Adequacy of data available for the Arctic Sea Basin

First Data Adequacy Report, Arctic Sea Basin Checkpoint

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Summary

Observations in the marine area are generally made with a specific purpose in mind. Costs can be reduced and marine knowledge improved when data are reused for multiple purposes. The EU is now actively moving towards this new paradigm. The Arctic Sea Basin Checkpoint (SBC) project addresses the availability of datasets, i.e. data provided in a coherent set from a specific source, describing a specific parameter (for instance temperature, salinity, bird behaviour, etc.), and will evaluate the quality and adequacy for multiple purposes in the Arctic.

The Arctic SBC is comprised of Work Packages (WPs) in the form of a literature review (WP1) and challenges (WP2-WP12). The literature search was performed with the objective of identifying datasets used in those documents and to evaluate whether the datasets are adequate for the purpose(s) of those documents. Each challenge is designed such that it addresses data availability and adequacy for a specific additional purpose, e.g. wind farm siting or assessing riverine input. The overarching objectives of this project are to examine the current data collection, observation, surveying, sampling and data assembly programmes in a sea basin, analyse how they can be optimised and deliver the findings to stakeholders through an internet portal. As part of the Arctic SBC project, a structure for collecting information on data adequacy was developed: the Content Management System (CMS).

The document at hand describes the Data Adequacy Report (DAR) therewith providing a view of the monitoring effort in the Arctic sea basin, with the aim to show how well the available marine data meets the needs of users. The monitoring effort is elaborated from three different viewpoints, which are clearly distinguished in three parts:

1) the needs of users (e.g. fisheries managers, coastal protection authorities, ports);
2) separate parameters (e.g. temperature, bathymetry, sea level rise);
3) the purposes for which data is used (e.g. marine spatial planning, assessment of (potential) MPAs, assessment of navigational risks).

The 625 documents identified by the literature review and registered in the CMS were used as input for this DAR. Another source of input was the challenges. This report will be reviewed by the Commission and the Panel (WP14). The feedback and comments, including any other new information, will be addressed in a second DAR.

The structure of the CMS allows for the presentation and analysis of the adequacy from many different angles and perspectives, of which the main are presented in this DAR.
In general we have found that the datasets that are available and have been evaluated in the present study usually have a quality that has a limited match with the requirements for the purpose for which it is used. For the spatial and temporal aspects, in most cases there was an association between the quality (i.e., resolution and coverage) and data requirements (match of quality for a specific purpose). As (for at least most challenges in the present project) the focus is on the entire Arctic region, a partial mismatch can be expected for many European data sources (such as EMODnet) which only focus on the European part of the Arctic. Only a small fraction of datasets were classified as unsuitable for specific purposes.

Within the scope of this study we identified some data sources and data sets that are particularly 'popular' for Arctic based studies, which indicates that those datasets are reused. It was also found that the original purpose for which data was generated is often not reported or not known. In case the purpose is known, data sources and data sets are often (re)used for the same purpose. For some original purposes, the datasets are reused for multiple additional purposes and some additional purposes use data generated with multiple original purposes.

Distinction between the purposes of data use provides more contrast in data quality requirements (i.e. adequacy) then distinction between data user types. This makes the analysis from the first perspective more valuable than the latter.

As adequacy evaluations become more meaningful when a dataset is evaluated multiple times (i.e. getting the perspective from multiple assessment reports), the CMS will become more powerful on the condition that it is kept up to date and new data adequacy evaluations are continuously added. To some extent this will be achieved in the second DAR. However, continuing maintenance and supplementing of the CMS beyond the project could further strengthen the evaluation of dataset adequacy.

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This project consumed huge amounts of work, research and dedication, conducted by many individuals and organizations at different locations of the world. We would like to thank all Arctic SBC project members for their contribution to this report:

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Acronyms and definitions

The present report requires a good understanding of specific definitions and acronyms. A list of those is therefore provided in this chapter.

Additional purpose	The purpose for which a dataset is used in an assessment report (see also 'original purpose').
Adequacy	The adequacy (or a set of indicators reflecting adequacy) of a dataset used for a specific purpose (of an assessment report).
Assessment report	A technical report or peer reviewed publication that describes the assessment of the state, exploitation or change of the marine environment or parts thereof.
Challenge	A challenge addresses the data availability and adequacy for a specific purpose, e.g. wind farm siting or assessing riverine input. Challenges are part of Sea Basin Checkpoint projects
CMS	Content Management System. An online system which is part of the Arctic Sea Basin portal, in which data sources, datasets, assessment reports and parameters can be registered, including relations between these aspects.
DAR	Data Adequacy Report. In this report the adequacy of datasets is described.
Dataset	Data provided in a coherent set from a specific source, describing a specific parameter (for instance temperature, salinity, bird behaviour, etc.)
Data source	The source (e.g. data portal) from which a dataset is made available. This can for instance be an organisation or an initiative.
MPA	Marine Protected Area.
Original purpose	The purpose for which a dataset was originally produced (see also 'additional purpose').
Parameter	A specific aspect describing the state or change of the marine environment (for instance temperature, salinity, bird behaviour, etc.). The common P02 vocabulary developed for SeaDataNet[1] is used and extended where necessary.
P02	A controlled vocabulary from SeaDataNet[1] used to describe parameters.
P03	A controlled vocabulary from SeaDataNet[1] used to describe parameter groups.
Quality	The intrinsic quality (or indicators reflecting the quality) of a dataset.
SBC	Sea Basin Checkpoint.
WP	Work Package.

[1] http://seadatanet.maris2.nl/v_bodc_vocab_v2/search.asp?lib=P02

1 Introduction

1.1 Background

Long term sustainable economic growth is the highest priority in the EU at the moment. One of the key drivers of sustainable growth is the concept of 'smart growth'. Smart growth means developing an economy based on knowledge and innovation. The marine and maritime sector or 'blue economy' was identified in a public consultation as having great potential and making a major contribution towards meeting Europe 2020 objectives. Again, a lot of emphasis was put on the importance of innovation. A strong, freely accessible knowledge base is conditionally for innovations. Both the private and public sector need to contribute to and use the system. Knowledge management becomes therefore more important than ever.

Observations in the marine area are generally made with a specific purpose in mind. For example, bathymetry is surveyed to ensure safe navigation, fish are sampled to estimate the size of the stock and pollution concentration is measured to meet regulations on bathing water or agriculture production. Costs can be reduced and marine knowledge improved when data are reused for multiple purposes, other than what they were generated for. Once the direct link between the collection of data and its application is broken, it becomes hard to determine what the priorities are for monitoring and who should monitor what. The EU is now actively moving towards the new paradigm, where data are collected once and are used for many purposes.

1.2 EMODnet

In order to achieve the goals of the blue economy the EU has taken initiatives to improve the collection and accessibility of marine data. Already in 2007 the EU developed the principal of a European Marine Observation and Data Network (EMODnet) which would centralise European marine data according to one standard. The rationale behind a centralised network of data is to:

- Collect data once and stimulate its reuse
- Develop standards across disciplines as well as within them
- Process and validate data at different levels. Structures are already developing at national level, but infrastructure at sea basin and European level is needed.
- Provide sustainable financing at an EU level so as to extract maximum value from the efforts of individual Member States
- Build on existing efforts where data communities have already organized themselves
- Develop a decision-making process for priorities that is user-driven
- Accompany data with statements on ownership, accuracy and precision, and
- Recognise that marine data is a public good and discourage cost-recovery pricing from public bodies.

1.2.1 Thematic portals

EMODnet has eight thematic portals

- **Biology**, data on temporal and spatial distribution of species abundance and biomass from several taxa: http://www.emodnet-biology.eu/portal/index.php;
- **Chemistry**, data on concentrations of nutrients, organic matter, pesticides, heavy metals, radionuclides and antifoulants in water, sediment and biota: http://www.emodnet-chemistry.eu/;

- **Physics**, data on salinity, temperature, waves, currents, sea level, light attenuation, and Ferry Boxes: http://www.emodnet-physics.eu/map/;
- **Geology**, data on seabed substrate, sea floor geology, coastal behaviour, geological events, and minerals: http://www.emodnet-geology.eu/geonetwork/srv/dut/catalog.search#/home;
- **Bathymetry**, data on water depth, coastlines, and geographical locations of underwater features (wreck): http://www.emodnet-bathymetry.eu/;
- **Seabed Habitats**, data on modelled seabed habitats, based on seabed substrate, energy, biological zone and salinity: http://www.emodnet-seabedhabitats.eu/;
- **Human activities**, data on the intensity and spatial extent of human activities at sea: http://www.emodnet-humanactivities.eu/view-data.php;
- **Coastal mapping**, building a joint European coastal mapping programme: http://coastal-mapping.eu/.

1.2.2 Checkpoints

The European Commission has initiated the Sea Basin Checkpoints (SBC, associated to EMODnet) to determine gaps in data and observation systems and priorities for an observation system that supports the delivery of sustainable growth and innovation. The Marine Knowledge 2020 concept of sea basin checkpoints was introduced within the "Marine Knowledge 2020" Communication and refined in the Roadmap, where each sea basin is studied in separate projects. The overarching aim is to support the deployment of a marine observation infrastructure that offers the most effective support to the blue economy. The cost-effectiveness, reliability and utility of the existing monitoring infrastructure are to be assessed by developing products based on these data and determining whether the products are meeting the needs of industry and public authorities.

There are Sea Basin Checkpoint projects for the following basins:

- North Sea (www.emodnet.eu/northsea/home)
- Mediterranean Sea (www.emodnet-mediterranean.eu)
- Atlantic Ocean (www.emodnet-atlantic.eu)
- Baltic Sea (www.emodnet-baltic.eu)
- Black Sea (www.emodnet-blacksea.eu)
- Arctic Ocean (www.emodnet-arctic.eu)

Sea Basin Checkpoint projects include several challenges addressing data availability and adequacy for a specific additional purpose, e.g. wind farm siting or assessing riverine input. The outcome of these challenges will be included in a Data Adequacy Report (DAR). The report at hand is the DAR of the Arctic Ocean Sea Basin Checkpoint (the Arctic SBC, see section 1.3).

1.3 The Arctic SBC project

The Arctic SBC is comprised of seventeen Work Packages (WPs) in the form of a literature review (WP1), and the challenges (WP2-WP12), website development (WP13), panels and stakeholder workshops (WP14 and 16), the DAR (WP15) and the project management (WP17). As the title of this report suggests, this report will focus on the DAR (WP15) and therewith also the challenges (WP2-WP12).

Each challenge is designed such that it addresses data availability and adequacy for a specific additional purpose, e.g. wind farm siting or assessing riverine input. The overarching objectives of this project is to examine the current data collection, observation, surveying, sampling and data assembly programmes in a sea basin, analyse how they can be optimised and deliver the findings to stakeholders through an internet portal. This is done by:

- a clearer view of synergies between different monitoring, observation and data collection programmes;
- an identification of how well the present data collection, monitoring and surveying programmes meet the needs of users;

- an identification of gaps;
- a view of where new technologies will allow faster, quicker and more accurate observation;
- an understanding of required temporal or spatial resolution of data products such as bathymetry or marine sediments;
- contributing to the identification of priorities both in terms of creation of new data and in making existing data more available and usable. It will also help the Commission to determine priorities in the context of the "Marine Knowledge 2020" initiative. It follows a request for such a process in the public consultation on "Marine knowledge 2020";
- assessing how well all available marine data meets the needs of users.

The objective of this Data Adequacy Report (DAR) is described in the following section.

1.4 Objective

For the DAR presented here, the objective is to contribute to the main aim of the project by reporting how well all available marine data meets the needs of users.

The availability and adequacy of monitoring data is elaborated from two different viewpoints, which are clearly distinguished in two parts (***Figure 1***):

1) Looking at the needs of users - fisheries managers, coastal protection authorities, national authorities responsible for marine Strategy Framework Directive, ports, shipping, offshore energy exploration, pipeline laying etc.
2) Looking parameter by parameter – water temperature, currents, nutrients, etc.
   For each parameter the data adequacy is described. Adequacy is also described per purpose in the main text and adequacy per specific dataset is included as Annex.

As described previously, SBC projects include several challenges addressing data availability and adequacy for a specific additional purpose, e.g. wind farm siting or assessing riverine input. The outcome of these challenges will be included in this DAR. This DAR is further based on the literature survey (WP1) conducted within the Arctic SBC (De Vries et al., 2016). The report will be reviewed by the Commission and the Panel (WP14). The feedback and comments, including any other new information, will be addressed in a second DAR.

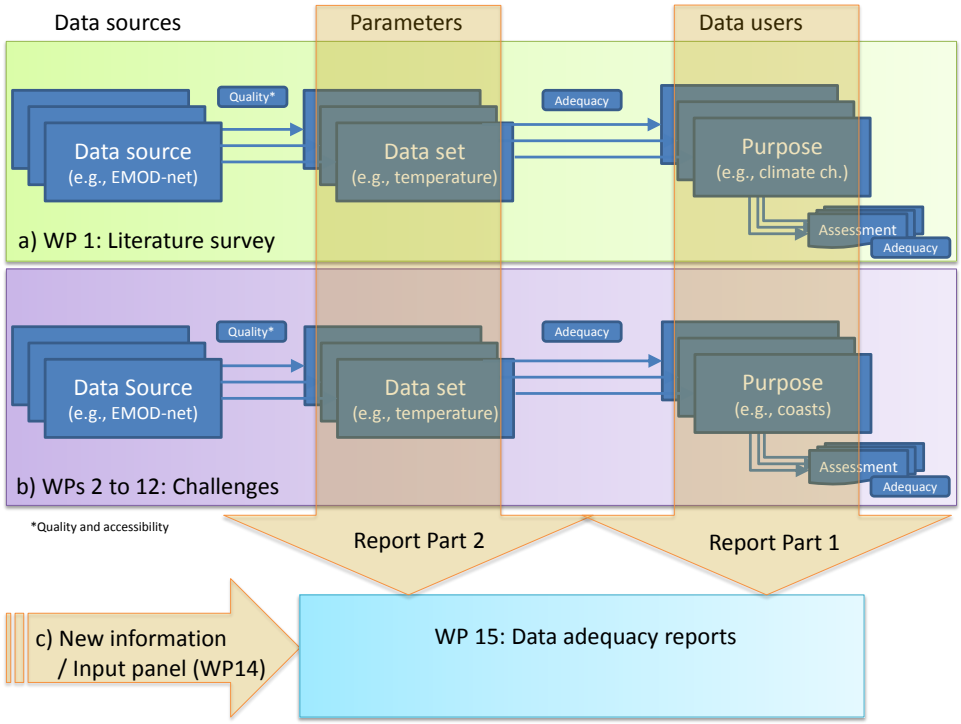

Figure 1. *Outline of all relevant elements in the Data Adequacy Report(s) and their relationships. Note: this outline only serves to illustrate the process.*

2 The Arctic Sea Basin

2.1 The definition of the Arctic Ocean

The Arctic Ocean, as defined in the CIA fact book (which is also used for this study), includes Baffin Bay, Barents Sea, Beaufort Sea, Chukchi Sea, East Siberian Sea, Greenland Sea, Hudson Bay, Hudson Strait, Kara Sea, Laptev Sea, Northwest Passage, and other tributary water bodies. This falls within the Arctic region, that can either be defined as the area above the Arctic Circle at approximately 66° 34' N (see dashed blue line in Figure 2) or as the region with an average temperature below 10 °C (50 °F) in July (see red isotherm in Figure 2). The Arctic region consists of an ocean surrounded by land. The following states surround the Arctic Sea Basin: United States, Canada, Iceland, Greenland (Denmark), Norway, Sweden, Finland and Russia.

Figure 2. *The Arctic region, defined as the area above the Arctic Circle (dashed blue line) or the area north of the red isotherm, with all territory to the north having an average temperature of less than 10 °C (50 °F) in July (https://en.wikipedia.org/wiki/Arctic_Ocean).*

2.2 Abiotic environment

2.2.1 Climate

The Arctic region experiences long and cold winters and short and cool summers. Within the Arctic Circle the sun disappears during the winter months and continuously shines during summer. The ocean water controls the temperature of the Arctic climate in coastal areas: in winter the ocean water (with a minimum temperature of -2 °C) prevents the air to cool down to extreme low values, whereas in summer the ocean cools the air preventing high temperatures. This moderating effect is stronger in summer than in winter as extended sea ice in winter can form an insulating layer preventing heat from the ocean from escaping to warm the air. Average January temperatures range from about -34 °C to 0 °C and average July temperatures range from about -10 to +10 °C.

2.2.2 Bathymetry

The Arctic Ocean consists of shelve seas and a deep Arctic Ocean Basin with mountain ridges and depth up to 5 km (Figure 3). The shelve seas are found on the Canadian and Russian sides of the Basin. The Lomonosov Ridge divides the Arctic Ocean Basin into two basins: the Eurasian Basin (4,000-4,500 m deep) and the Amerasian Basin (about 4,000 m deep). The average depth of the Arctic Ocean is 1,000 m, with a maximum depth of 5,450 m.

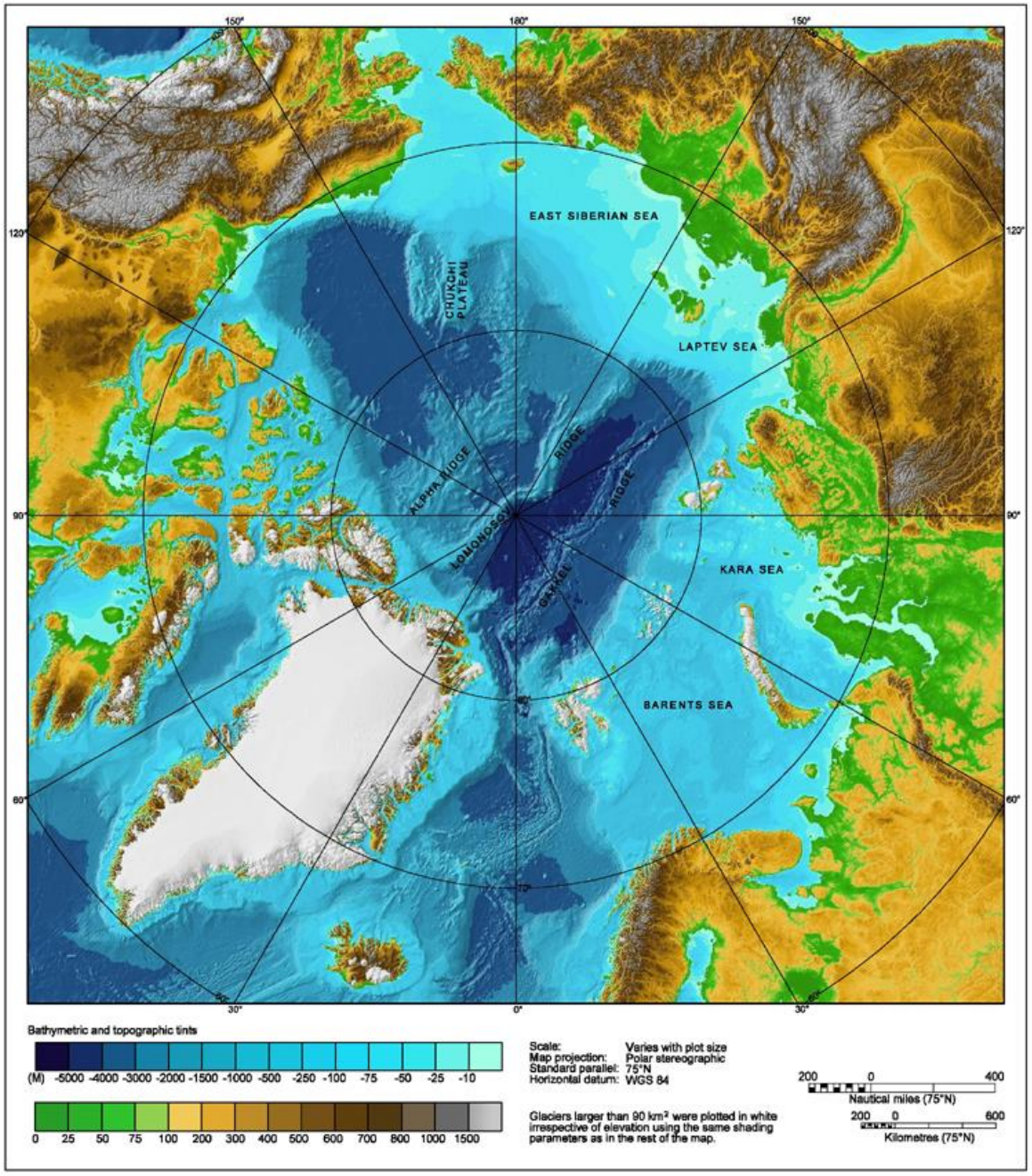

Figure 3. *Bathymetric map of the Arctic Ocean (http://www.ngdc.noaa.gov/mgg/image/IBCAO_betamap.jpg).*

2.2.3 Water movement

2.2.3.1 Currents

The Arctic Ocean connects to both the North Pacific through the Bering Strait, and the North Atlantic through the Greenland Sea and Barents Sea. Pacific water enters the Arctic Ocean via de Bering Strait, whereas Atlantic water reaches the Arctic Ocean mainly via the Fram Strait, between Greenland and Svalbard, and via the Barents Sea (Figure 4). The dominant currents in the Arctic Ocean are the Beaufort Gyre, with a wind-driven clockwise circulation, and the transpolar drift, transporting sea ice from the East Siberian Sea and Laptev Sea towards the Fram Strait.

Figure 4. *Predominant surface ocean currents in the Arctic (AMAP, 1998).*

2.2.3.2 Mixing of water and stratification

The Arctic Ocean is composed of different water masses. Figure 5 sketches the different water masses along a vertical section from Bering Strait over the geographic North Pole to Fram Strait. Most of the Arctic Ocean has a top layer with a relative low salinity and low temperature (Polar Mixed Layer). This layer is fed by fresh water from rivers in Russia and Canada. On the European side of the Arctic Ocean, more saline surface waters enter from the Greenland and Barents Seas. The Pacific derived waters are fresher, and therefore lighter, than the North Atlantic waters, so the water properties across the Arctic Ocean integrate these two extremes. The Arctic deep water is very dense and is composed of cold Arctic shelf water that sinks to the bottom and Greenland Sea Deep Water. As the stratification is stable, deeper water masses are more dense than the layers above.

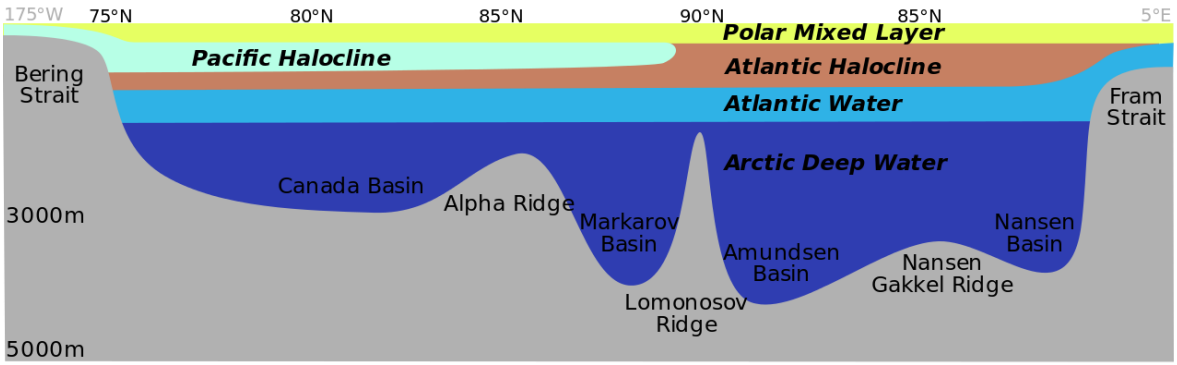

Figure 5. *Distribution of the major water mass in the Arctic Ocean. (https://en.wikipedia.org/wiki/Arctic_Ocean).*

2.2.3.3 Great Conveyer

In the oceans there is constant motion in the form of a global ocean conveyor belt (see *Figure 6*). This motion is caused by a combination of thermohaline currents in the deep ocean and wind-driven currents on the surface. Warmer water is less dense and remains at the surface, while cold and salty water sinks tot bottom of the ocean.

This process begins in European waters with deep water formation off the eastern coast of Greenland, where saline water derived from the Gulf Stream cools and evaporates to create water dense enough to sink to the ocean bottom. As more warm water is transported north, the cooler water sinks and moves south to make room for the incoming warm water. This cold bottom water flows south of the

equator all the way down to Antarctica. Eventually, the cold bottom waters return to the surface through mixing and wind-driven upwelling, continuing the conveyor belt that encircles the globe. Monitoring of Denmark Strait and Faroe-Shetland Channel indicates this process of deep water production is slowing (Dickson and Brown 1994, Dickson et al., 2002) and the surface waters are freshening (Reverdin 2014). Overturning in the North Atlantic is now known to be slowing with more of the northward Gulf Stream water recycling within the North Atlantic subtropical gyre and less in the North Atlantic Deep Water (NADW) (Bryden et al., 2005), but deep understanding of the variability is lacking.

Figure 6. *The ocean conveyor moves water around the globe (oceanservice.noaa.gov).*

2.2.4 Sea ice

The Arctic Ocean is covered with a 1-4 m thick sea ice layer with 1 m ice layer being relative freshly formed and 4 m thick ice layer being of multi-annual age. In winter the sea ice coverage grows, whereas in summer it shrinks again. Due to climate warming both sea ice extent (coverage) and volume are decreasing (Figure 7). Sea ice extent has been decreasing since the 1970s and appears to be accelerating, potentially related to changes in the melting season (Stroeve et al., 2007, Stroeve et al., 2014, Xia et al., 2014). In the Climate Change challenge changes in average ice cover, average extent of ice coverage, total ice cover in sea and mass of ice lost from Greenland are addressed (see section 6.5).

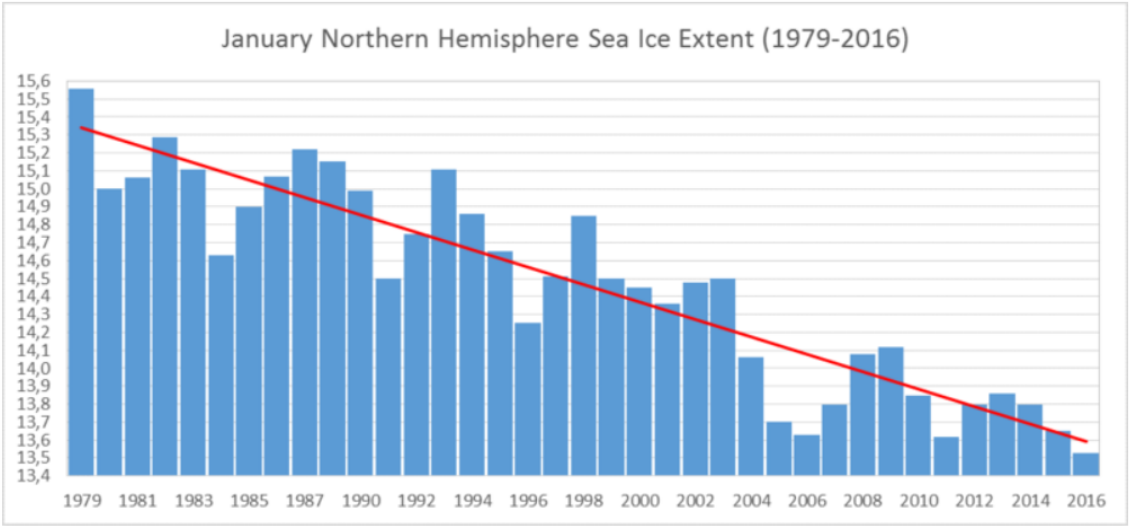

Figure 7. *Monthly January ice extent for 1979 to 2016 shows a decline of 3.2% per decade (National Snow and Ice Data Center).*

2.2.5 Rivers and coast

Rivers form an important link between the land and the oceans. They discharge (fresh) water, loaded with sediment and nutrients, into the seas and are home to both migratory fish species that depend on the river during part of their life cycle.

The Arctic Ocean receives a large amount of fresh water from rivers compared to other oceans. The major river basins in the Arctic Ocean are the Ob, Yenisey and Lena in Russia, and the Yukon and Mackenzie in the USA (*Figure 8*).

The river inputs challenges (see section 6.9) addresses the annual inputs to the Arctic Ocean of water, sediment, total nitrogen, phosphates, and migration of salmons and eels.

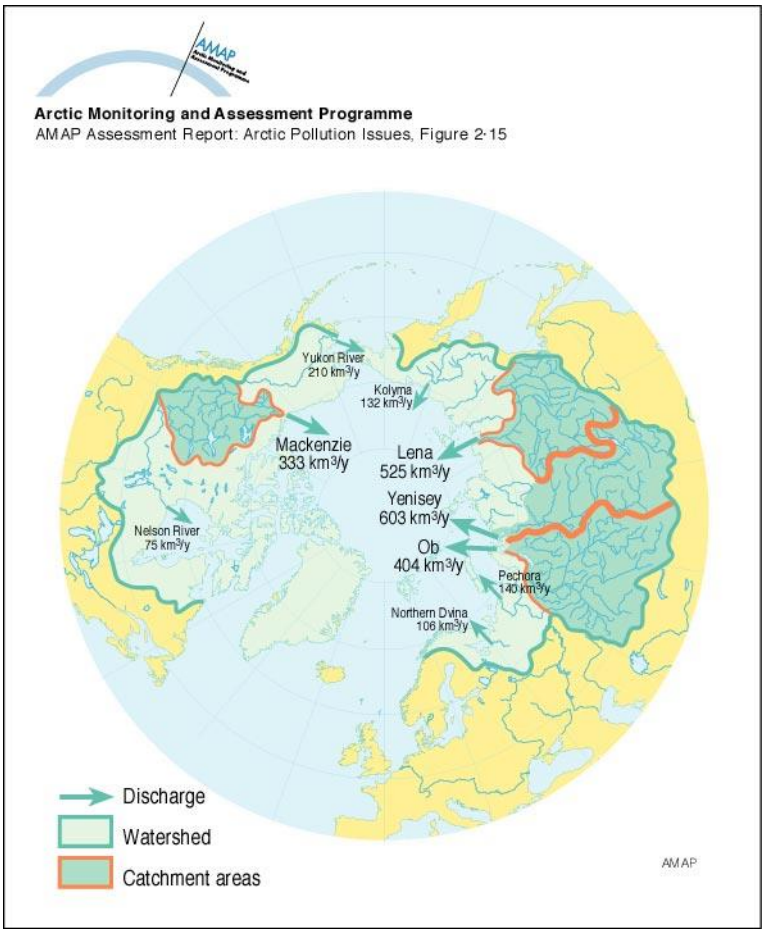

Figure 8. *Arctic Ocean watershed and catchment areas of some rivers and annual run-off (km3/y) of major rivers to the Arctic Ocean (AMAP, 1998).*

2.3 Biotic environment

2.3.1 The Arctic ecosystem

The Arctic houses a wide variety of species that are adapted to extreme conditions and are unique. The region is characterised by high seasonality with a long dark winter, an extended period of continuous daylight during summer and a brief spring and autumn season. This results in a short and strongly coupled grow season for species living in the Arctic. Energy transfer of key species within a food web can be followed through the season. Some of the species are directly connected to and/or dependent on the presence of floating ice, such as ice algae and bearded seals. *Figure 9* shows an overview of the marine food-webs in the Arctic.

