CMG

Collaboratory Mapping Greenland

Phase One

PINNGORTITALERIFFIK
GRØNLANDS NATURINSTITUT
GREENLAND INSTITUTE OF
NATURAL RESOURCES

Seabed 2030 Year 3 Annual Report
Appendix 2

Executive Summary

Greenland is a young nation of active local seafarers travelling between remote settlements and into the deep icy fjords, and highly dependent on sustainable fishery along the shelf. Greenlanders live remotely, but are also citizens in the globalized world utilizing modern technologies of mobile internet, GPS, and echo sounders. Greenlanders care about their community, the Arctic environment, and the globe.

Through this project, we would be given an opportunity to take part in the *Nippon Foundation – GEBCO – Seabed 2030 project* and contribute by providing depth data acquired through collaboration between our local communities. The data collection we propose will be done through on-ship engagement across Greenland, so called crowdsourced bathymetry. We aim to engage >50 fishing vessels of various sizes, >10 transport vessels and numerous small boats.

Bringing onboard the local communities on Greenland is essential to get the waters mapped as most areas are still poorly surveyed, or completely unsurveyed, and seldomly traversed by common, maritime traffic. Consequently, the project highly supports and interacts with the goals of the Mapping of Ocean Frontiers initiative. This is a Phase 1 of the proposed project, and if successful, we would look forward to apply for an extension if that will be given the opportunity.

Local whaling boat in Disko Bay, photo: Karl Zinglersen

Engaging seafarers in Greenland

Greenland is a seafaring nation. No roads exist between settlements across the sparsely populated country, so the waterways are the roads and highways of the country – often travelled by smaller boats for hundreds of nautical miles to get to the nearest town. Furthermore, the people and the country's economy depend predominantly on the resources of the sea. The sustainable catch of Greenland Halibut from small dinghies in the deep icy fjords has been booming, and the catch of the large Northern Prawn on the banks of the shelf has for years backed the national economy. Consequently, small and large ships travel the waters, and when you come to a new settlement you might ask for the best or safest route ahead and exchange tracks and experiences.

With this project we strive to engage with both the trawling corporations as well as the single fishers and hunters in the communities; both to include, with their consent, the data they collect into the Seabed 2030 project, but also provide them with the possibility to share their data among communities, and furthermore realize how scientific bathymetric data of the Seabed 2030 project can be of relevance to their activities.

The proposed community and crowdsourced mapping efforts are very much needed, as the vast majority of Greenland waters remains unmapped, and not within reach of common and global marine traffic. The project does consequently support the *Mapping of Ocean Frontiers* initiative.

Figure 1: If all fishery of Greenland volunteer to map the waters, their effort will highly support the goals of Seabed2030 - and provide themselves with analytical insight into the seabed morphology. Photo: Karl Zinglersen

Collaborative mapping in Greenland

Prominent, international scientific institutions have studied the oceans and fjords around Greenland to understand past and present, climate-driven processes of geology, glaciology, and oceans. These professional, academic efforts to map the seafloor of Greenland have been instrumental to our common understanding of the region and the history and future of the Greenland Ice Sheet. The collaborative work around the International Bathymetric Chart of the Arctic Ocean (IBCAO) within The Nippon Foundation-GEBCO-Seabed 2030 has been extraordinary in this regard. The outcome has not only used by the scientific community. For example, IBCAO Version 3.0 was used as a base when the Danish Geodata Agency produced their bathymetric overview map of Northern Greenland, Chart 3000.

Greenland's citizens and organizations have for decades been interested in visits by foreign scientists, and often provided support including logistics and local knowledge. Scientific institutions in Nuuk, such as Greenland Institute of Natural Resources, collaborate locally and internationally to study the environment of Greenland in order to enhance the sustainable activities in the region.

Figure 2: All settlements of Greenland are located at the coast, and the sea is a predominant resource for local and national economy. Dinghies and small size fishing vessel in Kangaamiut on the west coast of Greenland. Photo: Karl Zinglersen.

