Grant 869580	ArcticHubs

Deliverable title and number: D4.7 Described and communicated practical solutions to land use issues for each hub (D22)

Work Package: WP4

Type of Deliverable[1]: REPORT **Dissemination Level[2]:** PUBLIC

Lead Beneficiary: SLU

Lead Author(s): Per Sandström, Kirsi Forss, Maarit Kahila, Jerbelle Elomina, Anja Striberny, Amanda Karlsen, Sten Siikavuopio, Pasi Rikkonen, Niklas Jonsson, Magnus Karlberg, Håkan Lideskog, Mehmet Erk, Teresa Aschenbrenner, Rannveig Ólafsdóttir, Anna Guðrún Edvardsdóttir, Ragnheiður Bogadóttir, Ulf Tjåland, Hans Tømmervik, Sigrid Engen, Marit Klemetsen Arneberg, Jarle W. Bjerke, Seija Tuulentie, Taru Rikkonen, Roy Robertsen, Audun Iversen, Vigdis Nygaard, Håkan Lideskog, Kristine Lynge-Pedersen

Review(s): 1°/11/07/24 **Reviewer(s):** Ari Nikula, Pasi Rautio

Delivery: Due date: 31/07/24 – (M48) **Submission Date:** 30/07/24

1 ***Deliverable Type:***
R: Document, report (excluding the periodic and final reports)
DEM: Demonstrator, pilot, prototype, plan designs
ORDP: Open Research Data Pilot
DEC: Websites, patents filing, press & media actions, videos, etc.
OTHER: Software, technical diagram, etc.

2 ***Dissemination Level:***
PU: Public, fully open, e.g. web
CO: Confidential, restricted under conditions set out in Model Grant Agreement
EU-RES: Classified Information: RESTREINT UE (Commission Decision 2015/444/EC)
EU-CON: Classified Information: CONFIDENTIEL UE (Commission Decision 2015/444/EC)
EU-SEC: Classified Information: SECRET UE (Commission Decision 2015/444/EC)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869580.

D 4.7: Described and communicated practical solutions to land use issues for each hub

Table of Contents

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869580.

1. Executive summary

The development and application of Participatory tools and methods is an integrated part that permeate the entire ArcticHubs project. Consequently, a main objective of ArcticHubs was to develop, improve and apply participatory, interactive, multidisciplinary, and multi-actor tools. At the onset of the project some previously existing participatory tools and methods were already in use by some project partners. Such participatory tools include Maptionnaire, RenGIS, as well as Q- and Delphi methods. Here, our task was to apply these tools, observe and learn from the process and provide improvements. In some hubs, partners observed stakeholders' new and different needs for tools and methods. This led to the development of a series new participatory tools, including CodGIS, Serious Games, and new Unmanned Forestry Machine modules. What guided us in the development and improvement of all tools and methods, was to listen, learn and adjust based on needs and suggestions from involved stakeholders. Now, the ArcticHubs participatory toolkit build on methods that combines the benefits that digital and traditional methods can provide, to support both expert- and public participation. Such development have laid the grounds towards creative and improved participatory engagement during rights- and stakeholder processes.

The participatory tools provided via ArticHubs provide one or several of the following functions: collect data and knowledge, store collected data, communicate data among partners and stakeholders, engage and inspire participation, visualize and explain issues, produce and communicate results, communicate and explain proposed solutions, and finally support decision making. To summarize our overall work and to provide hub specific examples of applications and consequent outcomes of uses of the ArcticHubs participatory toolkits we designed and applied a Maptionnaire based survey on all ArcticHubs partners. Generalized, we asked partners what participatory tools they have used, what issues and conflicts have they addressed, and what the outcomes of these processes were. The outcomes of the survey, with hub specific examples of applications and outcomes of tools uses is provided in https://mpt.link/arctichubs. Here, examples from 13 hubs can visualized and information queried by stakeholders as well as the general public. These survey results will be built into the final ArcticHub results page summarizing all work during the project period https://projects.luke.fi/arctichubs/arctichubs-project-results/.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869580.

2. Framing and organization of this report

This report describe methods and tools used to identify, explain and address specific issues and conflicting interest among rights- and stakeholders, industries and planning authorities in individual hubs as identified during the ArcticHubs project period. The report could be seen as consisting of two parts. One is a conventionally written text and the other part of the report is map based, providing locations, visualizations, as well as explanations of identified conflicts and issues on each hub. The two parts should however be seen as one common report where text based and map based is combined.

The text based part of this report starts with a description of how the ArcticHubs consortium framed participation and defined the concept of Participatory tools and methods (hereafter termed Ptools). This section is followed by descriptions of each of the main Ptools and methods that has been applied during the entirety of the ArcticHubs project. Several of the key Ptools are already described in separate ArcticHubs reports and we will refer to these reports in the text.

The map-based part of this report demonstrate the following:

1. Provide a list of participatory tools and methods used to involve stakeholders in each hub case
2. Describe the conflict/issue identified throug use of these Ptools
3. List of stakeholders involved in adressing each specific conflict/issue
4. Describe the outcome in the specific case, including how practical solutions to potential and realized land use conflicts was communicated
5. Provide links to reports, publications, specific maps etc. that further describe the case

The answers to the survey questions are connected to places within each hub via query- and place based information provided through one common ArcticHubs wide map.

Some general words towards engaged participatory processes

The main objective of ArcticHubs work package 4 was to develop, improve and apply participatory, interactive, multidisciplinary, and multi-actor tools. Such tools and methods

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869580.

should lay the grounds towards creative and improved participatory engagement among rights- and stakeholders. The tools put to work, are aimed to be used by actors in specific hubs and in some cases by involved policy and decision makers to increase their knowledge and understanding of the possibilities of participatory methods in resolving the impacts of industrial effects on the environment, other livelihoods and on traditional land uses. Specifically, the toolkit was developed to improve dialogue among involved stakeholders and the general public with the objective to identify positive outcomes of documented issues and conflicts. Our toolkit build on methods that combines the benefits that digital and traditional methods can provide and to support both expert and public participation. The toolkit harbored in work package 4 has played key roles to support dynamic, mutual learning processes benefitting other ArcticHubs work packages with new and needed knowledge.

We have followed several paths towards fruitful participatory processes in ArcticHubs. We know that the context and prerequisites are different in each hub. It is important to understand these differences, both when designing the participatory approach and when evaluation its outcome. We list some rudimentary differences between hubs that user need to be aware of when designing the work processes, as well as when interpreting the outcome of the participatory processes.

- How well do you initually know the intended stakeholder group? How much have you worked with them before?
- The level of prior common knowledge of the intended stakeholder group play an important role when defining how you will adress conflicts/issues/cases.
- After evaluating the situations under 1 and 2, it is time to look through your participatory toolkit to select the most appropriet tools and methods to identify and adress the conflicts/issues/cases. Here it is important to evalute which are the most approprite methods to achieve the type of engagement you want.
- Apply tools and methods to the situation through iterative processes and be ready to re-evalute your choice of tools, as well as be ready to adjust and improve tools according to participants needs.

Incorporating understanding of these differences between hubs is necisarry to create an efficient, influential and solution oriented public participation processes.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869580.

2.1. What is a Participatory tool (Ptool) in the ArcticHubs context?

There is no clear definition of what constitute a Ptool. Early on in the ArcticHubs project, we defined a Ptool using the most common and broad definition, where we stated a "specific activity designed to encourage: joint analysis, learning and action". Thus, in ArcticHubs a Ptool is an activity (a verb) or a method, and not the actual instrument itself (e.g. a GIS). Our Ptools are however, sometimes referred to as CodGIS, RenGIS, drone based, Maptionaire etc. According to our definition, the participatory tool should designed and applied to stimulate and facilitate collaboration where rights- and stakeholders actively participate in defining and understanding issues and conflicts and identifying outcomes and solutions.

A participatory tool can be based on an actual instrument (e.g. a GIS) which should provide one or several of the following functions:

* Collect data and knowledge

* Store collected data

* Communicate data among partners and stakeholders

* Engage and inspire participation

* Visualize and explain issues

* Produce and communicate results, consequences and impact assessments

* Communicate and explain proposed solutions

* Support decision making

As a working definition we propose that a participatory tool as defined above, should also be interactive, multidisciplinary and multi-actor.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869580.

3. Exploring the ArcticHubs participatory tools and methods kit

A general description of the function and application of ArcticHubs' important participatory toolkit will follow in this section. How some of these Ptools have been developed and improved is further described in previously published ArcticHubs reports; **Maptionaire** (in D 4.1, D4.4 and D4.5), **RenGIS** (in D4.3 and 4.6), **Unmanned Forestry Machine** (in D4.2 and D5.4) and **Serious gaming** (in D6.9). Descriptions of other Ptools developed and used in ArcticHubs include CodGIS, Use of imagery from drones and cameras will follow.

Within the ArcticHubs project we have also developed and applied a number of participatory methods including **Q methods** and **Delphi** and future scenario analysis (in reports D 5.1, D5.2). The specific and hub-wise descriptions of application and outcomes of participatory process is provide via our Maptionaire based survey in https://mpt.link/arctichubs

Here follow descriptions of key participatory tools and methods developed, improved and applied in the ArcticHubs project:

3.1. Maptionaire

This section provides a general description of the Maptionaire Participatory tool kit. More detailed descriptions can be found in ArcticHubs deliverables D 4.1, D4.4 and D4.5. Examples of specific applications of Maptionnaire in individual hubs is provide in section "**4. Second part of the report: Survey for hubs about the land-use and sea-use conflicts and the Arctic Hubs results"** where the conflicts and issues identified and studied during the Arctic Hubs project in relation to land-use and sea-use are summarized and visualized in the following interactive map: https://mpt.link/arctichubs.

Public participation GIS (PPGIS) refers to map-based tools that enable data collection from a broad set of people striving for inclusivity and equality (Brown & Kyttä 2014). In the Arctic Hubs project the PPGIS tool that has been applied in most local study cases was Maptionnaire software by Mapita. The starting point was a standard version of Maptionnaire, which enabled implementation of map-based online surveys and export of the collected data as files. During the entirety of the project, Maptionnaire was applied in different hubs, and tested and improved in collaboration with the other Arctic Hubs

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869580.

partners and local stakeholders. The result is a new version of Maptionnaire with improved communication and interaction features: for example, discussions between participants, improved data visualization and communication of results through web-page functions.