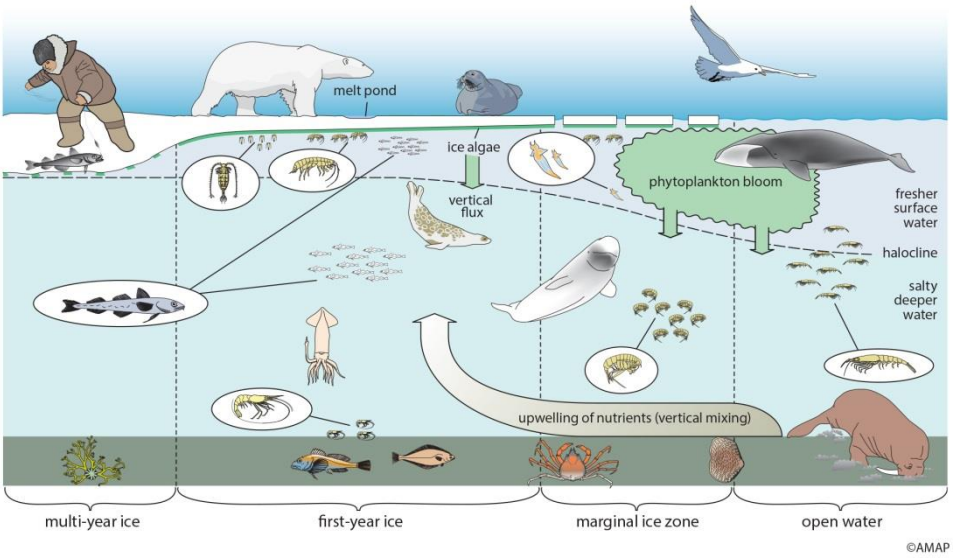

Figure 9. *A schematic overview of marine food-webs in the Arctic (AMAP, 2012).*

2.3.2 Primary production

In the Arctic area, phytoplankton is essential for primary production and serves as the base of the marine food web. Both the presence of nutrients and light availability limit primary production, giving the Arctic area a distinct seasonal character. Upwelling of warm nutrient-rich Atlantic water is one of the key factors driving primary production. The primary production season is constrained by snow and ice cover, low light angles and a relatively short season.

The Climate Change challenges (see section 6.5) addresses the primary production of the region by expressing the abundance of the three most abundant species of phytoplankton in time series.

2.3.3 Invertebrates

There are about 5000 known Arctic marine invertebrates, of which more than 90% live on or near the sea floor (benthic invertebrates). About 400 deep-sea species are known, and future deep-sea sampling might reveal more presently unknown species. Dominant groups are crustaceans, molluscs, annelids and bryozoa.

The growth and survival of the benthic invertebrates is restrained by food supply, and not by low water temperature. Species richness of invertebrates is highest in the Chukchi Sea, Barents Sea and Kara Sea. In these areas the benthos receives large food input from the water column.

2.3.4 Fishes

The Arctic Ocean is home to about 240 species of marine and diadromous fishes. Most Arctic Ocean marine fishes are benthic or demersal, living on or closely associated with the bottom. Few are pelagic, freely moving about in the water column. The dominant Arctic fish families are cods, eelpouts, snailfishes, sculpins, and salmonids. One of the key species in the Arctic is the Arctic cod (*Boreogadus saida*), because it is a critical link between lower trophic levels (copepods and under-ice amphipods) and birds, seals, and whales. The Arctic cod is the most northerly distributed gadid, occurring roughly between 60°N and the North Pole, nearshore as well as offshore.

2.3.5 Marine mammals

Twelve species of Arctic marine mammals are either restricted to or dependant on the Arctic: polar bear, walrus, four species of whales (bowhead whale, grey whale, narwhal, beluga) and six species of ice-associated seals (bearded seal (*Figure 10*), ribbon seal, ringed seal, spotted seal, harp seal, hooded seal). Several additional species (e.g. sperm whales, blue whales, fin whales, humpback whales, killer whales, harbour porpoise) are spotted occasionally or even regularly within marginal waters of the Arctic.

Figure 10. *A bearded seal on floating ice in Kongsfjorden, Svalbard (© Martine van den Heuvel-Greve).*

2.4 Human activity

2.4.1 Introduction

About 4 million people live in the Arctic region. Ten % of these are indigenous to the region, representing over 40 different ethnic groups. During the middle of the last century population growth increased rapidly due to immigration because of the discovery of natural resources. Most of the people are gathered in relative large settlements, whereas indigenous communities are more widely scattered. More recent population growth in the Arctic has ceased and even decreased in some areas, such as Russia.

Retreating sea ice in the Arctic opens up possibilities for increased human exploitation of the Arctic region. Especially shipping, fisheries, tourism, oil and gas exploitation and mineral extraction may increase in the future.

2.4.2 Shipping

Potential impacts from shipping are: the release of oil through accidental or illegal discharge, ship collisions with marine mammals, the introduction of alien species, disruption of migratory patterns of marine mammals, increased anthropogenic noise and increased atmospheric emissions (e.g. of black carbon – BC).

Shipping is one of the main vectors for invasive species to the Arctic. The polar regions (Arctic and the Southern Ocean) are the least by non-indigenous species invaded realms of the world (Molnar et al., 2008). The relative absence of transport vectors and the low temperatures are important factors for the relatively limited introduction of non-indigenous species to the Arctic ecosystem. However, due to

the melting of Arctic sea ice the north Pacific became connected to the north Atlantic ocean, resulting in new economic opportunities (shipping routes, sea mining). With these intensified economic activities, the risk of introducing exotic species in the Arctic sea increases. The rapid changes in the Arctic marine ecosystems related to climate change makes the system more vulnerable to invasive alien species (Norden 2014). Aquatic alien species can be found all over the globe and can cause serious problems such as harming native species, harming ecosystems and harming animal health, as well as posing a threat to public health, safety and economy (Crowl et al., 2008; Pimentel et al., 2005; Schiphouwer et al., 2012; Vander Zanden et al., 1999; Wilcove et al., 1998). In the Arctic Ocean various alien species have been reported, such as the king crab and the snow crab, various species of microalgae, macro algae, molluscs and fish. As alien species can pose a serious threat to the marine ecosystem in many different ways, they have been included specifically in the European Marine Strategy Framework Directive (Descriptor 2: "Non-Indigenous Species introduced by human activities are at levels that do not adversely alter the ecosystem") and are a focal point for management by many different organisations and governments (Ojaveer et al., 2013).

The Bathymetry challenge (see section 6.10) addresses the indication of areas for surveying for safer navigation taking into account emerging needs. The Alien Species challenge (see section 6.11) addresses the alien species and pathways of introduction, and impacts on ecology and economy.

2.4.3 Oil & gas

In 2008 the United States Geological Survey estimated that the Arctic regions contain 13 per cent of the world's remaining oil and 30 per cent of its gas. More than 70% of the mean undiscovered oil resources are expected to be present in five provinces: Arctic Alaska, Amerasia Basin, East Greenland Rift Basins, East Barents Basins, and West Greenland–East Canada. It is further estimated that approximately 84% of the undiscovered oil and gas occurs offshore.

Oil is already extracted in the Arctic region, most of them from onshore locations or in shallow sea areas (*Figure 11*). The Oil platform leak challenge (see section 6.4) tests the preparedness of operational tools for forecasting the effects of an oil spill.

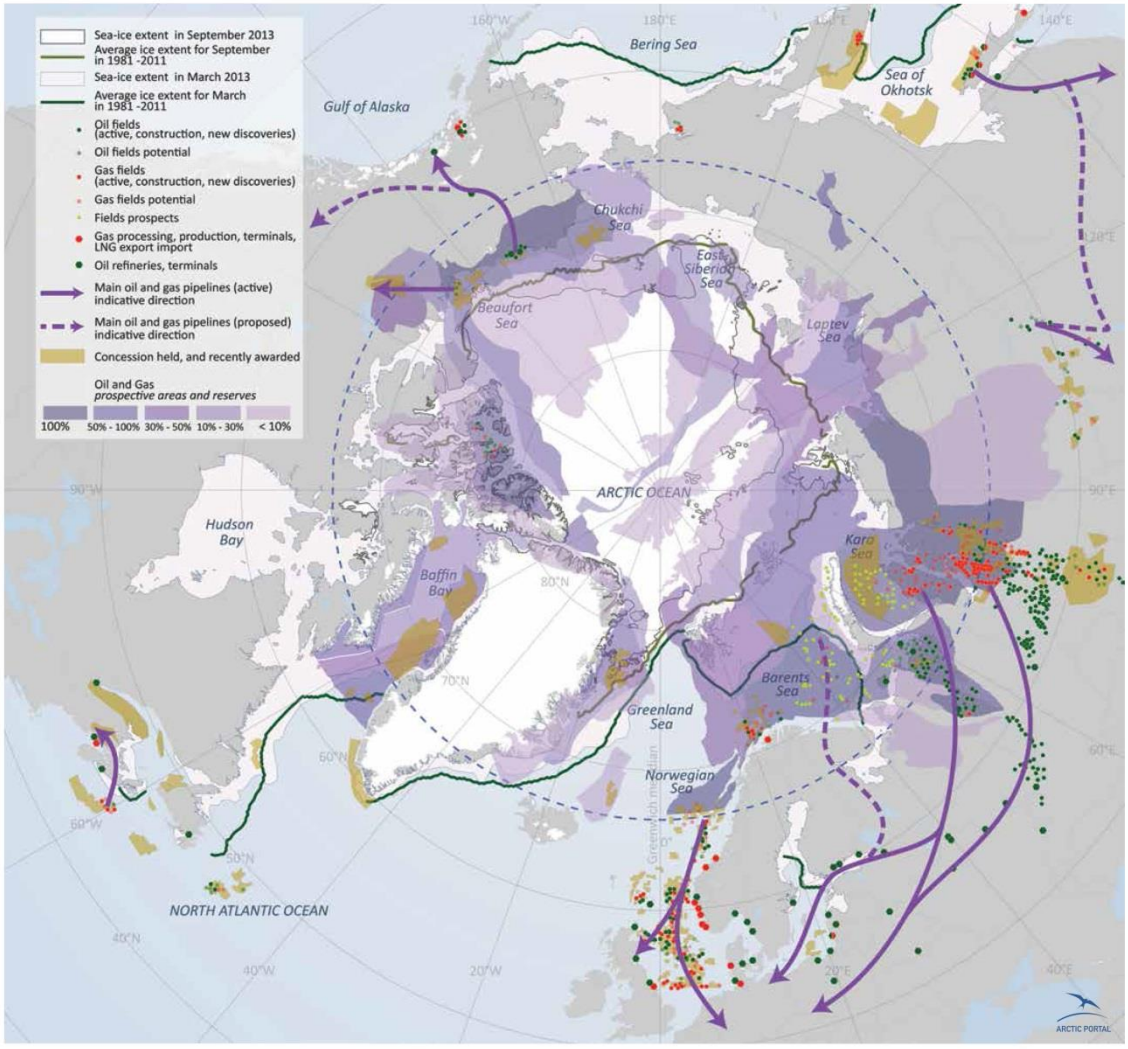

Figure 6.1: Main Oil and Gas Areas, Mining Sites and Sea-Ice Extent in the Arctic
Source: Arctic Portal, based on Nordregio; Johanna Roto and José Sterling, 2011, www.nordregio.se/Maps--Graphs/05-Environment-and-energy

Figure 11. *Main oil and gas areas and mining sites in the Arctic (http://www.arcticinfo.eu/images/Sada/Maps/map8.jpg)*

2.4.4 Fisheries

Fisheries are a key industry across the Arctic (Strategic Assessment of Development of the Arctic, 2014). Compared to regions such as the North Sea and Celtic Sea, they are based on relatively few fish species located in rich marine ecosystems in the low and sub-Arctic. The fisheries management in the Arctic sea basin is only partly covered by regional fisheries management organisations (RFMOs), but Arctic countries have well-established resource management regimes, including collection and analysis of data required for fisheries management.

Fishing impact is interpreted as any disturbance of the seafloor of fishing vessels operating mobile bottom gear, as predefined in the project call. There are several ways to estimate the level of seafloor disturbance depending on the information available. With increasing dependency on more sophisticated information and methods the relevance and accuracy of the indicator(s) increases. The simplest and probably least accurate description is based on the capacity and effort of the vessels operating in the Arctic region combined with some categorization of the métiers in terms of their impact on the seafloor thereby allowing a transformation of the fishing effort into a capacity- or effort-based measure weighted by seafloor impact. The assumption here is that there is a relationship between the capacity (number of vessels) or effort (usually kWdays) and fishing impact. The rationale is that vessels that use heavier gear (e.g. beam trawl) or larger gears (e.g. multiple combined pair trawls) will need more engine power to haul their nets through the water and over the sea floor, thus causing an increased impact on the seafloor. This method can work across very different metiers and fisheries types as long as they are mobile (towed) gears. Gill nets, fykes, potting and creeling cannot

be measured in the same way but have only minimal impact on the seabed so are not considered here as contributing to any fishing impact on the seafloor. While this is often applied as a best proxy for fishing impact in data-limited situations it is known for its potential for bias and lack of accuracy. Moreover, the spatial resolution of this type of information is usually low (i.e. regional or at best ICES rectangles as is required for logbook data).

More sophisticated but also more accurate indicators for seafloor disturbance are proposed by the Data Collection Framework (DCF) but these require high resolution data such as coming from Vessel Monitoring System (VMS) which, although collected by each member state as part of their DCF obligation are not readily available due to privacy issues. Data from fishing fleets in Europe has traditionally been collected by the state where the fish is landed and depending on the state various data collection programmes have been in place for many years. Over the last 20 years the EC has been working to bring these data collection programmes into a standardised format. This process cumulated in the establishment of the Data Collection Framework (DCF) in 2009. The DCF was developed to standardise fisheries data across the EU and ensure that member states operate fisheries data collection programmes that will meet the objectives of the common fisheries policy (CFP). Member states are now required to compile a wide range of biological and ecological data including the relevant data for this challenge, i.e. biological data for landings by area and species and stock related data from sampling programmes. Each of the nations involved in fishing in the North Sea are either bound by the EC fishing regulations or have agreements to follow similar reporting processes. Vessels over 15 meters must carry VMS and produce logbook data on all fishing activities. Vessels under 12 meters (10 meters in UK) are considered inshore vessels and do not need to report landings. However their catches are instead recorded by the registered fish traders who purchase at first sale. In most countries vessels over 15m operating in the North Sea are also required to carry VMS equipment that records their locations periodically. This data is held by the flag state of the vessel and is often subject to data protection regulations. VMS data, however, has complications in that VMS data from specific vessels come under the data protection act and need the permission of the vessel owner for their use. This means that even if VMS data exists it may not be available for general use.

The challenges on Fisheries Management (see section 6.7) and Fisheries Impact (see section 6.8) adress the catch effort, landings and impacts of fisheries.

2.4.5 Tourism

Arctic tourism is a popular and rapidly-growing industry that is expanding in terms of tourists, tour operators, diverse recreational pursuits, geographic scope, and seasons of use. Advanced ship technologies together with improved marine charts and navigational aids have allowed cruise ship travel to increase. The growing tourism industry presents both opportunities and challenges: opportunities to increase awareness of Arctic environmental issues and support for conservation, while providing a sustainable income source for northern communities; and environmental and cultural problems if tourism does not take these issues into account. To address these issues, the World Wide Fund For Nature (WWF) Arctic Programme began to develop principles and codes of conduct for Arctic tourism, and a mechanism for implementing them.

2.5 Marine Protected Areas (MPAs)

Within the Arctic, different types of national MPAs have been established under national legislations, for which a good overview is available in the World Database of Protected Areas (WDPA) by the UN/IUCN. Also high seas MPAs known as Vulnerable Marine Ecosystems (VMEs) have been established by Regional Fisheries Management Organisations (RFMOs). In addition, a number of Ecologically and Biological Significant Areas (EBSAs) have been defined: focus areas that may qualify as MPAs in the future, but are not MPAs now. In the challenge MPA (see section 6.3) the focus is only on the established MPAs.

3 Monitoring effort in the Arctic Sea Basin

3.1 Overview of monitoring programs and databases

A lot of monitoring programs and databases are developed and coordinated within the separate Arctic states. Large international monitoring programs and databases are: EMODnet portal; Arctic Council working groups; Copernicus; International Council for the Exploration of the Sea – ICES; The Sustaining Arctic Observing Networks; The Arctic Portal; ArcticData; ACADIS; The Arctic Science Portal; and European Ocean Biogeographic Information System (Table 1). These were used as a basis for this project. Complete lists of data sources, datasets and parameters used for the Arctic SBC are presented in section 3.2.

Table 1 Overview of main monitoring programs and databases in the Arctic

Program/database - URL	Description
The European Marine Observation and Data Network (EMODnet) - www.emodnet.eu	A consortium of organisations within Europe that assembles marine data, data products and metadata from diverse sources in a uniform way. EMODnet is organised by 'lots' currently comprising: Biology; Chemistry; Physics; Geology; Bathymetry (previously Hydrography and Sea Bed Mapping); Seabed habitats; Coastal mapping ; Human activities.
The Arctic Council - www.arctic-council.org	Intergovernmental forum promoting cooperation, coordination and interaction among the Arctic states, Arctic Indigenous communities and other Arctic inhabitants on common Arctic issues, in particular on issues of sustainable development and environmental protection in the Arctic. The work of the Council is primarily carried out in six Working Groups, of which the most relevant within the context of this report are described below:
The Arctic Monitoring and Assessment Programme (AMAP) - www.amap.no	The AMAP is a working group of the Arctic Council and monitors the Arctic environment, ecosystems and human populations, and provides scientific advice to support governments as they tackle pollution and adverse effects of climate change.
Conservation of Arctic Flora and Fauna (CAFF) - www.caff.is	CAFF is the biodiversity working group of the Arctic Council. CAFF serves as a vehicle to cooperate on species and habitat management and utilization, to share information on management techniques and regulatory regimes, and to facilitate more knowledgeable decision-making.
The Circumpolar Biodiversity Monitoring Program (CBMP) - www.caff.is/monitoring	The CBMP is an international network of scientists, governments, Indigenous organizations and conservation groups working to harmonize and integrate efforts to monitor the Arctic's living resources. The CBMP has been endorsed by the Arctic Council and the UN Convention on Biological Diversity and the official Arctic Biodiversity Observation Network of the Group on Earth Observations Biodiversity Observation Network (GEOBON). The CBMP is coordinating the wide range of Arctic biodiversity monitoring activity spanning biological, geographical, and climatic disciplines.
Protection of the Arctic Marine Environment (PAME) - www.pame.is	PAME is the focal point of the Arctic Council's activities related to the protection and sustainable use of the Arctic marine environment and provides a unique forum for collaboration on a wide range of activities in this regard
Sustainable Development Working Group (SDWG) - www.sdwg.org	The goal of the Sustainable Development program of the Arctic Council is to propose and adopt steps to be taken by the Arctic States to advance sustainable development in the Arctic.
Copernicus - - www.copernicus.eu	Copernicus is a European system for monitoring the Earth. Copernicus consists of a complex set of systems which collect data from multiple sources: earth observation satellites and in situ sensors such as ground stations, airborne and sea-borne sensors. It processes these data and provides users with reliable and up-to-date information through a set of services related to environmental and security issues. The services address six thematic areas: land, marine, atmosphere, climate change, emergency management and security. They support a wide range of applications, including environment protection, management of urban areas, regional and local planning, agriculture, forestry, fisheries, health, transport, climate change, sustainable development, civil protection and tourism.

Program/database - URL	Description
International Council for the Exploration of the Sea (ICES) - www.ices.dk	The International Council for the Exploration of the Sea (ICES) is a global organization that develops science and advice to support the sustainable use of the oceans. ICES has a well-established Data Centre, which manages a number of large dataset collections related to the marine environment. The majority of data – covering the Northeast Atlantic, Baltic Sea, Greenland Sea, and Norwegian Sea – originate from national institutes that are part of the ICES network.
The Sustaining Arctic Observing Networks (SAON) - www.arcticobserving.org	SAON facilitates partnerships and synergies among existing observing and data networks. The SAON process was initiated by the Arctic Council (AC) in 2007. Its goal is also to promote sharing and synthesis of data and information.
The Arctic Portal - www.arcticportal.org	The Arctic Portal is a comprehensive gateway to Arctic information and data on the internet, increasing information sharing and co-operation among Arctic stakeholders and granting exposure to Arctic related information and data. The Arctic Portal is a network of information and data sharing and serves as host to many web sites in a circumpolar context, supporting co-operation and outreach in science, education, and policy making.
ArcticData - portal.inter-map.com	Arcticdata is a web portal housed under the Arctic Portal, where spatial datasets with attached attribute data from CAFF and PAME are being made available to the public and research community to access and use as needed.
ACADIS - https://www.eol.ucar.edu/field_projects/acadis	ACADIS is a collaborative project between the University Corporation for Atmospheric Research (UCAR), the National Center for Atmospheric Research (NCAR), and the National Snow and Ice Data Center (NSIDC). ACADIS developed the Arctic Data Explorer - offering accessible, multifaceted and efficient navigation of interdisciplinary Arctic data. As of late March 2016, all ACADIS data and publications are available via the NSF Arctic Data Center. The ACADIS Gateway is no longer available. All future data and publication submissions should be made directly to the NSF Arctic Data Center. Further information can be found in the NSF Arctic Data Center Q & A document (see https://www.eol.ucar.edu/field_projects/acadis).
The Arctic Science Portal - www.arctic.gov/portal/index.html	This portal can be thought of as a library of links (URLs) to websites where Arctic data are made publicly available. Main focus is on the US Arctic.
European Ocean Biogeographic Information System - www.eurobis.org	The European Ocean Biogeographic Information System – EurOBIS – is an online marine biogeographic database compiling data on all living marine creatures. The principle aims of EurOBIS are to centralize the largely scattered biogeographic data on marine species collected by European institutions and to make these data freely available and easily accessible.
The Arctic Regional Ocean Observing System (Arctic ROOS) - http://www.arctic-roos.org	The Arctic ROOS is the Arctic node under EuroGOOS - the European Global Ocean Observing System. It has been established by a group of 14 member institutions from nine European countries working actively with ocean observation and modelling systems for the Arctic Ocean and adjacent seas. Arctic ROOS promotes, develops and maintains operational monitoring and forecasting of ocean circulation, water masses, ocean surface conditions, sea ice and biological/chemical constituents.

3.2 Overview of datasets, data sources and parameters

A full list of currently identified data sources listed in the content management system (CMS) of the project are listed in Annex 3. A full list of datasets, their associated P02 parameter (a controlled SeaDataNet vocabulary for parameters[2]) and the data source from which it originates, as they are currently listed in the CMS are listed in Annex 4. A description of the CMS is given in Chapter 5. Note that the lists show the current state (September 2016) and will be updated for the second DAR.

[2] http://seadatanet.maris2.nl/v_bodc_vocab_v2/search.asp?lib=P02

In addition, the datasets (and their associated P02 parameter) currently used or considered for use for each challenge are listed in Annex 6 per WP. The availability, quality and adequacy of datasets for the individual challenges will be addressed in Chapter 5. The datasets that are used in both the challenges and the collected literature will be presented and discussed in Chapters 7, 8, 9 and 10.

There were no specific statements found in literature to fitness for purpose of data (De Vries et al., 2016). Nevertheless, several studies for marine spatial planning, oil spill response, fisheries management and -impact assessment, riverine input and invasive species, generally addressed this issue. The main results of the literature review are described in Chapter 4. Details are provided in the literature report (De Vries et al., 2016).

In order to translate the information in the CMS into an indication of monitoring effort, the number of listed datasets are determined and plotted from three different perspectives: parameters (*Figure 12*); user types (*Figure 13*); and additional purpose (*Figure 14*). The coherence and structure of the information is explained in more detail in Chapter 5. More detailed analysis of the datasets are presented in Part 1, 2 and 3 of this report.

The number of datasets in the CMS listed under each parameter group is highly variable (*Figure 12*), this is not only caused by difference in monitoring effort, but also the effort for discovering datasets. As the present project focuses on the Arctic, it is not surprising that most datasets are listed under the parameter group 'cryosphere' (i.e. the frozen water part of the Earth system). For the Arctic this is a very relevant parameter group, but for many other sea basins not so much.

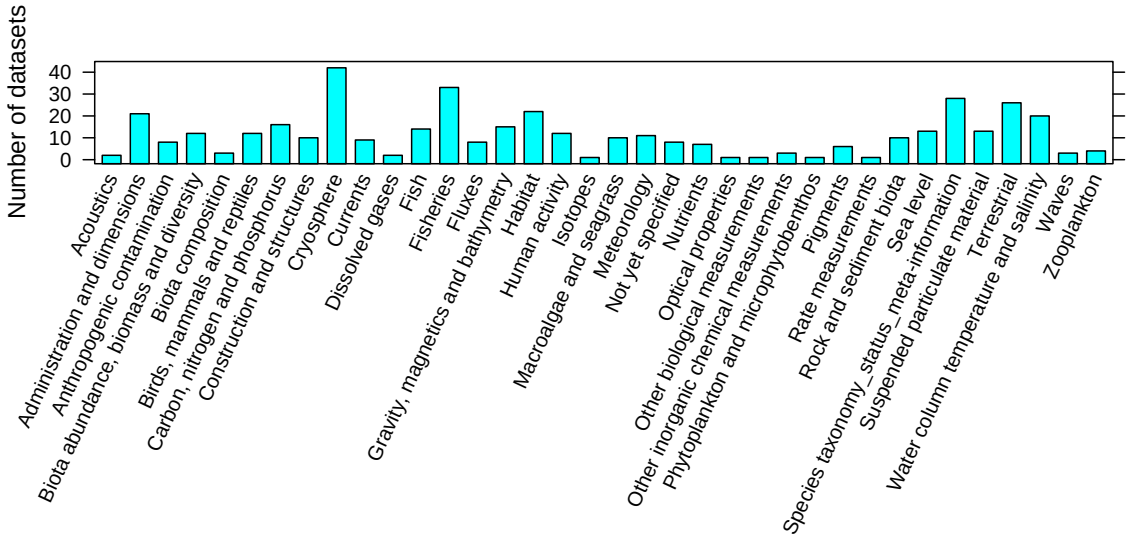

Figure 12. *Number of datasets listed in the projects Content Management System specified per P03 parameter group.*

When the number of datasets in the CMS are listed per user type, we also see that the numbers are highly variable. This is partly caused by the monitoring effort (which results in a specific amount of data availability) but also the broadness of the interest of specific users (e.g. 'consultants/researches' will have a much broader interest in data than for instance the 'cable laying industry').

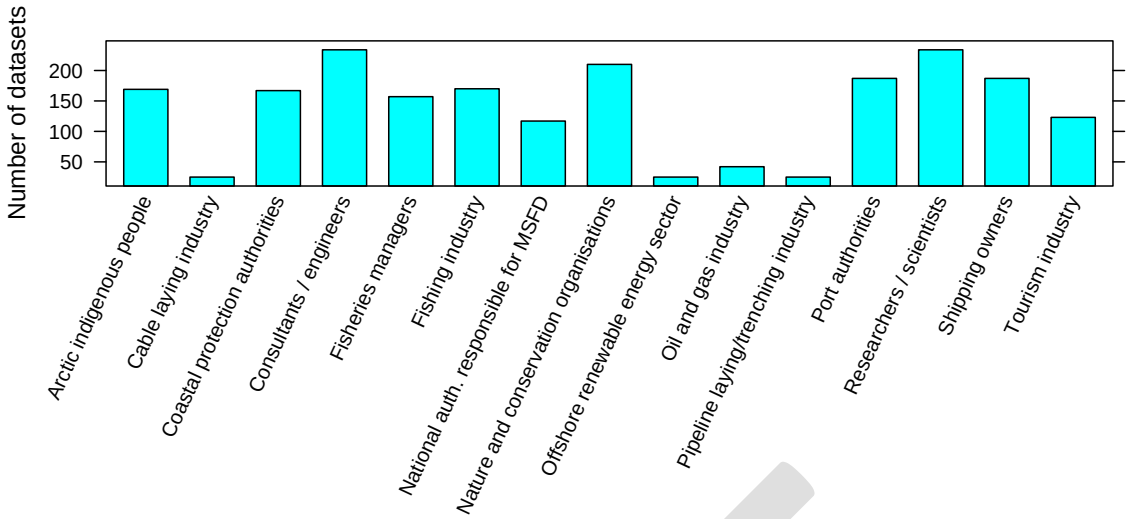

Figure 13. *Number of datasets listed in the projects Content Management System specified per user type.*

When the number of datasets in the CMS are listed per purpose for which data is used, we again see that the numbers are highly variable. This is partly caused by differences in monitoring effort (which results in a specific amount of data availability) but is also related to the focus of the present study. This can be seen for the purpose 'climate change' which of course is highly relevant for the Arctic (the focus of the present study).

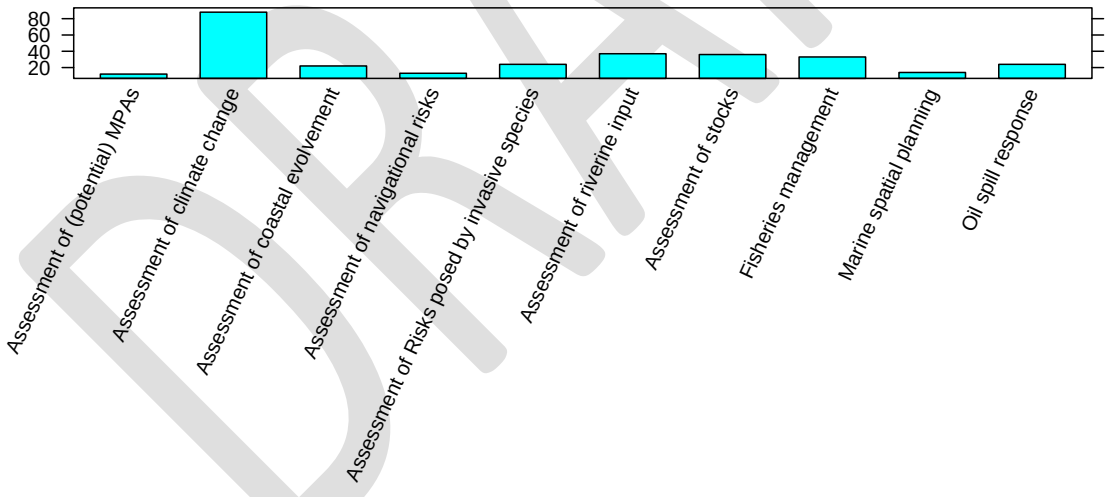

Figure 14. *Number of datasets listed in the projects Content Management System specified per purpose for which the data is used.*

4 Literature review results

Earlier in the project, a structured literature search and review was performed. *Figure 15* illustrates how the literature review relates to the Data Adequacy Report (DAR). The literature review was used to identify relevant literature and data sources. From both relevant datasets are identified. In the DAR, information from the literature review and the challenges are combined and used to evaluate the adequacy of the datasets. This chapter summarises the findings from the literature review, which are described in more detail in a separate report by De Vries et al. (2016).

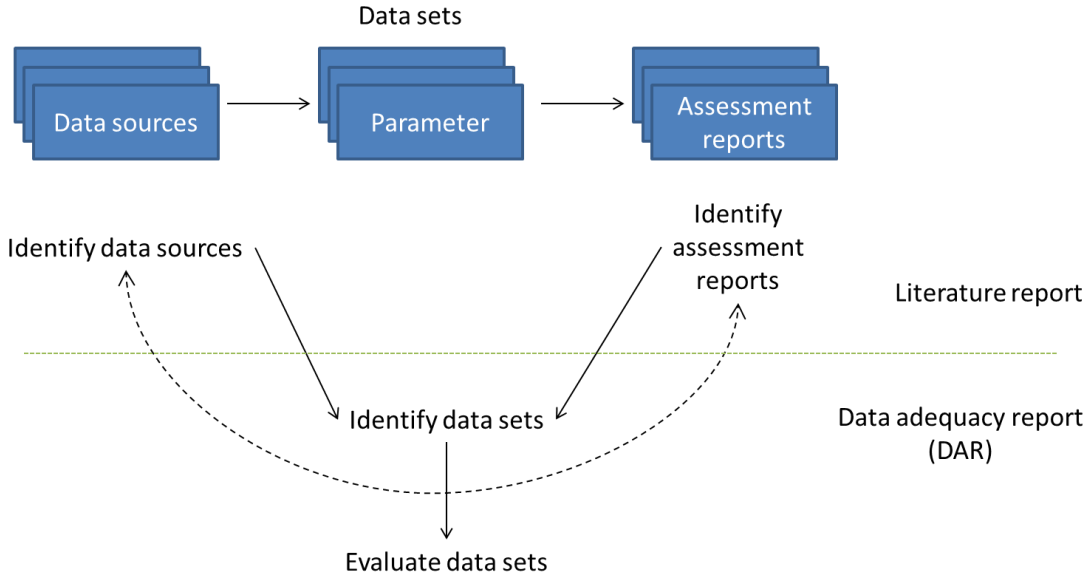

Figure 15. *Schematic overview of the work presented in literature report and the work that is presented in this DAR.*

4.1 Structured literature search results

One of the objectives of the current study is to obtain insight into the (re)usage of data possible for other purposes than it was originally generated. With a structured search relevant literature was identified that potentially reuses data. Chapter 5 presents the context within which the collected literature is used. Here we summarise the amount of literature that was collected (n = 625) from different sources in the structured search (*Figure 16*). Figure 17 lists the purposes for which the assessment reports would use data. The number of reports that are available per purpose is highly variable.