Greenlandic vessels have already participated in the gathering and contribution of data to the IBCAO-GEBCO bathymetric models through personal deliveries to the Greenland Institute of Natural Resources of bathymetric data from trawlers and travelling boats as well as through the OLEX navigational system services. More than 4 million depth soundings were collected from the voluntary shipmasters of only very few vessels. These data sets have played an important role in mapping troughs, banks, inland waters, and fjord systems, where the larger research vessels do not visit.

Potential of involvement and data sharing

The number of boats and ships is Greenland is higher than the number of cars and trucks, so the potential is great. Through this project we will involve local communities in a collaborate effort to strengthen the local and common knowledge of the submerged landscape beneath their vessels. People already do share safe routes between islands and rocks but have not had the technical ability to share bathymetric data across platforms and build a collaborate model together with the international scientific and hydrographic institutions behind IBCAO and GEBCO.

Through our local presence and contacts, our ability to speak the local language, Greenlandic, and access to local channels of communication (native language Facebook groups, telephone directories, long-term local partners, and access to the national database of fishermen and vessels), we can reach out and activate them in person. In addition, the mobile broadband internet connection has been highly developed in recent years with 4G in all settlements, and thus follow up and support much easier than few years ago.

We can be in direct contact with a great number of contributors, such as owners and shipmasters of trawlers, small and medium size fishing vessels, travelling boats, tourist boats, dinghies, and private boats.

Figure 3: The travelling boat of Nuuk, including police cutters, have already provided far-reaching lines of data along the Greenland coastline - and continue to do so through chartered cruises for tourists, scientists, and geologists. Photo: Karl Zinglersen

Consequently, we anticipate that such an effort of communication and technical collaboration will strengthen the ties between local maritime communities and the science networks. In terms of data gathering, only a small fraction of the local vessels in Greenland has participated until now, and only from Nuuk. All towns and settlements in Greenland have

access to the sea, and the number of boats and ships of any sizes is large relative to the population size.

Methods of collaborative mapping

Due to the applicants' profound familiarity with the coverage of existing multibeam data used in the IBCAO and GEBCO models, we know the limitations of the models, namely coastal fjords and inlets and will focus on these busy local waterways.

We aim to build up a project with strong ties to local operators and international science. Greenland Institute of Natural Resources in Nuuk will lead the local mapping efforts, community engagement and support. This will include meetings with local enterprises within commercial fishery of international scale - building on existing long-term relations, direct on-the-boat visits with shipmasters of vessels for fishery, whaling, tourism, and charter – and often also upon previous acquaintances of the project group or colleagues. The story of the project and the results could be spread in local newspapers, magazines, and social media. The scientists and technicians of the locally based applicant, Greenland Institute of Natural Resources, will assist the shipmasters with retrieving depth measurements from their navigation systems or install data loggers for new recordings. Through the project we will visit many locations of Greenland with a focus on particularly poorly mapped waters.

Figure 4: A local fisher with a dinghy in West Greenland. Dinghies are main transport vehicles of Greenland, where the number of ships and boats is higher than cars and trucks. Photo: Karl Zinglersen

The international collaborators in the Mapping of Ocean Frontiers, University of Stockholm and University of New Hampshire, will make certain that GPS and bathymetric data loggers are available and functioning, and that data can be retrieved and processed.

The approach and methodology of the project will strive to follow the recent guidelines of the International Hydrographic Organizations' Crowd Sourced Bathymetry Working Group (IHO, *IHO B-12 Edition 1.0.0 – IHO Guidance on Crowdsourced Bathymetry*, 2019). The Greenland Institute of Natural Resources has biannual meetings with the Hydrographic Office, of the Geodata Agency of Denmark, a member of the IHO and co-author of the guidance.

In terms of management of data and metadata the project will follow the guidance's chapter 3, applicable to data from vessels with no survey-grade instruments and sensors. Furthermore, the

project will perform cross-checks between collected data sets, remove biases, calculate uncertainties, and possibly correct these. Due to the access to authoritative, multibeam data sets by the applicant and partners within Mapping of Ocean Frontiers, we can validate and check for general inconsistencies in the collected crowd sourced data.