The development of Maptionnaire in the Arctic Hubs project was done by applying PPGIS projects in the hubs, learning from them and based on the local needs, ideas and feedback improving the tool and its interactive functionalities. Altogether Maptionnaire PPGIS was applied in 7 hubs and 12 projects. Each application of the tools were different in nature but with some communality:

- Collecting information from the local stakeholders with map-based surveys
- Organizing workshops and interviews, using the PPGIS surveys in onsite situations
- Co-creating surveys and the engagement processes with local stakeholders
- Utilising dedicated webpages to share information and interactive maps, allowing discussions and commenting on project results

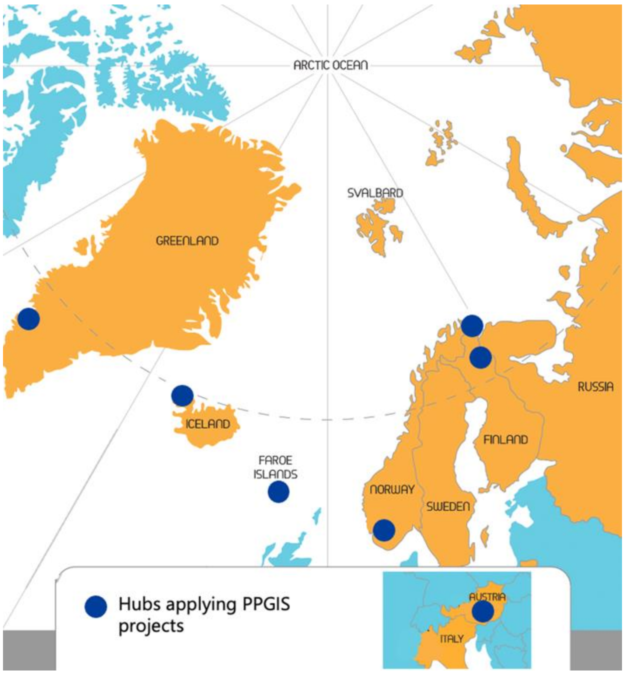


Figure 1. Hubs where PPGIS was applied

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869580.

The PPGIS work in the Arctic Hubs was initiated in 2020 in three selected pilot hubs; Inari in Finland, Westfjords in Iceland and Egersund in Norway. Through these cases Maptionnaire was introduced to the whole Arctic Hubs team as the pilot hubs gathered their first experiences with PPGIS data and engaged local communities with PPGIS tool. In this phase the beta version Maptionnaire tool allowed creating map-based online surveys where participants could mark their answers on maps as points, lines and areas. The survey could also include regular questions to collect background information, and e.g. values and opinions. **The results of the pilot phase were reported in the deliverable D4.1 Beta version of interactive PPGIS tool.**

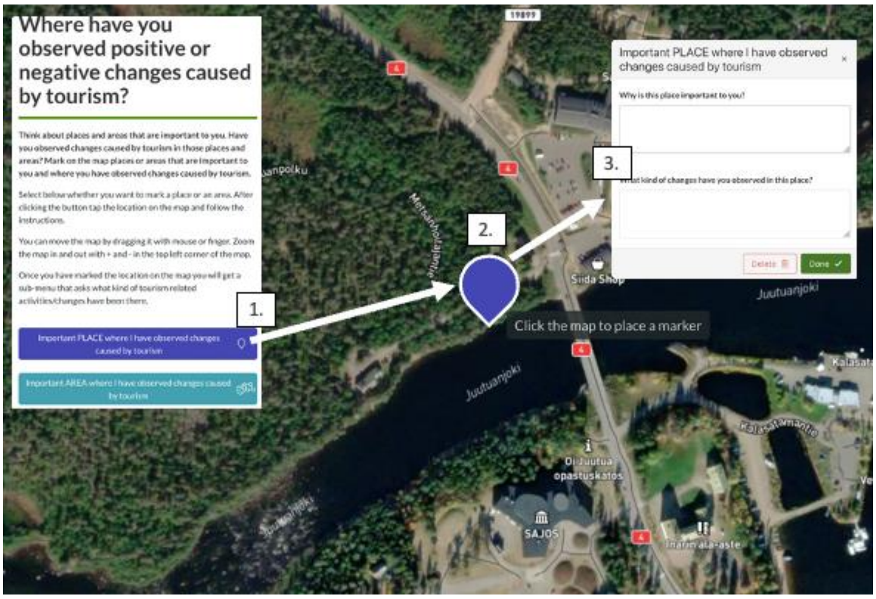


Figure 2. Example from the pilot survey about tourism in the Inari hub.

After the pilot phase more PPGIS projects were carried out in several hubs. **Results of this phase were reported in the *Deliverable D4.4 PPGIS and other participatory methods of the impacts of the Hubs* and in *Deliverable 4.5 More interactive PPGIS with improved data analysis and communication methods.*** New Maptionnaire solutions were developed and tested in the hubs including the following features:

- **Maps showing the responses by other participants:** In the survey participants could see which places, lines and areas other participants in the survey have marked on the map. This optional function can be especially useful when the situation deals with public answers.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869580.

- **Map-based discussion tool:** This feature allows online discussion to take place on the map in specific locations. Places, routes or areas can be predefined on the map, and clicking on them will open a discussion window, where participants can write their own comments and reply to other comments. Users with administrative rights have the possibility to moderate comments and participate in the discussion.
- **Website with capability of sharing results, commenting and embedding questionnaires:** The added website functions in Maptionnaire enable building informative engagement pages around the project topic and publishing the PPGIS results as interactive online reports. Among regular text, image and video features the functions allow embedding surveys, interactive maps and discussions.

The added website functions in Maptionnaire enable building informative engagement webpages around the project topic, as well as publishing the PPGIS results as interactive online reports. Among regular text, image and video features the functions allow embedding surveys, interactive maps and discussions.

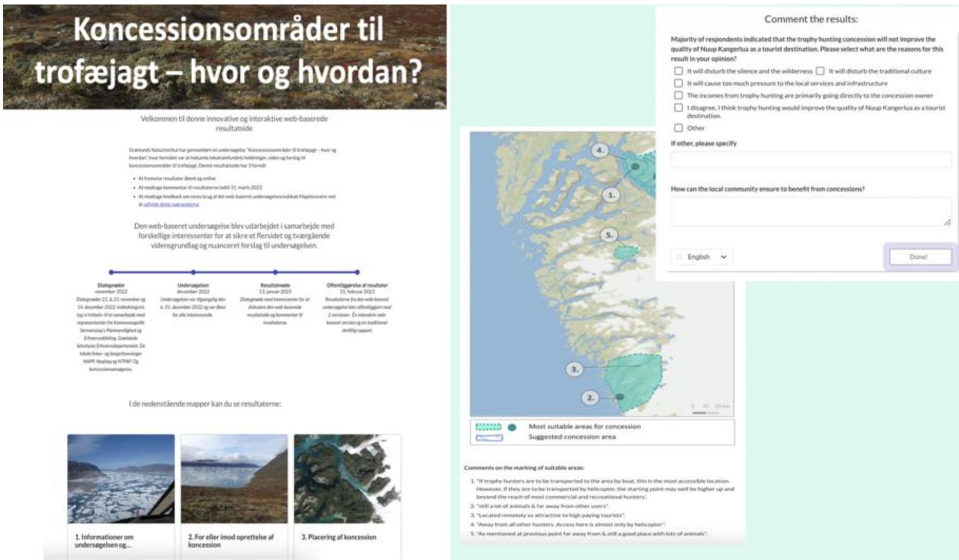


Figure 3. Screenshot illustrating the map-based discussion tool showing an image of the target area with a short description of the plan. The user can see the comments given by others and give his/her own response.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869580.

3.2. RenGIS

This section provides a general description of the RenGIS Participatory tool kit. More detailed descriptions can be found in ArcticHubs deliverables D 4.3 and D4.6. Examples of specific applications of RenGIS in individual hubs is provide in section "**4. Second part of the report: Survey for hubs about the land-use and sea-use conflicts and the Arctic Hubs results"** where the conflicts and issues identified and studied during the Arctic Hubs project in relation to land-use and sea-use are summarized and visualized in the following interactive map: https://mpt.link/arctichubs.

RenGIS (i.e. Reindeer GIS) is a participatory GIS (Brown and Kyttä 2014, Sandström et al. 2020) and one of several Ptools in the ArcticHubs toolkit. The original aim of RenGIS was to be a custom-developed tool for Sami reindeer herding communities to compile and communicate their Reindeer Husbandry Plans (Sametinget 2022a, Sandström et al. 2003, Sandström 2015, Sandström et al. 2023). The development of RenGIS has been a continuous process since 1998, initially led by the Swedish Forest Agency and lately by the Sami Parliament, when reindeer herding communities initiated the process in order to address their need for a GIS-tool to be used in consultations with forestry specifically. Researchers from the Swedish University of Agricultural Sciences (SLU) have been involved in the process from the very beginning. The aim of the tool RenGIS in the Reindeer Husbandry Planning process was to initiate a system to support co-production of knowledge that combine traditional knowledge among reindeer herding communities with updated data on other land uses. This aim has also been guiding the work in ArcticHubs where we have added new modules and data to the system (Deliverable 4.3 and 4.6). Throughout the years, work has followed iterative processes that allowed for a constant inventing, testing, evaluation and development of the tool. This way of working is also implemented in ArcticHubs.

The specific aim and role of RenGIS in ArcticHubs was for the system to function as the instrument for expert users and knowledge holders, i.e. reindeer herders to create and manage geographic data. As such, RenGIS is designed and used as the foundation for co-production of knowledge among indigenous communities and researchers. The core of the development and use of RenGIS was centred in the Swedish hubs of Gran, Malå, Gällivare and Jokkmokk. Parallel to the specific work carried out in ArcticHubs, work is also ongoing other reindeer herding communities in Sweden and experiences are

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869580.

continually shared among all users. Knowledge, experiences and methods from the work with RenGIS in the Swedish hubs is also made available to all participating hubs and learning cases. Hence, the RenGIS platform provide tools for enhanced and advanced levels of participation as it targets participation of specifically selected expert knowledge holders to work side by side with researchers to co-produce new knowledge.