The literature review (De Vries et al., 2016) resulted in the identification of 625 assessment reports (*Figure 16*) which are registered in the CMS. Only a sub-selection of the collected literature body will be evaluated for data usage and the adequacy of the data used. This is described in more detail in Chapter 5.

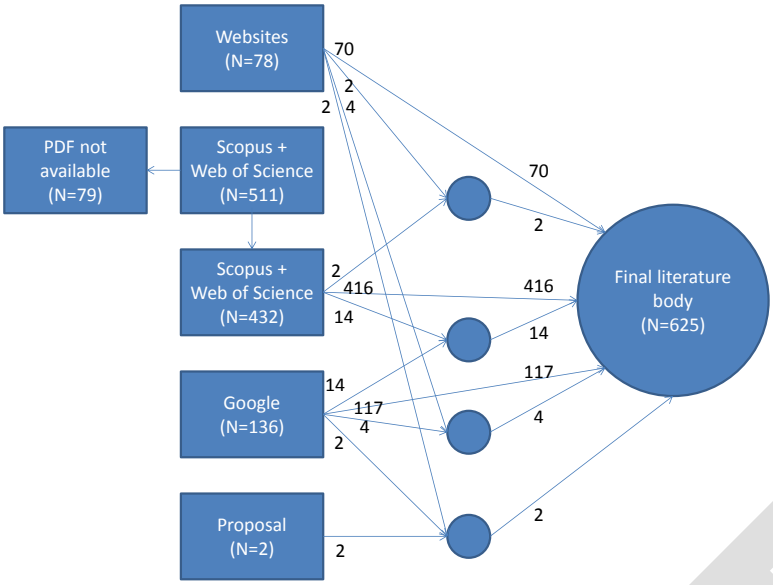

Figure 16. *Number of relevant documents, specified per source. Small discs represent the merging of duplicates. The large disc represents the total body of literature obtained from Google.*

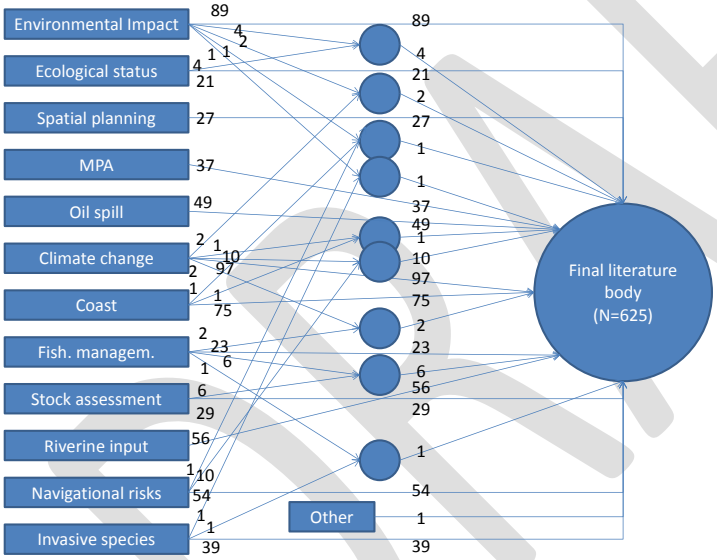

Figure 17. Number of relevant documents obtained from all sources, specified per purpose. Small discs represent the merging of duplicates. The large disc represents the total body of literature to be used in future steps.

4.2 Evaluation of literature review on inadequate data

References in literature to goals not achieved because of inadequacy of data (e.g. unable to estimate coastal erosion accurately) have been listed for each assessment purpose in the literature review (De Vries et al., 2016). The main data limitations could be attributed to a lack of measurements. This was the case for the purpose of: Marine spatial planning; Assessment of (potential) MPAs; Assessment of navigational risks; and Assessment of risks posed by invasive species. For some other purposes inadequate data could also be attributed to other causes: Oil spill response (time to obtain data); Assessment of climate change and Assessment of coastal evolvement (lack of accuracy /precision); Fisheries management and -impact and Assessment of riverine input (Reluctance of data-owners to release data). Results are presented in Annex 5.

In addition to these references to inadequate data, the findings from reviews of Arctic data (the National Academy of Sciences 2001 & 2006; Lichota & Wilson, 2010; and NOAA, 2014) were summarised (De Vries et al., 2016).

5 Structure and coherence: The Content Management System

5.1 Introduction to the Content Management System

In the present study the evaluation of adequacy of a large amount of data is structured following a coherent approach for the collection, analysis and presentation of information. A content management system (CMS) is developed and used to support and enable such a structured and coherent collection and registration of information. The CMS can be accessed online on the project website (http://www.emodnet-arctic.eu/CMS), but is password protected with accounts. However, data registered in the CMS can be retrieved from the publically available dashboard of the project website (http://www.emodnet-arctic.eu/dashboard). The CMS and its structure and the coherence of information is described in this chapter (see section 5.2).

Before setting up the CMS the approaches of the North Sea and Mediterranean Sea Basin Checkpoint were studied, and where useful the approach was adopted. The Arctic Sea Basin Checkpoint CMS makes a clear distinction between datasets, data sources and in some cases assessment reports. Data quality and data adequacy are treated as separate issues.

5.2 A framework for data management and assessment

In order to assess available marine data a framework, which will help to understand in which context datasets and information are collected, is required. Given the overarching objectives of identifying and assessing datasets, the framework encompasses the relation between: relevant literature and challenges; datasets used in literature and challenges; and the sources (i.e. data portals) from which the datasets can be obtained. A clear concept of data quality and data adequacy was also defined.

Note that a list of definitions used in the framework and throughout this report is included at the beginning of this report. These definitions are a requirement for setting up and understanding the framework.

The framework used for the management and assessment of datasets is presented in *Figure 18*. It shows the relation between data source, datasets and assessment reports. All elements of the framework and terms used are described below in the following sections (a short description is also included at the beginning of this report under 'Acronyms and definitions'). The identification of data sources, datasets, and assessment reports are described in the 'literature review' report of this project (De Vries et al., 2016). The evaluation of adequacy of datasets is described in more detail in Section 5.2.6.

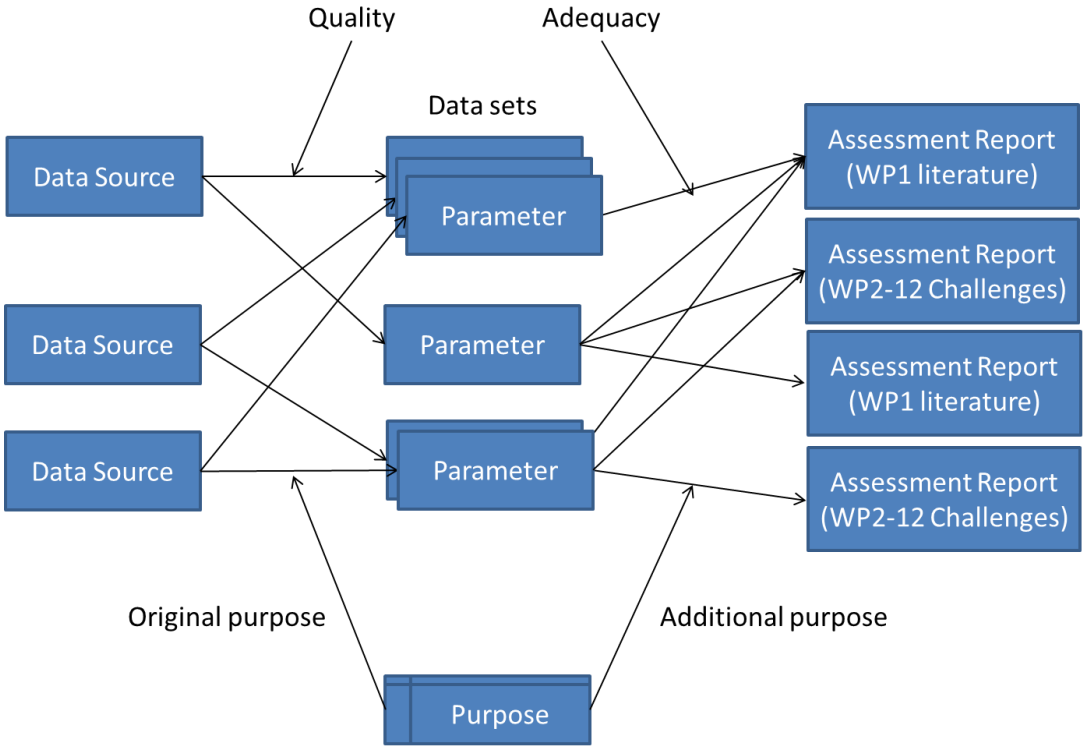

Figure 18. *Conceptual framework, showing the relations between data sources, datasets and assessment/challenge reports. The framework is implemented in an online 'Content Management System' (CMS), which is part of the Arctic Sea Basin portal. The CMS is accessible with a password at http://www.emodnet-arctic.eu/cms/.*

5.2.1 Data sources

In the literature review (De Vries et al., 2016), a preliminary list of (potentially) relevant data sources has been identified. A data source is the source (e.g. data portal) from which a dataset is made available. This can for instance be an organisation or an initiative. The list of data sources is based on data sources that are already identified in the Mediterranean Sea and North Sea SBC projects (only those that are also relevant for the Arctic SBC), supplemented with relevant data sources from the WP leaders. These data sources are linked to specific datasets in the CMS.

5.2.2 Datasets / parameters

A dataset is a coherent set of data for a specific parameter (e.g. temperature, or bird abundance), from a specific data source (i.e., data portal). Parameters are based on the P02 level vocabulary of SeaDataNet[3]. The advantage of using existing definitions for parameters is that it can be linked to information from other initiatives using the same definitions and it can be aggregated to the higher P03 level (which is also a SeaDataNet vocabulary, for parameter groups).

When an assessment report uses one or more datasets, a link is created in the CMS between the datasets and the assessment report. Multiple datasets can exist for a single parameter (i.e., originating from different sources or of a different quality). These relationships are visualised in Figure 18.

[3] http://seadatanet.maris2.nl/v_bodc_vocab_v2/search.asp?lib=P02

5.2.3 Assessment reports

Assessment reports are in the present context defined as "*technical reports or peer reviewed publications that describe the assessment of the state, exploitation or change of the marine environment or parts thereof.*" Each assessment report can use data depending on the purpose for which the assessment report was written and the requirements of the study described, a dataset may be either adequate or inadequate. Adequacy of datasets is therefore evaluated for each time it is used in an assessment report.

Each of the project challenges is also registered as (specially labelled) assessment report in the CMS. This way, findings for each WP is also documented in the CMS and can be combined with the findings obtained from the literature body collected in the structure literature search (De Vries et al., 2016). So for both the collected literature and the challenges, datasets (and corresponding parameters, data sources) are identified and linked to the reports.

5.2.4 Purposes

For each dataset it is recorded what the 'original purpose' was (i.e. the purpose for which the dataset was generated) if known and with which purpose it was used in an assessment report ('additional purpose'). This way, the original purpose can be compared with additional purposes (see also Section 7.4). Hence, a list of purposes is defined. WPs, which are part of the project, were used as a basis for the definition of these purposes.

As described in the introduction of this report, the Arctic SBC project is comprised of WPs in the form of challenges (e.g. wind farm siting or assessing riverine input). Each challenge is designed as such that it addresses data availability and adequacy for a specific additional purpose. However, in the original project call, these challenges are not directly linked to specific purposes. In fact, some challenges don't even serve a direct practical purpose (other than addressing data availability and quality), for instance the 'bathymetry' challenge which indirectly serves a purpose for navigational safety. Therefore, a list of purposes is defined in the literature review and linked to the challenges/WPs as defined in the project (Table 2, De Vries et al., 2016). The list was established by defining a closely matching purpose for each challenge. For reasons of completeness, the purpose 'Assessment of environmental impact' was added to the list. This was considered a relevant purpose by the Arctic SBC literature review team but was not covered by a specific challenge/WP, nor will it be addressed specifically as it is outside the scope of the present study. The list of purposes as presented in Table 2 is expected to cover the main purposes for which data could be generated and used within the scope of the Arctic Ocean.

Table 2. A list of purposes and most closely matching work packages in the project (De Vries et al., 2016)

Purpose	Most closely matching Work Package
Assessment of environmental impact#	NA - Impact assessment
Marine spatial planning	WP02 Wind farm siting
Assessment of (potential) MPAs	WP03 MPA
Oil spill response	WP04 Oil leak platform
Assessment of climate change	WP05 Climate Change
Assessment of coastal evolvement	WP06 Coast
Fisheries management	WP07 Fisheries management
Stock assessment	WP07 Fisheries management + WP08 Fisheries impact
Assessment of riverine input	WP10 River input
Assessment of navigational risks	WP11 Bathymetry
Assessment of risks posed by invasive species	WP12 Alien species

There is no specific WP/challenge within the project focusing on this particular purpose. It will only be addressed in the literature review and data adequacy report of the project. Note that the purpose "Assessment of environmental impact" was included before the search and thus literature was searched for this particular purpose.

5.2.5 Dataset quality

The quality of a dataset is considered to be an intrinsic property of the set (i.e. it does not depend on its use). The quality can therefore be evaluated regardless of the assessment reports in which they are used (*Figure 19*). The quality of a dataset are evaluated by using a set of indicators. These indicators are selected based on work done in the Mediterranean Sea and North Sea SBC projects. Balancing between detail and practicality, the indicators are basically a set of closed questions, which are scored within the CMS. The indicators (sometimes also related to the data source) cover aspects of spatial and temporal resolution (which is assumed to also be a proxy for accuracy, see also Section 7.3) and coverage; accessibility; costs; service level; responsiveness; processing level; and temporal window (i.e., forecast, hindcast, (near) real-time). The full set of quality indicators used and their possible score values are listed in Annex 1.

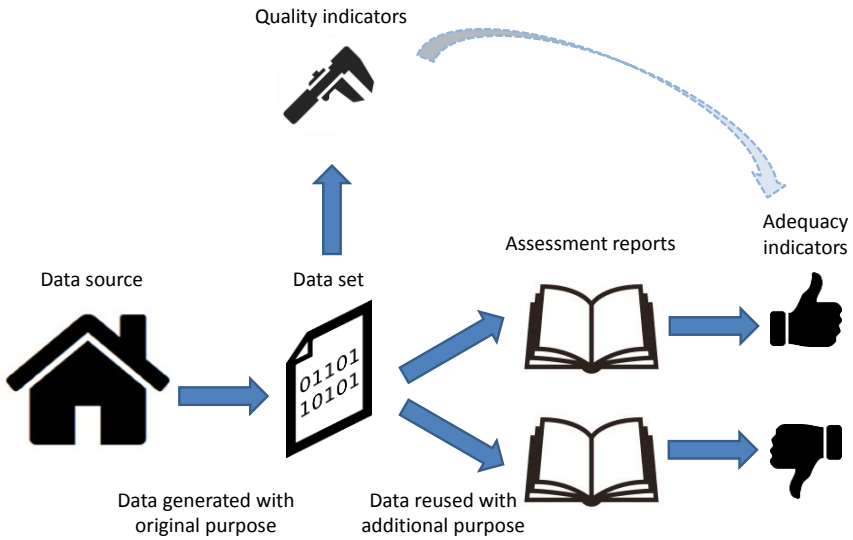

Figure 19. *A dataset is generated/published by a source with an (original) purpose. The quality is evaluated regardless of its (potential) use in assessment reports. For each time a dataset is used in an assessment(/WP challenge) report with an (additional) purpose, the adequacy of the data for that report is scored. The quality indicators are thus stored at a different level in the database as the adequacy indicators. However, the quality can be studied in relation to the adequacy. Note: for simplicity, this illustration only shows a single data source and a single dataset. However, the CMS holds multiple data sources where each data source can be linked to multiple datasets (Figure 18).*

5.2.6 Dataset adequacy

The adequacy of a dataset is not considered to be an intrinsic property of the set, as it depends on the specific purpose for which it was used. In this project, the adequacy of a dataset will therefore be evaluated for each separate assessment report in which it was used (*Figure 19*). The adequacy of a dataset is therefore a summary of the collection of assessment reports in which it was used. Like quality, the adequacy is evaluated by a set of indicators (in the form of closed questions). These indicators are also scored with the CMS. The set of adequacy indicators are listed in Annex 3.

To interpret the adequacy results, it is useful to know how many assessment reports are addressed (dataset adequacy is evaluated for each assessment report in which it is (considered to be) used). In the literature review 625 assessment reports were identified and added to the CMS (see Chapter 4). Each of the ten work packages was added as a special assessment report to the CMS as well. In addition, the challenge leaders have added a small number of reports to the CMS after the literature review. In total, the CMS holds (at the time of extraction for this report) 691 assessment reports. The challenge leaders were then asked to select the most relevant literature from the CMS. This is used as a starting point for the analysis for adequacy. This way, at least the most important work for all

relevant topics is covered. Currently 118 assessment reports (including the challenges) were evaluated, leaving the majority not assessed (n = 573). More than halve of the analysed reports (n = 64) do not explicitly use data and only 54 of the reports were used to address the adequacy of the data that they use or have considered using.

Adequacy is scored for a set of indicators using closed questions with a fixed set of possible answers, allowing for presentation with bar plots, which is used throughout the remainder of this report. The numbers on the y-axis will indicate the number of times datasets received a specific score. So, the total height of the bars in the bar plots represent the number of dataset evaluations. In specific cases, when only a single assessment report is presented (this is the case when each WP challenge is presented separately in Chapter 6), the y-axis can be interpreted as simply the number of datasets (as each dataset is only evaluated once by the one assessment report). Colour-coding used to mark the indicator value in the bar plot is kept consistent throughout the report.

There are three scoring values that are used for most quality and adequacy indicators, and may be confusing. These are: 'unknown', 'not assessed' and 'not applicable'. To avoid confusion, these scores are explained in the text below, whereas for the other scores we refer to Annex 2. The score 'unknown' is assigned to an indicator when it has been evaluated, but the appropriate score is unknown based on the available information. For instance, when a dataset is considered but not used in a challenge, and the information required for assessing the quality or adequacy indicator can only be obtained with a payed account, the indicator will be scored as 'unknown'. The indicator scoring value of 'not assessed' is only used when the dataset was actually not evaluated (for instance when the dataset was considered for a challenge but had little relevance; or when available time was insufficient, in which case the indicator can be scored at a later stage). The value 'not applicable' is only used when an indicator is not applicable. For example: spatial resolution is not applicable when the dataset covers a specific site (e.g. river) or when the data is not spatial in nature (e.g. species taxonomical information).

Each of these bar plots (with colour-coded stacked bars of adequacy evaluations for each indicator) will either present a sub-selection from the CMS (i.e. each of the challenges in Chapter 6) or present all data (both results from the challenges and the literature search), but in each case they are grouped differently (i.e. grouped per parameter, user type or purpose). Specific issues that are not covered by the generic scores from the CMS are either discussed in the results from the literature review (Chapter 4) or for each specific challenge (Chapter 6).

6 Challenge results

6.1 Introduction

This chapter presents the data adequacy as reported by each challenge. Each challenge is presented in a separate section with three subsections. Each challenge will start with a subsection presenting the main findings and discussing specific issues with respect to data availability, quality and adequacy. Please note that these findings and issues vary considerably between the different challenges as each challenge has a different aim and set-up and has been performed by different team members. Therefore the description and main results for each challenge has its own style, structure and level of detail. This subsection is followed by two subsections describing data quality and adequacy respectively. The latter two subsections will use the generic scoring for quality and adequacy (as specified in Annex 1 and Annex 2 and explained in Chapter 5) as registered in the CMS. This allows for a consistent and generic presentation of the data quality and adequacy for each challenge. For specific information we refer to the first subsection of each challenge.

The scores from the CMS will be evaluated together with information from the literature review to provide insight into the data adequacy in the Arctic Sea Basin from a user type's perspective (Chapter 8), per parameter (Chapter 9) and per purpose (Chapter 10). Overall findings based on the CMS will be presented in Chapter 7.

6.2 Wind farm siting (WP02)

6.2.1 Challenge description and main results

The objective of the Wind Farm Siting Challenge is to find economically viable areas for Offshore Wind Energy (OWE) development with little impact on both the ecosystem and other human activities, in the Norwegian Sea and Barents Sea.

- The Offshore Wind Development should be economically viable.
- For the purpose of the Arctic Ocean Checkpoint project we have taken this to signify that we attempt to identify the area that is best fits this aim.
- This forms the first part of our assessment: determining where the best chances to develop offshore wind lie.
- The Offshore Wind Development should have little impact on other uses – including the ecosystem - of the proposed area.
- This forms the second part of our assessment: taking away from the identified technical area those parts that are too important for other activities at sea and should better be left available to them.

To determine the best technical and economic area several datasets are needed to discriminate the options to develop offshore wind turbines.

1. An economical and viable development needs a market for the generated electricity. This means the presence of cities, ports or large industrial sites. Alternatively high voltage connection points can also be used to reach a market. Currently existing connection points are often also located near cities, ports, large industrial sites and power stations (conventional/nuclear/etc.)
2. Developing offshore wind energy also requires facilities like ports, quays, cranes to support the activities of building, operating and maintaining the turbines and the supporting infrastructure of cables and transformer platforms. On-shore this also means that availability of motorways, railways and airports is beneficial to have, e.g. to allow specialized persons or replacement parts quick access to the area.

A search has been done to identify locations that satisfy points 1 and 2. The results are bundled together in Table 3.

Table 3. Locations representation for both market and presence of infrastructure in relation to offshore wind energy development (data from amongst others Wikipedia and other websites of municipalities and ports). Suitability or presence of infrastructure is indicated as follows: 0 absent/unsuitable; 1 present/suitable; 2 with limitations.

Name	Inhabitants	Port Maint	Port Cons	Heavy Ind	Grid Connect	Railroad	Motorway	Airport	Country
Murmansk	300000	1	1	1	1	1	1	1	RU
Severomorsk	50000	1	1	0	1	1	1	1	RU
Tromsø	70000	1	1	0	1	0	2	1	NO
Bodø	50000	1	0	0	2	1	2	1	NO
Trondheim	180000	1	1	0	1	1	1	1	NO
Narvik	18000	1	1	0	1	1	2	2	NO
Hammarfest	7500	1	0	0	1	0	2	2	NO
Kirkenes	3500	1	1	0	1	0	2	2	NO
Longyearbyen	2000	0	0	0	0	0	0	1	NO
Nikel	12500	0	0	1	1	0	2	0	RU
Archangelsk	350000	1	1	0	1	1	2	1	RU
Severodvinsk	190000	1	1	1	1	1	2	2	RU

NO Norway, RU Russia

maint: maintenance

Cosn:

Ind; industry

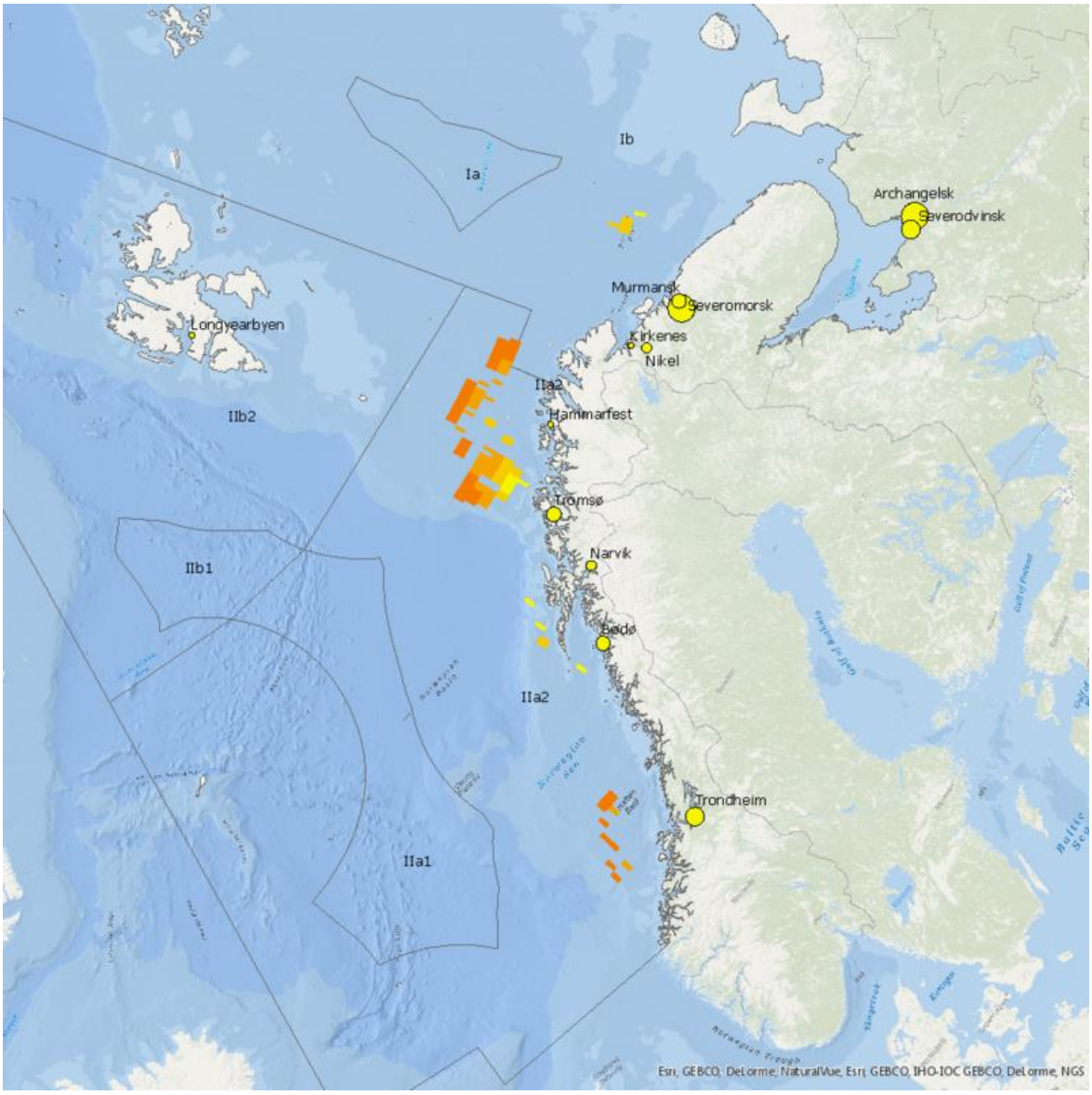

Figure 20. *Map of the Norwegian Sea and Barents Sea, showing the locations from the table above. Yellow-to-orange colours indicates the identified area suitable for offshore wind farm development, darker colours signify higher mean wind strength.*

Next two datasets become important:

1. Bathymetry (water depth, metres) (GEBCO 2014 gridded bathymetry 0.0083 degrees). This indicates where suitable water depths occur that are compatible with either a fixed or a floating offshore wind turbine.
2. Wind strength (m/s) (Copernicus Marine Environmental Monitoring Services or CMEMS). CMEMS provides a set of satellite-derived datasets (with global coverage 0.25 degrees) that covers six recent years, with monthly wind climatology for 59 months (from 72 months, so a few are missing). To support the analysis an average wind resource was calculated and used. Please note that the instrument on the satellite, a scatterometer, comes with its own limitations. One of these is that a scatterometer cannot determine wind speeds over land or over ice-covered sea. Thus the average wind resource dataset has no data where sea ice has prevented observations during the observation period. The available wind resource for the Norwegian Sea is comparable and possibly somewhat larger than for the North Sea. Where data is available the same holds true for the Barents Sea. As such there is sufficient wind resource available. The resolution of this dataset is used also for the analysis.

A third important dataset has been derived based on the data from points 1 and 2, in combination with a geographical dataset of the coastlines (Arctic countries coastlines):

3. Distance to port and market.
   This is useful to determine how far – by sea – it is to a possible site to develop an offshore wind farm. This distance is an important economical factor as it determines many costs, such as length of the High Voltage (HV)-cables which bring the generated power to market, travel time when building, operating and maintaining the wind farm.

Assessment Part 1

To properly interpret the datasets outlined above some realistic assumptions about offshore wind technology options are needed.

- How far from port and market is it economic interesting to attempt to develop OWE?
  The maximum distance within the North Sea, currently one of the best developed OWE areas, is a little over 200 km (close to the centre, on the Doggerbank). For the purpose of this study the upper limit has been set at 250 km.
- How does water depth interact with offshore wind turbine (OWT) technology?
  - Fixed OWTs can be built to water depths to about 50 m., with several construction options including monopoles, tripod, jacket and gravity-based (concrete) foundations structures. This choice more or less follows the current state of technology in the North Sea.
  - Floating turbines can be built in water depths starting from ca. 100 m. to ca. 500 m. deep. These numbers match with pilot installations and early wind farm developments for turbines such as the HyWind (SPAR-type) and WindFloat (floating jacket). This technology is still new and not many such turbines are current in operation. Data assembled by the EU-project ACCESS on a.o. SPAR-type platforms (D 4.21) shows that these are reasonable assumptions.
- Sea ice and offshore wind turbines
  Offshore wind parks have not yet ventured in to (sub-)Arctic waters and waters where sea ice can occur. Technically it is possible to build wind turbines strong enough to withstand the forces exerted by sea ice. It adds cost and the economics of offshore wind turbines does not allow for such additional costs. Based on that conclusion the pragmatic choice made for this study to not suggest OWE development in ice covered waters also has a base in economics. Pragmatic as the scatterometer data do not allow for collection of wind speed data (by way of a satellite) over ice-covered sea areas.
  Please note that technology options to construct ice-resisting OWT do exist and some of those can be gleaned from the reports of ACCESS.
  When considering the development of OWE in these waters, icing of the turbines blades can form one more complication that requires both technical attention and may impact the economics. This is an active field of research within wind turbine development.

Assessment Part 2

The second step of the assessment is to take away from the technical and economic potential determined in the first step, those areas where an impact on the ecosystem or other uses of the sea area can be expected. For this study four marine uses have been considered:

- **Fisheries**, by way of a dataset generated for OSPAR by ICES Working Group on Spatial Fisheries Distributions (WGSFD). What was used it the surface interaction of mobile bottom-touching fishing gears (Swept Area Ration or SAR), the associated fishing activities do not combine favourably with offshore wind turbines as the fishing gear may cause damage to electricity cables and for floating turbines also with the mooring cables. Such interactions also pose a danger to the fishing vessel and its crew. Please observe that other types of fishery, e.g. angling and other passive gears, are present in the area and can be performed within an OWF.
- **Shipping**, for this a dataset collated and made available by Halpern et al. (2015) was identified and used. It has global cover, is in high detail (ca. 1 x 1 km) and of a recent year (2013).
- **Marine Protected Areas**, to respect nature conservation areas the MPA-database that was put together for the MPA Challenge was re-used. The MPA-database relies heavily on the

WDPA, but many other (national) sources have been checked. These checks have led to a few dozen additions across the whole Arctic.
Please note that especially for Norwegian waters a wealth of data (geographically explicit in many cases) is available. But considering each of those and whether that would constitute sufficient cause to not develop OWE would have been too bit a task for the project. A choice was made to base this assessment on known protected locations already within our sights. The MPA-dataset serves here as a proxy to ensure little impact on the ecosystem.

- **Oil and Gas** infrastructure, including pipelines (Norwegian Petroleum Directorate or Oljedirektoratet).
  These were incorporated using the map services offered by the NPD to reveal the positions of oil and gas infrastructure (platforms and subsea installations) as well as pipelines.

When implementing each of the three above datasets suitable cut-off values or choices are required. For the fourth dataset oil and gas infrastructure mere presence was seen as sufficient.

For Fisheries the effort within the technical OWE area was considered. Due to a lack of pattern, the final choice was made by eye. OWE-blocks having several (five or more) and fairly intense fisheries hits where deselected for wind farm development. This also considered access to fishing grounds that could become isolated within wind far areas. The result is that 75% of the fishing effort within the technical OWE area has been respected and this area has been subtracted.