The processed datasets will be made available in 100 m grids for future versions of the IBCAO and GEBCO bathymetric models through the Arctic and North Pacific Ocean Regional Centre within the Seabed 2030 project hosted by University of New Hampshire and Stockholm University. Following the IHO guidance Chapter 5, the project will make the same processed data grid available under Creative Commons Attribution 4.0 International License, subject to changes by the IHO. Certain, national legislation of the Kingdom of Denmark might not make this possible. However, the Danish Geodata Agency is a co-author of the IHO guidance, so we hope for support.

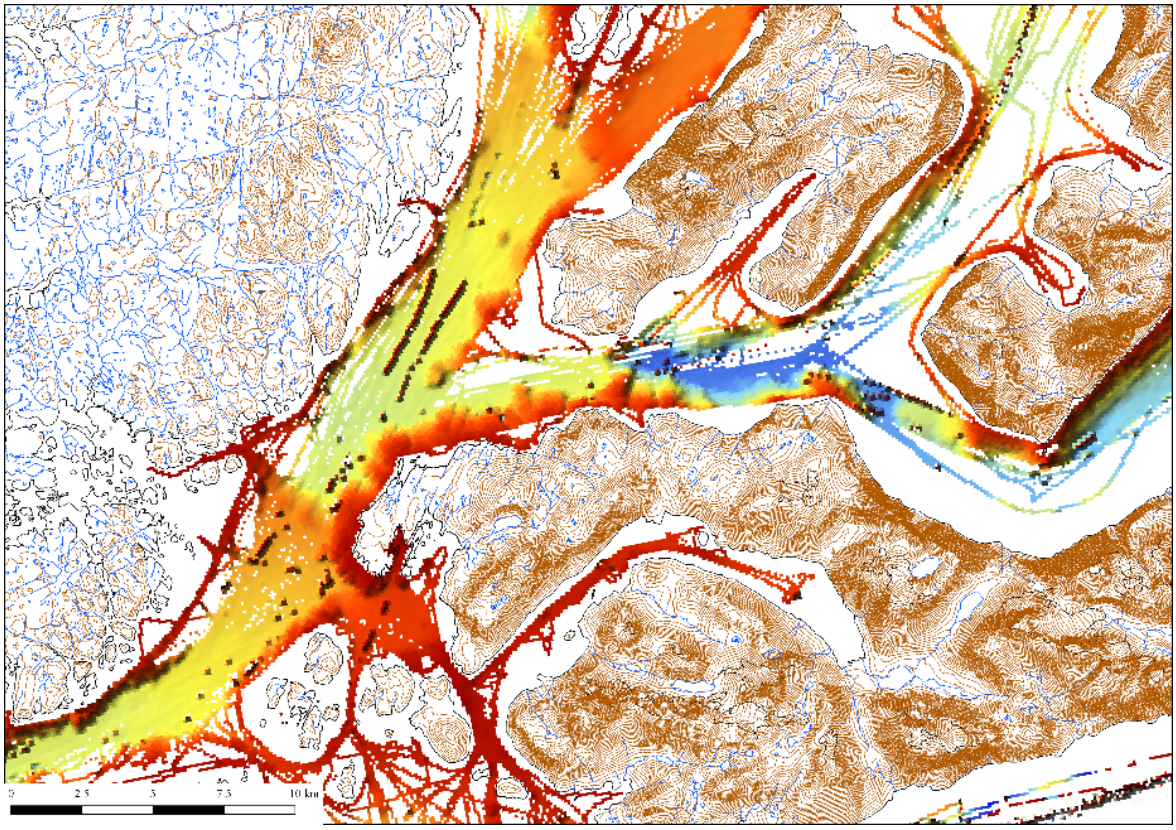

Figure 5: Crowdsourced bathymetry collected in 2015 applied to IBCAO and GEBCO models. Together the individual soundings and tracks describe the sea floor morphology accurately and with a wealth of details – but naturally not without erroneous data points. Data collection and modelling: Karl Zinglersen

Deliverables and dissemination

Scientific community:

- *Maps and models:* The project will deliver bathymetry products by combining the echo sounder mapping data from different vessels into a grid with a cell-size of 100 x 100 m on the standard IBCAO projection.
- *Data usage:* The projected surveys will provide new data which will be incorporated into the General Bathymetric Chart of the Oceans and International Bathymetric Chart of the Arctic Ocean (IBCAO).
- *Peer-reviewed publications:* The project will participate in publications planned within the overarching Mapping of Ocean Frontiers project.
- *Meetings:* Project results will be presented by the project partners at workshops and conference meetings when feasible where beneficiaries and stakeholders are encouraged to attend and discuss these outcomes. Costs for these efforts are not requested.
- *Popular science portals*: The project and key findings will be published and promoted on popular science portals, such as 'ResearchGate' and 'Academia.edu'.

