure we do not miss anything, and there are always bathymetric data they have found which we do not have, and vice versa. By deepening this collaboration, we can ensure that the grids we produce for the Polar Regions really are the state-of-the-art. We have no numbers on the data that this has given us, or what it will provide, but every depth value near and underneath the floating ice shelves is hugely valuable for us, since the grids we produce are used for numerical modelling and assessments of the outlet glaciers vulnerability. However, the previous OMG data comprises a massive contribution from NASA over the years.

Also, in Year 5, the Project Team will continue to engage with the widest possible community to seek additional data contributions. This will include leverage via the Ocean Decade, and also the IHO and IOC communities.

2.2. WP 2: System and Tools

WP2 focuses on with the technical tools, systems and processes required to build and publish the GEBCO Ocean Map. Building on previous years' activity, the Project Team will continue to enhance the statistics system, used in calculating the area of seabed mapped at any moment in time. We will work on development of the GEBCO Grid download tool to handle polar stereographic grids and we will work with the University of New Hampshire (UNH) to extend the capabilities of UNH's GapFiller tool that will help expedition planners identify gaps in the GEBCO grid.

The GapFiller tool has been developed by Colin Ware at UNH/CCOM-JHC. It is a standalone Windows based software package that is designed for to support Seabed 2030 by providing tools which allow for efficient seafloor mapping during both transit and area mapping. It can be used to easily (just a few key strokes) to plan transits or survey and is designed to show all existing data sets (including data sets yet to be included in the GEBCO Grid as published yearly). so that as transits or surveys are planned, we can assure that we optimize new coverage rather than go over areas already mapped. Routes can be planned by hand or automatically to optimize new coverage. As routes are planned it shows the estimated coverage based on general knowledge (from predicted bathymetry) of the water depths so that overlap between lines is predicted and coverage can be optimized.

It has the ability to automatically adjust transit lines to overlap, by a set amount, with existing data from the GEBCO grid and to then give estimates of time and data coverage from the proposed lines. It also has the ability to generate survey patterns designed to fill polygons provided by the user. It has already been used for planning for gap filling missions for the GEBCO 2022 grid, including the inaugural 2021 Saildrone crossing from San Francisco to Hawaii, the 2021 Northwest Passage cruise from Seward, Alaska to Nuuk, Greenland, and for the E/V Nautilus's seafloor mapping in the Papahānaumokuākea Marine National Monument (PMNM).

It is currently being used to plan upcoming work, which also will be taking place in the PMNM, using both E/V Nautilus's EM302 and the DriX Autonomous Surface Vessel (ASV).

This software will be further developed, refined and improved based on user feedback and it is available to all.

This will make route planning onboard much easier, encouraging mariners and scientists to, much more easily, plan work in areas of gaps and gather bathymetry for Seabed 2030 whilst also avoiding duplication of effort by re-mapping areas previously mapped.

We will build on the success of the Global Center as a Seabed 2030 Trusted Node (data recipient) for those Crowd Sourced Bathymetry (CSB) contributors that are not part of larger organized networks.

The Team will also build on the complex work undertaken in previous years to accelerate development of a multi-resolution grid and to operationalize this new generation GEBCO product as detailed in the Seabed 2030 RoadMap. This is likely to involve some inexpensive adaption of existing GIS applications which will need to be funded within this Year 6 budget.

The need for a multi-resolution approach was set out in the Seabed 2030 paper published in 2018 in the Geosciences journal¹.

Our goals are to implement a solution that meets the needs of our users and our vision while minimizing impact on existing workflows and processes. The ESRI platform offers out-of-the-box functionality that can be used to deliver data at multiple resolutions on demand to our user community. Each Seabed 2030 Regional Center will deliver raster-format data at the appropriate resolutions based on water depth wherever submitted data can support the resolution goals. Data will be assembled into a mosaic data set using ESRI out-of-the box functionality and will then be made available through the project's ESRI Online portal managed by the Global Center. Some customization will be necessary to enable user requests of data at particular resolutions and to optimize performance for this very large dataset. This will be more easily achieved by engaging with a contractor who will work with the team to build the necessary enhancements. ROM cost of this work \$25K

Details of implementation will be established by the Atlantic/Indian, South and West Pacific and North Pacific Centers, all of whom currently use the ESRI technology as part of their workflows. Once details are sorted out they will be distributed and reviewed by the broader technical team to ensure that all requirements are met.