For Shipping connectivity and access to ports is vital for its purpose. With a cut-off at 600 (unit!) or more "vessel movements" the needs for shipping seem to be sufficiently taken into account. Also since intersected OWE-blocks are fully subtracted from the technical OWE area.

For Marine Protected Areas (nature conservation and general biodiversity considerations) the existing MPA-database was used in combination with a 5 km buffer distance outside. So OWE development will stay at least 5 km away from nature conservation areas. A sensible choice as a number of the MPA is also home to bird nesting colonies.

For Oil and Gas infrastructure the presence of any infrastructure has led to subtracting the blocks from the technical OWE area. The selection had to be made by hand as the software did not adequately detect overlap.

Please note that only a very limited number of OWE-blocks have been eliminated due to a single obstruction. In many cases shipping obstructions combine with either fishing grounds or areas in or near MPA.

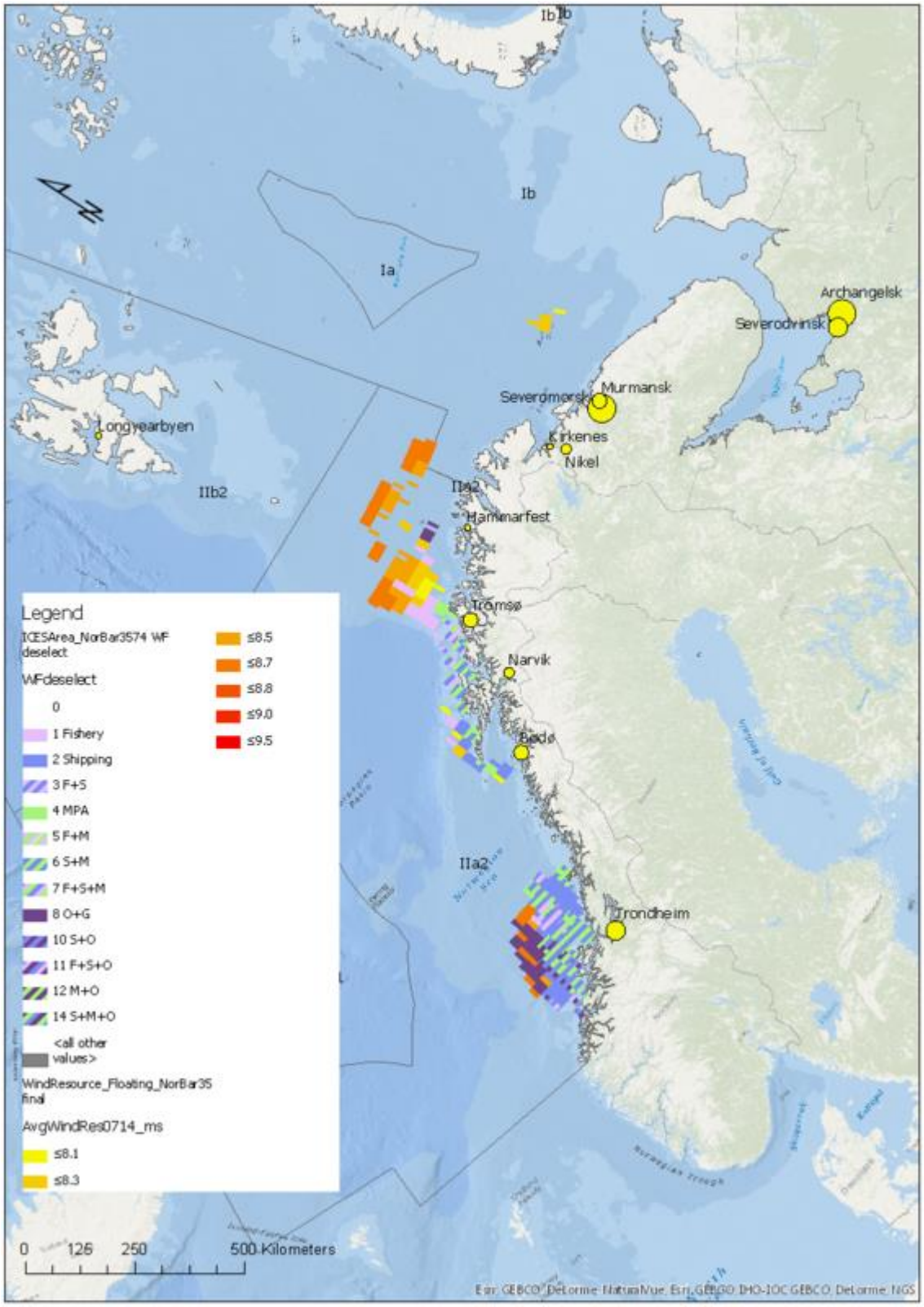

Figure 21. *Map showing OWE development potential for (floating) offshore wind turbines in the Norwegian Sea and Barents Sea, as well as dropped area with an indication of the other sea uses that were given precedence.*

Final outcome:

Fixed wind turbines

From a technical OWE development area for fixed offshore wind turbines consisting of 13 blocks spread out along the Norwegian coast none remain after taking other sea uses into account. Most are lost to both shipping and marine protected areas.

Floating wind turbines

From a technical area of 290 blocks there remain 124 blocks after taking other sea uses into account. Six of those are in the Russian part of the Barents Sea (ICES area Ib), on the Murman Rise. The remainder is in Norwegian waters (ICES area IIa2), mostly around the Lofoten and Troms. West of Trondheim the combination of other sea uses results in only a few remaining OWE blocks.

The main characteristics of these areas have been summarised in Table 4.

Table 4. Characteristics of the most suitable areas for developing offshore wind farms in the Norwegian Sea and Barents Sea (per ICES area)

ICES area	No. OWE blocks	Mean distance to port (km)	Mean water depth (m)	Mean wind speed (m/s)	Area (km2)
Ib	6	238	179	8.2	1553
IIa2	118	203	272	8.4	29969

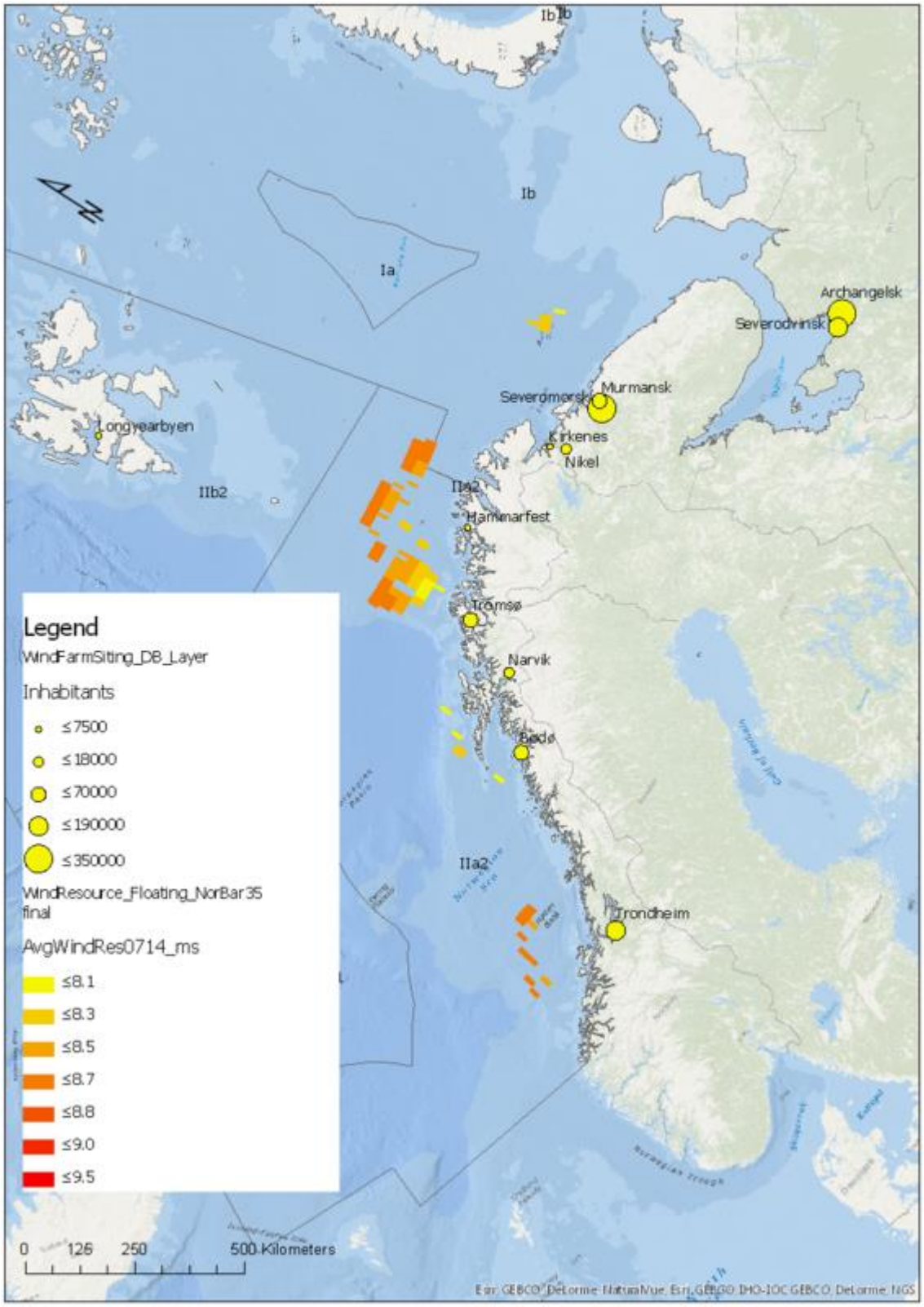

Figure 22. *Map showing the area with potential for developing (floating) offshore wind energy parks in the Norwegian Sea and Barents Sea. Also shown are human settlements that may play a role in this development.*

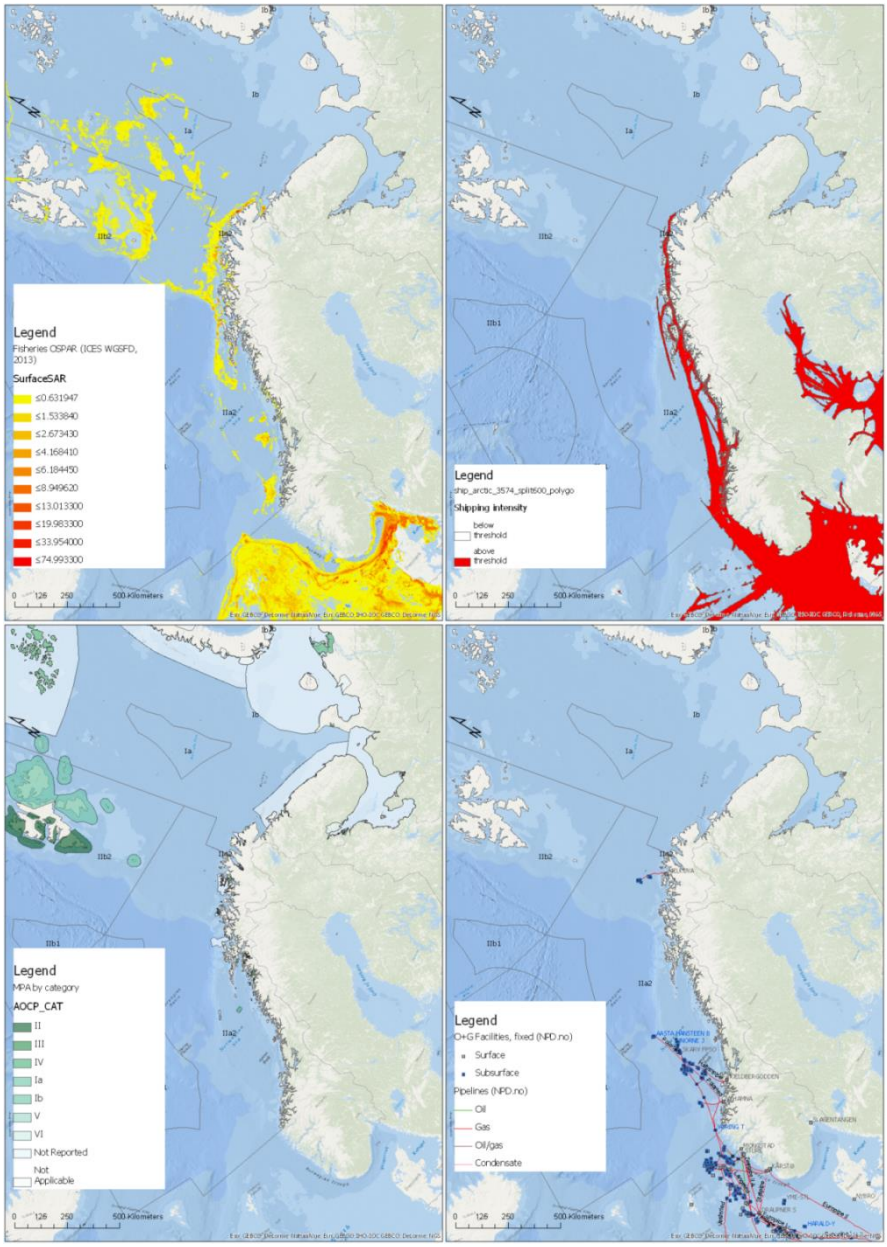

Figure 23. *Maps showing human activities in the Norwegian Sea and Barents Sea: fisheries (top left); shipping intensity (top right); Marine Protected Areas (bottom left); oil and gas facilities (bottom right).*

Lessons learned from the 1st Wind Farm Siting Challenge

The end results as presented show that with the available data an adequate assessment can be made on the potential development of offshore wind parks in the Norwegian Sea and Barents Sea.

For a second time around, a smaller block size for the OWE-analysis could be used. This could result in less area being lost to other uses and/or ecosystem concerns. The wind resource data was not decisive for the development and need not govern the geographical accuracy.

Also now that the three most promising areas are known, the possibility exists that better datasets can be uncovered that do not cover the entire original study area but do cover at least one but preferably all three of them. This will be addressed in the second DAR.

Offshore development of wind energy in this region will have to rely on floating turbine technology. This technology may need several more years to mature sufficiently for deployment in Arctic and sub-Arctic waters. For an in-depth assessment of the economics of an offshore wind farm the technology

choices regarding moorings, also in relation to geophysical conditions on and in the seabed will be needed.

The datasets that were used, are available on the internet, but the ease with which they can be found leaves ample room for improvement. Discoverability is often times low.

6.2.2 Data quality

Figure 24 shows the quality indicators for the seven datasets considered for this challenge. The accessibility of the data is good as most could be directly downloaded and some downloaded after creating an account (all within a day). All datasets were free of charge. The data formats had to be converted (processed) before use in this challenge. There were no datasets used that specifically covered the Arctic Sea Basin. Most had a global spatial coverage and one dataset covered part of the Arctic. In general the data had a high spatial resolution. Temporal resolution varies considerably, from daily up to yearly data. There is no forecast data or (near) real-time data used, only historical or hindcast datasets. The vertical resolution of the data (i.e. measured at a certain water depth or height) is either not assessed for this challenge or measured at the water surface.

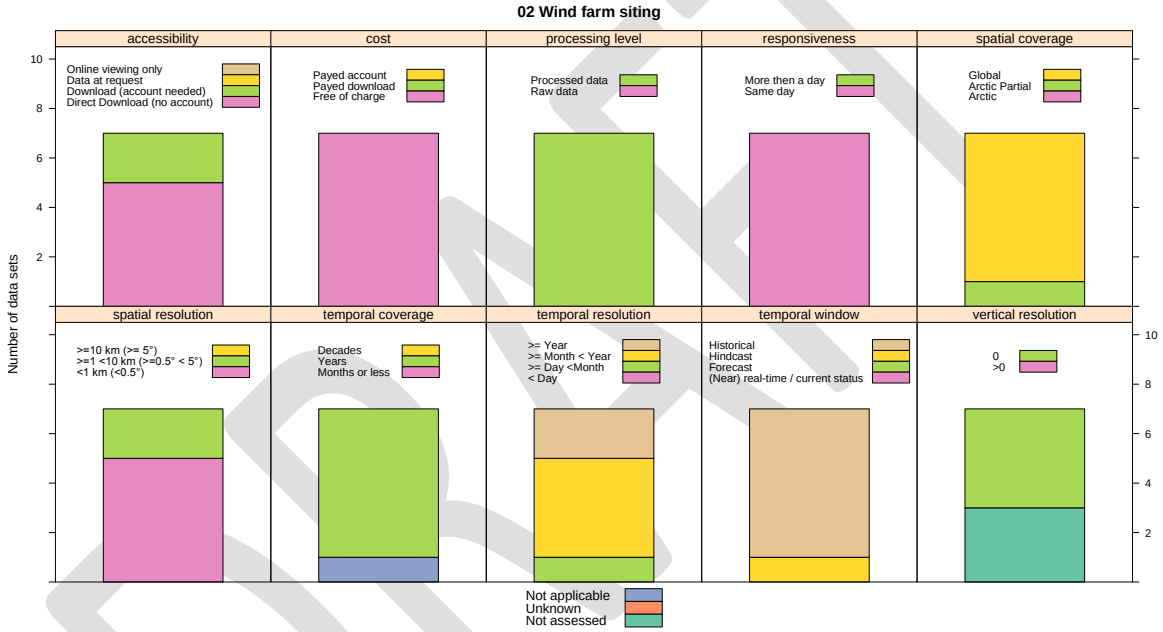

Figure 24. *Quality indicators for the datasets used and considered for use in the 'wind farm siting' challenge. Colour-codes of specific categories are presented above each indicator. Generic categories (i.e. relevant to all indicators) are presented at the bottom of this figure.*

6.2.3 Data adequacy

The adequacy indicators for the datasets used and considered for use in this challenge show that most data is adequate for use (*Figure 25*). With the exception of one dataset, all datasets considered for this challenge were actually used. One dataset was not assessed. There were no known budget or time restrictions. The data formats had to be converted before use and data was processed for this challenge. Spatial and temporal coverage and resolution were adequate for use. Most of the data was essential to this challenge.

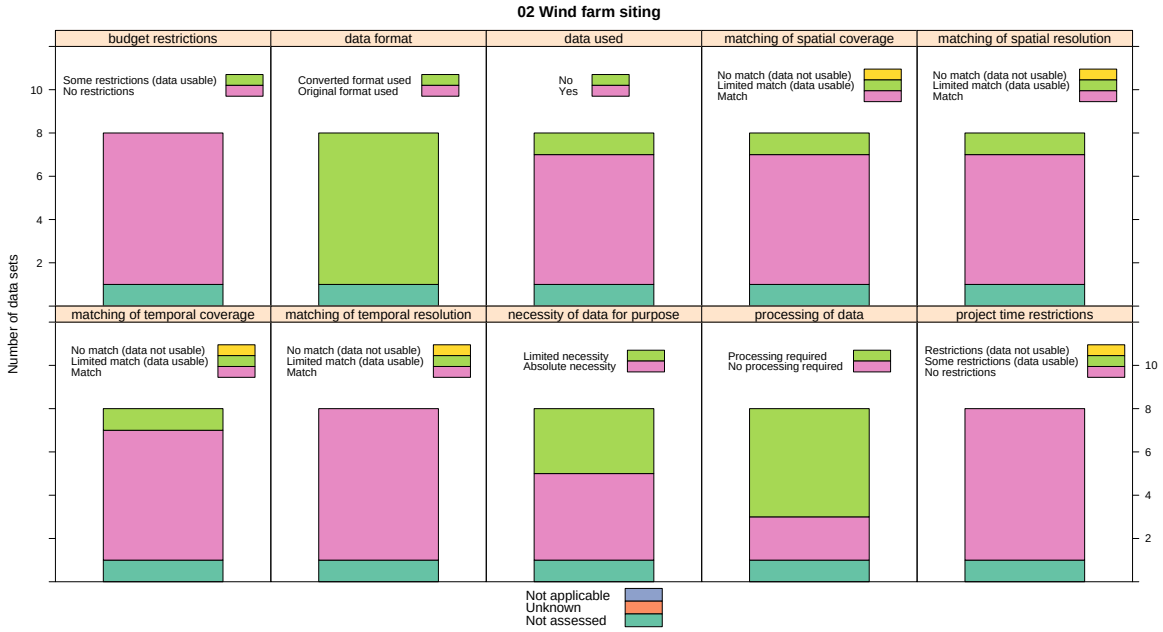

Figure 25. *Adequacy indicators for the datasets used and considered for use in the 'wind farm siting' challenge. Colour-codes of specific categories are presented above each indicator. Generic categories (i.e. relevant to all indicators) are presented at the bottom of this figure.*

6.3 Marine protected areas (WP03)

6.3.1 Challenge description and main results

In this challenge the network of Arctic MPAs is analysed. Data on MPAs were obtained from various sources, the most comprehensive being the World Database on Marine Protected Areas. EU Natura 2000 areas are not present in this part of the world. From the OSPAR database with 333 records, only 8 MPAs were inside the Arctic region studies and these were included. Vulnerable Marine Ecosystems (VMEs) were not present in the area either. Eleven Norwegian MPAs and 5 proposed Norwegian MPAs were included. For the USA, 38 additional MPAs published by NOAA were included, including a lot of fishery closures. A check on the Canadian data sources from DFO did not reveal any new MPAs compared to the Word Database on Marine Protected Areas. The same was true for the MPAs of Greenland and Russia. Finally, the network of EBSAs was included. The MPAs were classified according to the IUCN classification.

The resulting dataset of MPAs will become available in a geoviewer later on in the project (see *Figure 26* as an example). The geoviewer will also allow for comparisons of the MPA network with habitat maps and fishery intensities.

The next steps are to analyse the coherence of MPAs using OSPAR criteria. For this, we will take a number of species and estimate to what extent the network of MPAs is covering their distribution. Finally, the effect of climate change on MPAs will be estimated. During the process, we record which information is available and which is lacking, to give an estimate of data adequacy.

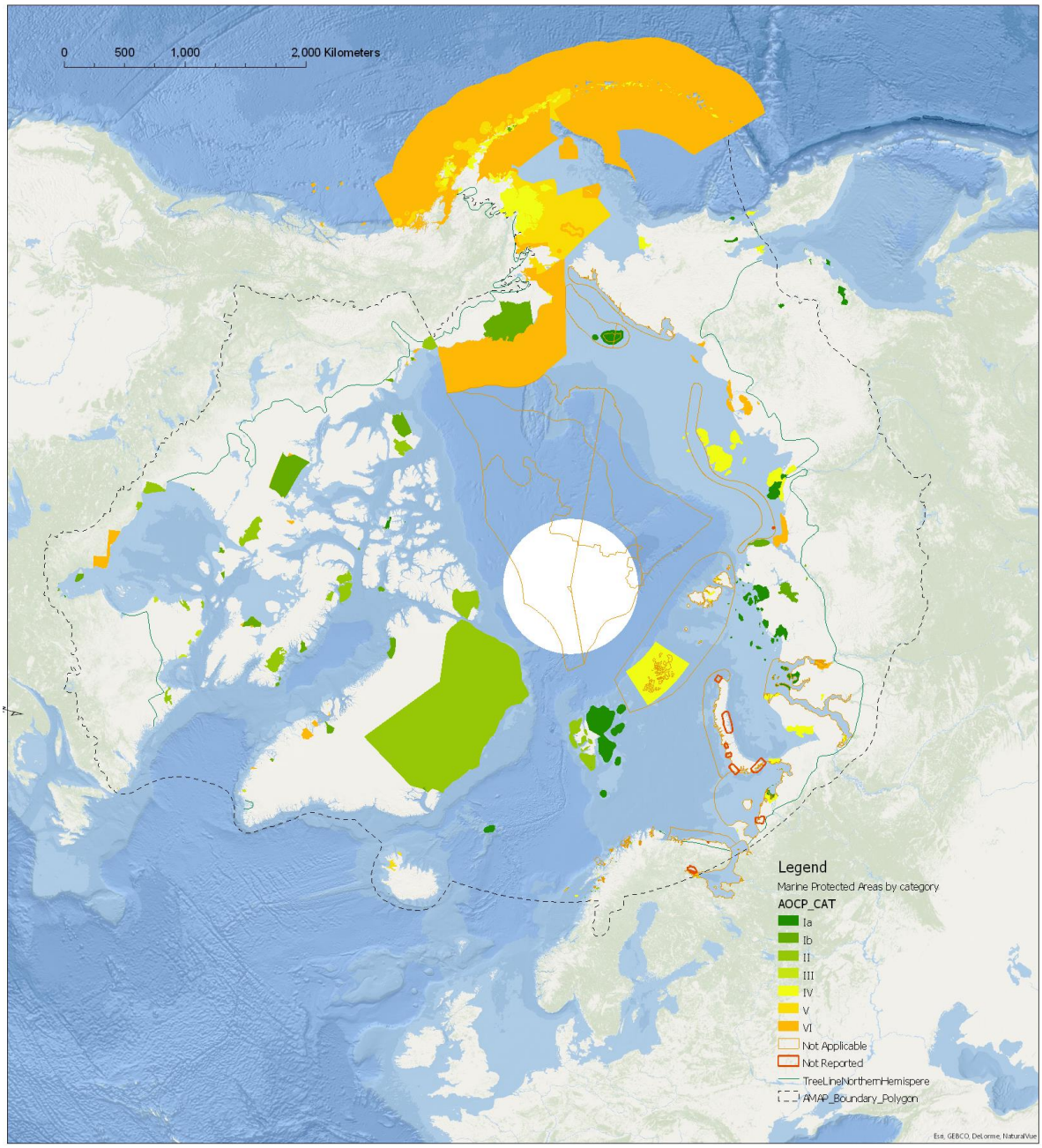

Figure 26. *MPAs in the Arctic (challenge results, July 2016).*

6.3.2 Data quality

Figure 27 shows the quality indicators for the nine datasets considered for this challenge. The accessibility of the data is good as the majority could be directly downloaded, one could be downloaded after creating an account and one dataset had to be requested. For one dataset responsiveness was more than a day. All datasets were free of charge (for two datasets this was not assessed). Some data formats had to be converted (processed) before use in this challenge, but also raw data was used. There were no datasets used that specifically cover the Arctic Sea Basin. Most have a global spatial coverage or cover part of the Arctic. Most of the data used have a high spatial resolution. Temporal resolution is not relevant for most of the datasets (i.e. no time series). For the datasets for which temporal resolution is relevant, it is relatively low (monthly to >yearly). Datasets mostly reflect historical conditions. The vertical resolution of the data (i.e. measured at a certain water depth or height) is either not assessed for this challenge or the data has no vertical height (vertical resolution is 0 m).

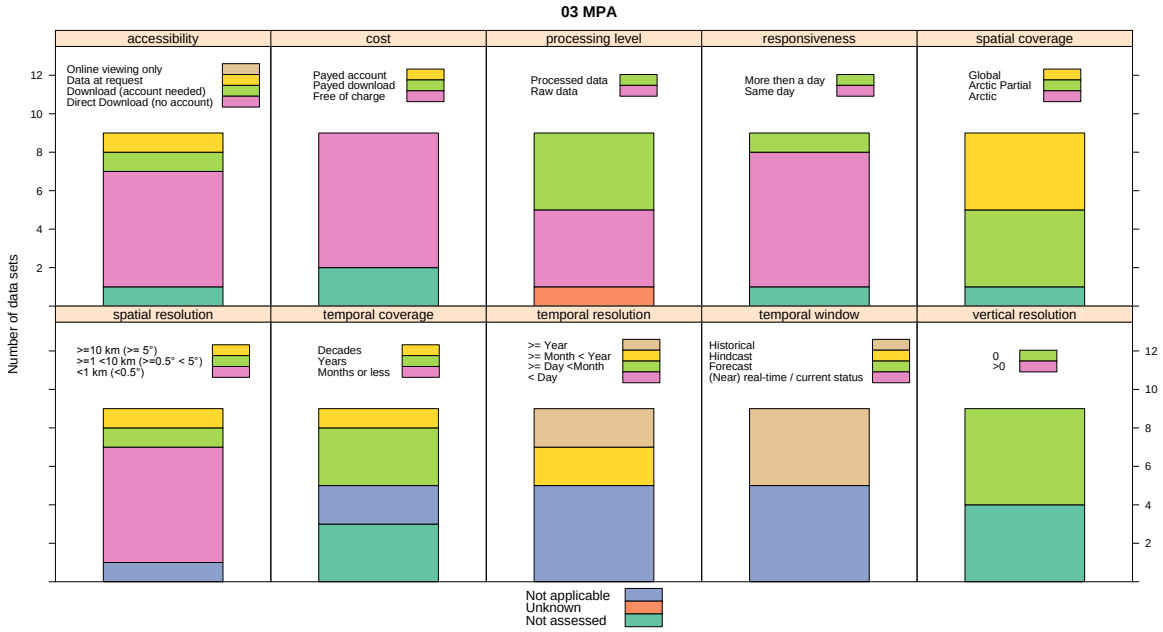

Figure 27. *Quality indicators for the datasets used and considered for use in the 'marine protected areas' challenge. Colour-codes of specific categories are presented above each indicator. Generic categories (i.e. relevant to all indicators) are presented at the bottom of this figure.*

6.3.3 Data adequacy

The adequacy indicators for the datasets used and considered for use in this challenge show that most data is adequate for use (*Figure 28*). With the exception of two datasets, all datasets considered for this challenge were actually used. There were no budget or time restrictions leading to unusable data. Most data formats had to be converted before use and most data was processed for this challenge. Spatial and temporal coverage and -resolution were adequate for use, except for one dataset of which the spatial coverage did not match. Most of the data was essential to this challenge.

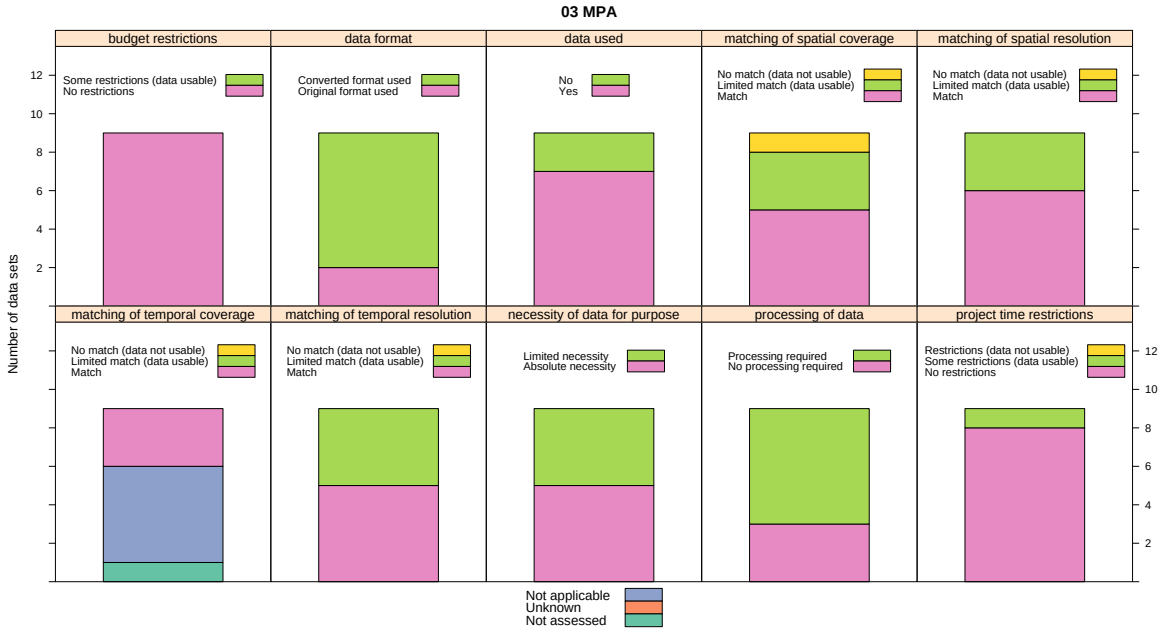

Figure 28. *Adequacy indicators for the datasets used and considered for use in the 'marine protected areas' challenge. Colour-codes of specific categories are presented above each indicator. Generic categories (i.e. relevant to all indicators) are presented at the bottom of this figure.*

6.4 Oil platform leak (WP04)

6.4.1 Challenge description and main results

The objective of this challenge is to test the preparedness of operational tools for forecasting the effects of an oil spill. The challenge has the form of an unexpected oil spill in the Arctic region. The challenge inputs are organized through the series of Key Questions the responder will need to ask regarding the incident for the initial information and the information required to prepare products for response personnel:

1. What was spilled? – The nature of the product, particularly persistence and toxicity. Light condensates or light, highly refined products have initial high toxicity, but are not very persistent in the environment. Heavy fuel oils are very persistent, but not very toxic, usually causing harm via oiling fur or feathers or smothering. Crude oils have different combinations of both these characteristics.
2. Where will it go? – The trajectory of the spill is key information for providing basis for executing the response efficiently and estimating environmental risk.
3. Who will it hit? – Natural resources in the area vary in sensitivity to oil contact. Responders need to know the timing and variety of organisms in the path of the oil spill and their varying sensitivity to oil contact in order to best organize the response to minimize harm. Safety of human responders from inhalations, oil contact and other risks is also critically important.
4. How could the oil spill affect society? – Oil spills can lead to loss in revenues from tourism and lack of public trust

At 10:27 (BST) on 10/05/2016, the Arctic Checkpoint was alerted that an explosion had occurred at 08:15 (CET) on the Prirazlomnaya Platform, 60 km off the coast in the Pechora Sea. Oil is leaking subsurface, at a rate of 800m³/day: this is expected to be reduced to 500 m³/day following emergency repairs within 24 hours, with the leak being stopped completely within 72 hours.