Government and public:

- *National meetings:* The results will be presented discussed at a biannual Greenland National Nautical Committee, in which GINR is represented.
- *Government:* The results of the project will be made accessible and presented to government managers and advisory bodies for knowledge-based Marine Spatial Planning, e.g. the Ministries of Maritime Infrastructure and Natural Resources.
- *Education:* The project will prepare material for the Greenland education programme, i.e. accredited university field course in Nuuk 'Arctic Marine Ecosystems' and natural science teaching in public high schools (Nuuk); this is intended to promote natural science in Greenland and enhance societal knowledge on natural sciences and environment.
- *News and media*: Key findings and highlights along with visits from members of the international network will be promoted and published in newspaper articles and local TV/radio media if feasible.
- *Public events*: Key findings will be presented at public outreach events, e.g. 'Culture Night' at GINR, visited annually by 1,000-1,500 people from Nuuk – almost 10% of the town's population.
- *Facebook, Twitter and websites*: Progress in project and key findings will be promoted on the institute's social media accounts visited by the general public and stakeholders, such as government, NGOs, research institutes, funding agencies and public authorities.

The Nippon Foundation will be acknowledged by the project partners in all aspects of promotion and data usage.

Applicant information

Name: Greenland Institute of Natural Resources

Pinngortitaleriffik, Greenland Institute of Natural Resources (GINR), is a scientific institute in Nuuk, Greenland monitoring and researching biological natural resources in the sea and on land in Greenland and the Arctic. The institute is within the Government of Greenland and is headed by an independent board of stakeholders and a director. The institute collaborates with many scientific institutions across the globe with interests in the Arctic. The institute operates two larger vessels: a scientific trawler for offshore surveys (under construction, to be finished early 2021) and a medium-sized research vessel for inshore surveys, both equipped with multibeam instruments. Within the field of bathymetry, the project scientists have been and are currently participating in large projects such as #Modelling #Greenland #Seafloor, Hidden Habitats, NASA Ocean Melting Greenland, BedMachine v3, Seabed 2030/IBCAO, and NSF Greenland Rising among others. The institute holds a database of high-resolution bathymetry data across Greenland.

Dr. Diana W Krawczyk: Scientist at Greenland Climate Research Centre. Leading the #Modelling #Greenland #Seafloor program and acoustic instrumentation of Greenlandic research vessels at GINR. Co-author of latest IBCAO v4.

Email: dikr@natur.gl
https://www.researchgate.net/profile/Diana_Krawczyk

Mr. Aqqaluk D Sorensen: Scientist at Dept. of Environment and Minerals. Geophysical data processing and analysis, instruments, community meetings.

Email: aqqs@natur.gl

Mr. Karl B Zinglersen: PI of the project. Scientist at Dept. of Environment and Minerals. Spatial data management and analysis. Leading the NatureMap development. Co-author of latest IBCAO v4.

Email: kazi@natur.gl
https://www.researchgate.net/profile/Karl_Zinglersen

Ms. Jane L Plesner: MSc student at Institute of Geology, University of Copenhagen, associated with GINR.

Ms. Ninni Jeremiassen: MSc student at Institute of Geology, University of Aarhus, associated with GINR.

Greenland Institute of Natural Resources, Kivioq 2, GL-3900 Nuuk, Greenland. Telephone: +299 361200. Email: adm@natur.gl, website: www.natur.gl and www.gcrc.gl

Implementation of the project

The project is divided into work packages covering the methods and aims of the project locally in Greenland and internationally. Responsible parties are in parentheses.