At the upstart of the ArcticHubs project the most current version of RenGIS at the time already had numerous functions, purposes and roles. In addition to being a data collection tool, RenGIS has become the main data storage and display tool for a whole series of internal and external data sources. In addition to specific data about reindeer husbandry, RenGIS contain and are continually updated by the Sami Parliament with the most recent satellite image mosaics, topographic maps as well as data about all other land user's footprints, including hydropower dams, present and prospected mines, wind power parks, forestry and other infrastructure. In ArcticHubs, researchers from SLU, have added to that, by introducing new functions and data sets to RenGIS such as the data module HistoricGIS including state initiated mappings of reindeer husbandry as well as the industrial and infrastructure development within the reindeer husbandry area (a database in Swedish termed Omvärldsfaktorer). SLU has also explored and added new functions to RenGIS to facilitate analysis and visualization of data by reindeer herders as a direct response to their presented needs. Needs communicated to us during the continuous cooperation and communication between the research team, reindeer herding communities, land use planners and other land users.

ArcticHubs has contributed to the development of the new version of RenGIS. The work has been carried out in close cooperation between SLU, participating reindeer herding communities in each hub and ArcticHubs partner Gran sameby. The new data sets and applications in RenGIS build on earlier experiences with development of user-friendly modules and tools. Testing and implementation of new modules and tools have been pioneered in ArcticHubs participating reindeer herding communities. During the test and development face, data produced is owned and controlled by participating reindeer herding communities and SLU. Developed methods and tools however are made public as well as made available for all ArcticHubs partners in accordance with the open data policy and ArcticHubs data management plan. To summarize, RenGIS could support all Ptool functions defined in section 2.1 What is a Ptool in ArcticHubs context?.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869580.

3.3. CodGIS

Examples of specific applications of CodGIS in the Varangerfjord hub is provide in section "**4. Second part of the report: Survey for hubs about the land-use and sea-use conflicts and the Arctic Hubs results"** where the conflicts and issues identified and studied during the Arctic Hubs project in relation to land-use and sea-use are summarized and visualized in the following interactive map: https://mpt.link/arctichubs.

In contrast to RenGIS, CodGIS was not a pre-existing GIS tool when ArcticHubs was initiated. CodGIS is an attempt to combine telemetry and GIS for collection, visualisation, and interpretation of migratory behavioural data of wild Atlantic cod (*Gadus morhua*) around aquaculture sea cages. Whereas the ArcticHubs participatory toolkit predominantly consist of tools that actively involve the people from different hub-communities, in CodGIS we take participation to a new level by collecting data from a nonhuman stakeholder. Our participant is the Atlantic cod, an important ecosystem indicator and valuable resource for local fisher communities. The Atlantic cod is an economically important species in Northern Norway, including the Varangerfjord. Possible interactions between salmon aquaculture and wild fish have been and are an area of conflict. Several studies demonstrate that Atlantic cod aggregate around salmon farms and feed on waste pellets (reviewed in Bøhn et al. 2024). Such aggregation may have negative consequences for local cod fishers for several reasons: 1) Aggregations of wild fish around salmon farms are inaccessible for fishing boats (Uglem et al. 2014), 2) feeding on pellets instead of natural prey alters the fatty acid composition of cod (Meier et al. 2023) and 3) the resulting change in nutrition status may affect fitness (Barret et al. 2018), 4) the change in habitat use may change spawning migrations and behaviour (Skjæraasen et al. 2022). The approval process of new aquaculture locations is an integral part of the Norwegian coastal zone planning process. In this process, geographical information about important spawning and fishing areas are essential to balance the trade-offs between nature protection and conversation, tourism and recreation, access to natural resources, and industrial use of area (e.g. by the aquaculture industry) (Integrated coastal zone planning (fiskeridir.no)). Upon establishment, the fish farmer is obliged to regularly monitor and report possible effects of the fish farm on the recipient. Such monitoring includes first and foremost i) discharge of sea lice through sea lice counts at the farm, ii) monitoring of disease outbreaks at the farm, iii) monitoring the effects of discharge of organic matter and chemicals underneath the sea cage through

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869580.

analysis of sediment samples. Notably, potential interactions with wild fish are not part of this monitoring process.

Acoustic telemetry is a widely used dynamic tool to monitor terrestrial and aquatic animal movements (Hussey et al. 2015). Data collection with passive acoustic telemetry consists of two components. Firstly, a set of receivers are deployed at pre-defined fixed positions. Secondly, receivers record transmitter signals that are emitted in predefined intervals once an animal equipped with a transmitter enters the proximity range of the receiver. The output consists of millions of data points that can be subsequently used to derive information about short- and long-term movements and habitat use (residency and site fidelity) over a daily and seasonal range.

In CodGIS we tested the application of passive acoustic telemetry to monitor the migratory behaviour of a total of 37 Atlantic cod, equipped with transmitters, and released in proximity to salmon cages in a North-Norwegian fjord over a ten-month period (Figure 4). Data was recorded by 11 receivers (two of which were lost during the study and data from these were never retrieved) (Figure 1). The fish were captured and released at two time points (1) End of June, 2) beginning of October 2020). The use of wild cod was approved by the Norwegian Food Safety Authority (FOTS ID 23299). In total, 1,320,100 datapoints were registered.

The telemetry dataset was processed using ArcGIS Pro and stored in a geodatabase format. The dataset is Time Enabled which means that the spatiotemporal data can be analysed not only in space but also in time in ArcGIS pro. This temporal information was used to create animations and Heat Maps of the fish' movements ([CodGIS_60sec on Vimeo]). Such animations are powerful to illustrate the dynamics of behavioral data taking both the spatial and temporal dimension into account.

We further summarised the recorded data inform of an abacus plot using the R Package glatos (Holbrook et al. 2017), which provides a detailed overview of the spatial-temporal registrations for each single fish (Figure 5). Our analyses revealed that a major part of the group resided in close proximity to the fish farm for several weeks after release, indicating that most individuals were attracted to the fish farm. This was the case for both the fish that were released end of June and beginning of October. Some individuals resided even almost the entire registration period close to the fish farm (e.g. ID 13, ID38, Figure 2). Other individuals left the area and were not found again (ID3, ID4). Four fish were only detected on one day after release and were excluded from further analysis. The average registration period of all fish was 166 ±73 days. The residence of the fish at the different

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869580.

locations was expressed as a residence index (the number of days registered at one locality, divided by the number of days registered over the whole registration period) (Figure 6). A statistic comparison (non-parametric Friedman test) of residence indeces at the different stations confirmed a significantly ($p<0.0001$) higher residence at the fish farm compared to the other locations, with exception of station 4 (Eastern border) that was located relatively close to the fish farms. Twenty-three out of thirty-three (69.7 %) of the tagged fish were more than 50 % of the detection days found at the fish farm. We could not register an overall common pattern of swimming depth underneath the salmon cages with large variations over time and between individuals detected (example of daily swimming depth registration presented in Figure 7).

A few aspects are limiting the scope of interpretation of our CodGIS study. Unfortunately, the anchoring of some receivers failed due to stormy weather conditions in autumn. Some of the receivers (receiver 4) could be retrieved at a different location, but due to drifting we cannot be sure of the excact location when fish data was registered. This could be avoided in the future by more secure anchoring of the receivers and the addition of a GPS tracking device. Also, a receiver array covering larger parts of the area would provide more information about where the fish were located in times of absence. A second receiver array in a location without (or prior to the establishment of) fish farming would furthermore provide an important control data set, showing the natural migratory behaviour in the absence of fish farming. Even though logistically challenging, a recapture of the cod would provide highly relevant information on growth, stomach content and fatty acid composition. Overall, accoustic telemetry as used in our CodGIS pilot study proves to be an interesting tool to study natural movements of aquatic animals in order to monitor changes in habitat selection and migratory patterns prior and after the establishment of salmon farms. With regards to the Varangerfjord area, it would be interesting to expand this to other economically relevant species, for example the red king crab (*Paralithodes camtschaticus*).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869580.

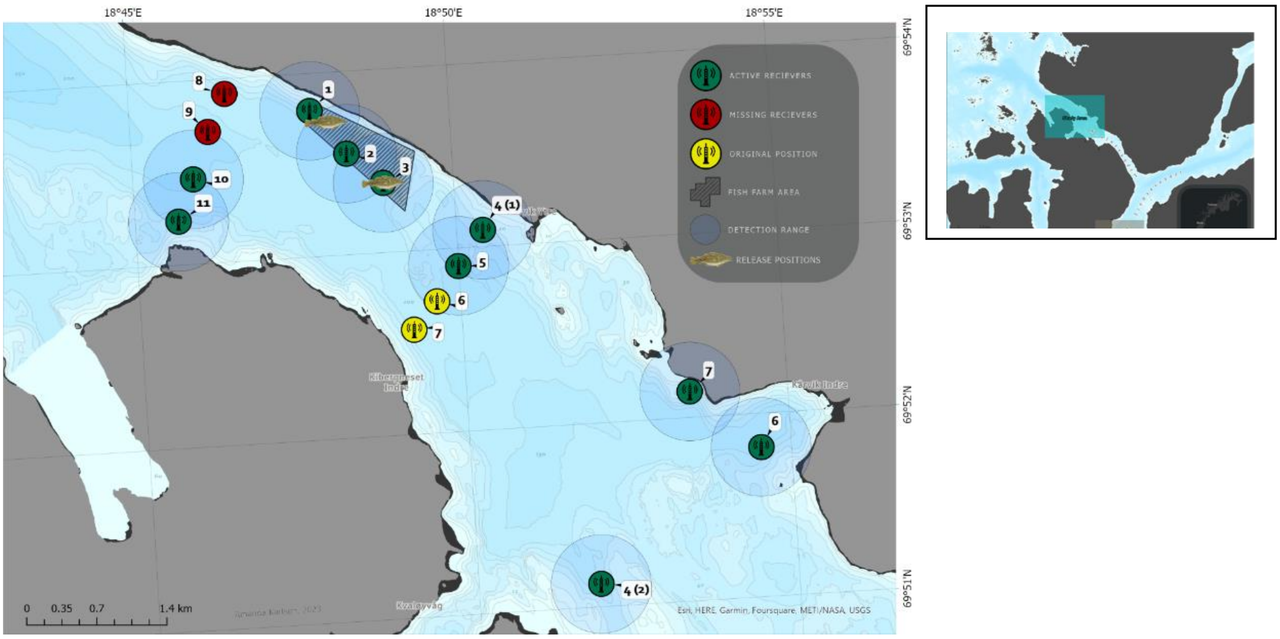


Figure 4. Study area and locations of receivers in proximity to Finnvika fish farm area in Kvaløysundet, Tromsø municipality, Northern Norway. Shaded area: fish farm.