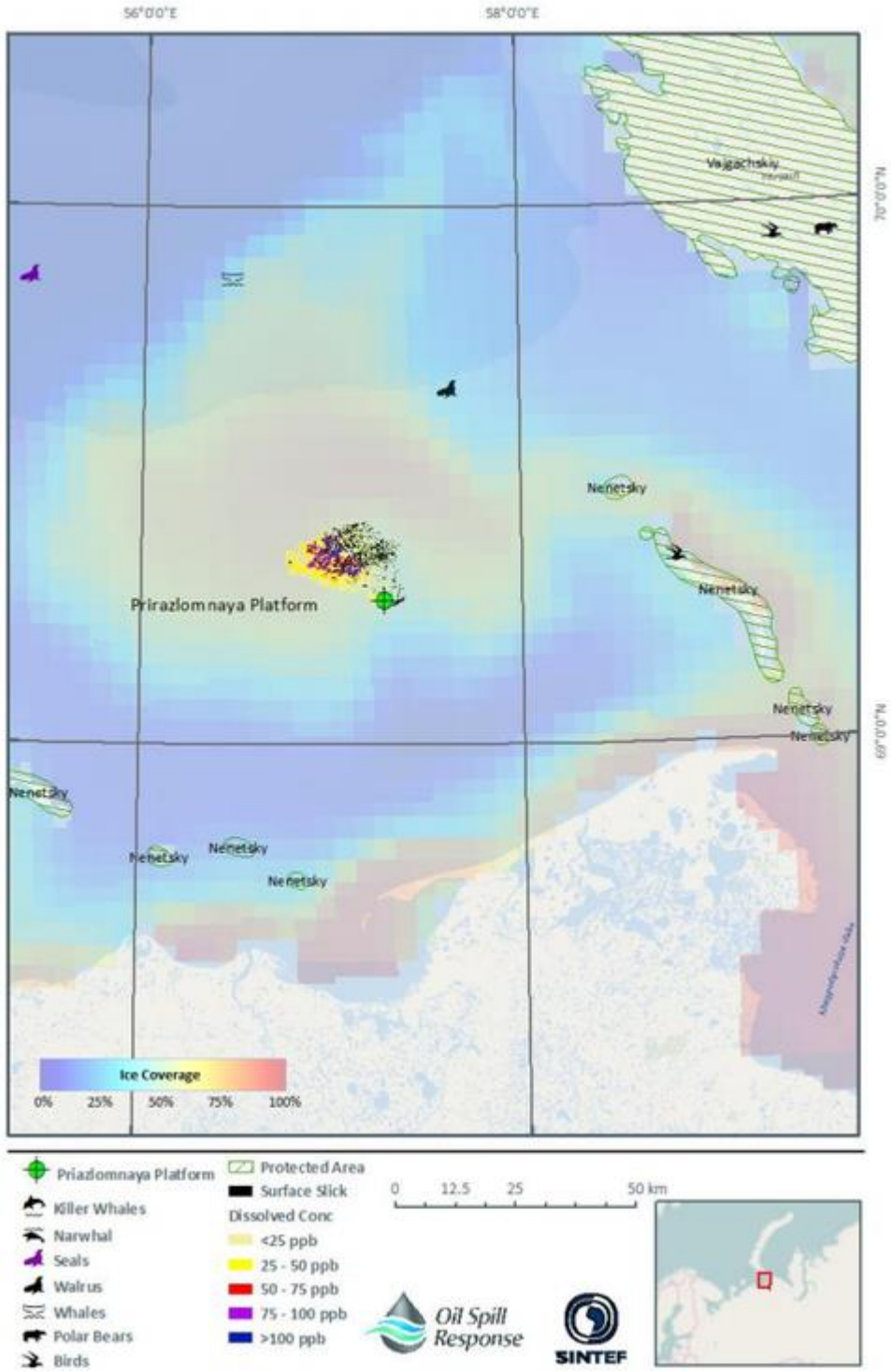

Figure 29. *The location of the leaking oil slick and the ice pack 60 km off the coast in the Pechora Sea, three days after the incident (13-May-2016 08:15 CET).*

Initial modelling was carried out using RPS ASA's 2D OILMAPTM model. Because of the entrainment of the oil in the ice, the hydrodynamic data was made equal to the ice velocity fields and wind action has been switched off. Forecast Modelling on the 12th May and 13th May were carried out using SINTEF's 3D OSCAR model that provides additional information about the oil in the water column. Metocean data was sourced from The Met.no website. A long range forecast (out to six months) was carried out using the Lagrangian particle-tracking software package, Ariane in conjunction with a 20 year output from the leading edge 1/12th degree resolution NEMO ocean model coupled to LIM2 ice model.

The oil spill is in a complex, ice infested environment that reduces the reliability of any oil spill forecast. In this case, the Prirazlomnaya Platform is in pack ice flowing westward at up to 0.5 m/s.

The oil, which is lighter than water, can be expected to rise to the underside of the ice pack where it will be trapped into the moving ice sheet. During the first 72 hours, more and more oil was transported north-westward as the ice sheet flows over the top of where the leak is. The ice pack is currently breaking up, making an accurate prediction of where the oil can be recovered very difficult.

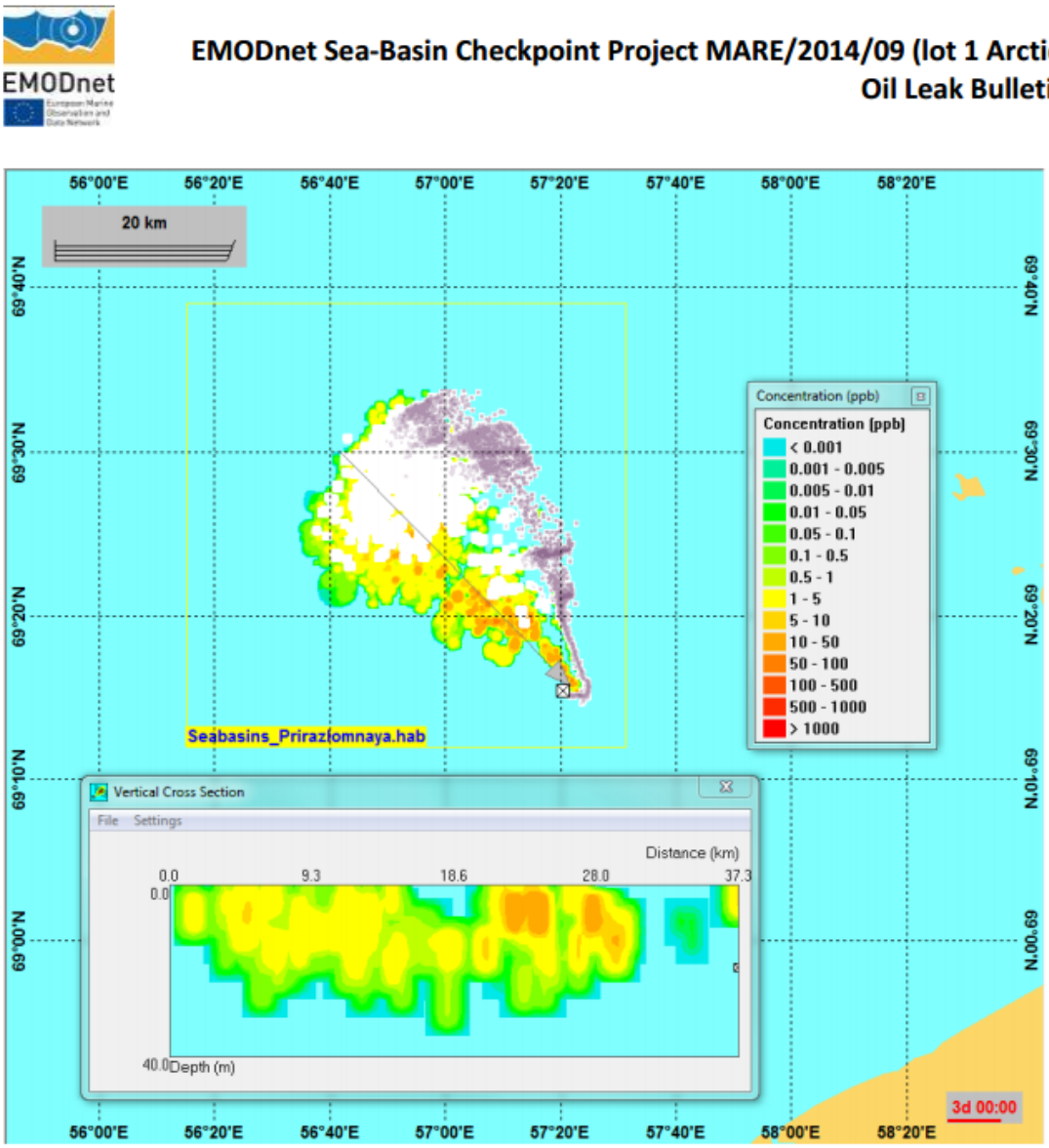

Figure 30. *Day 3 (13-May-2016 08:15 CET). Surface oil shown overlaid with a plot of maximum subsurface concentrations and a cross section of subsurface oil concentration at end of Day 3. Cross section is for arrow shown on map.*

Bulletins produced at 24, 48 and 72 hours after the spill can be found on the project website (http://www.emodnet-arctic.eu/oil-leak-platform).

6.4.2 Data quality

Figure 31 shows the quality indicators for the five datasets considered for this challenge. The accessibility of the data is good as most could be directly downloaded or could be downloaded after creating an account. All datasets were available within a day. Most datasets were free of charge, one dataset required a payed account. All data formats had to be converted (processed) before use in this challenge. There were two datasets used that specifically cover the Arctic Sea Basin. Others have a global spatial coverage or cover part of the Arctic. Most of the data used has a spatial resolution between 1 and 10 km. Temporal resolution is relatively high for most of the datasets, with a frequency

of less than a day. All sets are forecasted data. The data mostly has a vertical resolution, i.e. is measured at a range of water depths or heights.

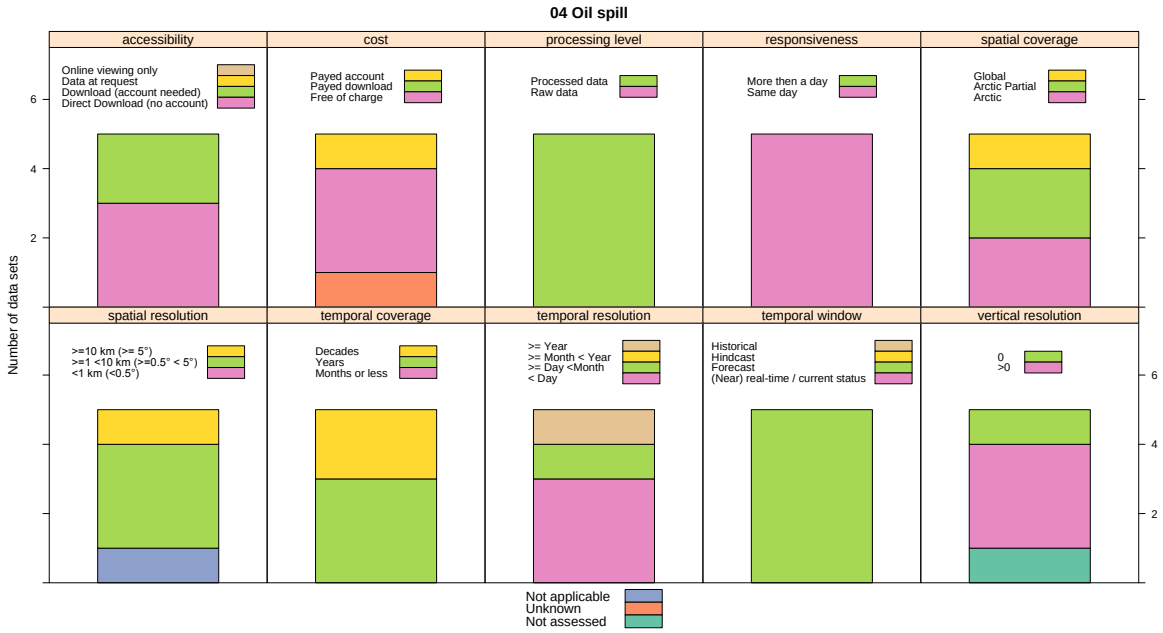

Figure 31. *Quality indicators for the datasets used and considered for use in the 'oil platform leak' challenge. Colour-codes of specific categories are presented above each indicator. Generic categories (i.e. relevant to all indicators) are presented at the bottom of this figure.*

6.4.3 Data adequacy

The adequacy indicators for the datasets used and considered for use in this challenge show that most data is adequate for use (*Figure 32*). One dataset was not assessed. All other datasets considered for this challenge were also used. There were no budget or time restrictions leading to unusable data. Original data formats were used and data did not need to be processed for this challenge. Spatial and temporal coverage and resolution all matched and were thus adequate for use.

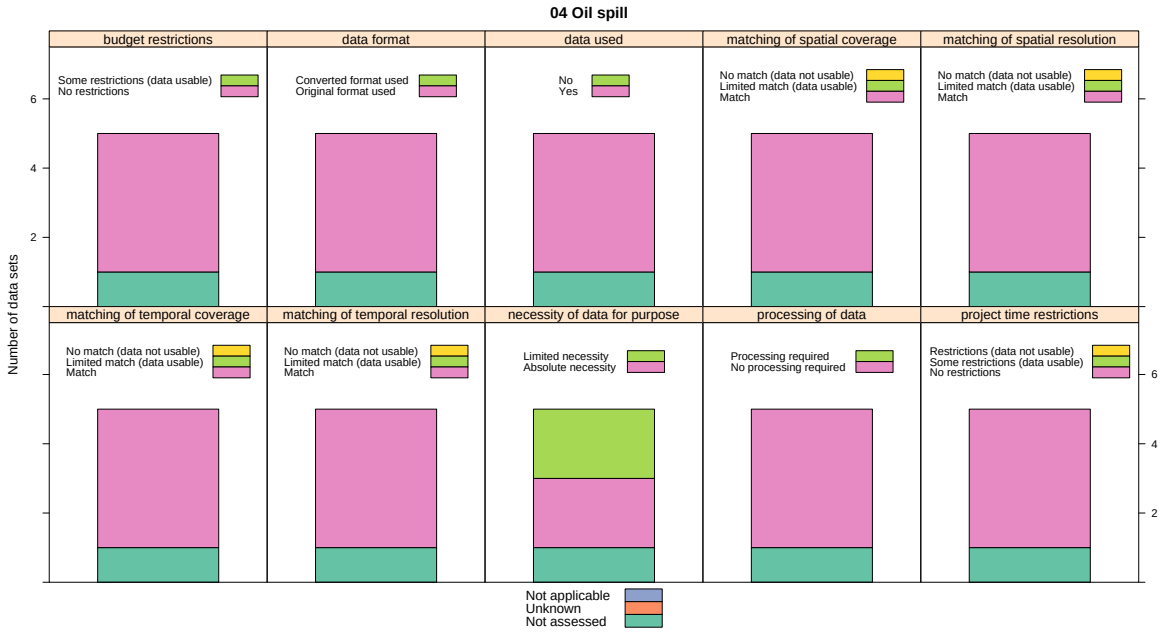

Figure 32. *Adequacy indicators for the datasets used and considered for use in the 'oil platform leak' challenge. Colour-codes of specific categories are presented above each indicator. Generic categories (i.e. relevant to all indicators) are presented at the bottom of this figure.*

6.5 Climate change (WP05)

6.5.1 Challenge description and main results

The Climate Change Challenge evaluates publicly available data on climate change and its effects in the Arctic Sea Basin. Nine sub-challenges have been set for which parameters have been selected, focusing on (among others) temperature, ice and phytoplankton. Links to the sub-challenges can be found below.

During the data collection several things came to light. For some topics, such as sea ice extent for example, a lot of data from different sources is available. For other topics, such as phytoplankton, it can be quite difficult to gather useful data for the entire area. For many parameters, data can be found on a very small spatial and temporal scale, making it difficult to present an overview of the entire Sea Basin. For certain parameters, this also would not make sense as different parts of the sea basin can have completely different circumstances. This is the case not only for phytoplankton, but also for animal behaviour for example. Some practical problems we came across with some examples:

- Data was asked from SAHFOS, this data is freely available for non-profit research scientists but not for commercial enterprises, when asked for further information on the data, no replies followed.
- For phytoplankton a collection of data is available on the COPEPOD website, however the data does not cover the entire Sea Basin or the required time period and the data is presented in a format which needs processing before it can be presented in the preferred way.
- Data on Sea Ice is available through a portal of NERSC, however the catalogue has quite technical terms which might confuse non-experts or layman. The same goes for the used format in which the data can be downloaded, as this is not a standard format for many data users.

Per sub-challenge the following results are recorded:

6.5.1.1 Time series of average annual temperature at sea surface and bottom

For this sub-challenge there was not enough data available to complete. The data Sea Surface Temperature is widely spread and freely available, however the data on Sea Bottom Temperature is hard to find. No clashes were found in the data. The datasets combined from different sources gave the same results. For this sub-challenge we feel major gaps are present for sea bottom temperatures, for sea surface temperatures the data is quite spread-out both spatially and temporally.

Because this sub-challenge is quite broad and not clearly defined, in the results multiple options are given for the viewer to observe.

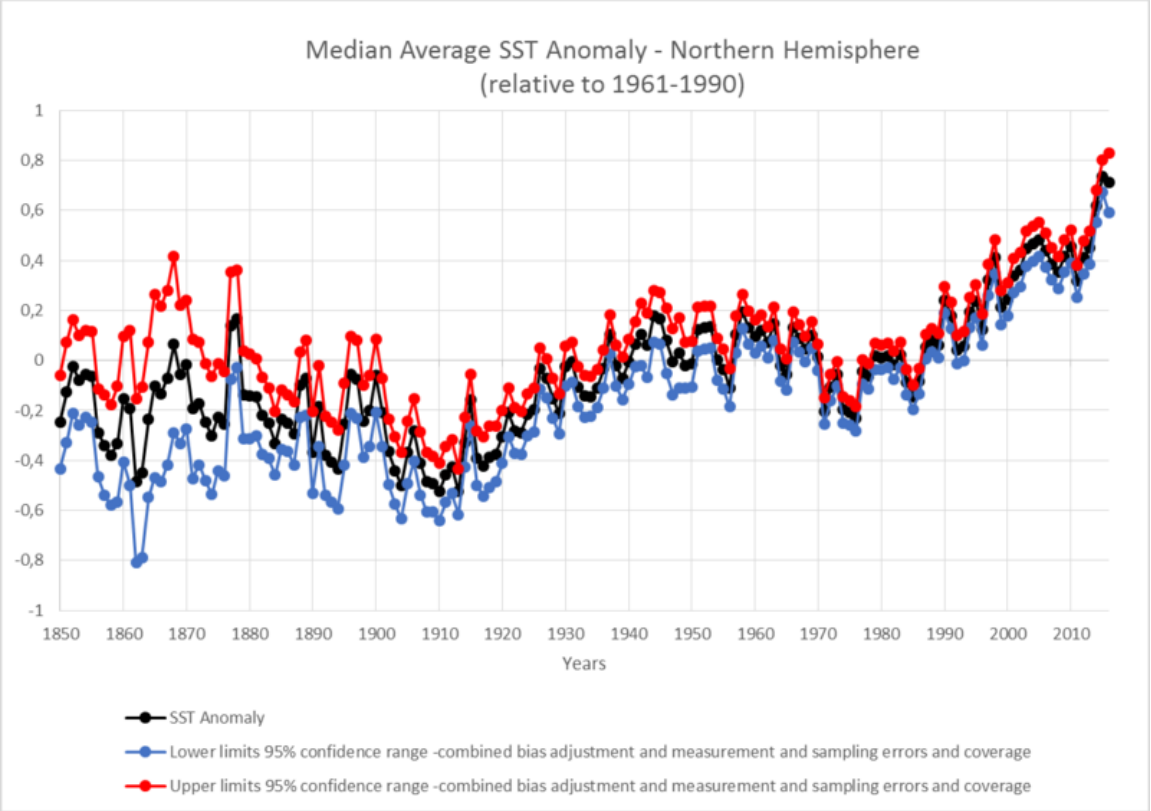

Figure 33. *Median average Sea Surface Temperature anomaly for the Northern Hemisphere, data source: UK Met Office).*

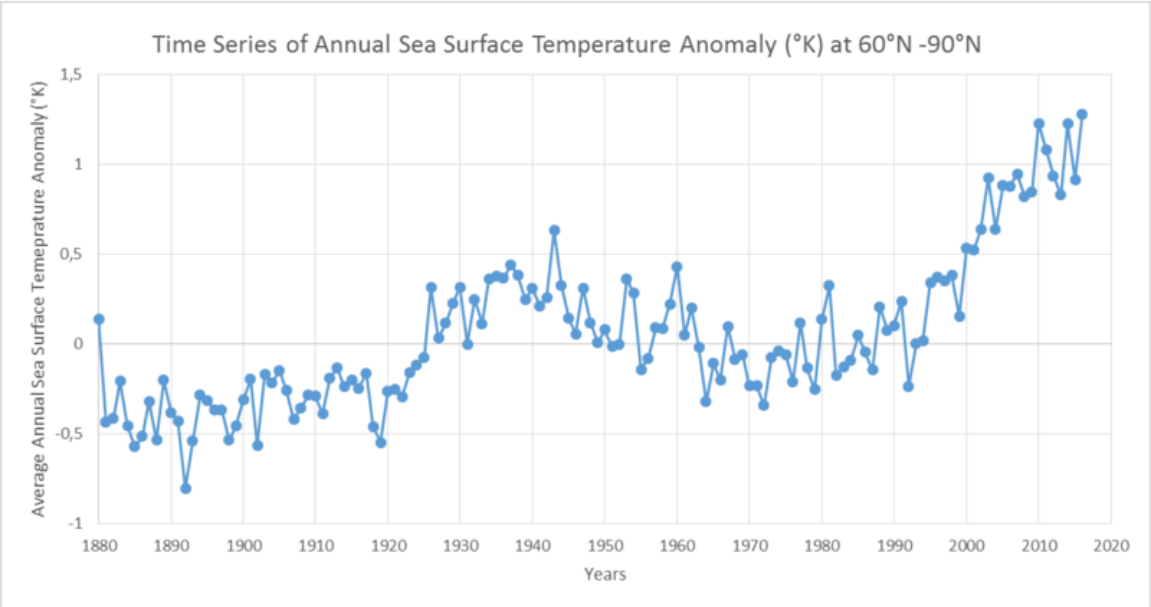

Figure 34. *Sea Surface Temperature anomaly, data source: NOAA.*

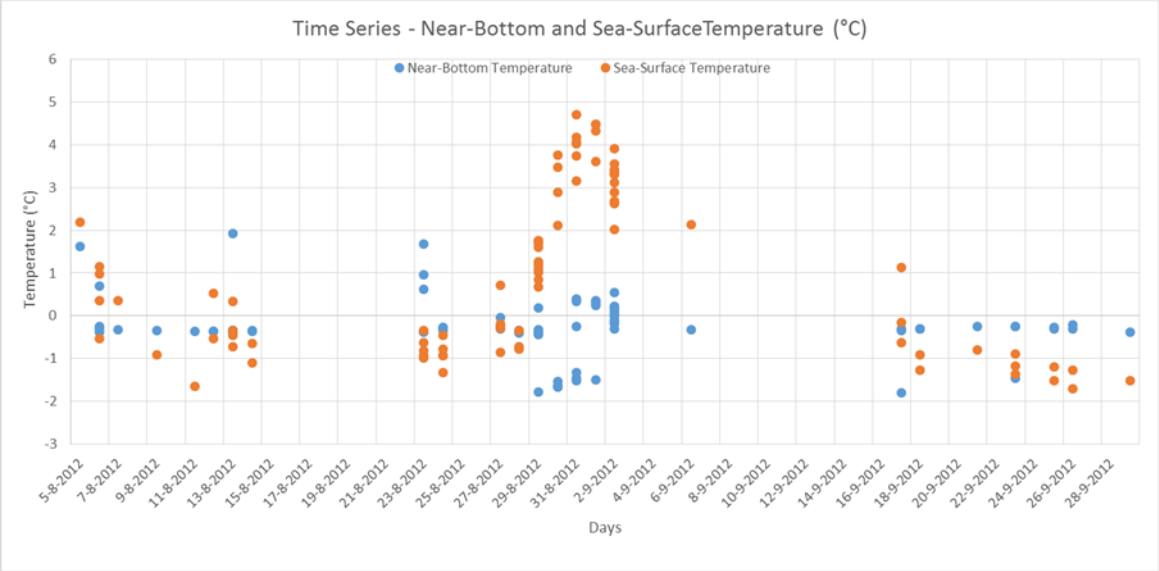

Figure 35. *Sea Surface and Bottom Temperature in 2012, data source: Rabe et al. 2015.*

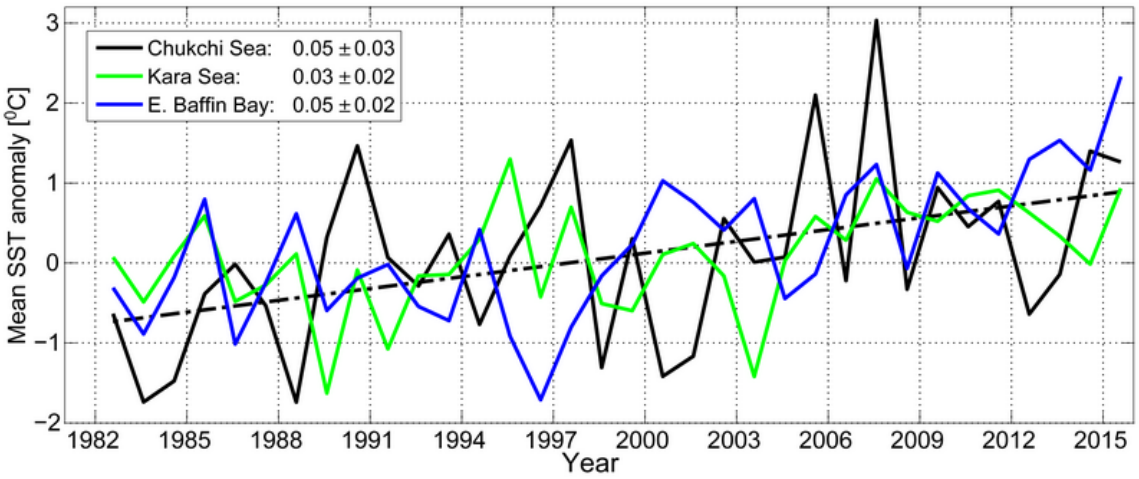

Figure 36. *Time series of area-averaged Sea Surface Temperature (SST) anomalies [°C] for August of each year relative to the August mean for the period 1982-2010 for the Chukchi and Kara seas and eastern Baffin Bay. The dash-dotted black line shows the linear SST trend for the Chukchi Sea (the same warming trend as eastern Baffin Bay). Numbers in the legend correspond to linear trends (with 95% confidence intervals) in °C/year (source: Timmermans & Proshutinsky, 2015).*

Surface air temperatures measured in the Arctic since 2005 have been higher than for any five-year period in the last 130 years.

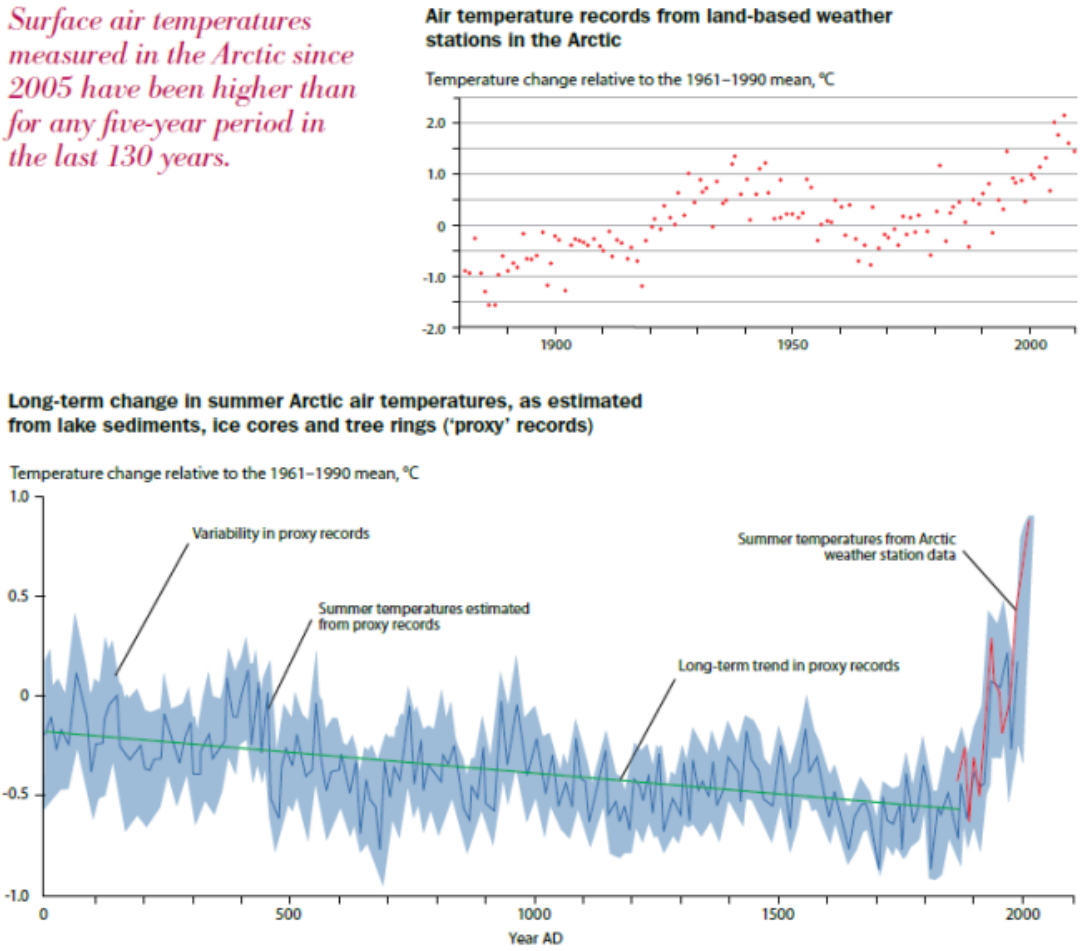

Figure 37. *A reconstruction of Arctic summer temperatures. The blue line shows estimates of Arctic temperatures over the last 2,000 years, based on proxy records from lake sediments, ice cores, and tree rings. The green line shows the long-term cooling trend. The red line shows the recent warming based on actual observations. From Kaufman et al. (2009), modified by UCAR (source: AMAP 2012).*

Online sources

Besides the cited literature, the following online sources have been used and/or consulted for this sub-challenge:

- http://www.nunatsiaqonline.ca/stories/article/656742015_noaa_arctic_report_card_shows_increased_heat/
- https://www.ncdc.noaa.gov/data-access/marineocean-data/extended-reconstructed-sea-surface-temperature-ersst-v4
- http://www.hypertextbook.com/facts/2007/LylyLi.shtml
- http://icoads.noaa.gov/index.shtml
- http://www.cru.uea.ac.uk/
- http://www.metoffice.gov.uk/hadobs/hadsst3/data/download.html
- ftp://ftp.ncdc.noaa.gov/pub/data/noaaglobaltemp/operational/timeseries/

6.5.1.2 Time-series of average annual internal energy of the sea

For this sub-challenge not enough data was available for completion. The data on this topic is widely spread and freely available, but is mainly global and not focused on our study area. The results below give an overview of the North Atlantic ocean, the entire Atlantic ocean, as well as a global overview. Major gaps in this sub-challenge are the availability of data and the spatial coverage of the data.