1. Project management: (Karl Zinglersen)
    a. Collaboration with the Nippon Foundation – GEBCO – Seabed 2030-Mapping the Ocean Frontiers
    b. Project meetings and management
    c. Project budget
    d. Communication and public relations (Communication office)
2. Data collection with large scale data participants in Nuuk: (Aqqaluk Sorensen)
    a. Meetings with participants (Aqqaluk, Diana, Karl)
    b. Data acquisition, management, and processing (Students)
    c. Feedback to users (Aqqaluk)
3. Data collection with small scale data participants and communities: (Aqqaluk Sorensen)
    a. Field work in two towns/settlements (Aqqaluk Sorensen, Karl Zinglersen, students)
    b. Data logger provision and installation (Students)
    c. Data acquisition, management, and processing (Students)
    d. Feedback to users (Aqqaluk Sorensen)
4. General data management and standards (Karl Zinglersen)
    a. Compliance to IHO guidance for metadata and quality assurance
    b. Gridding and export to IBCAO and GEBCO bathymetric models
5. Science and dissemination (Diana Krawczyk)
    a. Scientific analysis and discussions
    b. Scientific dissemination in papers and scientific communities

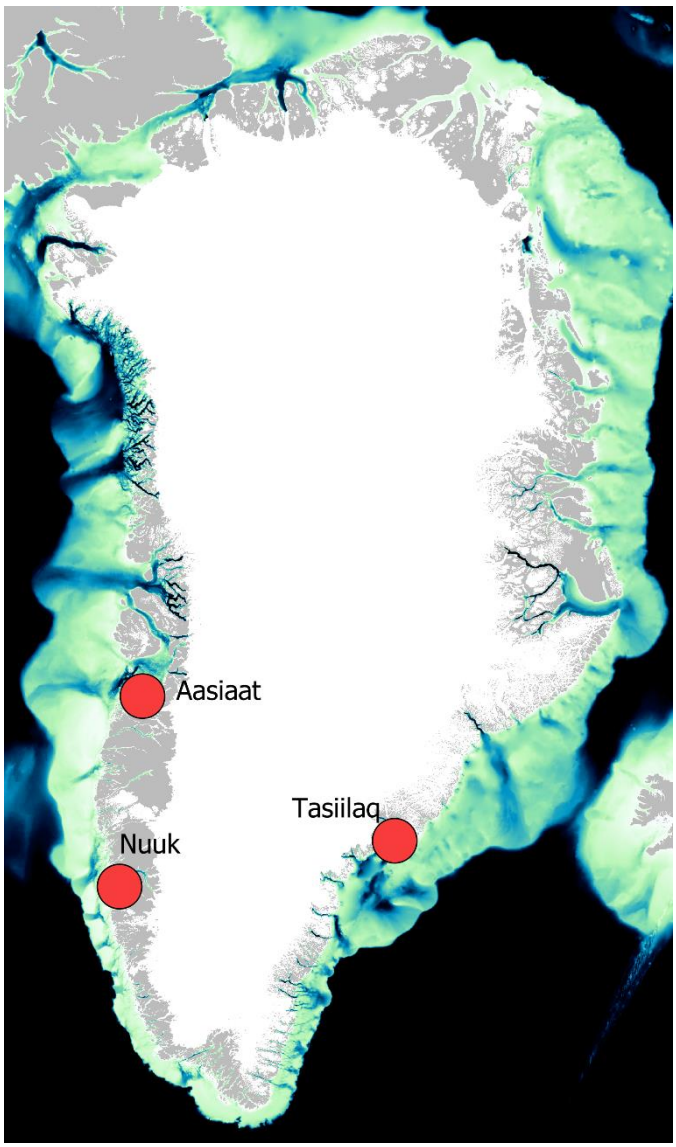

Figure 6: Proposed settlements for field work, subject to changes. Nuuk is the capital of Greenland where major trawling companies reside. For Aasiaat, particularly the near shore areas are of interest.

The scientific analysis and dissemination will be conducted in collaboration with the Mapping of Ocean Frontiers project group.