This will not add data to the Grid, per se, but it will significantly improve the ability of users to extract data at higher resolutions and so meets our stated objective of bringing "together all available bathymetric data to produce the definitive map of the world ocean floor by 2030 and make it available to all."

We will maintain the strong collaboration with Scripps Ocean Institute (SOI) for production of SRTM15+ yearly updates that form the base layer of the GEBCO Grid for all but very high latitude regions. By updating SRTM on a yearly cycle, the new base version can be used by Seabed 2030, cutting down time each year in removing the same data that had to be removed in the previous Grid computations. It will also allow us to better include sparse data (including CSB) and improve the overall quality and continuity of the GEBCO product.

¹ <https://www.mdpi.com/2076-3263/8/2/63> : The Nippon Foundation—GEBCO Seabed 2030 Project: The Quest to See the World's Oceans Completely Mapped by 2030

Also, we will continue to support of web services for visualization of SB2030/GEBCO data sets as a valuable application, particularly for QC and planning purposes.

2.3. WP 3: Technology innovation

WP3 focuses on technological innovation as a key enabler in the acceleration of seabed mapping (from data collection, to processing and to product creation). In Year 5, we had professional support in drafting a Technology Innovation White Paper and, following internal checking, we plan to publish this in Year 6. Following successful collaboration with MOU partner, Kongsberg Maritime (KM), we will continue to refine the bespoke Data Uploader tool for KM systems used in scientific and industry fleets. In parallel we will refine a Data Uploader tool developed by Stockholm University that can be used by other (non-KM system) donors.

Again in collaboration with KM, we will operationalize the SeaKoMap (Seabed 2030-Kongsberg Maritime Cloud Processing) capability that will allow us to use this cloud technology to support Regional Centers in tackling data back-logs.

SeaKoMap is a solution for 3rd party operators to process backlogs of data using Kongsberg's Blue Insight platform to provide a cloud-based, modular platform for the secure visualization, processing and sharing of ocean data. There will be 2 "virtual processing terminals" accessed by authorised operators anywhere in the world. It will be loaded with software from MOU partner QPS and will be managed by Seabed 2030 for:

- Remote data processing via a web-based solution
- Generation of cleaned bathymetric surfaces for transfer to the Regional Centers for ingestion in the GEBCO Grid.

The next stages within the main Seabed 2030 Programme of work are to:

- Establish Data Processing Routines, QC & Standards
- Undertake User Acceptance Trials

Once the above is complete (4 to 5 moths) we would wish to use our alumni as operators and to put in a separate bid for approx \$160K XPrize funding (held by the Nippon Foundation) for "people time" and licence costs. Involvement of the alumni network will help our Regional Centers deal with data backlogs and will work as a force multiplier to add more data to the grid and contribute to the Seabed 2030 mission.

The backlog data has not been fully assessed and we cannot yet determine the volume of new data that can be added to the Grid.

Alongside partners from IHO's Crowd Sourced Bathymetry Working Group (CSBWG) and UNH, we will continue to support global CSB activity and technology developments; and we will also collaborate with other partners to increase autonomous data collection and to support

Seatrec's Project NEMO (Novel Echosounder to Map the Ocean) in its development of floats fitted with echosounders:

Seatrec, a MOU partner, has brought together an interdisciplinary team of scientists and engineers to develop an autonomous profiling float with an echosounder to map the seafloor. The novel thermally recharging echosounder float (called NEMO) is the integration of three technology breakthroughs over recent years: autonomous profiling floats as demonstrated by the Argo programme ; the innovative echosounder designed by Airmar Technologies in collaboration with Innomar Technologies; and the transformative ocean thermal energy harvesting technology developed by Seatrec.

Leading Project NEMO is seafloor mapping pioneer Prof Larry Mayer, Director of the Center for Coastal and Ocean Mapping at the University of New Hampshire and also co-Head of Seabed 2030's Arctic and North Pacific Data Center. (Through the latter role, Seabed 2030 will be a collaborator in the project.)