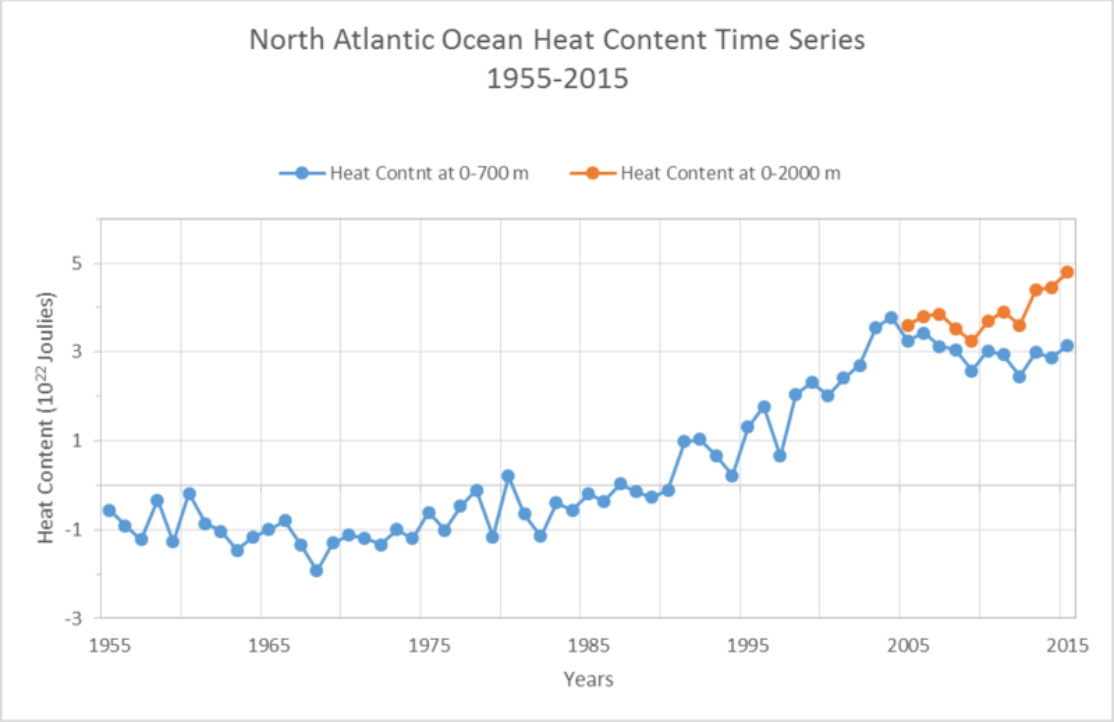

Figure 38. *North Atlantic Ocean Heat Content for the water layers between the mentioned depths. Data source: NODC/NOAA.*

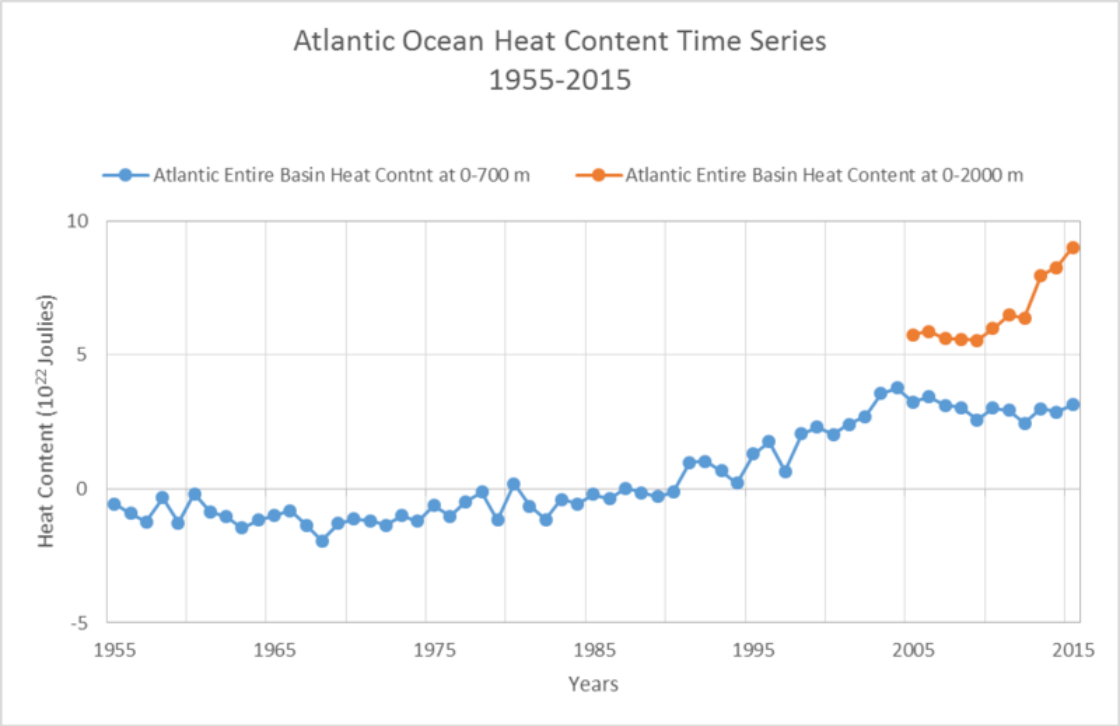

Figure 39. *Atlantic Ocean Heat Content. Data source: NODC/NOAA.*

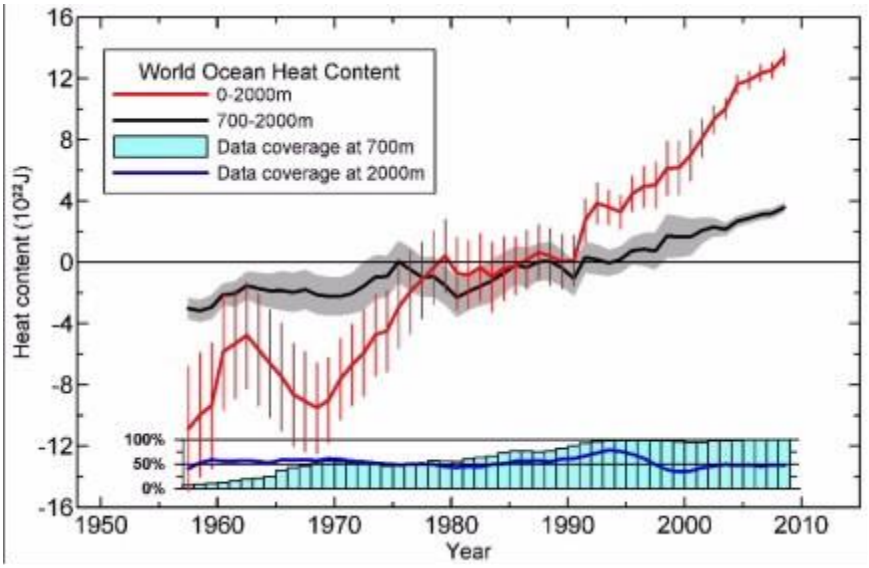

Figure 40. *Time series of average annual internal energy of the sea (source: Levitus et al., 2012).*

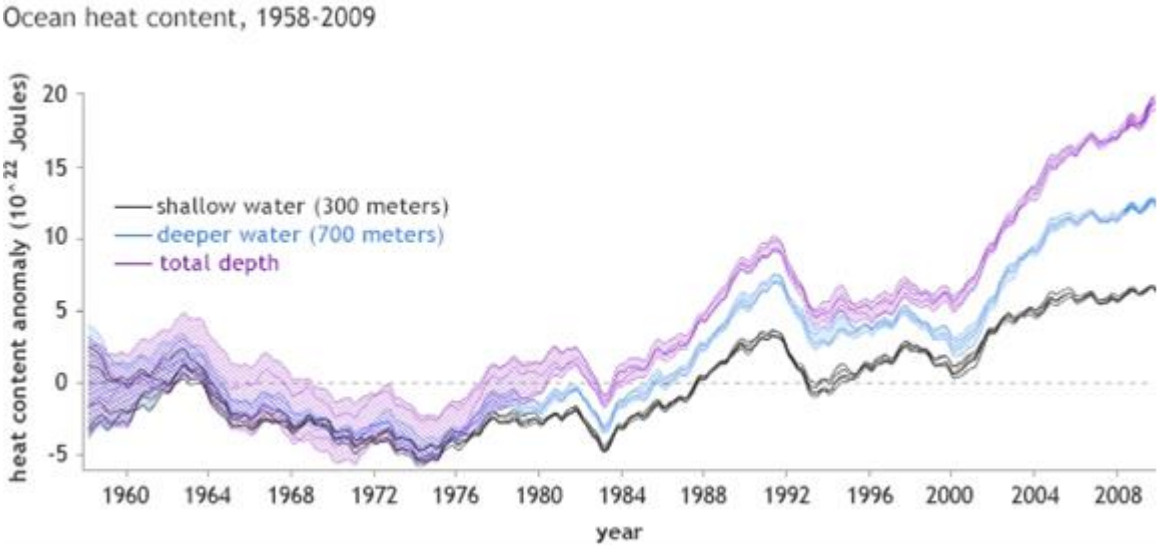

Figure 41. *Ocean heat content, 1958 – 2009. Source: Becker (2015).*

Online sources

Besides the cited literature, the following online sources have been used and/or consulted for this sub-challenge:

- http://www.nodc.noaa.gov/OC5/3M_HEAT_CONTENT/basin_data.html
- http://www.acs.org/content/acs/en/climatescience/oceansicerocks/thermalenergy.html
- https://www.climate.gov/taxonomy/term/8390/feed

6.5.1.3 Total ice cover in sea (kg) over past 100 years plotted as time series

For this sub-challenge not enough data was available for completion. The choice was made to focus on sea ice extent and sea ice thickness instead of cover in kg. The data on this topic is widely spread and freely available.

Major gaps in this challenge include information on ice cover mass.

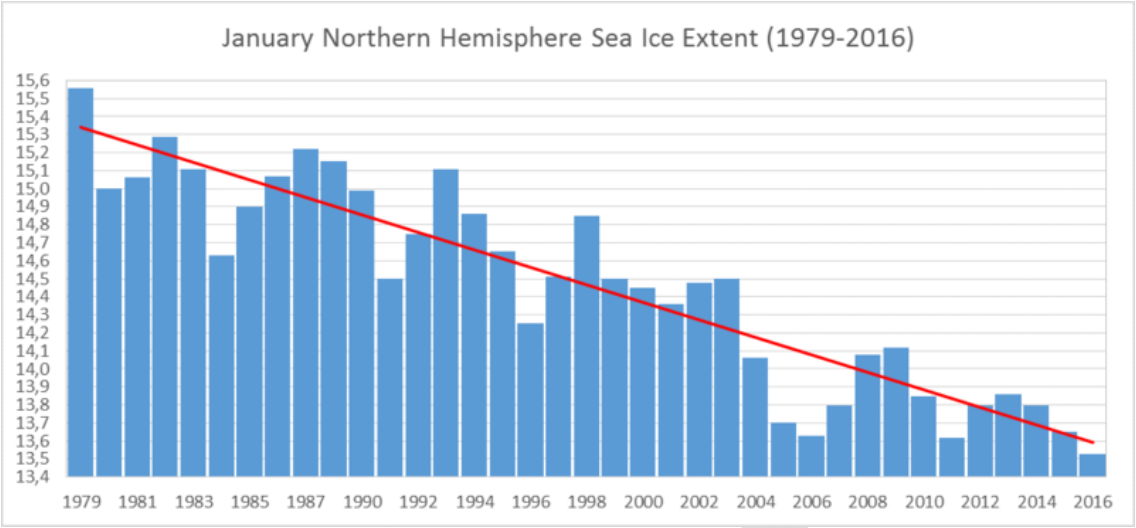

Figure 42. *Sea Ice extent in the Northern Hemisphere in January, from 1979 to 2016, in million square km. Data source: NSIDC.*

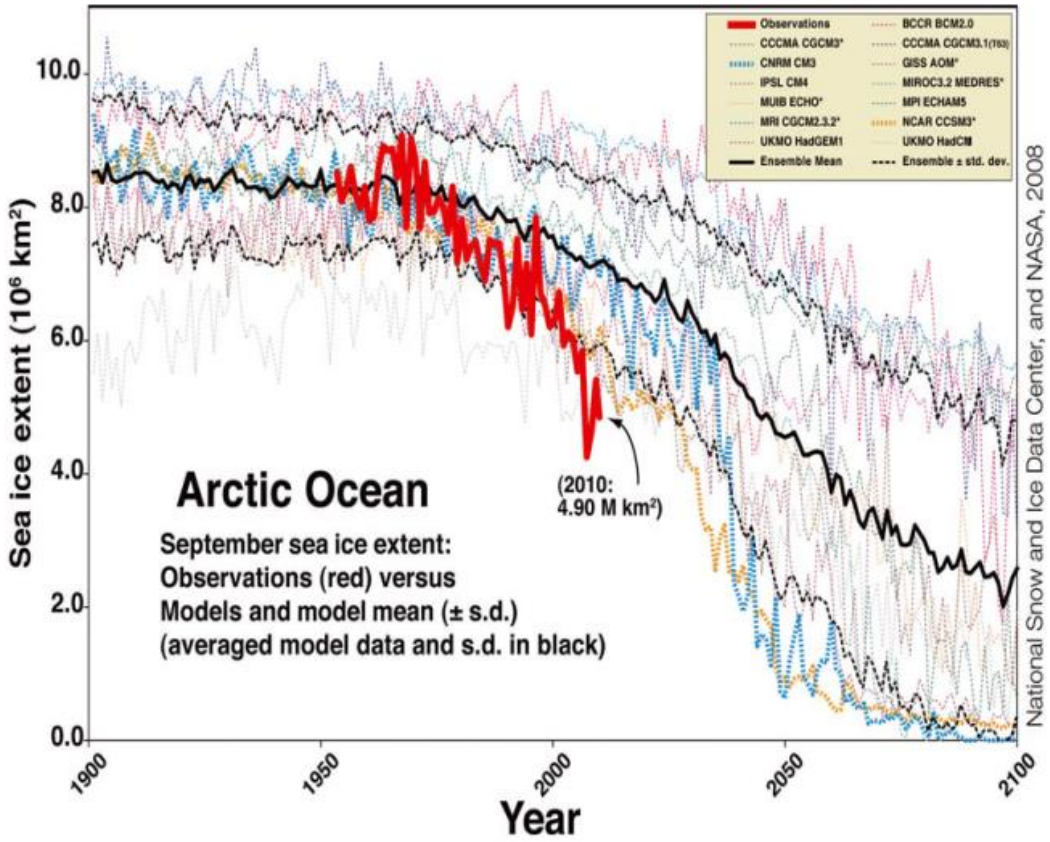

Figure 43. *Arctic September sea ice extent from observations (thick red line) and 13 Coupled Model Intercomparison Project phase 3 (CMIP3) models, together with the multi-model ensemble mean (solid black line) and one standard deviation range of model estimates (dotted black line). Models with more than one ensemble member are indicated with an asterisk. Note that these are September means, not yearly minima. (Adapted from Stroeve and others, 2007; courtesy of J. Stroeve.) (source: Kattsov et al., 2010).*

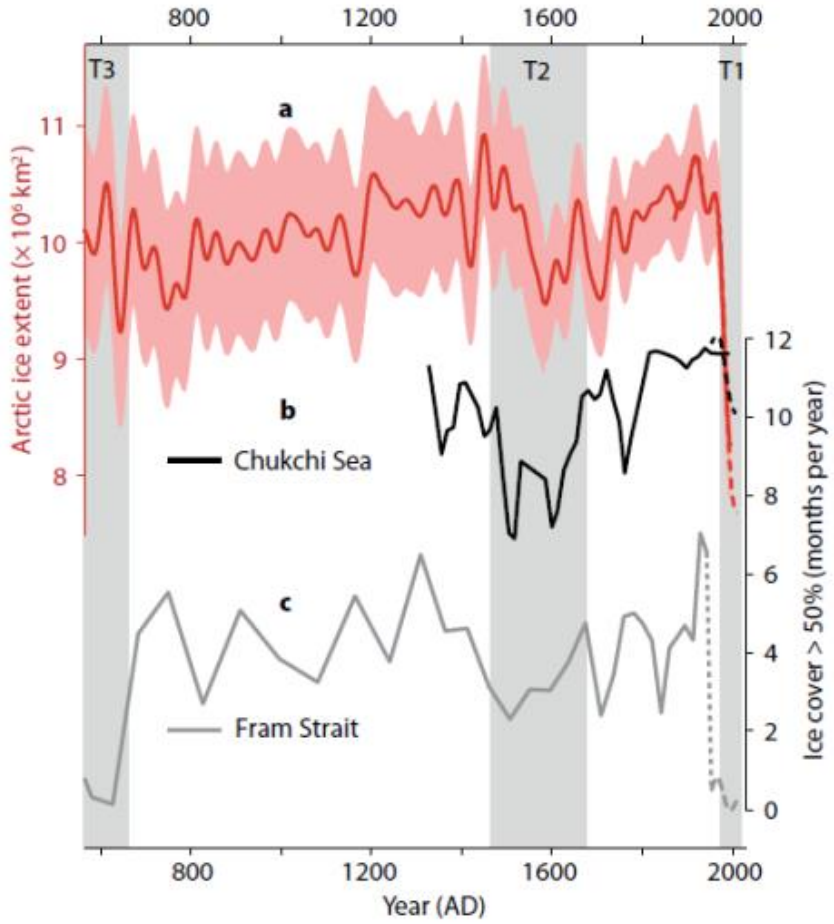

Figure 2. Reconstruction of Arctic summer sea ice variation. (a) Forty-year smoothed reconstructed late-summer Arctic sea ice extent, with 95% confidence interval, and yearly ice duration in the (b) Chukchi Sea and (c) Fram Strait. *Reprinted by permission from Macmillan Publishers Ltd.:* Nature, *Kinnard et al. (2011), copyright 2011*

Figure 44. *Reconstruction of Arctic summer sea ice variation. (a) Forty-year smoothed reconstructed late-summer Arctic sea ice extent, with 95% confidence interval, and yearly ice duration in the (b) Chukchi Sea and (c) Fram strait. (Source: Walsh 2013).*

Online sources

Besides the cited literature, the following online sources have been used and/or consulted for this sub-challenge:

- Data on Sea Ice and Ice Sheets is freely available from the National Snow and Ice Center. They offer data from (a.o.) NOAA and NASA in formats such as text files, Shapefiles and PNG. http://nsidc.org/data/search/#keywords=sea+ice/sortKeys=score,,desc/facetFilters=%257B%257D/pageNumber=1/itemsPerPage=25
- National Snow and Ice Data Center (NSIDC) - http://nsidc.org/data/g10010
- Ocean Climate Laboratory (OCL) of National Oceanographic Data Center (NODC) (http://www.nodc.noaa.gov/OC5/3M_HEAT_CONTENT/basin_data.html)

6.5.1.4 Mass of ice lost (or gained) from Greenland expressed as time series

For this sub-challenge enough data was available to complete it. The data on this topic is widely spread and freely available. No clashes were found in the data found; the datasets combined from different sources gave the same results. For this sub-challenge we feel no major gaps are present, however the data is quite spread-out both spatially and temporally.

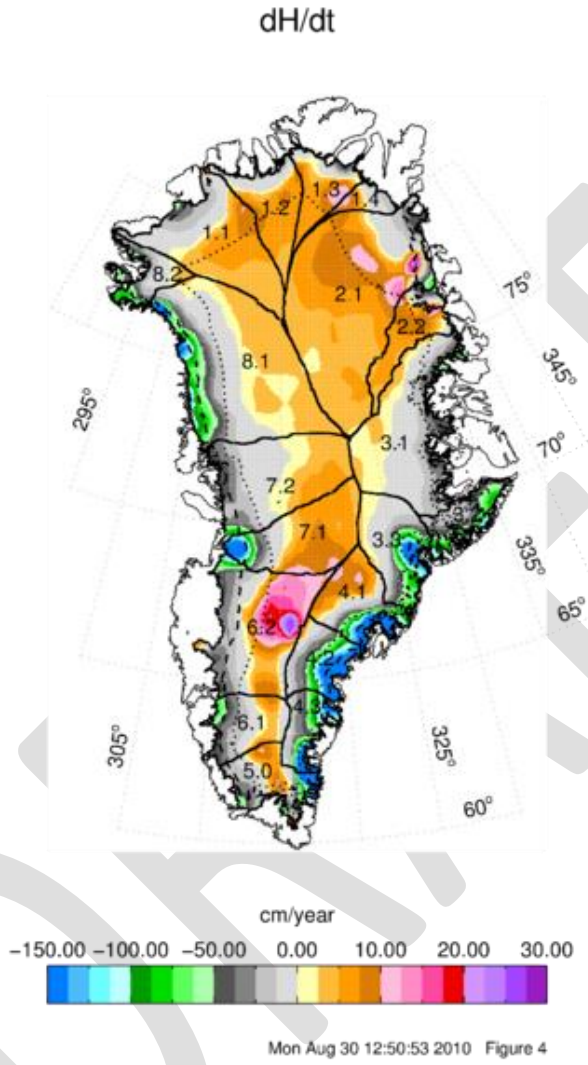

Figure 45. *Ice loss in Greenland in cm/year over the period 2003-2007. Source: NASA.*

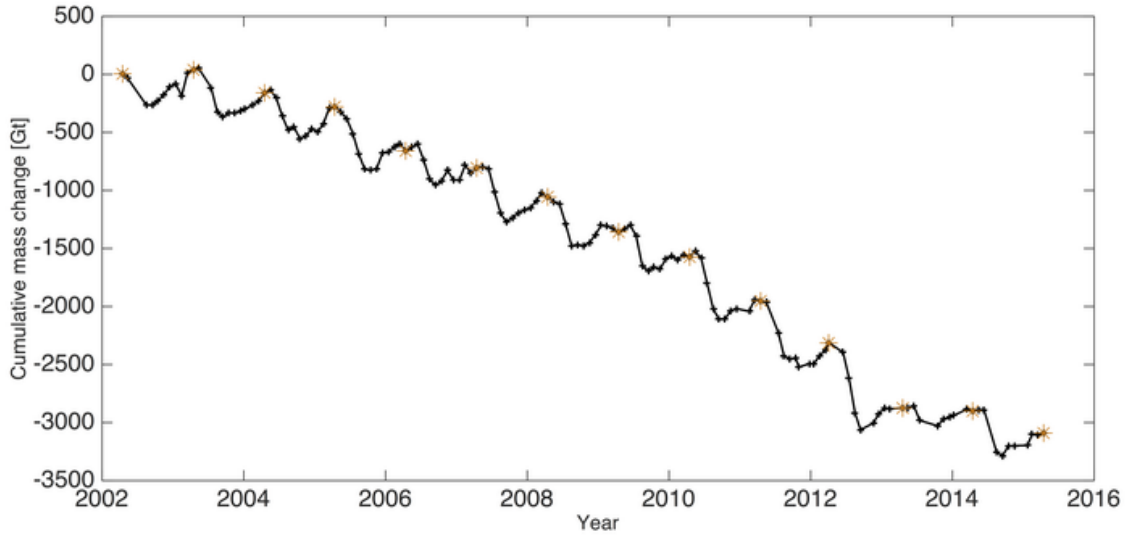

Figure 46. *Cumulative change in the total mass (in Gigatonnes, Gt) of the Greenland Ice Sheet between April 2002 and April 2015 estimated from GRACE measurements. Each symbol is an individual month and the orange asterisks denote April values for reference. (source: Tedesco et al., 2015).*

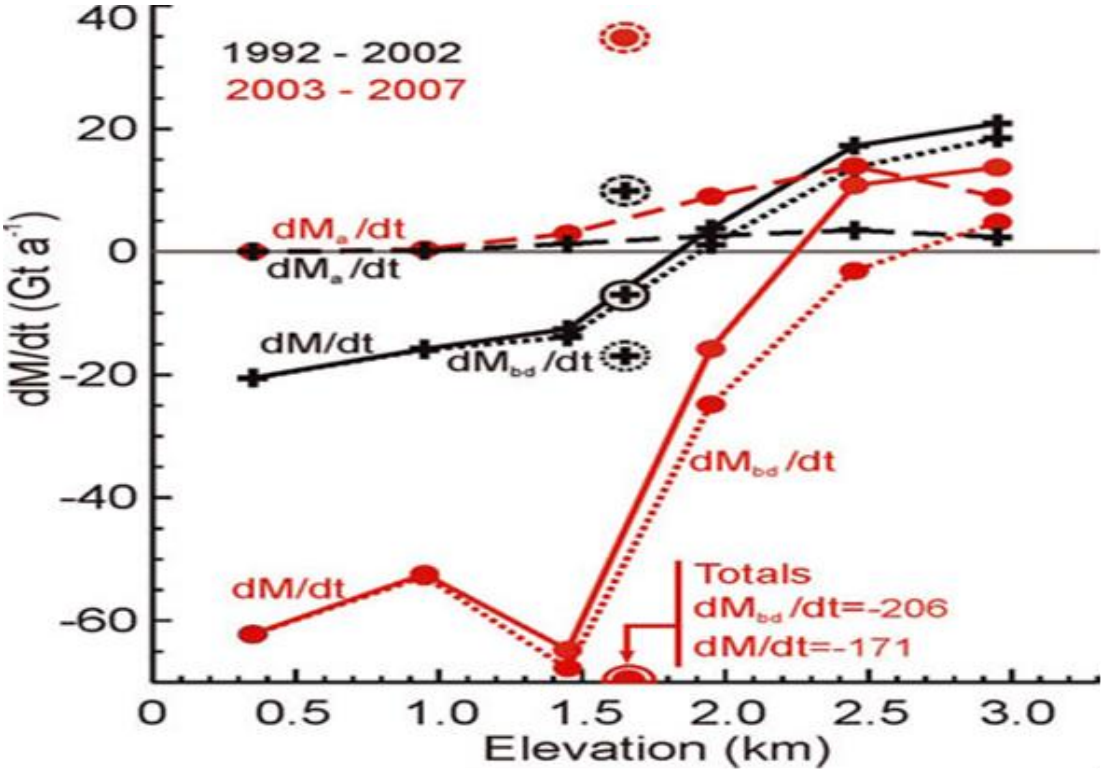

Figure 47. *dM/dt is total rate of mass change, dMa/dt is the component driven by temporal variations in snow accumulation, and dMbd/dt is the component driven by ablation and ice dynamics, all averaged by 500m elevation bands over the ice sheet for the 1992–2002 and 2003–07 periods. Circled symbols are totals for all elevations weighted by area. (source: Zwally et al., 2011).*

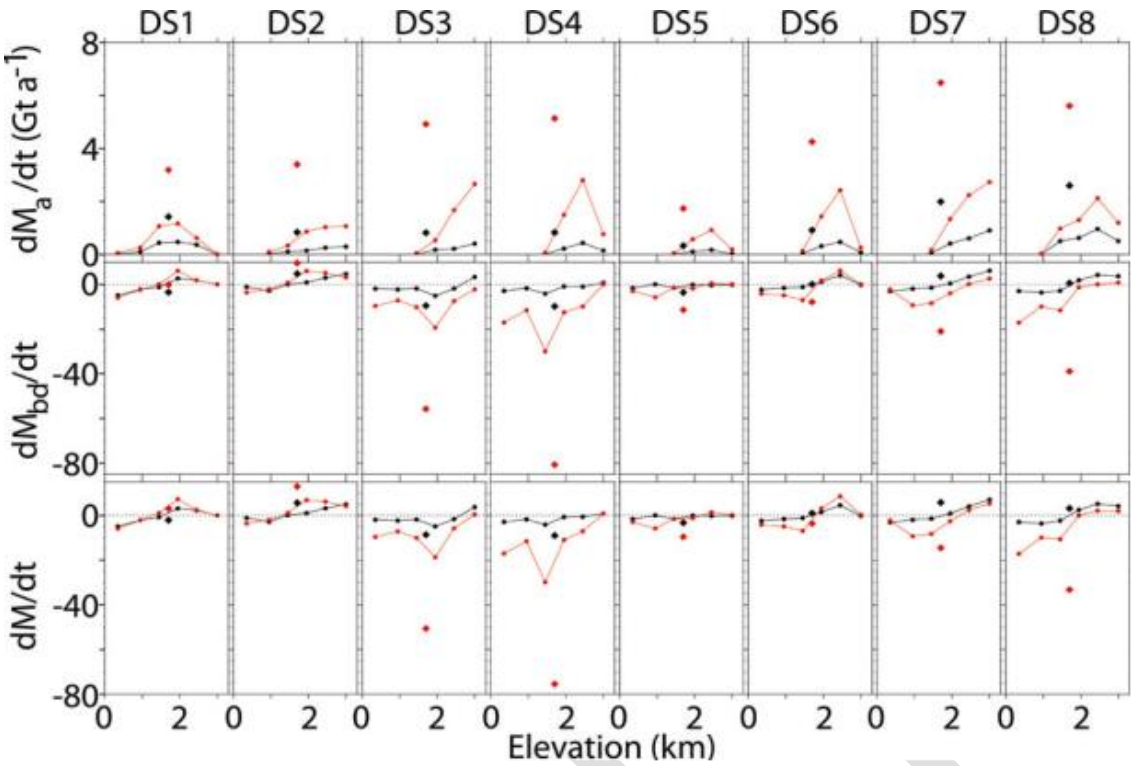

Figure 48. *Components of mass change by drainage system. dMa/dt, dMbd/dt, dM/dt (Gt a–1) averaged over 500m elevation bands for the eight drainage systems for 1992–2002 (black) and 2003–07 (red) with totals for 1992–2002 (black symbols) and 2003–07 (red symbols). Accumulation-driven mass increases are largest in DS3, DS4, DS7 and DS8, and dynamic-/ablation-driven thinning is largest in DS3, DS4 and DS8 and very small in DS1, DS2, DS5 and DS6. (source: Zwally et al., 2011).*

Online sources

Besides the cited literature, the following online sources have been used and/or consulted for this sub-challenge:

- NASA: http://icesat4.gsfc.nasa.gov/

6.5.1.5 Traditional way of life in the Arctic region, animal behaviour and climate change

This sub-challenge is quite the odd-one out, because it is both an enormously broad question, as well as quite qualitative. It was decided to answer this question in text instead of as a time-series or graph as it will be much more illustrative. Because of the broad question, gaps in data can be found everywhere. However, there is also a lot of information available on this topic. To truly answer the question of the availability and quality of data, a more narrow and specified question should be asked.

Climate change can have both direct and indirect effects. Not only higher sea temperatures or melting sea ice can be seen as a result, entire ecological systems including (human) behaviour can be impacted as well. It is expected for the polar regions to show the results of climate change before other regions will, which makes it an ideal study environment for looking into effects of climate change on (human) behaviour (Berkes & Jolly, 2001). However, before we can study the impact of climate change on animal behaviour linked to the traditional way of life, we need to study the 'traditional way of life' and the animals related to this.

The 'traditional way of life' can be linked to indigenous people, keeping to traditions set many generations ago, often making use of subsistence herding, gathering, hunting or fishing. However, information on all different communities in the entire Arctic region is not readily available, which could be seen as the first gap in knowledge.