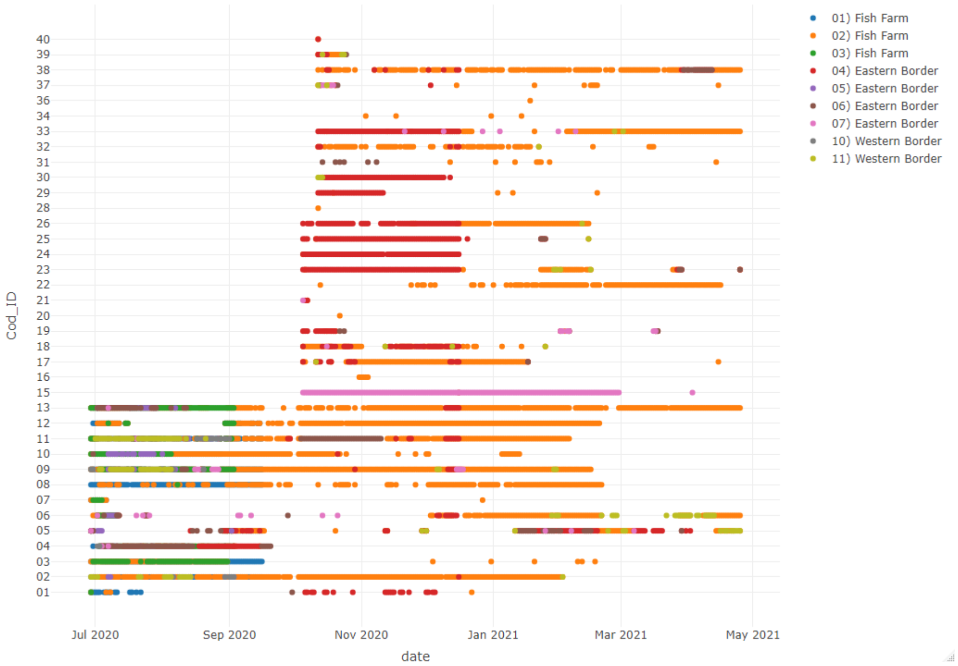


Figure 5. Abacus plot showing the daily registrations at receiver locations 1-3 (fish farm), 4-7 (eastern border), 8-11 (western border) (Figure 4).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869580.

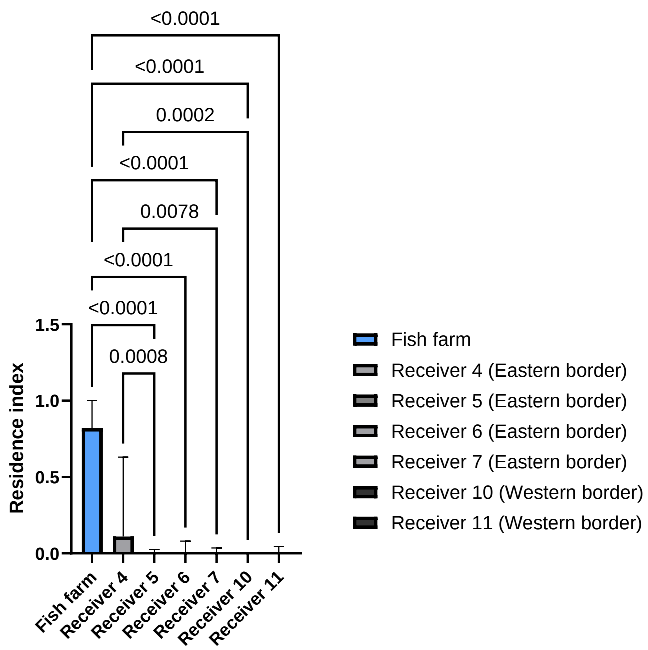


Figure 6: Residence index expressed as number of days registered at location/total number of days registered (median + interquartile range).

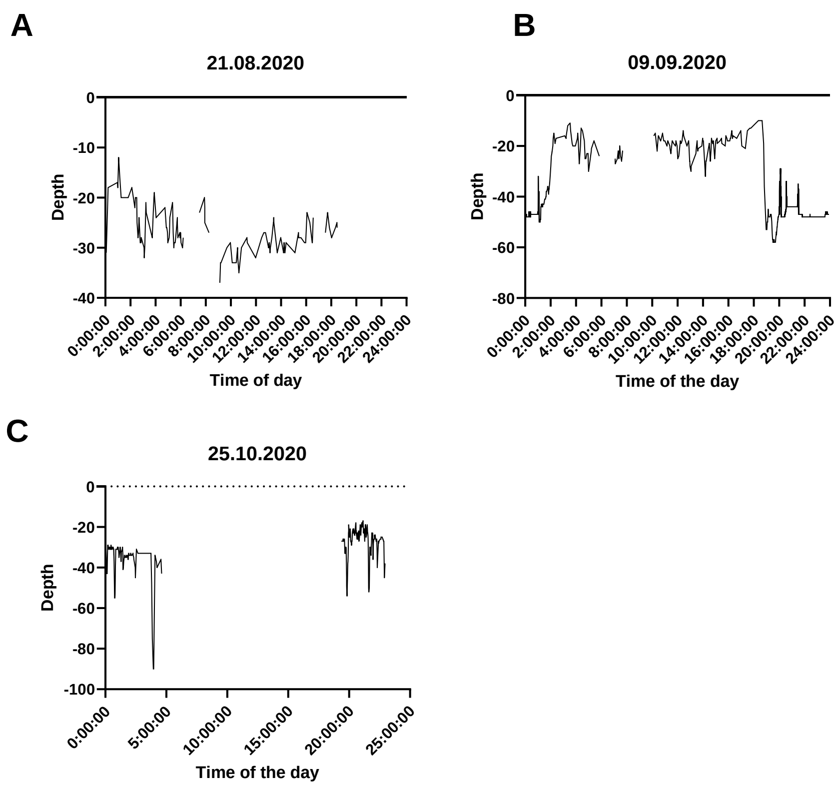


Figure 7. Examples of daily depth profiles below the fish farm registered in summer (A), early autumn (B) and later autumn (C) (cod ID #8).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869580.

3.4. Unmanned Forestry Machine

This section provides compiled information about the research conducted about the Unmanned Forestry Machine (UFM). More details about UFM can be found in deliverable D4.2 and D5.4. Examples of specific applications of UFM in the Malå hub is provide in section "**4. Second part of the report: Survey for hubs about the land-use and sea-use conflicts and the Arctic Hubs results"** where the conflicts and issues identified and studied during the Arctic Hubs project in relation to land-use and sea-use are summarized and visualized in the following interactive map: https://mpt.link/arctichubs.

The concept of Lean Forestry has been further developed where the main idea is that forestry operations should be conducted very precisely and only where and when needed e.g. by avoiding large scale single type of operations (Rautio et al. 2023, Ersson et al. 2023). The hypothesis is that UFM can be used as a tool to facilitate such socially responsible Lean Forestry and thus increasing the possibilities of harmonic coexistence of various Ecosystem services. Through workshops and interviews to document the goals and visions among reindeer herders in Malå reindeer herding community, the case study specifically focused on precise reforestation methods with particular focus on leaving as much as possible of lichen untouched during the process of soil scarification and planting. To meet these requirements, a complete autonomous architecture for conducting precise forest regeneration with a new type of ground preparation and planting device have been developed and demonstrated. This architecture includes a detection system to collect data from the surrounding environment as well as on-board the UMF and convert that into useful information for decision making. A Mission Planner is used to formulate the reforestation mission i.e. follow a predefined route covering the regeneration area and precision plant seedlings at a predefined density on suitable micro sites. This mission is further decomposed in the "Behavior Planner" into finite states (navigation, micro site selection, plant feeding, site preparation and planting etc.) with transitions in-between that are activated when certain conditions are fulfilled. When a state is enabled, a process of activities is then carried out. For the states involving driving the vehicle or using the auxiliary equipment, a local planner level is used to generate suitable local paths avoiding predefined ground properties and objects, crane trajectories etc. Then, a System Controller level is used to generate the actual control commands. This includes tracking systems to follow the local drive path and to follow the auxiliary equipment trajectories as well as other control signals (e.g. to pendulum arms, anti-spin, engine etc.).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869580.

The sequence for how autonomously to do precise forest regeneration while simultaneously avoiding lichen was demonstrated close to Malå Sweden 2024-06-04. To the left in Figure 8, the UFM at test site is shown and the blue markers in the right picture illustrates the chosen planting spots.

Figure 8. Demonstration of autonomous forest regeneration and lichen avoidance

Through new autonomous forestry machines lean forestry principles can be facilitated and all dimensions of sustainability can be improved simultaneously (Rautio et al. 2023). Thus, utilisation of Lean Forestry through UFM is a socially responsible solution enabling multiple use of forests with less conflict of interests and higher social acceptance.

3.5. **Serious Games** as a Participatory tool through the Development of Bridging Worlds Game

Examples of specific applications of Serious Gaming in the Malå hub is provide in section "**4. Second part of the report: Survey for hubs about the land-use and sea-use conflicts and the Arctic Hubs results"** where the conflicts and issues identified and studied during the Arctic Hubs project in relation to land-use and sea-use are summarized and visualized in the following interactive map: https://mpt.link/arctichubs. First we provide a description of the overall role of Serious Games and the specific work carried out in the Malå hub.