Project NEMO will start with a pilot demonstration deploying a cluster of NEMO floats to cover an area centered around Point Nemo – the most remote location on planet earth. Upon a successful pilot demonstration, the NEMO float clusters can be deployed at selected locations to map the gaps in seafloor bathymetry.

Two prototype profilers will be ready by January 2023 (on schedule) and that they will be tested off Hawaii. If tests are successful, RV FALKOR, operated by the Schmidt Ocean Institute (another MOU partner) will deploy them at Point Nemo in mid 2023.

Data will be provided to Seabed 2030. It is too early to estimate the coverage we expect them to generate – First, we need to demonstrate that they work.

Successfully deploying technology that can accurately and inexpensively map the most remote point in the ocean will help us chart a way forward to the world's first high-resolution map of the seafloor.

2.4. WP 4: Mapping Activities (formerly Mapping the gaps)

The combined efforts of the entire global mapping community to fill the gaps in our existing bathymetric coverage remain paramount. Whilst early in its life cycle, the UN Decade of Ocean Science is already providing leverage at a global, high-profile level: we are beginning to see mapping and CSB projects that have an opportunity to align with Seabed 2030 and deliver new data. We must also remain attuned to other modes of accelerating the data gathering and contribution efforts. Here we will continue to promote our Ocean Frontiers Mapping process and also continue to accelerate of CSB activity particularly now the challenges of COVID are abating and our partners in South Africa, Palau and Greenland are better able to engage directly within their communities. We are also seeing a greater interest in CSB activity from

prominent super-yacht clubs and associated networks, which we should support, and we anticipate that this will encourage even more citizen-science participation.

Based on the success of the Year 5 Special Project 7, we should continue availability Satellite Derived Bathymetry (SDB) for use within the GEBCO Grid. Here we can leverage existing data to derive products in shallow and difficult to reach areas that are suitable for use within the GEBCO Grid.

2.5. WP 5: Management

WP5 focuses on delivery of the operational and strategic management aspects of the project.

2.5.1. WP 5.1 Operational management

Seabed 2030 funds will continue to be managed through the IHO Secretariat bank account. The Seabed 2030 Director will be responsible for financial management, project status reporting to The Nippon Foundation, The GEBCO Guiding Committee (GGC) and Seabed 2030 Sponsors.

Activities will continue to ramp up from Year 6 onwards as we press ahead towards the 2030 vision. This, and our increasing visibility within the UN Decade of Ocean Science, will see the tempo increasing in Seabed 2030 Project activity. There is increasing external interest in collaborating in ocean mapping activities from CSB to full ocean mapping. Noting that the majority of Center staff are engaged in time consuming technical activity, there remains a need for a bolstered and capable team within the Project core.

The recruitments of the Head of Partnerships (HoP) and the Head of Communications & Decade Initiatives (HCDI) are already proving invaluable as the tempo of Seabed 2030 activity significantly ramps up within the Ocean Decade, and as we expand our stakeholders and have more than doubled (from Year 4) our MOU partners. Shifting these 2 posts from 0.5FTE to 0.8 FTE will provide necessary support in the delivery of Seabed 2030 outcomes particularly in:

- Monitoring and management of workplan
- Management of the growing body of strategic MOU partners who require bilateral engagement on a more frequent basis.
 - Noting that failure to engage frequently with MOU partners and manage expectations/involvement in the Project risks lack of their confidence in us and a stalling or decline of existing numbers.
- Expanding our MOUs significantly beyond the Y5 current number of 28 (which is more than double the number from Y4).
 - A further 11 are under consideration
 - Members State MOUs take an increased level of management.
- Supporting engagement to increase our current level of 175 (above Y5 target of 170) partners to around 215.

- Engagement with extensive Decade initiatives and science projects that wish to align with Seabed 2030.
- Delivering a robust plan for extensive external communications across all media channels to generate, and retain, interest amongst the widest community of stakeholders and supporters. Particularly against the backdrop of competing high profile Decadal activities.