During the last century, Arctic regions have modernized enormously. For example, in Greenland subsistence hunting and fishing is still widespread, but it is increasingly becoming a leisure activity in comparison to a 'way of life' (Curtis et al., 2005). A similar change can be found in Northern Siberia (Koptseva, 2014), Alaska (Moerlein & Carothers, 2012), as well as in the Northern reaches of Canada

(Berkes & Jolly, 2001; Searles, 2008), where supermarkets and imported foods now add to the traditional gathering and hunting (Lougheed, 2010). For this study, no differentiation will be made between peoples completely depending on a subsistence way of life, partly depending on it, or not depending on it but still applying it for traditional or other purposes.

Because of modernization but also other types of rapid social, economic, and demographic change, as well as resource development, trade barriers and animal-rights movements, there have been many changes in human behaviour and the 'traditional way of life' (Nuttall et al., 2005). It is quite hard, maybe even impossible, to filter out which change led to which exact effect, as many of the changes will link together and influence each other.

Climate change does not only affect the species used for subsistence reasons, it also affects the means of gathering them. For example, the shrinking of summer sea ice can lead to a smaller hunting area, extreme weather can damage village infrastructure, melting permafrost can lead to altered spring run-off patterns and changing sea levels and tidal fluctuations can pose dangerous fishing conditions.

Moerlein & Carothers (2012) describe fish as being the most reliable subsistence resource in Alaska. In several communities in the North-West of Alaska the catch contains chum salmon (*Oncorhynchus keta*), Dolly Varden (*Salvelinus malma*) and several species of whitefish (Moerlein & Carothers, 2012). It is mentioned the fishing and hunting practices are extremely flexible in response to changing conditions and needs (Moerlein & Carothers, 2012).

Berkes & Jolly (2001) describe the main species for hunting of a community in the Canadian Arctic as musk-ox (*Ovibos moschatus*), lesser snow goose (*Anser caerulescens*), ringed seal (*Pusa hispida*), and various fish species. During the winter, people hunt musk-ox and, to a lesser extent, caribou (*Rangifer tarandus*), Arctic foxes (*Alopex lagopus*), wolves (*Canis lupus*), polar bears (*Ursus maritimus*), and ringed seals (*Pusa hispida*). This study provides a list of examples of local environmental changes and effects on subsistence activity described by members of the community. Impacts include impacts on access, safety, predictability and species availability. Examples are: old ice doesn't come in close to the settlement in summer anymore which makes it more difficult to hunt seals; too much broken ice in winter makes travel dangerous; from year to year the arrival of spring is different; more rain in the fall increases chances of freezing rain, which can lead to caribou starving. The effects of these changes and impacts and the responses of the effected peoples vary. Because of modernization most communities have a wider range of food options now which makes it less vital to directly adept to the environmental changes. Berkes & Jolly (2001) describe coping strategies such as using different vehicles for travel, changing hunting areas or waiting for the appropriate timing as short-term responses. On long-term adaption only speculations are made. It is mentioned however that climate change may not always have a negative effect, with seawater temperatures rising marine fishes of boreal origin move poleward into the Arctic seas (Christiansen et al., 2014) such as two species of Pacific salmon which were very welcome to the local inhabitants.

Hendriksen & Jørgensen (2015) describe effects from a combination of modernization, globalization and climate change on subsistence living conditions in Upernavik in Northern Greenland. For the local communities, since the 1980's Greenland Halibut fishing in summer from dinghies has been a major source of income. Dangerous situations arise when the shorter period of sea ice forces fishing to be carried out in the dark winter period as well. The same goes for hunting whale and seal. Hendriksen & Jørgensen (2015) describe that the local communities have been rather resilient and adaptive in meeting the challenges set by climate change, due to their traditional and local knowledge. However, they also point out that governance is even more challenging than the changes in the natural environment; it is not only climate change which threatens the traditional way of life.

As an example, we can look at the migratory behaviour of caribou. Caribou are a source of food in traditional ways of life all over the Arctic. An interactive map with caribou habitats can be found here: http://carma.caff.is/carma-interactive-map. Climate change can have many ways of impacting caribou, for example through the change of habitat and food accessibility, temperature and other climatic impacts, see Table 5.

Table 5 Climate change impacts on caribou. Source: http://carma.caff.is/carma-interactive-map/status-and-trends

Climate Change Condition	Impact on Habitat	Impact on Movement	Impact on Body Condition	Impact on Productivity	Management Implications
Earlier snowmelt on coastal plain	Higher plant growth rate	• Core calving grounds move further north • Less use of current calving grounds	• Cows replenish protein reserves faster • Higher calf growth rate	• Higher probability of pregnancy • Higher June calf survival	Need for wider calving ground protection
Warmer, drier summer	• Earlier peak biomass • Plants harden earlier • Reduction in mosquito breeding sites • Increased oestrid harassment • Increased frequency of fires on winter range • Fewer "mushroom" years	• Movement off of calving grounds earlier • More use of insect relief habitat in July • Avoidance of recently burned winter habitat	Increased harassment will lower fall body condition	Reduced probability of pregnancy	Protection of insect relief areas important
Warmer, wetter fall	More frequent icing conditions	Caribou abandon ranges with severe surface icing	• Higher winter mortality • Earlier weaning		
Warmer, wetter winters	• Deeper denser snow • Icing conditions, especially in tundra and arctic islands	• Increased dependence on low snow regions • stay on winter range longer	Greater over winter weight loss higher incidence of extended lactation	lower over winter mortality on calves	Need to consider protection of low snow regions
Warmer springs	• More freeze/thaw cycles during spring migration • faster spring melt	Movement slowed and/or movement unto drier windswept ridges	Accelerated weight loss in spring	Higher wolf predation on cows and calves due to use of windswept ridges	Concern over timing and location of spring migration in relation to traditional harvesting areas

Overall Effect:
In very general terms the calving range improves but movement and reliance on more northern portions of the calving range; animals leave calving range earlier; cows and calves suffer reduced summer and fall body reserves due to increase in oestrid fly harassment; mosquito harassment may be reduced if summers drier; more frequent icing on fall, winter and spring ranges which depending on the location of these ranges may have moderate to severe implications to body condition and survival

In relation to management, there will be an overall need to assess habitat protection in relation to climate trends, need to factor climate change impacts on harvest strategy, need to communicate impacts of climate on harvest patterns and timing and a need to set up comprehensive monitoring programs.

Sharma et al. (2009) describe the behaviour of two herds of caribou in Canada: "Migratory caribou appeared to prefer regions with higher snowfall and lichen availability in the fall and winter. In the summer, caribou preferred cooler areas likely corresponding to a lower prevalence of insects, and they avoided disturbed and recently burnt areas." They used models to indicate the possible responses of these two herds to climate change. The results are quite varying, as the response depends on the current migratory pattern and habitats and the possible effect of climate change in this: limiting the range of one herd but increasing the range of the other, limiting both to a certain region (Sharma et al., 2009). Impacts of such effects on the traditional way of life can include the loss of possible hunting areas or herds in certain periods of time or permanently, as well as the other way around.

In conclusion, it is not possible to answer this sub-challenge in one sentence. As everything else in the natural world, the effects depend on many different factors such as species, distribution, migratory patterns, herd-specific behaviour, habitat change, etc. etc. It can however be concluded that climate change impacts the traditional way of life, of which the impact on animal behaviour may be a part.

6.5.1.6 Abundance of three most abundant species of phytoplankton expressed as time series

This sub-challenge is quite hard to solve, due to the following reasons:

- The study area is quite broad and is home to many different types of (eco-)systems, which makes it unwise to generalize the three most abundant species of phytoplankton.
- Even in small geographical areas the most abundant species may change year to year, so what is one year the most abundant species may the next year not be the most abundant species anymore.
- Most studies seem to focus on either zooplankton or primary production in the broader sense of the word, mostly focusing on chlorophyll concentrations and not on individual species.
- The data which is available is quite spread out both on a temporal a spatial level, is presented in different formats and needs different levels of processing.
- There seem to be gaps in both time and space of monitored areas in the arctic when it comes to individual species of phytoplankton. The data found was not up-to-date.

The definition of plankton is a group of organisms in aquatic environments which are carried along by ocean currents without the means to swim against them. Phytoplankton are the 'flora' plankton, or microalgae, and contain chlorophyll for photosynthesis. Primary production in oceans can be measured through chlorophyll concentrations, however this does not distinguish between different species of phytoplankton. Dinoflagellates and diatoms are the two most common classes of phytoplankton.

In the Arctic area, phytoplankton are essential for primary production and serve as the base of the marine food web. Both the presence of nutrients and light availability limit primary production, giving the Arctic area a distinct seasonal character. Upwelling of warm nutrient rich Atlantic Water is one of the key factors driving primary production.

As described in Hallegraeff (2010): "Climate change confronts marine ecosystems with multifactorial stressors, such as increased temperature, enhanced surface stratification, alteration of ocean currents, intensification or weakening of nutrient upwelling, stimulation of photosynthesis by elevated CO2, reduced calcification from ocean acidification, and changes in land runoff and micronutrient availability". Because climate change does not affect the phytoplankton habitat in a singular way, it is difficult to predict the response of the phytoplankton community. For example, the winter sea ice decline creates favourable conditions for upwelling, creating in turn favourable conditions for phytoplankton (Falk-Petersen et al., 2015). Other studies however indicate a less favourable condition for phytoplankton through freshening of the water by melting ice (Coupel et al., 2015). Larsen et al. (2014) indicate the decreased sea ice as associated with earlier phytoplankton blooms. It is clear that

the declining sea ice extent in the Arctic area is contributing to shifts in primary production (Frey et al., 2015; Logvinova et al., 2015). In 2011, NOAA published a map showing the change in primary productivity, based on a study by Arrigo & van Dijken (2015), see *Figure 49*.

The higher ocean temperatures create an increasingly stratified water column, inhibiting nutrient rich waters to mix with nutrient depleted waters. Amounts of larger phytoplankton such as diatoms are predicted to be reduced as they need more nutrients to survive, in comparison to smaller phytoplankton such as cyanobacteria (Lindsey & Scott, 2010). However, in the polar regions the reduced mixing will keep the plankton closer to the surface (and sunlight), creating favourable conditions for an increase in plankton (Hallegraeff, 2010).

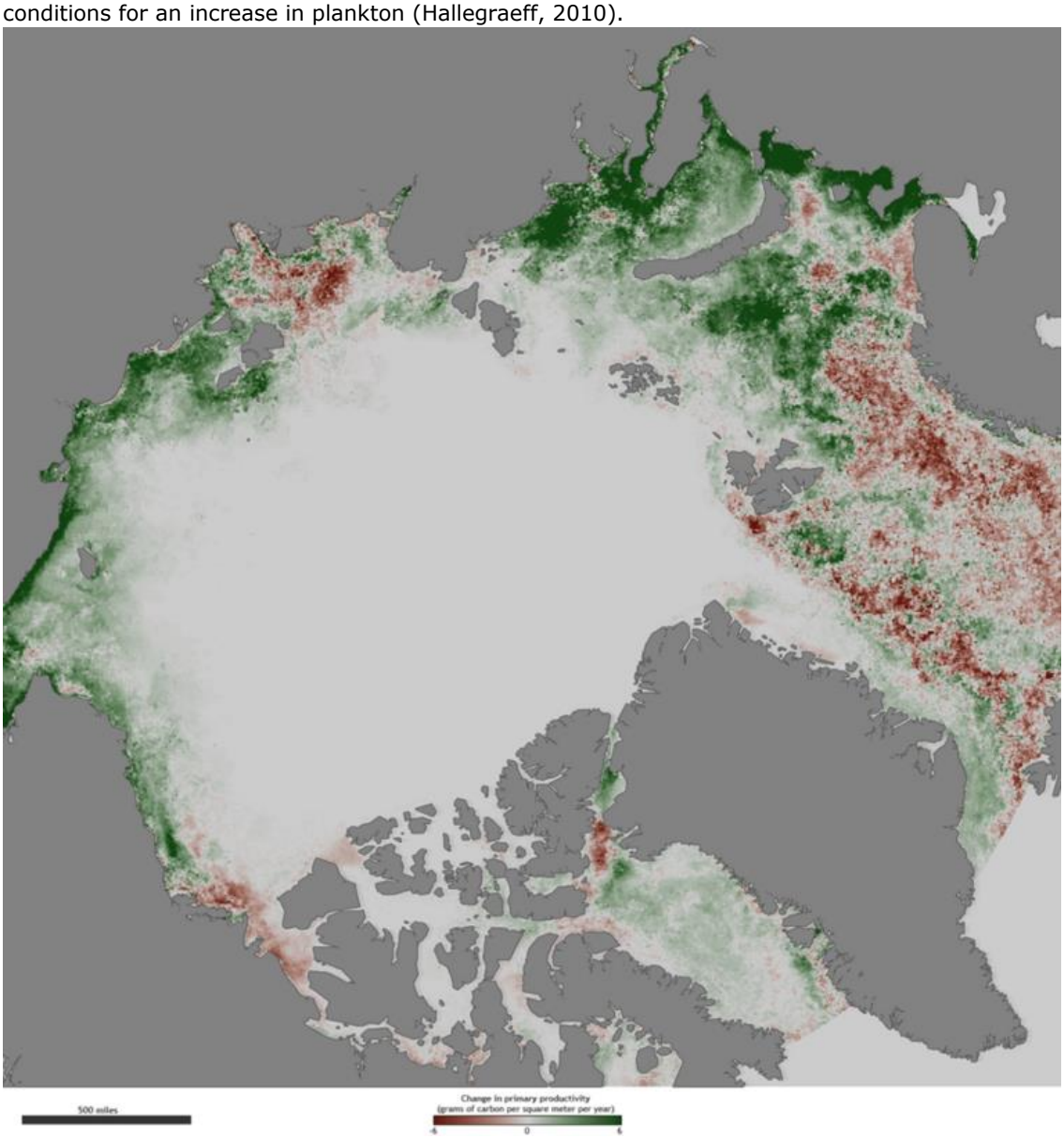

Figure 49. *Changes in primary production between 1998 and 2000. Browns show declines, while greens show increases. Increases in primary production were greatest in the eastern Arctic Ocean, mirroring the areas of greatest sea ice loss in the Kara and East Siberian seas (source: Arrigo & van Dijken 2015 and NOAA 2011).*

As can be seen on Figure 49, the change in primary production varies in the entire Arctic area. To answer the question of this sub-challenge, it was decided to not focus on the entire area but to take a smaller area as an example. The Kara Sea was chosen as it seems to have had a change in primary production over the years, and phytoplankton on species level is available. As the three most abundant species of phytoplankton tend to fluctuate over the years, it was chosen to focus on species groups.

Data was downloaded from COPEPOD (The Coastal & Oceanic Plankton Ecology, Production & Observation Database - An online database of plankton abundance, biomass, and composition data compiled from a global assortment of cruises, projects, and institutional holdings, it was created by NOAA's National Marine Fisheries Service). The data was selected on coordinates roughly edging the Kara Sea (Longitude between 50 and 100, Latitude between 70 and 80), grouped on species groups and averaged per year to create time series. The following graphs were the results:

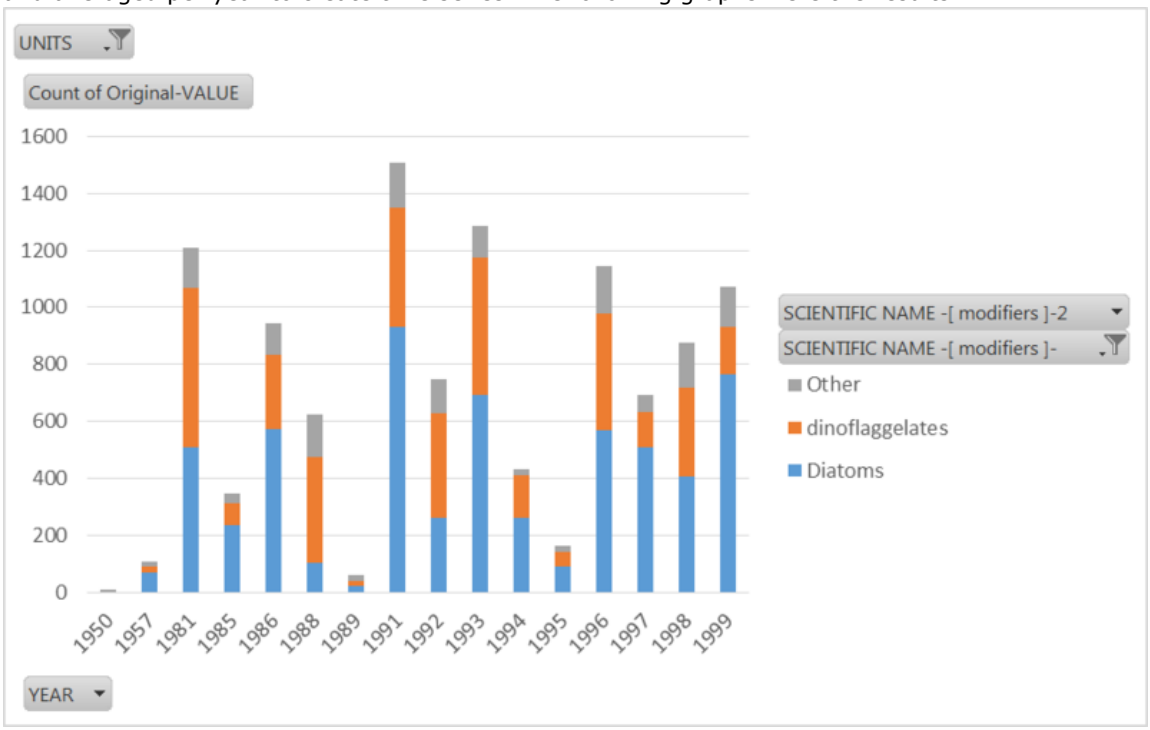

Figure 50. *Data from monitoring cruises in the Kara Sea area, downloaded from NOAA and sorted on species groups. The units on the y-axis are #/mL.*

As can be seen in the above graph, as well as read in the text, diatoms and dinoflagellates seem to be the most abundant species groups in this area.

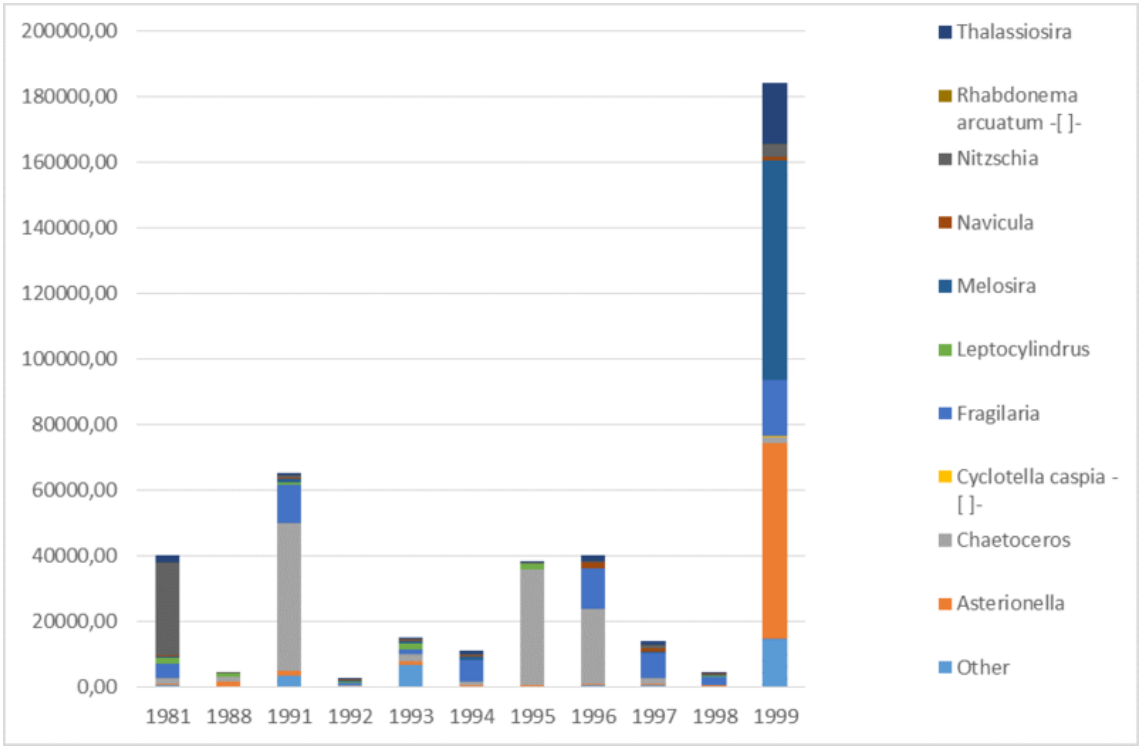

Figure 51. *Diatom data from COPEPOD, selected on coordinates roughly edging the Kara Sea (Longitude between 50 and 100, Latitude between 70 and 80), grouped on species groups, averaged per year. The units on the y-axis are #/m^3.*

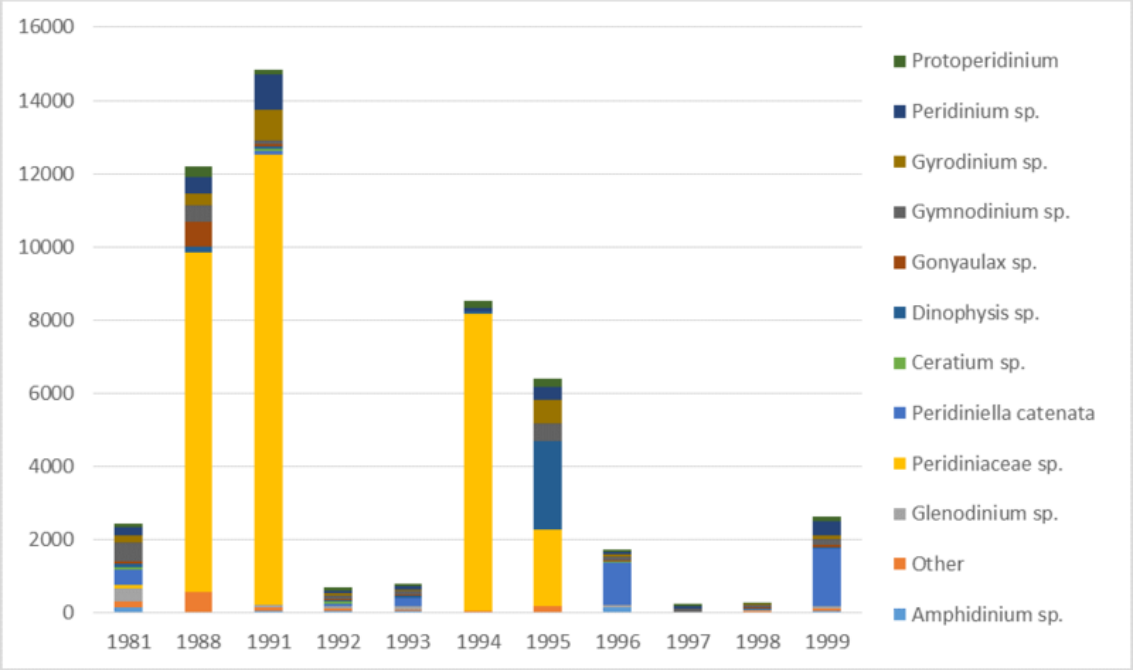

Figure 52. *Dinoflagellate data from COPEPOD, selected on coordinates roughly edging the Kara Sea (Longitude between 50 and 100, Latitude between 70 and 80), grouped on species groups, averaged per year. The units on the y-axis are #/m³.*

From the Biological Atlas of the Arctic Seas 2000: Plankton of the Barents and Kara Seas - physical and biological data for the region extending from the Barents Sea to the Kara Sea during 158 scientific cruises for the period 1913 - 1999, phytoplankton data per cruise in Kara Sea and Barents Sea, the Kara sea data was downloaded. The most abundant species in this dataset were: *Fragilaria* spp., *Thalassiosira* spp., *Chlorophycota* spp., *Nitzschia* spp. and *Melosira* spp.. These species groups can also be seen in the data from COPEPOD.

Online sources

Besides the cited literature, the following online sources have been used and/or consulted for this sub-challenge:

- http://earthobservatory.nasa.gov/Features/Phytoplankton/
- http://www.arcodiv.org/Database/Plankton_datasets.html
- https://www.nodc.noaa.gov/OC5/BARPLANK/WWW/INV_CRUS/inventory.html
- http://www.st.nmfs.noaa.gov/copepod/
- https://www.climate.gov/news-features/features/sea-ice-declines-boost-arctic-phytoplankton-productivity

There are no results yet for: temperature grid, ice coverage grid, and ice cover maps. These will be addressed in the second DAR.

6.5.2 Data quality

Figure 53 shows the quality indicators for the 80 datasets considered for this challenge. The accessibility of the data is good as most could be directly downloaded or could be downloaded after creating an account. Nearly all datasets were available within a day and were free of charge. Approximately half of the data formats had to be converted (processed) before use in this challenge. Most datasets specifically cover the Arctic Sea Basin, or part of it. A smaller part has a global spatial coverage. The spatial resolution of the data varies considerably, from less than 1 km up to more than 10 km. Temporal coverage is mostly years or even decades, with some covering only months or less. Temporal resolution also varies, mostly within a range from daily to yearly. Datasets mostly reflect historical conditions. Some datasets are related to a certain water depth or height, but most are measured at the water surface.

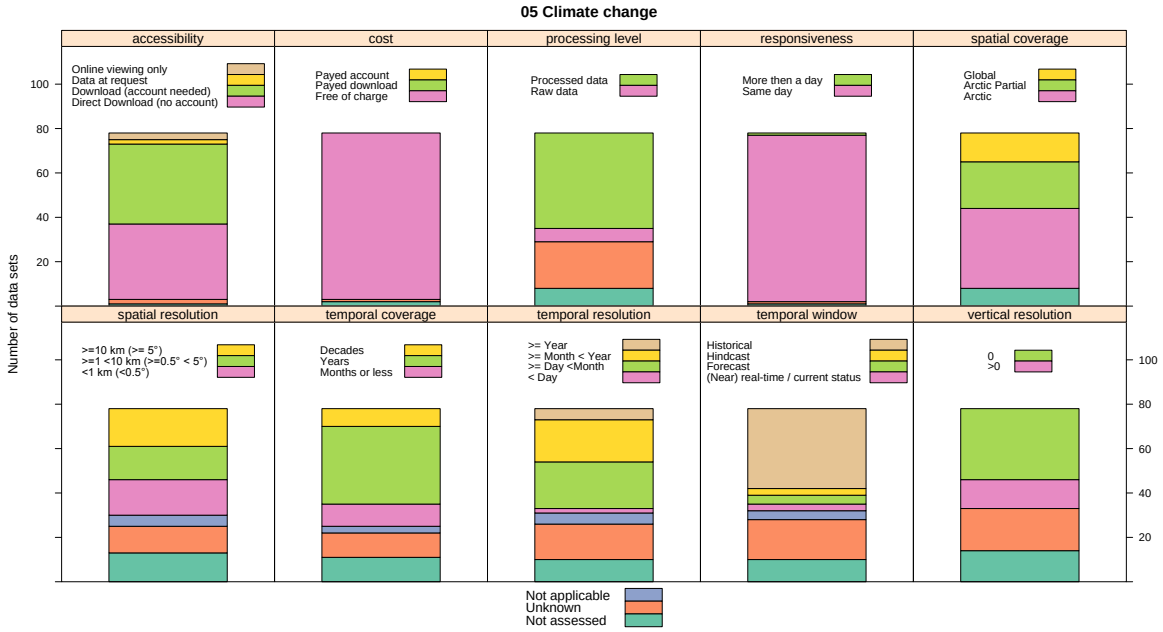

Figure 53. *Quality indicators for the datasets used and considered for use in the 'climate change' challenge. Colour-codes of specific categories are presented above each indicator. Generic categories (i.e. relevant to all indicators) are presented at the bottom of this figure.*

6.5.3 Data adequacy

The adequacy indicators for the datasets used and considered for use in this challenge show that most data considered was adequate for use (*Figure 54*). There were many datasets considered for this challenge (>80). There were no budget or time restrictions leading to unusable data. As far as known, original data formats as well as converted data formats were used and most data needed to be processed for this challenge. Spatial and temporal coverage and -resolution all (limitedly) matched and were thus adequate for use. However, most datasets considered for this challenge were not used. This was mainly because there was a better alternative available: there were many datasets that are only partly relevant (i.e. have a small overlap with the climate change challenge), which is related to the broad aim of this challenge. Selecting the usable parts of datasets would require too much time, knowing that there are datasets available that are more suited for this challenge. Other reasons are: the website is difficult to search and/or the data is fragmented and thus needs a lot of effort (i.e. time/budget) to download and process all; unknown or unconventional data formats or; unknown language.

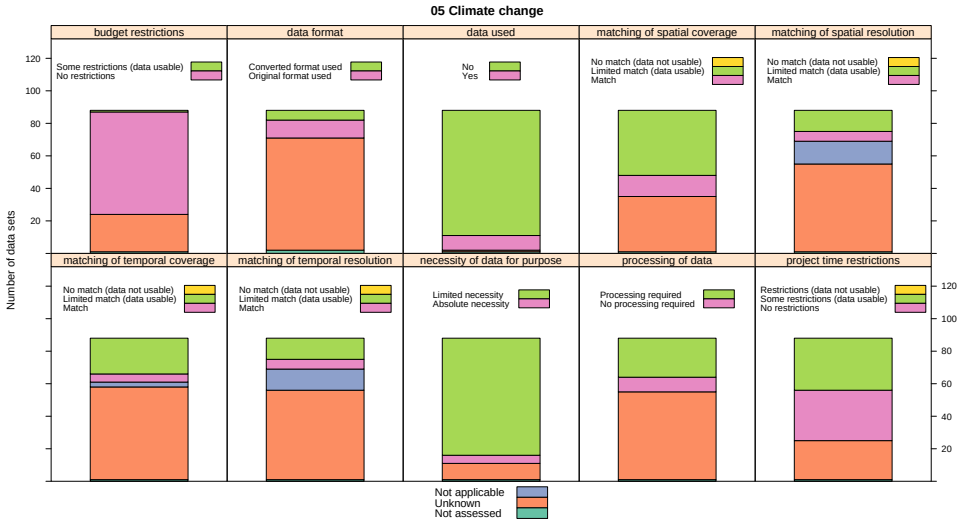

Figure 54. *Adequacy indicators for the datasets used and considered for use in the 'climate change' challenge. Colour-codes of specific categories are presented above each indicator. Generic categories (i.e. relevant to all indicators) are presented at the bottom of this figure.*

6.6 Coasts (WP06)

6.6.1 Challenge description and main results

The Coast Challenge aims to produce spatial data layers and time plots for parameters, namely sea level rise and sediment balance per stretch of coast for the Arctic study area.

6.6.1.1 Sea level rise

Sea level rise is influenced by changes in atmospheric pressure, melting of sea ice and polar ice caps, and water temperature. A dramatic sea level rise acceleration in the Arctic Ocean was reported in the 1980s. The changes in the patterns of wind-driven and thermohaline circulation may account for most increase of sea level in the Arctic Ocean and their accumulative action can explain more than 80% of the sea level variability during 1950-1990. In light of global change, this sea level rise could be a manifest of warming in the Artic coupled with a decrease of sea ice extent, warming of the Atlantic waters, changes in the Arctic Ocean circulation, and an increase in coastal erosion and thawing of permafrost.

Most important data source for sea level data is the Permanent Service for Mean Sea Level (PSMSL). The PSMSL global data bank contains data from 1461 stations worldwide of which 95 are located in the Arctic Circle and two on Iceland just below the Arctic Circle. The figures below show the locations of PSMSL stations in the Arctic and the number of stations per country. The data can be downloaded free of charge from http://www.psmsl.org/data/. There is no PSMSL data available for Greenland.