Project Overview of Serious games in ArcticHubs

"Bridging Worlds" is an ambitious real-time strategy, action-adventure RPG developed from Arctic Hubs' research. The project transforms empirical research on land use and forestry into an immersive narrative experience, highlighting the challenges faced by Sami reindeer herders in northern Sweden. The game exemplifies Clark C. Abt's concept of serious games by combining educational content with engaging gameplay. "Bridging

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869580.

Worlds" offers players a compelling story and a deeper understanding of Sami culture and environmental issues, aiming to raise awareness about socio-environmental impacts and promote sustainable forestry practices. A working prototype of the game is available to play on the project's website, providing an early glimpse into this innovative approach to research dissemination.

What are Serious Games?

Serious games, as defined by Clark C. Abt, are designed primarily to educate, inform, or train players rather than merely entertain them. These games blend the freedom and creativity of play with the precision of abstract thought, making them powerful tools for learning and development. Used in fields like education, industry, government, and personal development, serious games can teach complex subjects, model real-world scenarios, and help professionals plan strategies and make decisions in a risk-free environment.

"Sea Hero Quest" is a notable serious game designed to aid dementia research by collecting data on spatial navigation. With over 4.3 million players, it has gathered 17 years' worth of gameplay data, demonstrating how serious games can democratize scientific research and enable significant discoveries through gaming.

Research Approach for Serious Games

The research for "Bridging Worlds" includes interviews with reindeer herding communities, forestry workers, young people, and civil society members in Malå, Northern Sweden. This is further supported by workshop findings with Nilaskolan students in Malå, and visual materials like video, photographic, and drone footage of reindeer herding activities. Insights from Arctic Hubs and SLU, including GPS tracking data of reindeer migrations and expertise in tourism and land use, have also informed the game development.

Serious games: Co-Creation through Participation

First Visit: Community Engagement and Field Research in Malå (November 2023)

A series of educational and community engagement activities in Malå, funded by ArcticHubs and supported by SLU researchers, offered rich interactions and learning experiences. These engagements were not only a means of gathering data but also served as participatory tools to disseminate research findings and stimulate community thinking about land use conflicts.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869580.

The game design workshops for grade 7 students, based on Jesse Schell's 'The Art of Game Design,' transitioned from theoretical discussions to hands-on development of a 2D platformer using Construct 3. These workshops introduced students to the gaming industry and foundational game design concepts, allowing them to actively participate in the creation process.

In-depth interviews with the Sami community provided invaluable perspectives on gaming, cultural representation, and daily challenges. These insights are integral to ensuring the game authentically reflects Sami culture and experiences. The Malå Future Summit was another crucial engagement event where the game concept was presented, sparking interest and dialogue with various industry representatives and community members. These discussions highlighted the community's enthusiasm for a game that celebrates their lifestyle and addresses issues like climate change and industrialization.

Second Visit: Workshop at Nilaskolan (June 2024)

A workshop at Nilaskolan in June 2024 involved grade 7 students, allowing young people to project their perspectives of community members through imaginative character creation. Students completed worksheets defining "Malå's Heroes," detailing characters' names, occupations, beliefs, and more. These worksheets formed the basis for characters modelled in Tinkercad, a 3D modelling app designed for young people.

The characters created during the workshop were integrated into a game scene depicting an empty "market festival." These characters, along with scripts generated from the worksheets, reflect the perspectives and opinions of the community, showcasing the diversity of beliefs and occupations deemed significant by the young people. This participatory approach not only educated the students about game design but also engaged them in a dialogue about their community and its future.

Serious Game outcome in the Malå Hub

Target Audience

The primary target audience for "Bridging Worlds" is young people in northern Sweden, ages 8 and up. The game aims to educate children about Sami culture, land use, forestry, and environmental challenges. By engaging young players, the project hopes to influence a broader audience, including policymakers and the general public, through children's communication with their families and communities. Secondary audiences include educational institutions, environmental organizations, and cultural enthusiasts.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869580.

Platforms

The game is primarily aimed for launch on the Steam store, followed by a release on the Nintendo Switch. Steam's vast reach and accessibility make it ideal for young people and educators, while the Nintendo Switch's popularity among families and children ensures wide engagement.

Gameplay Experience

"Bridging Worlds" is a real-time strategy, action-adventure RPG that immerses players in the cultural heritage and environmental challenges of the Sami people in northern Sweden. Drawing inspiration from games like Pokémon Brilliant Diamond, Animal Crossing, and Pikmin, it combines elements of exploration, resource management, and community interaction. Players take on the role of a Sami reindeer herder, navigating quests and challenges that reflect real-life issues faced by the Sami community.

Game Spaces

The game has two main spaces:

1. **Community Space**: Similar to Animal Crossing, where players interact with community members, trade items, and prepare for migration periods.
2. **Migration Space**: Inspired by Pikmin, where players guide their herd through seasonal migration routes, managing resources and avoiding dangers.

Objectives and Rules

Objective: Successfully engage with a Sami reindeer herding community, researchers, and forestry representatives to ensure the herd's well-being through seasonal migrations.

Rules:

1. Manage resources like food, tools, and reindeer health.
2. Interact with community members for insights, items, and support.
3. Plan and execute migration routes while avoiding hazards.
4. Balance immediate needs with long-term sustainability goals.

Goals:

1. **Primary Goal:** Successfully complete the seasonal migration while maintaining the health and numbers of the reindeer herd.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869580.

2. **Secondary Goals:** Build strong community relationships, enhance the village with crafted items, and educate players about sustainable practices and reindeer herding's cultural significance.

Participants

The project is driven by a dedicated team, including MA and BA students from Canterbury Christ Church University who contribute to programming, audio production, design, research, art, and animation. Key research advisers from ArcticHubs' partners including Touch, SLU, and Gran sameby offering specialized knowledge in reindeer herding practices. Local community members, including Sami families, forestry professionals, and residents of Malå, Sweden, participate in workshops and interviews, providing valuable feedback that shapes the game's narrative.

For more detailed information about the team and their roles, visit bridgingworlds.uk .

By integrating community participation and expert insights, "Bridging Worlds" serves as both an educational tool and a medium for promoting dialogue about land use conflicts, ensuring that the research findings resonate with and are disseminated to a wider audience.

3.6. Images from drones and 360 degree cameras in a Virtual Reality environment

Examples of specific applications of these tools in the Gran sameby hub is provide in section "**4. Second part of the report: Survey for hubs about the land-use and sea-use conflicts and the Arctic Hubs results"** where the conflicts and issues identified and studied during the Arctic Hubs project in relation to land-use and sea-use are summarized and visualized in the following interactive map: https://mpt.link/arctichubs.

Innovative reindeer herders in Gran sameby explored new ways of reaching out and explain "the world view with hoofs". Reindeer as well as most prey species have evolved towards having an almost complete 360 degree view of the world. This is one of several responses to predator avoidance by always seeing and detecting movements all around you. In today's landscape often crowded with many different land use forms this evolutionary fine-tuning also come with a cost of seeing everything. In an attempt to visualize reindeer's views of today's busy landscape we explored possibilities to mount

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869580.

360 degree cameras on reindeer, reindeer herders and reindeer dogs. This work carried out in Gran sameby is documented in the following YouTube video: https://www.youtube.com/watch?v=NNdsPIG6R88A

In additions to this, drone images have been used to communicate issues related to land use conflicts between different industries and reindeer husbandry in the Gällivare and Malå hubs. Drone images also provided input to inform the UFM about the distribution of ground lichen to support smart and lean soil scarification.

Sources to the work in Gran sameby:

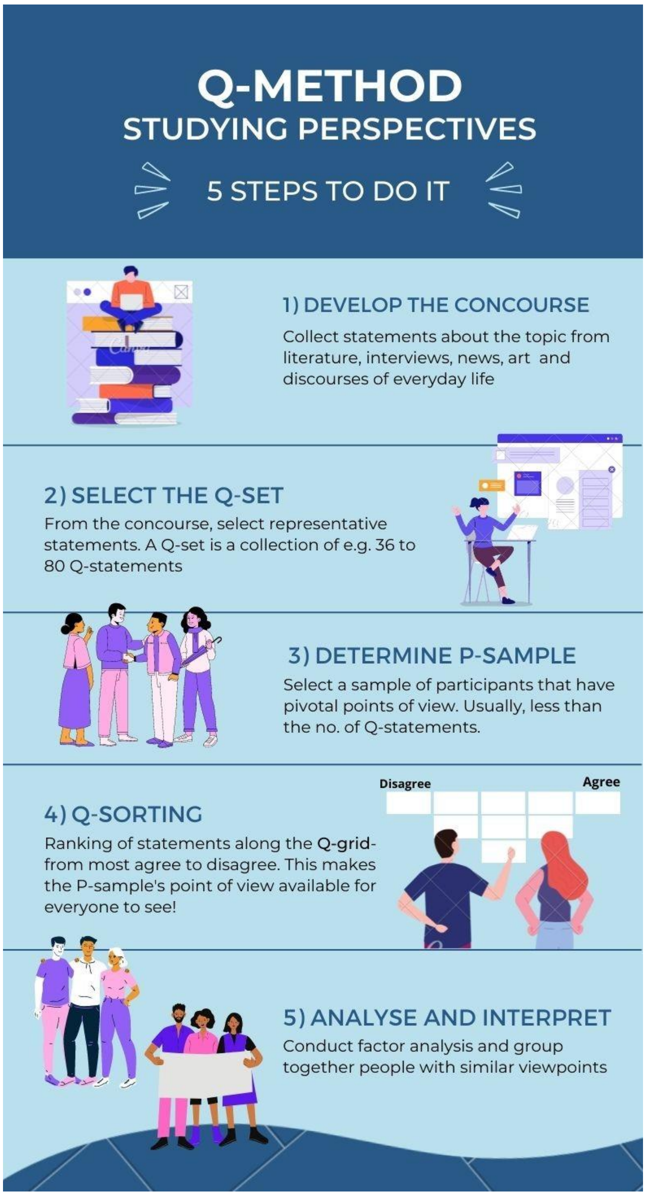
Studies and information on Vr Learning: https://www.newcastle.edu.au/highlights/our-researchers/education-arts/education/apps-for-humanity https://immersionvr.co.uk/about-360vr/vr-for-education/ https://www.futurelearn.com/info/blog/virtual-reality-education-immersive-learning https://xd.adobe.com/ideas/principles/emerging-technology/virtual-reality-will-change-learn-teach/

Notes on blindness:

Use of the clip from this VR experience is covered via fair use "17 U.S. Code § 107 - Limitations on exclusive rights: Fair use" and the Swedish Citat- & Återgivningsrätt. https://www.youtube.com/watch?v=tb5DwAZIQZw

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869580.