Project timing

Tentative planning in consideration with other parallel projects

Period	**Activities**
February 2021 to March 2021	Start up and provisioning: Start up meetings, meetings with stakeholders and large-scale data partners, communication to communities, preparation for IHO guidance compliance including data management framework, preparation of data loggers, communication to relevant hydrographic authorities.
Outputs	*Meeting minutes with data participants in Nuuk, IHO compliance document, data structure guideline, data loggers received*
March 2021 to March 2022	Work with large scale data partners, including data acquisition, processing, and management.
Outputs	*Raw data files, processed data files in correct format*
May 2021 to September 2021	Field work in selected communities, Aasiaat and Tasiilaq, including planning, travelling, visits to ships, local interest groups, and individuals, data acquisition, installation of loggers.
Outputs	*Raw data files, loggers installed, logbook of communication with individuals and communities*
October 2021 to March 2022	Processing of collected data, online and telephone support to participants,
Outputs	*Processed data sets ready for Seabed2030 related models*
March 2022 to May 2022	Dissemination and evaluation of project field work. Public relation communication of preliminary results.
Outputs	*National and/or local radio, relevant local, national and international media (radio, newspaper, magazines, social media)*
October 2021 to May 2022	Scientific analysis of preliminary and final results, scientific dissemination, if feasible involving students.
Outputs	*Participation in papers and if possible scientific meetings within Mapping of Ocean Frontiers network.*

The timeline and activity plan reflect the phase 1 of the project. If phase 1 is successful, we plan to submit a proposal for phase 2 of the project for further fieldwork to communities, involving of more organizations, and a larger scale public and scientific dissemination.

Project budget of phase 1

Activity	Items	Rate EUR	Sum EUR
Project management, economy etc., salary/days	5	500	2500
Communication and meetings, salary/days	5	500	2500
Support and preparation, salary/days	5	500	2500
Large-scale participants, salary/days	20	500	10000
Field work travel costs	2	2000	4000
Field work per diem and minor costs	16	100	1600
Field work accommodation	16	200	3200
Field work salary/days	16	500	8000
Data management and modelling salary/days	21	500	10500
Dissemination salary/days	10	500	5000
Total sum			**49800**

If the project's phase 1 is successful, we will apply for an extension to a phase 2 with a comparable budget and timeline.

Community data participants

The project aims to collaborate with vessel operators in Greenland waters, and have prepared a catalogue of potential participants and participant groups.

Large fishery companies:

1. Royal Greenland: Organization in Nuuk, 8-10 vessels, including offshore and inshore trawlers. Utilize MaxSea, OLEX. Considering installation of auto tracking multi beam for fishery. Point of contact: Mika Heilmann.
2. Polar Seafood: Organization in Denmark and Nuuk, unknown number of vessels, Point of contact: Kristina Guldbæk

Medium to small size fishery companies:

1. Collaboration or communication through the fishers' and hunters' association, KNAPK. Point of contact: Lars Dahl or Tonnes Berthelsen (director)
2. Fishery businesses across Greenland.
3. Uses often MaxSea or Garmin. Installation of data loggers needed.
4. Number of vessels to target: 10-30

Travelling boats or similar:

1. 60 North. Organization in Qaqortoq. 3 vessels, utilize MaxSea primarily, point of contact: Rasmus Chr. Rasmussen
2. Greenland Explorer. Organization in Nuuk, 1 vessel, MaxSea. Point of contact: Taatsi Berthelsen
3. Disko Line. Organization in Ilulissat and South Greenland, 5 vessels, unknown navigation software, probably MaxSea/TimeZero. Point of contact: Noëlle Simoud
4. Sirius Greenland. Organization in Sisimiut. 2 vessels, unknown navigation software, probably MaxSea/TimeZero. Point of contact: Bo Lings.
5. Tourist operators in Disko Bay area: Ilulissat, Qeqertarsuaq, Aasiaat and Qasigiannguit.

Single person tourist operators or fishermen

1. Owners of dinghies and motorboats
2. Communication via Facebook or local newspapers, or direct interaction for known persons.
3. Various navigation software: MaxSea/TimeZero, Garmin etc. – data loggers needed, e.g. 30 for a start.