2.5.2. WP 5.2 Strategic direction

The hard work of Project Team members is ongoing and we continue to build our numbers of wider supporters/contributors. A flagship programme of the Ocean Decade, Seabed 2030 remains a focus for global bathymetric mapping in support of achieving UN Sustainable Development Goal 14 (Life below water). Our mission deadline aligns with that of Ocean Decade outcomes and we are a pillar of “the science we need for the ocean we want” which increases our visibility and underscores the importance of bathymetry as a foundation layer for all ocean science. Year 5 was busy and we can expect an increased tempo of activity in Year 6 and beyond as we raise our profile and other Decadal projects begin to contribute to our own.

User input and feedback is essential if we are to shape Grid growth, development and portrayal to meet user needs. To achieve this, we must continue to build our relationship with the user community to develop a growing body of supporters who will help us drive forward our mission.

There is still a need to provide justification to some potential contributors to encourage them to provide data to Seabed 2030 and also to better define user priorities for mapping. An additional, and important, engagement strand has been the launch of our Use Cases Community Survey (*Wind in the Sails*) to seek user views that will allow the Project to better collate and quantify the value and benefits of seabed mapping and to identify user-defined priority areas.

This complex work is moving to next stages of development towards providing benefits analysis, a review of key areas and targeted community engagement to facilitate a Global Priority List which will be the first of its kind.

A body of evidence already exists that supports the relationship between ocean floor shape and the many ocean and climate processes/issues that are touched on above. That said, while much of this is open source, it is not all in one place. We started the Seabed 2030 project with a strong commitment to avoid duplication and instead work towards fostering a close collaboration for the most efficient use of global resources. In that spirit, we are launching a piece of work, named Wind in the Sails (WITS), with Blue Economy solutions company NLA International (MOU partner) to start to gather this evidence together.

The more data we acquire about the details of seabed shape, the more we recognize that the ocean and its floor are more dynamic than we ever thought. By cataloguing models used to help quantify the environmental, social and economic values and benefits of seabed mapping, we will be in a much better position to articulate the areas in greatest need of being surveyed – and, crucially, why government, industry, academia and philanthropy should support such activity.

WITS supports the Seabed 2030 Project by providing empirical evidence to enable the development of a prioritised targeted survey strategy. The ultimate aim of this three phase project is to unite the global hydrographic community and operators within the maritime domain around a 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 gridded depth variable resolution.

The findings within this report cover Phase 1 and Objective 1 of the overall recommended three phase approach. Before a strategy can be developed there is a need to understand the baseline of extant global survey work and activity that will support and may contribute to Seabed 2030 and, also, which users want hydrographic data, what type of data is wanted and where should Seabed 2030 surveys be focused and prioritised.

There is a challenging piece of work in both scale and complexity and has not been undertaken anywhere before (there have been smaller scale studies of some national waters but these are very localised and do not necessarily join up with prioritization of adjacent national waters or areas beyond national jurisdiction nor do they involve all global ocean stakeholders)

Project work began in May 2020 (Seabed 2030 Y3) and has continued in Y4 and Y5 thus:

- Y3/4 -Phase 1 – Rapid Evidence Review & Fast Action Priority List
 - Obj1 – Collate Known Mapping Needs (inc Online Survey#1)
 - Obj 2 – Fast Action Priority List
 - Online Survey #2
- Y5 Phase 2 – Detailed modelling, benefit extrapolation & need
 - Obj 3 – Catalogue premium models
 - Obj 4 – Model potential global benefit
 - Obj 5 – Develop final model (best fit model from those at Obj 4).

The outstanding work is now in Phase 3 – Benefits Analysis & Prioritisation thus:

- Obj 6 - Seabed 2030 Benefits analysis / review key areas (\$68K)
- Obj 7 - Seabed 2030 Prioritisation (\$56K)
- Obj 8 - Targeted community engagement (\$56K)

We propose to defer Obj 7 until Y7 (2023/4)

But for Y6, we propose to undertake Obj 6 and Obj 8 – the latter can be carried out in parallel to other objectives. Outputs will be as follows:

- Obj6 - Production of Seabed 2030 parameters, and Production of Seabed 2030 benefits documentation – Value Chain, Executive Fact Sheet, Value Proposition and a set of Use Case Evidence.
- Obj8 – Engaging with the full range of global ocean stakeholders, to inform both benefits analysis and global prioritisation work, (inc by survey and one to one informed user engagement).