3.7. Q-method as a participatory method



Examples of specific applications of Q-methods in individual hubs is provide in section "**4. Second part of the report: Survey for hubs about the land-use and sea-use conflicts and the Arctic Hubs results"** where the conflicts and issues identified and studied during the Arctic Hubs project in relation to land-use and sea-use are summarized and visualized in the following interactive map: https://mpt.link/arctichubs.

As part of work package 3 "Assessment of socioeconomic and cultural impacts". We aimed to conduct an in-depth analysis of local people's perception in the arctic, with the question: How local stakeholders and citizens perceive the development of existing and new economic activities in the European Arctic and Alpine countries. To address our research aims and question, we used Q-method which is a mixed qualitative and quantitative method to study perspectives in a systematic and replicable manner (R. Brown 1993; Watts and Stenner 2005). Q-method is a scientific study of subjectivity – or the sum of behavioural activity that constitutes a person's current viewpoint, opinions, beliefs, values, tastes, perspectives and what they think and feel about a certain topic (Stephenson 1935), see figure 9 and more details are available in D3.4. Synthesis report comparative analysis on socio-cultural effects in WP3.3.

One of the key aspects that makes Q method participatory is its deliberate inclusion of a diverse range of stakeholders. The method provides a venue for stakeholder participation

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869580.

on the onset of the study: from the first step which is the development of the concourse which will be the basis of the survey that will later on be used in Q-sorting (Ramlo 2016; Zabala and Pascual 2016). Participant's viewpoints are also included in the interpretation phase of the results. Q-method is also used to characterise **how different groups of people think** regarding a certain topic, in this case, the Arctichubs. Through Q-method we can **explore** local people and indigenous **people's perspective about the conflicting land use** of the new and existing economic activities in their communities and we can give form and structure to the different range of perspectives without prioritization. This means that 'marginal' views are given the same treatment as 'mainstream' views. However, this depends on the ability of the researchers to ensure that diverse opinions are represented in the Q-set and suitable participants takes part in the study. The most important contribution of the results of the Q-method is its input to decision making and in providing suggestions in creating guidelines and policies (Elomina et al. 2024; Watts and Stenner 2012; LUKE 2022).

Inversely, Q-method also has its critiques. The main one being the representativeness of the concourse and selection of the statements. There's a risk that important perspectives might be missed if the statement set is not comprehensive enough. This is why including local experts, project partners and the policy board was crucial in the development of the concourse and the statements to reduce or avoid underrepresentation (Stirling and Simmons 2003). Additionally, as the Q-methods results are based on interpretation and as all interpretative approached, there maybe bias. To address these, we made sure that participants were asked follow up questions to clarify their responses. Additionally, all project partners were included in the interpretation of the results as each project site or hub has its own unique context that can potentially explain a certain viewpoint. Lastly, the forced distribution of the statements in an inverted grip may be perceived as limiting to the participants, However, according to Brown (1993) this has no significant effect on the results of the factor analysis. The forced distribution only makes participants to consider their judgements of each statement more critically.

Despite these critiques, Q-method remains a valuable tool in many research contexts, particularly for exploring subjective viewpoints on complex issues. Case in point, we were able to collect different points of view or opinion types on the development of economic activities in different hubs, see figure 10. In ArcticHubs, we conducted a two-tier approach: (1) Arctic region level Q-study which included all the hubs, see map; and (2) hub level Q-study which were conducted in 8 selected hubs (Kittilä, Gällivare, Egersund, Suduroy,

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869580.

Westfjords, Nuuk, Leoben and Val Germanasca), one hub per country including learning cases from Austria and Italy. The advantage of this approach is that we gain more confidence in the final interpretation of the findings since the two-tier approach will reveal regional and local nuances in selected hubs. All the findings are available in D3.4.

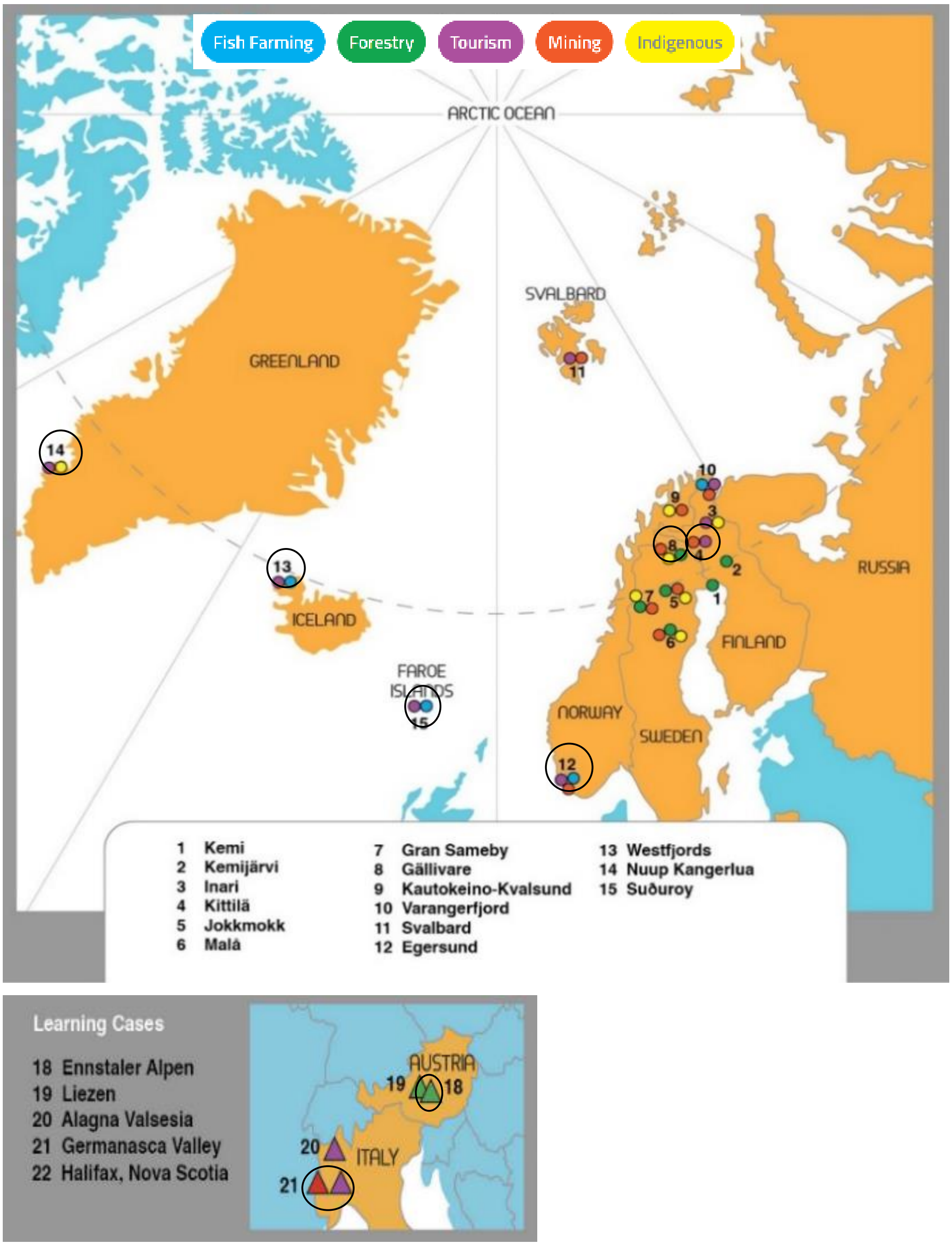


Figure 10. Arctic- hubs and learning cases where Q-methods have been applied.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869580.

Specific case example; conducting Q-method in Gällivare

Figure 11. Conducting Q-method in Gällivare Dec 2023. Collecting perspectives on development through Q-method.

To provide an illustrative example, we present the Gällivare case and our experience in conducting Q-method in this hub. First, our project partners conducted a semi structured interview with experts in corresponding hubs. Participants were chosen purposively: those who have the best insight, has influence on decision making and has differing perspectives about Gällivare development. Based on these interviews, we selected which representative statements are relevant with the help of our local project partners, SLU. From there, we created the Q-method study. To conduct Q-study in Gällivare, we started with a research stay in the municipality from April to March 2023 and on Dec 2023 to have a better context of the hub and meet the local stakeholders in person. We then conducted Q-method through an online survey and manual Q-sorting (ranking of the statements in an inverted grid). Participants were sent a link to conduct the Q-sorting while researchers guide them through the process and ask clarifying questions. Manual Q-sorting was with the use of a Q-grid board and statement cards, see figure 11. This way participants can explain their sorting as they go through the survey which makes our data collection more robust. After accomplishing the survey, we have a follow up question and answer and participants can also ask clarifying questions.

In Gällivare, we also conducted the Q-sorting in a focus group setting where each participant has their own set of statement cards and the Q-grid. This setup was particularly interesting as the participants were very enthusiastic in discussing not only about forest issues and operations but also about other issues regarding other industries, and the

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869580.

overall development of the municipality as it how it affects their forests and their way of life. Other topics were raised like representation of marginal groups in the municipality, their perspective on current decision making and what they think will happen to Gällivare in the future. All these information was collected and incorporated in the interpretation. Results were also sent to the project partners and local stakeholders for feedback.

Other hubs such as Westfjords, Nuuk and Faroe Islands also conducted an in-person data collection where participants were able to freely comment and tell their experiences about their area and how they perceive current development of the industries that are currently operating. Like Gällivare, all the hubs that conducted Qstudy also followed the same participatory process of developing the survey, accomplishing the survey and interpreting the results of the survey.

Conclusions of the application of Q-method

Q-method, as implemented in ArcticHubs project, demonstrates strong participatory elements. It engages diverse stakeholders, values subjective perspectives, adapts to local contexts, and provides multiple opportunities for active involvement in the research process. By combining qualitative and quantitative approaches, it offers a rigorous yet flexible tool for capturing and analyzing diverse viewpoints on complex issues

The participatory nature of Q method makes it particularly suitable for studying perspectives on development in the Arctic region, where diverse stakeholders and complex socio-ecological systems necessitate inclusive and nuanced approaches to research and decision-making. While the method has its limitations and may not be fully participatory in all aspects of research design, it nonetheless represents a significant step towards more inclusive and participatory forms of social scientific inquiry.

Some results of the ArcticHubs Q-study are available in video form, watch it here: https://www.youtube.com/playlist?list=PL8nmJRi21moHfuT8GKafERo3n6BcWm4jW

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869580.

3.8. Delphi methods

Examples of specific applications of Delhi methods in individual hubs is provide in section "**4. Second part of the report: Survey for hubs about the land-use and sea-use conflicts and the Arctic Hubs results"** where the conflicts and issues identified and studied during the Arctic Hubs project in relation to land-use and sea-use are summarized and visualized in the following interactive map: https://mpt.link/arctichubs.

Using the Delphi method in constructing future scenarios

In general, futures studies (also referred as futures research, foresight, futurism, futures thinking, and futurology) is the systematic study of possible, probable, and preferable futures, and analysis of their potential impacts on society. The methods and tools of futures studies are used to analyse and structure today's problems and challenges in a future-oriented way for decision making aiming at a systematic, participatory, holistic, future intelligence gathering and medium-to-long-term vision building process (Bell, 1997).

For scenario construction purposes in ArcticHubs project we used one of the most used futures studies methods, the Delphi method. Delphi method concentrates on gathering and categorising expert future views through surveys, interviews, and also in latter phases of the process, workshops. The aim of the method is to help and stimulate a group of chosen experts of local practices and regional and national decision-makers and authorities to work as a whole when dealing with complex future topics and/or problems (see Linstone & Turoff, 1975, Bell 1997, Kuusi 1999).

There are three key principles in Delphi method, namely: 1) anonymity, 2) successive iteration of future questions and topics, and feedback of results and 3) interactivity of future views. Delphi method usually aims to present desirable and probable future development, certainty estimation of probable future, and importance assessments of most influential driving forces, trends, or changes in operational environment. Common for all the foresight methods is the participatory nature within the implementation of a foresight process.

The Delphi process in ArcticHubs

The common elements that aims to follow for each of the foresight processes in Hubs were the following steps (in chronological order):

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869580.

1. The starting point was the local level discussions through workshops, webinars, stakeholder meetings or interviews for identifying the most important future topics for scenario preparation purposes. We also compared the findings (future topics) with earlier WPs results (e.g. PPGIS data (WP4) and interviews (WP1 and WP3)) and identified new emerging and regionally relevant future topics for scenario building process.
2. Simultaneously we conducted a review of relevant foresight literature search on hub and region-specific research. This was done to utilise local/regional/national foresight reports & strategic plans and programmes in identifying Hubs relevant future topics.
3. As a result, from steps 1 and 2 key future topics and questions for the Hubs and regions were further elaborated through hub's research group to be utilized in steps 4 and 5.
4. We conducted several expert surveys, workshop(s) and/or interviews on future threats and opportunities in each Hubs and/or regions. Those hubs that conducted expert surveys, future statements were prepared as part of the process involving local, regional, national participants to contribute to scenario construction.
5. We involved an extensive number of stakeholders to future workshops in order to construct Hub-specific alternative future scenarios. All the insight from steps 1-4 were utilized in workshops (e.g. feedback reports of the results were prepared for workshop participants from step 4 expert survey results).

Table 1. The list of Hubs and their focus in scenario processes.

Location and countries	The focus of Hubs and regions
1. Inari, Finland	A Tourism and Indigenous hub in municipality of Inari, Northern Finland
2. Northern Finland and Sweden	A Forestry Hub in Västerbotten, Norrbotten and Lapland in northern Sweden and Finland, based on Kemi region
3. Malå, Sweden	Forestry, mining and Indigenous Hub in Västerbotten, northern Sweden

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869580.

4. Suðuroy, Faroe Islands	The tourism and fish farming hub in Faroes
5. Nuuk, Greenland	Tourism and Indigenous People Hub in Nuuk, Greenland
6. Varanger, NO	The fish farming, tourism and indigenous hub in northern Norway
7. Westfjords, Iceland	The fish farming and tourism hub in in northwestern Iceland
8. Youth, International	The youth Arctic futures with an emphasis on Indigenous communities

Delphi method as a multi-actor approach

We used multi-actor approach in all steps of the foresight work. The work distinguished between three groups: (1) global industries, SMEs, international and European actors (including public administration, international organizations, NGOs), (2) indigenous and local communities and stakeholders in the hub regions and (3) regional and national authorities outside the hub regions within an interest in the topic of a Hub or region.

In all processes, the key stakeholders were the local land-use experts. Local level expertise is here understood as vernacular expertise which, according to Lowe et al. (2019), means the expertise that people have about the places in which they live and work, how these places function and how they relate to the wider world. For most of those processes, which conducted Delphi survey, national and regional experts were invited as respondents.

Delphi survey results and materials from previous work packages were used as a basis for workshop discussions to contextualize the future perspectives of the regions and hubs.

Contrary to expert surveys, the workshop participants were in most of the workshops locals. In the workshops they, thus, had a possibility to comment and evaluate both the locals' and outsiders' views of the future of the region or hub. Workshop participants were selected e.g. by asking the local recipients of the expert survey of their willingness to participate the workshops (Inari, FI), using the snowball method to identify interested local participants (Malå, SE) or engaging at least partly the same group throughout

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869580.

different ArcticHubs' work package workshops (Westfjords, IS). Exceptions of only-local workshop participation were Forestry workshop, Nuuk workshops, and Arctic youth workshop, which by definition was aimed at enabling the discussion of young people over national borders, especially because the youth are the ones the future affects the most. Forestry workshop had a wider geographical reach as well and it consisted of forest experts from national level and from local level, representing e.g. municipalities, nature conservation associations and reindeer herders. In Greenland, also Greenlandic national and regional actors were taken onboard due to the size of the society. In addition to the Arctic youth workshop, young people were specifically targeted in other processes as well. For example, in Suðuroy, FO, workshop and survey were conducted with young upper-secondary school students, around 80 people participated in the workshop, and 73 of the workshop participants also submitted their responses to the survey. Similarly, in Westfjords, IS, high-school students were targeted with a workshop of their own. Indigenous peoples were present in their home regions (Inari, FI; Malå, SE; Varanger, NO and Nuuk, GL) and also in the Arctic youth workshop around half of the participants were of indigenous origin.

Conclusions of applying the Delphi method

In ArcticHubs foresight processes, the aim was to construct scenarios and evaluate their impacts in different areas among partnering countries. The foresight work based on multi-actor involvement from local to global perspective in a situation where several, and also contradicting drivers are affecting arctic futures. Different hubs and regions had slightly different scenario processes, but the question of threats and opportunities in each of the hubs was included in all scenario work. Such alternative scenario information can be used further to interact and advise actors and policymakers in the field in a future-oriented manner. Through analysing and structuring today's challenges in a future-oriented way we can better prepare ourselves to seize the opportunities and tackle the threats. All Hubs represented nice variance between scenarios and their contents, and the results can be further utilized in local decision-making when heading for the desired future. As for the ArcticHubs project, the dissemination work through future forums shows firstly the way for this kind of future building.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869580.

4. Second part of the report: Survey for hubs about the land-use and sea-use conflicts and the Arctic Hubs results

INTERACTIVE MAP summarizing and describing issues and conflicts and consequent outcomes from application of Ptools and methods

This section of the rapport refer to results of the ArcticHubs wide inventory of hub based experiences. Here, conflicts and issues identified and studied during the Arctic Hubs project in relation to land-use and sea-use are summarised and visualised on an interactive map: https://mpt.link/arctichubs. The map is publicly available through this link.

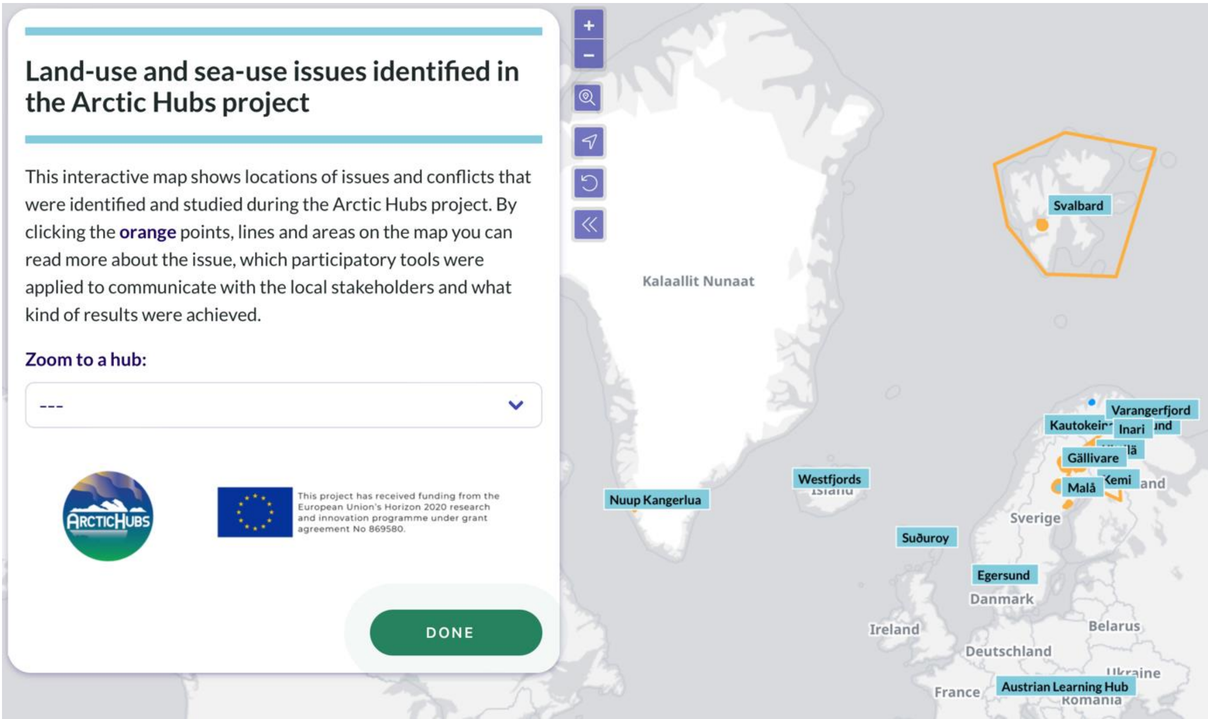


Figure 12: Interactive map about the land-use and sea-use issues that were identified and studied during the Arctic Hubs project. This online map allows visitors to view the locations and attached information on the map.