Ultimately we can demonstrate on a global scale the priorities and benefits of ocean mapping, we can more strongly encourage politicians and decision makers in government, industry, academia and philanthropy to facilitate mapping of these areas

2.5.3. WP 5.3 Communication

In the relatively short life of the Project we have achieved a significant level of respect and recognition. We must still build on this to create much public awareness of Seabed 2030 activity and of the value of our work to humankind. This communication and outreach activity is fundamental to increasing levels of support across all sectors and not just from within the community who already know of our good work. We have seen evidence of increased

engagement and a growth in partners through our media releases, newsletters and our participation in major events such as COP26.

In addition to our standard PR activity and media engagement, we are now seeing increased media activity as part of our participation in the Ocean Decade. Nonetheless we are competing with other high-profile programmes and so we must not relax in our drive to service media attention whilst also ensuring we build, maintain and refresh relevant content across all media platforms. By doing this we will capture, and retain, the interest and support of the widest possible audience.

GEBCO's 120-year anniversary will be celebrated on 23 April 2023 during the opening ceremony of the 3rd session of the IHO's Assembly with potential secondary celebrations at the GEBCO Symposium provisionally scheduled for October 2023 in Tokyo. Noting also that the Alumni Conference is now scheduled for July 2023, we recommend deferring any Seabed 2030 event until 2024 or later.

2.5.4. WP 5.4 Capacity development

The Nippon Foundation – GEBCO Alumni community consist of some 103 people in 43 countries who are a hugely valuable resource for Seabed 2030 and, more generally, for stewardship of the oceans. They will be more effective if they are organized to facilitate communication with themselves, with others, and if we enlist them in projects. The Head of Engagement and Development provides this vital link and to coordinate alumni across discrete capacity development activities that support Seabed 2030.

3. BUDGET NARRATIVE

3.1. Centers

As reported in previous years, the salary component of the center budgets approximately equates to 11 Full Time Equivalent positions. Due to significant input from host institutions, at their own cost, the true number of staff contributing to Seabed 2030 activities across all centers is the region of 35 people. However, it is essential to retain and enhance output activities whilst countering downward budgetary pressures on these host institutions that, in the manner described, have traditionally cross-subsidised the Seabed 2030 budget in the operation of the Centers. Extraordinary global events have driven global inflation and, thus for Year 6, a rate of 7.4% (an average taken across Seabed 2030 host countries) has been added to the previous year's personnel costs.

3.2. Special Projects & Events

We propose to run a series of 8 series of Special Projects (SP) in Year 6 as follows:

- SP1: Greenland Crowd Source Bathymetry (CSB) continuation - see Section 2.4 above
- SP2: Global Crowd Source Bathymetry (CSB) continuation – see Section 2.4 above
- SP3: Media Content Generation - see Section 2.5.3 above
- SP4: Use Cases – Final Phases – see Section 2.5.2 above

- SP6: Grid Quality Improvement – see Section 2.2 above
- SP8: Multi-Resolution Grid development – see Section 2.2 above
- *Note: SP5 (Tech Innovation Strategy) and SP7 (Satellite Derived Bathymetry Ingest) completed in Year 5.*

3.3. Project Team & Alumni Coordination

The core Project Team budget includes fees (salaries/overhead/other support) for: Director, Project Administrator and the 3 functional Heads of:

- Engagement and Development
- Communications and Decade Initiatives
- Partnerships

Project Team activities (activities that are not Center-specific or undertaken by Director, functional Heads and Administrator) constitute the second component of the Project Team budget. These include: travel, meetings and communication activities. These amounts are based on nil-inflation-adjusted values for personnel costs only with an increase in travel to take account of a full time Director and the 3 functional Heads; and the increasing return to normal travel on business.

4. APPENDIX I – YEAR 5 BUDGET DETAILS

See separate Word document: The Nippon Foundation - GEBCO Seabed 2030 Year 6 Budget APPENDIX I

5. APPENDIX II – Year 6 PROGRAMME OF WORK SUMMARY

See separate Word document: The Nippon Foundation - GEBCO Seabed 2030 Project Year 6 POW Summary APPENDIX II