The interactive map was built using Maptionnaire. The information for the map was collected from each hub through a questionnaire where all ArcticHubs partners marked the issues they identified and collaborated to address and resolve together with local rights- and stakeholder during the entirety project. Thirteen hubs contributed information regarding their issues and altogether 48 locations were marked on the overall ArcticHubs map.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869580.

The issues are marked on the map either as a point, line or area and each map entries were accompanied with background information of the issue, which participatory methods were used when comminicating with the locals and what kind of results were achieved during the project. The questions we asked:

- When the project was active?
- What was the reason behind the issue/conflict?
- Who were the parties involved?
- What participatory tools were used when involving stakeholders?
- What results/outcomes were obtained during the project?

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869580.

5. Referenses

Abt, C.C. 1970. *Serious Games*. New York: Viking Press.

Barrett, L. T., Swearer, S. E., Harboe, T., Karlsen, Ø., Meier, S., Dempster, T. 2018. Limited evidence for differential reproductive fitness of wild Atlantic cod in areas of high and low salmon farming density. Aquaculture Environment Interactions, 10: 369-383.

Bell, W. 1997. Foundations of futures studies – Human science for a new era. Volume I. New Brunswick: Transaction publishers.

Brown, S. 1993: A Primer on Q Methodology. In *Operant Subjectivity* 16 (3/4), pp. 91–138. DOI: 10.22488/okstate.93.100504.

Brown, G. & Kyttä, M. 2014. Key issues and research priorities for public participation GIS (PPGIS): A synthesis based on empirical research. Applied Geography, 46: 122-136.

Bøhn, T., J. F. Strøm, P. Sanchez-Jerez, N. B. Keeley, T. Johansen, K. Ø. Gjelland, Sandlund N., Sæther B. S., Sætra I., Olsen E. M. 2024. Ecological interactions between farmed Atlantic salmon and wild Atlantic cod populations in Norway: A review of risk sources and knowledge gaps. Reviews in Aquaculture.

Elomina, J; Živojinovi, I; Calanasan, K. C. 2024. D3.4. Synthesis report comparative analysis on socio-cultural effects. Deliverable 3.4. H2020 ArcticHubs project. With assistance of [I. Dabic, S. Ivanovic, H. Pülzl, A. Lindau, H. Vacik, M. Giardino et al. BOKU University - University of Natural Resources and Life Sciences. Vienna, Austria.

Ersson, B. T., Hansson, L., Manner, J., Sandström, P., and Sonesson, J. 2023. Forest management in northern Fennoscandia: the need for solutions that mitigate conflicts during forest regeneration and increase the use of continuous cover forestry. Silva Fennica, 57(3). https://doi.org/10.14214/sf.23053

Holbrook, C., Hayden, T., Binder, T., Pye, J., Nunes, A. 2017. Glatos: A package for the Great Lakes acoustic telemetry observation system. R Package version.

Hussey, N.E., Kessel, S.T., Aarestrup, K., Cooke, S.J., Cowley, P.D., Fisk, A.T., Harcourt, R.G., Holland, K.N., Iverson, S.J., Kocik, J.F., Mills Flemming, J., & Whoriskey, F. 2015. Aquatic animal telemetry: A panoramic window into the underwater world. Science, 348.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869580.

Kunnas, J., Keskitalo, C.H., Pettersson, M. and Stjernström, O. 2019. The institutionalization of forestry as a primary land use in Sweden. In The Politics of Arctic Resources. pp 62-77. Routledge

Kuusi, O. 1999. Expertise in the future use of generic technologies. Epistemic and methodological considerations concerning Delphi studies. Helsinki: HeSE Print.
Kunnas, J., Keskitalo, C.H., Pettersson, M. and Stjernström, O. 2019. The institutionalization of forestry as a primary land use in Sweden. In The Politics of Arctic Resources. pp 62-77. Routledge
Linstone, H. A., and Turoff, M. 1975. The Delphi method: Techniques and applications. Available https://www.foresight.pl/assets/downloads/publications/Turoff_Linstone.pdf

Lowe, P., Phillipson, J., Proctor, A., & Gkartzios, M. 2019. Expertise in rural development: A conceptual and empirical analysis. World Development, 116, 28-37.

LUKE. 2022. Participatory research tools: Q-methodology to study perspectives. Accessed 06 July 2024 Available at: https://projects.luke.fi/arctichubs/2022/08/03/participatory-research-tools-q-methodology-to-study-perspectives/

Meier, S., van der Meeren, T., Skjæraasen, J. E., Bannister, R. J., Rasinger, J. D., Karlsen, Ø. 2023. Terrestrial fatty acids from feed oil in feed for farmed salmonids are transferred to the liver, gonads, and muscle of wild Atlantic cod (Gadus morhua). ICES Journal of Marine Science, 80(4): 1143-1154.

Ramlo. S. 2016. Mixed Method Lessons Learned From 80 Years of Q Methodology. In *Journal of Mixed Methods Research* 10 (1), pp. 28–45. DOI: 10.1177/1558689815610998.

Rautio P, Lideskog H, Bergsten U, Karlberg M. 2023. Lean forestry – a paradigm shift from economies of scale to precise and sustainable use of ecosystem services in forests. Forest Ecol Manag 530, article id 120766. https://doi.org/10.1016/j.foreco.2022.120766.

Sandström, P., Granqvist Pahlén, T., Edenius, L., Tømmervik, H., Hagner, O., Hemberg, L., Olsson, H., Baer, K., Stenlund, T., Brandt, L.-G. and Egberth, M. 2003. Conflict resolution by participatory management: remote sensing and GIS as tools for communicating land use needs for reindeer herding in northern Sweden. Ambio 32(8): 557-567.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869580.

Sandström, P. 2015. A toolbox for co-production of knowledge and improved land use dialogues – The perspective of reindeer husbandry. Acta Universitatis Agriculturae Suecicae - Silvestra 2015:20.

Sandström, P., Cory, N., Svensson, J., Hedenås, H., Jougda, L. And Borchert, N. 2016. On the decline of ground lichen forests in the Swedish boreal landscape: Implications for reindeer husbandry and sustainable forest management. Ambio 45(4): 415-429.

Sandström, S., Sandström, P. and Nikula, A. 2020. Who is the public and where is participation in Participatory GIS and Public Participation GIS. In: McDonagh, J. and Tuulentie, S. (eds.) Sharing knowledge for land use management: decision-making and expertise in Europe's northern periphery. Edward Elgar Publishing, Cheltenham, UK. 179 pp.

Sandström, P., Sandström, S., Roos, U. and Cronvall E. 2023. Case study: Reindeer husbandry plans – 'Is this even monitoring? In Monitoring biodiversity - combining environmental and social data. Editors E. C. H. Keskitalo, A. Allard and A. Brown. Pp. 333-348. DOI: 10.4324/9781003179245-17

Schell, J. 2008. *The Art of Game Design: A Book of Lenses*. Burlington: Morgan Kaufmann.

Sea Hero Quest. 2016. Available at: https://www.alzheimersresearchuk.org/research/for-researchers/resources-and-information/sea-hero-quest/

Skarin, A., Sandström, P. and Alam, M. 2018. Out of sight of wind turbines – Reindeer response to wind farms in operation. Ecology and Evolution 8: 9906-9919.

Skjæraasen, J. E., Ø. Karlsen, Ø. Langangen, S. Meier, K. M. Dunlop, van der Meeren T., Keeley N. B., Myksvoll M. Dahle S., G., Moland E. 2022. Attraction of cod Gadus morhua from coastal spawning grounds to salmon farms. Aquaculture Environment Interactions 14: 229-242.

Stephenson, W. 1935. Correlating Persons instead of tests. In *J Personality* 4 (1), pp. 17–24. DOI: 10.1111/j.1467-6494.1935.tb02022.x.

Stirling, A. and Simmons, P. 2003. a review of Q Methodology, Multi-Criteria Mapping and. In *Qualitative Research* (February).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869580.

Uglem, I., Karlsen, Ø., Sanchez-Jerez, P., Sæther, B. S. 2014. Impacts of wild fishes attracted to open-cage salmonid farms in Norway. Aquaculture Environment Interactions, 6(1): 91-103.

Watts, S. and Stenner, P. 2005. Doing Q ethodology: theory, method and interpretation. In *Qualitative Research in Psychology* 2 (1), pp. 67–91. DOI: 10.1191/1478088705qp022oa.

Watts, S. and Stenner, P. 2012. Doing Q Methodological Research. Theory, Method & Interpretation. London: SAGE Publications. Available online at https://methods.sagepub.com/book/doing-q-methodological-research, checked on March 2021.

Zabala, A. and Pascual, U. 2016. Bootstrapping Q Methodology to Improve the Understanding of Human Perspec tives. In *PloS one* 11 (2), e0148087. DOI: 10.1371/journal.pone.0148087

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869580.