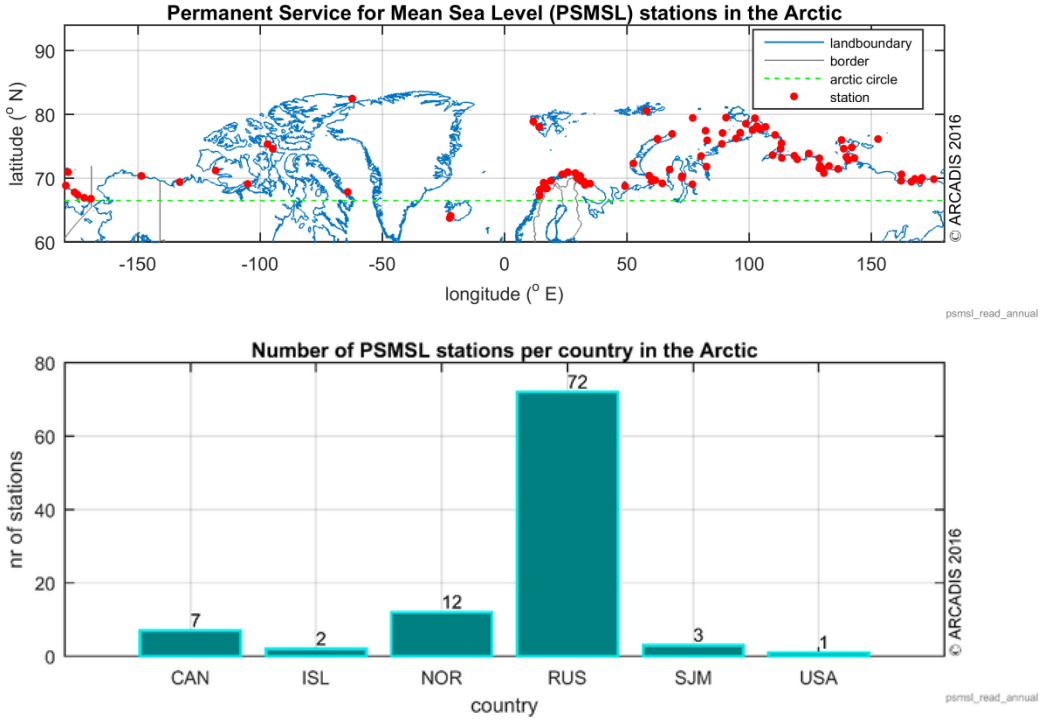

Figure 55. *Locations of PSMSL stations in the Arctic (top figure) and the number of stations per country (bottom figure).*

The PSMSL data are reduced to a common datum, namely the Revised Local Reference (RLR), which is defined to be approximately 7000 mm below mean sea level. The figure below shows an example of time series of annual sea level relative to this RLR at Reykjavik on Iceland.

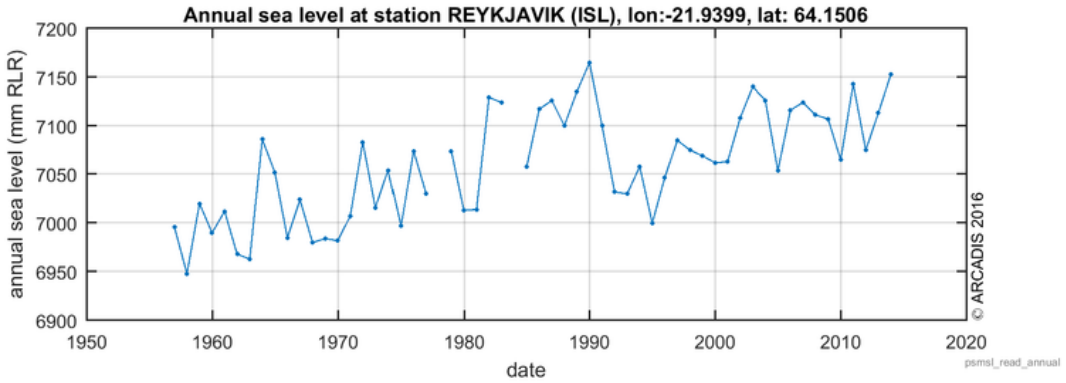

Figure 56. *Example of time series of annual sea level relative to the Revised Local Reference (RLR) at Reykjavik on Iceland.*

For many applications (including climate change studies) the long term time series are required. The map below shows the locations of sites with at least 40 years of RLR data, which are the most useful records for studies of long term sea level trends. Note that the coverage of this map is much poorer than that of the previous map. The number of stations in the Arctic with this long term temporal coverage amounts to 52. There is no long term data available in Greenland, Canada and the USA.

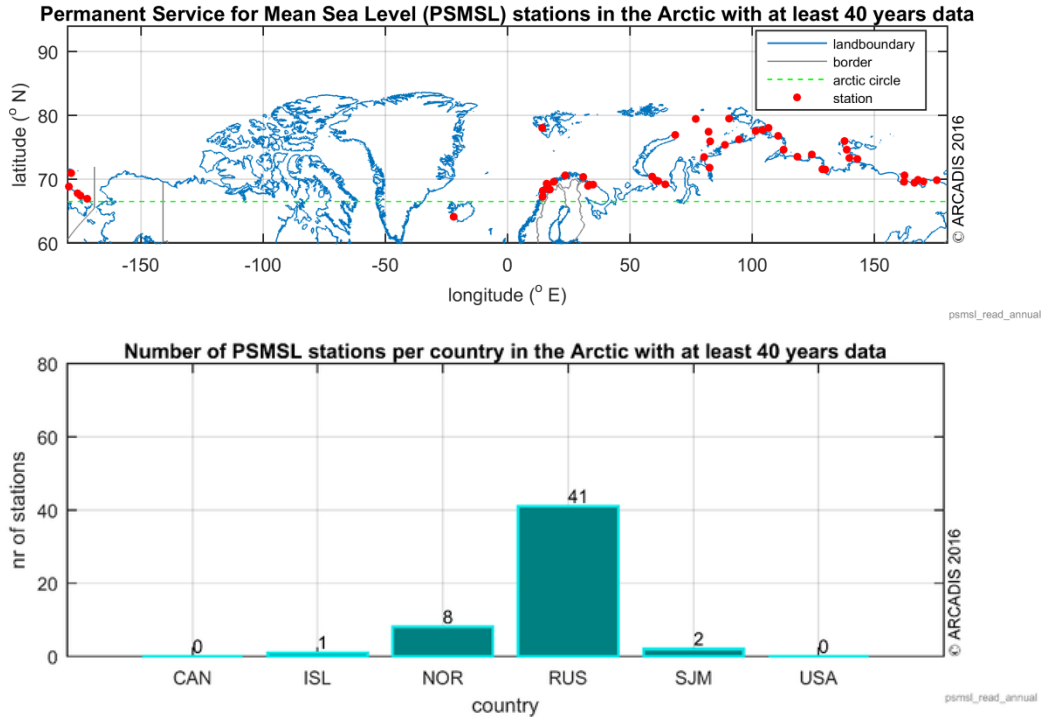

Figure 57. *Locations of sites (top figure) and number of stations per country (bottom figure) with at least 40 years of Revised Local Reference (RLR) data.*

6.6.1.2 Sediment balance

The sea level rise also affects the sediment balance, which is defined as the amount of each type of sediment present along the Arctic coast. Thousands of kilometres of Arctic sea coast retreat 2-6 m/year under that action of shore erosion. This means that tens of square kilometres of Arctic land are consumed by the sea every year. This shore erosion is a source of sediment coming into the sea from the land. Therefore, it plays a part in formation of the Arctic sea sediment balance. Sediment discharge from rivers is a second important input into this the sediment balance.

In this challenge we assess whether the availability, consistency and resolution of existing data in these aspects is sufficient and if this is the case to calculate the average annual sea level rise and sediment balance per stretch of coast.

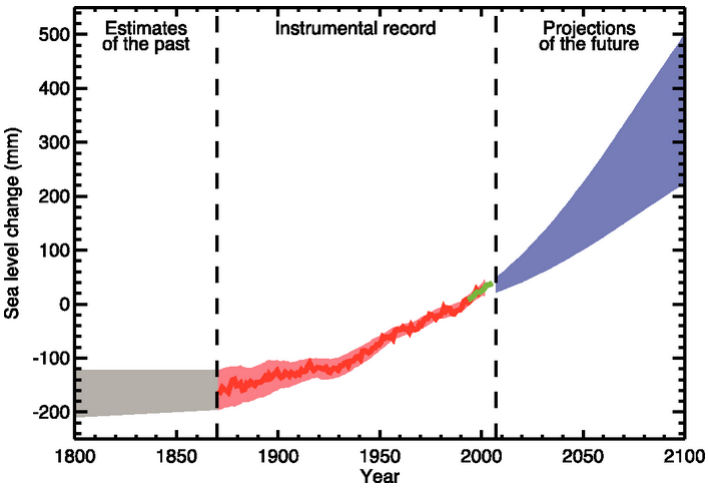

Figure 58. *Picture from IPCC Climate Change 2007: Working Group I: The Physical Science Basis.*

6.6.2 Data quality

Figure 59 shows the quality indicators for the 22 datasets considered for this challenge. The accessibility of the data is good as all could be downloaded, although in most cases an account was required. Nearly all datasets were available within a day. Most were free of charge, four were payed downloads. Nearly all data formats had to be converted (processed) before use in this challenge. More than half of the datasets have a global spatial coverage. The others specifically cover (part of) the Arctic. Most of the datasets have a high spatial resolution (< 1 km). Temporal coverage is mostly years or even decades, with some covering only months or less. Temporal resolution also varies, mostly within a range from daily to yearly. Datasets mostly reflect historical conditions. Some datasets are related to a certain water depth or height, but most are measured at the water surface.

Figure 59. Quality indicators for the datasets used and considered for use in the 'coast' challenge. Colour-codes of specific categories are presented above each indicator. Generic categories (i.e. relevant to all indicators) are presented at the bottom of this figure.

6.6.3 Data adequacy

The adequacy indicators for the datasets used and considered for use in this challenge show that most data is adequate for use (*Figure 60*). With the exception of two datasets, all datasets considered for

this challenge were actually used. There were no budget or time restrictions leading to unusable data. Most data formats had to be converted before use and all data was processed for this challenge. Spatial coverage of the datasets (partly) matched the required region of the Arctic Sea Basin. Spatial resolution and temporal coverage and -resolution of most datasets were limited, although this did not lead to unusable data. Most of the datasets were essential to this challenge.

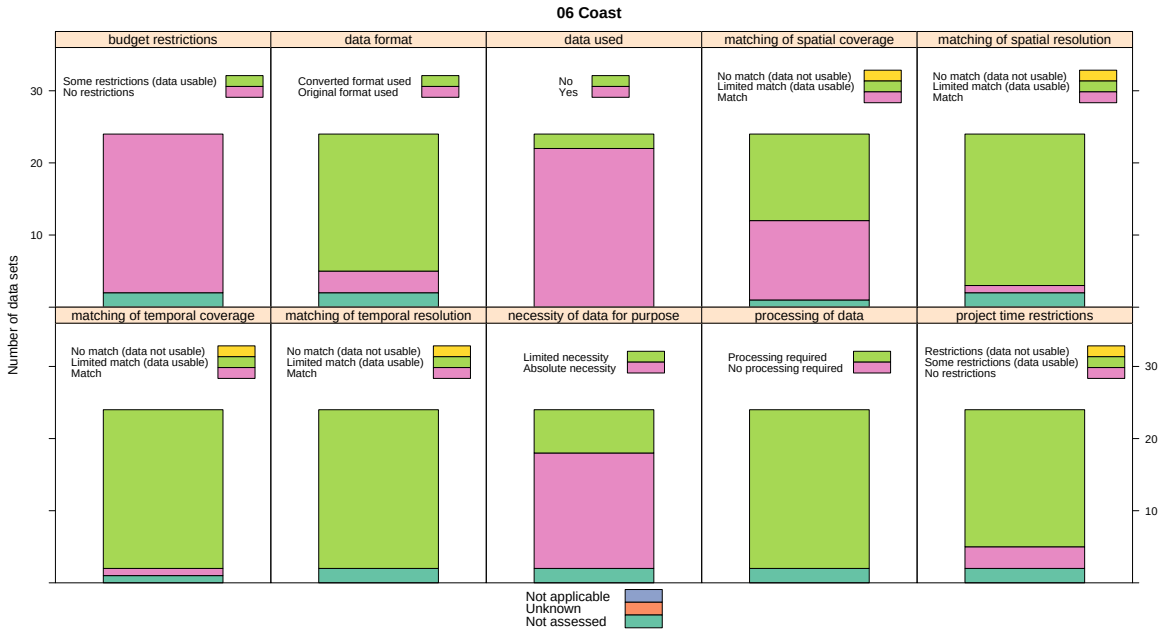

Figure 60. *Adequacy indicators for the datasets used and considered for use in the 'coast' challenge. Colour-codes of specific categories are presented above each indicator. Generic categories (i.e. relevant to all indicators) are presented at the bottom of this figure.*

6.7 Fisheries management (WP07)

6.7.1 Challenge description and main results

Changes in the Arctic fisheries places increasing importance on fisheries governance and management in the region. However, a significant portion of international waters in the Arctic Ocean is currently not covered by any specific fisheries regulatory framework. The compilation of catch data and identifying gaps are vital requirements to support wide management of the region, and could assist by giving:

- Indications of declining historic fisheries
- Indications of new, growing fisheries
- Measures of track records of fishing by different countries across the region as a whole.

This challenge focuses on compiling vital fisheries data, i.e. removals by the fisheries. The objective of this challenge is to collect and process fisheries landings data (excluding shellfish) including discards and bycatch information (of fish, mammals, reptiles and seabirds). The available data has been scrutinised to identify current gaps while also considering future use of the data.

Fisheries landings

The term 'landings' is used for the portion of catch that is brought on shore, while the term 'catch' refers to the total fish captures, whether brought on board the vessel and landed or not (i.e. discards). Thus because landings exclude these discards, the weight of landings is less that the weight of the catch. For the data presented for this objective it is not always clear whether it relates to commercial fisheries catch or fisheries landings. The resulting data will be made available later in the project and addressed in the second DAR.

The source of global marine catch data is the database collected annually by the Food and Agriculture Organization (FAO) of the United Nations[4]. Global time series of catch data have been maintained over more than 60 years and are available through the FAO fisheries and aquaculture database. For statistical purposes, 27 major fishing areas have been internationally established (see *Figure 61*). Major fishing areas 18 (Arctic Sea), 21 (Northwest Atlantic) and 27 (Northeast Atlantic) cover the Arctic area as defined in the CIA fact book. The FAO fisheries and aquaculture database contains, amongst others, capture production statistics by country or territory, species item, and FAO Major Fishing Area.

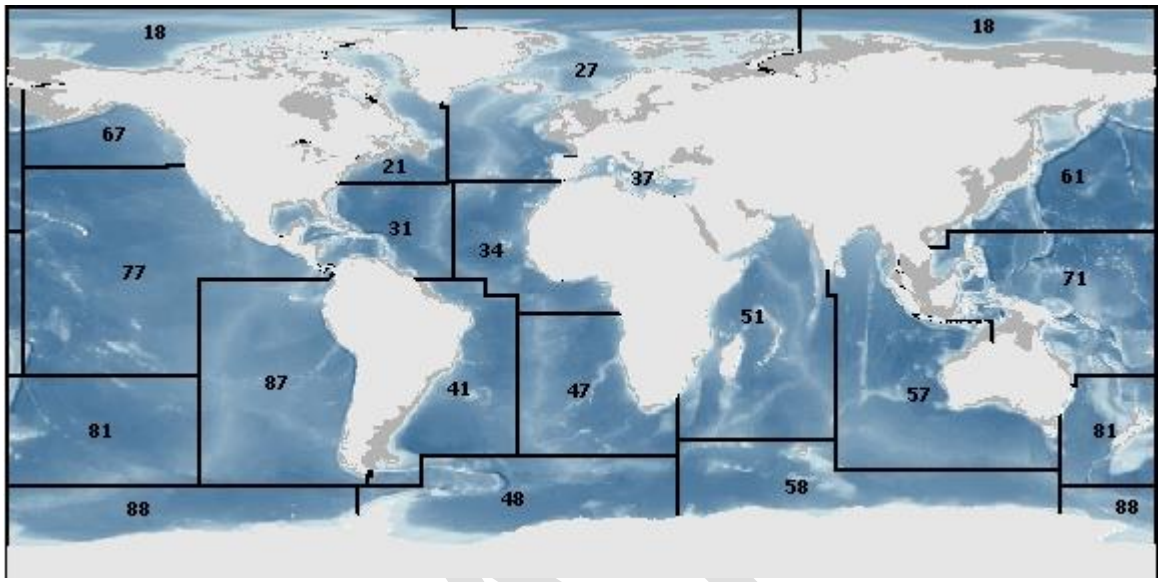

Figure 61. *Map of Major FAO Fishing Areas (source: FAO).*

FAO area 18

As FAO area 18 solely covers the Arctic area (i.e. Arctic sea). Catches can be selected from the FAO database for this major fishing area. However, it is believed that the current catches stored in the FAO database for this fishing area are too low to be credible (Zeller et al., 2011). Zeller et al. (2011) presents a catch reconstruction of the area for the period 1950-2006. This work has been extended in time to 2010 in the Seas Around Us Project (http://www.seaaroundus.org/). However, there is an ongoing debate on the credibility of these reconstructions.

FAO area 21

The Northwest Atlantic (i.e. FAO area 21) is covered by the NAFO convention area which has been divided into a number of NAFO divisions[5]. NAFO divisions 0A, 1A and 1B cover the Arctic part of the Northwest Atlantic. Catch statistics by year, country, gear, tonnage, and main species have been downloaded for these divisions from the NAFO website (21B database) by decade for the period 1960-2014. As the different variables (i.e. country, gear, tonnage, main species) are coded in the datasets, data processing is required in order to present the data. Note that total catch of USA by species is not included in the data.

[4] FAO catch data: Catch data can be accessed using the software package FishStatJ which can be downloaded from the FAO website. In order to access the catch dataset, the global workspace also needs to be downloaded from the FAO website. The global workspace consists of four datasets; (i) global capture production, (ii) global aquaculture production, (iii) global commodities production and trade, and (iv) global production by production source. Once the workspace is imported into FishStatJ the relevant catch dataset, i.e. global capture production, can be selected. The catch dataset runs from 1950 onwards. The filter option enables one to select relevant major fishing area(s). Source: http://www.fao.org/fishery/statistics/software/fishstatj/en

[5] NAFO: The Northwest Atlantic Fisheries Organization (NAFO) is an intergovernmental regional fisheries management organization (RFMO) founded in 1979. It's overall objective is "to contribute through consultation and cooperation to the optimum utilization, rational management and conservation of the fishery resources of the NAFO Convention Area" (http://www.nafo.int). The NAFO members (currently twelve) send their annual compilation of information on national catches and landings to the NAFO Secretariat. Source: http://www.nafo.int/fisheries/frames/fishery.html

FAO area 27

For management purposes, the Northeast Atlantic (i.e. FAO area 27) is divided into ICES fishing areas[6]. ICES areas I, II, Va and XIV cover the Arctic part of the Northeast Atlantic. Catch statistics by species, area, country and year for these areas have been downloaded from ICES website for the periods 1903-1949, 1950-2010 and 2006-2014. For the first two periods it is clearly stated that this concerns landings data, rather than catch data. For the third period it is not that clear.

Discards and bycatch

Within this study the term 'discarding' refers to that portion of unwanted catch (i.e. fish) which is returned to the sea for whatever reason. Discards may be dead or alive. Furthermore, the term 'bycatch' in this study refers to incidental catches of mammals, reptiles and seabirds. The amount of discards and bycatch will depend on the fishing technique that is used. Generally, targeted single species fisheries generate few discards but can cause incidental bycatch of megafauna, while mixed fisheries (i.e. fisheries that target several species) may generate higher amounts of discards. Monitoring programmes, such as observer or self-sampling programmes, are used to estimate the magnitude of discards and/or bycatch in different types of fisheries. Such collected data is not always reported, they can be presented in scientific journals or even in grey literature. Estimates of discarding and bycatch are therefore less readily available than landings or catch data.
At present the available information that has been found on discards and bycatch for the Arctic area is scarce; only fragmented discards and bycatch information was found (described below). Within this challenge it is therefore not possible to create a comprehensive overview of discards and bycatch for the Arctic area.

FAO area 18

Bycatch

The circumpolar Seabird Working Group of the CAFF (Conservation of Arctic Flora and Fauna) has published a report on Incidental Take of Seabirds in Commercial Fisheries in the Arctic Countries in 1998 (CAFF, 1998). The report examines the available information on incidental take of seabirds in commercial fisheries in the Arctic countries, namely USA (Alaska), Canada, Finland, Greenland, Iceland, Norway and Russia. The information presented is characterised by much uncertainty and lack of data concerning incidental take of seabirds.

FAO area 21

Discards

The Scientific, Technical and Economic Committee for Fisheries (STECF) is actively trying to collate fisheries dependent information[7]. This also includes discards information. Thus far it only contains data from EU Member States. Discards data for the ICES areas that cover the Arctic part of the Northeast

[6] ICES: The International Council for the Exploration of the Sea (ICES) is an intergovernmental organization science organization that "provides scientific advice on the marine ecosystem to governments and international regulatory bodies that manage the North Atlantic Ocean and adjacent seas" (http://www.ices.dk). ICES has been gathering and publishing fisheries statistics since 1904. Annual nominal catches in the Northeast Atlantic region are officially submitted by 20 ICES member countries (http://www.ices.dk). The current data is collected and coordinated in collaboration with the Statistical Office of the European Communities (Eurostat). Source: http://www.ices.dk/marine-data/dataset-collections/Pages/Fish-catch-and-stock-assessment.aspx

[7] STECF: The Scientific, Technical and Economic Committee for Fisheries (STECF) provides input to help the European Commission implement the EU's Common Fisheries Policy (CFP). The Commission consults the committee on all matters relating to conservation and management of living aquatic resources. Members of the STECF are nominated by the Commission. STECF may form internal working groups, whose meetings can also be attended by invited experts (https://stecf.jrc.ec.europa.eu/). The STECF Expert Working Group on Fisheries Dependent Information (FDI) is consulted by the Commission to assess fishing effort deployed and catches by fisheries and métiers (i.e. a fishing activity which is characterised by one catching gear group and a group of target species, operating in a given area during a given season). For this, STECF gathers FDI for all EU member states. Time series are provided as far back as possible for a number of defined fishing areas. Discards statistics are available by species, regulated gear, vessel length and country. Source: https://datacollection.jrc.ec.europa.eu/dd/effort/tables

Atlantic (I, II, Va and XIV) was downloaded from the data dissemination webpage. However, for ICES areas I, II and XIV time-series only contain data that are linked to Deep Sea species.

Bycatch

The ICES Working Group on Bycatch of Protected Species (WGBYC) has collated, stored and summarized annual bycatch data reported by European member states affected by the EC Council Regulation 812/2004 (ICES, 2015). This Regulation (EC, 2014) obliges member states to monitor bycatches of cetaceans in certain fisheries, certain periods of the year and certain European waters and to report the results of the monitoring to the EC. This has resulted in the WGBYC database which stores collected data on bycatch monitoring and assessment for protected species, including mammals, birds, turtles, and rare fish. The database runs from 2006 onwards.
Using data collected during 2006-2008 in the coastal monkfish and cod gillnet fisheries active in the Norwegian coast, Bjørge *et al*. (2013) have statistically modelled the bycatch rate of harbour porpoise (*Phocoena phocoena*). It is concluded that about 6900 harbour porpoises are taken annually in these fisheries.

Fangel et al. (2015) assessed the incidental bycatch of seabirds in Norwegian coastal commercial fisheries in 2009. The purpose was, amongst others, to quantify the magnitude of seabird bycatch rates and estimate total bycatch from the entire fleet by different estimators. Overall, the total bycatch of the screened fisheries was estimated at around 11000 birds in 2009.

Problems and Gaps

- Collected data on discards and/or bycatch is less readily available than landings or catch data. It was therefore not possible to generate overall comprehensive overview of discards and bycatch in the Arctic area; only fragmented data has been found.
- For the catch data presented here it is not always clear whether it relates to commercial fisheries catch or fisheries landings.
- The current catches in the FAO database for area 18 are thought to be too low to be credible. Alternative catch reconstructions exist but these are based on assumptions of which, in turn, their credibility is contested.

6.7.2 Data quality

Figure 62 shows the quality indicators for the 14 datasets considered for this challenge. The accessibility of the data is slightly limited as a few datasets were only available as online viewing. However, most data could be directly downloaded with no account required. As far as known, all datasets were available within a day and free of charge. Most data formats had to be converted (processed) before use in this challenge. The spatial coverage for most datasets is part of the Arctic. Most of the datasets have a low spatial resolution (>= 10 km). Temporal coverage is mostly years or even decades. Temporal resolution is mostly yearly or less than yearly. Datasets mostly reflect historical conditions. Vertical resolution is either unknown or not assessed for these datasets.

Figure 62. *Quality indicators for the datasets used and considered for use in the 'fisheries management' challenge. Colour-codes of specific categories are presented above each indicator. Generic categories (i.e. relevant to all indicators) are presented at the bottom of this figure.*

6.7.3 Data adequacy

The adequacy indicators for the datasets used and considered for use in this challenge show that most data is adequate for use (*Figure 63*). Half of the datasets considered for this challenge were actually used. There were no known budget restrictions leading to unusable data. For a few datasets there were crucial time limitations. These were related to the additional effort required to retrieve the right data from the source in a usable context (layout, format). Most data formats had to be converted before use and all data was processed for use this challenge. Spatial coverage of the datasets only partly matched the required region of the Arctic Sea Basin, i.e. there were no datasets that fully matched the area. Spatial resolution of most datasets was limited, which in one case lead to unusable data. Temporal coverage and -resolution of most of the datasets matched, a few limitedly matched and for one dataset there was no match. As far as known, most datasets had a limited necessity to this challenge and a smaller part was essential.

Figure 63. *Adequacy indicators for the datasets used and considered for use in the 'fisheries management' challenge. Colour-codes of specific categories are presented above each indicator. Generic categories (i.e. relevant to all indicators) are presented at the bottom of this figure.*

6.8 Fisheries impact (WP08)

6.8.1 Challenge description

This challenge focuses on collecting information on the impact of fisheries in the Arctic. Fisheries impact is interpreted as any disturbance of the seafloor caused by fishing vessels operating mobile bottom gear. There are several ways to estimate the level of seafloor disturbance depending on the information available.

It is assumed that there is a relationship between the capacity (number of vessels) or effort (usually kWdays) and fishing impact. The degree of impact will depend on the fishing technique that is used. The rationale is that vessels that use heavier gear (e.g. beam trawls) or larger gears (e.g. multiple combined pair trawls) will need more engine power to haul their nets through the water and over the sea floor, thus causing an increased impact on the seafloor. This method can work across very different métiers (i.e. a fishing activity which is characterised by one catching gear group and a group of target species, operating in a given area during a given season) and fisheries types as long as they are mobile (towed) gears. Gill nets, fykes and creeling cannot be measured in the same way but have only minimal impact on the seabed and are therefore excluded from this analysis.

This challenge focuses on compiling information on the actual impact of fisheries in the Arctic. The objective of this challenge is to collect and process fishing capacity and effort data. Furthermore, as the degree of impact will also depend on type of habitat that is disturbed, this challenge has also looked into compiling habitat information for the Arctic area. The resulting data will be made available later in the project and addressed in the second DAR.

Fishing capacity and fishing effort
Fishing capacity is considered to be a fairly crude proxy of fisheries impact (Piet et al., 2006) as there is no straightforward relationship between fishing capacity and the pressure exerted on the ecosystem; only if the vessels that make up the capacity engage in fishing do they contribute to pressure. Within this challenge the number of vessels per fishing métier has been used as indicator for fishing capacity.

Fishing effort is a better proxy for fishing impact and more often applied in data-limited situations. However, again the link between fishing effort and fisheries impact is certainly not directly correlated as the impact of one unit of fishing effort on the ecosystem may differ between métiers and/or the sensitivity of the area exposed to that specific fishing method. More sophisticated but also more accurate indicators for seafloor disturbance require high resolution data such as data that comes from Vessel Monitoring System (VMS). This data is held by the flag state of the vessel and is often subject to data protection regulations. As VMS data from specific vessels come under the data protection act it is not readily available for general use.

At present the available information that has been found on fishing impact for the Arctic area is scarce; only fragmented data has been found (described below). Within this challenge we therefore did not succeed in generating an overall overview of fishing impact.

Data
The Scientific, Technical and Economic Committee for Fisheries (STECF) collates fisheries dependent information for the Northeast Atlantic[8]. This also includes effort information (i.e. hours fished) by

[8] STECF:The Scientific, Technical and Economic Committee for Fisheries (STECF) provides input to help the European Commission implement the EU's Common Fisheries Policy (CFP). The Commission consults the committee on all matters relating to conservation and management of living aquatic resources. Members of the STECF are nominated by the Commission. STECF may form internal working groups, whose

fishing gear. Maps of fishing effort by year, gear type and ICES rectangle for the period 2000-2014 for the Arctic part of the Northeast Atlantic (ICES areas I, II, Va and XIV – see Challenge 7 for more information on ICES areas) can be directly downloaded from the STECF website.

The Northwest Atlantic Fisheries Organisation (NAFO) provides monthly catch and effort information by year, country, tonnage, main species, division and year for the Northwest Atlantic on the NAFO website (21B database) for the period 1960-2014[9]. However, as the coding of the presented effort is unclear, it is uncertain whether this information is useable.

Habitat information

Habitat information has been obtained from various sources. Different working groups within the Arctic Council provide some kind of information on important areas within the Arctic area[10]. For example, the biodiversity working group of the Arctic Council (CAFF) presents information on protected and important areas. Within CAFF 11 Ecologically and Biologically Significant Areas (EBSAs) have been identified in the Arctic. EBSAs are "*special areas in the ocean that serve important purposes, in one way or another, to support the healthy functioning of oceans and the many services that it provides*" (http://www.caff.is). Furthermore, the working group on Arctic Monitoring and Assessment Programme identified 97 areas of heightened ecological significance, including 40 areas used by fish (mostly spawning areas) within the Arctic Large Marine Ecosystems (LMEs). These areas were identified on the basis of their importance to fish, birds and/or mammals (AMAP/CAFF/SDWG, 2013). There are also different European initiatives, e.g. EUNIS and MAREANO project, that provide some kind of habitat information for specific Arctic parts of the Northeast Atlantic. Furthermore, Challenge 3 (Marine Protected Areas) may provide additional information on areas within the Arctic that deserve special conservation and/or are more vulnerable to fishing.

Problems and Gaps

- It was not possible to generate an overall overview of fishing impact at low spatial resolution in the Arctic area; only fragmented data has been found. Furthermore, the coding of the presented unit of effort data is not always clear making it not possible to use the data.
- Due to privacy issues high-spatial resolution data on fishing impact is not readily available for general use.
- Specific organisations that were addressed to identify accessible data did not reply.

6.8.2 Data quality

Figure 64 shows the quality indicators for the 21 datasets considered for this challenge. The accessibility of the data is limited as part of the datasets were only available as online viewing. However, a large part of the data could be directly downloaded with no account required. As far as known, all datasets were available within a day and free of charge. One dataset required a payed account. Most data formats had to be converted (processed) before use in this challenge. Most datasets cover part of the Arctic. The spatial resolution varies from < 1 km up to more than 10 km.

meetings can also be attended by invited experts (https://stecf.jrc.ec.europa.eu/). The STECF Expert Working Group on Fisheries Dependent Information (FDI) is consulted by the Commission to assess fishing effort deployed and catches by fisheries and métiers. For this, STECF gathers FDI for all EU member states. Time series are provided as far back as possible for a number of defined fishing areas. Source: https://datacollection.jrc.ec.europa.eu/dd/effort/maps

[9] NAFO: The Northwest Atlantic Fisheries Organization (NAFO) is an intergovernmental regional fisheries management organization (RFMO) founded in 1979. It's overall objective is "to contribute through consultation and cooperation to the optimum utilization, rational management and conservation of the fishery resources of the NAFO Convention Area" (www.nafo.int). The NAFO members (currently twelve) send their annual compilation of information on national catches and landings to the NAFO Secretariat. Source: http://www.nafo.int/fisheries/frames/fishery.html

[10] Arctic Council: The Arctic Council is an intergovernmental forum for Arctic governments and people. The Council promotes interaction among the different Arctic parties on common Arctic issues. The work of the council is primarily carried out by six working groups, one of which is the Conservation of Arctic Flora and Fauna Working Group (CAFF). In addition, Task Forces or Expert Groups may be established to carry out specific work. Source: http://www.arctic-council.org/index.php/en/

Temporal coverage is mostly decades. Temporal resolution is mostly yearly or less than yearly. Datasets mostly reflect historical or hindcast conditions. There are no known datasets with a vertical resolution of > 0 (i.e. measured at certain depth or height).

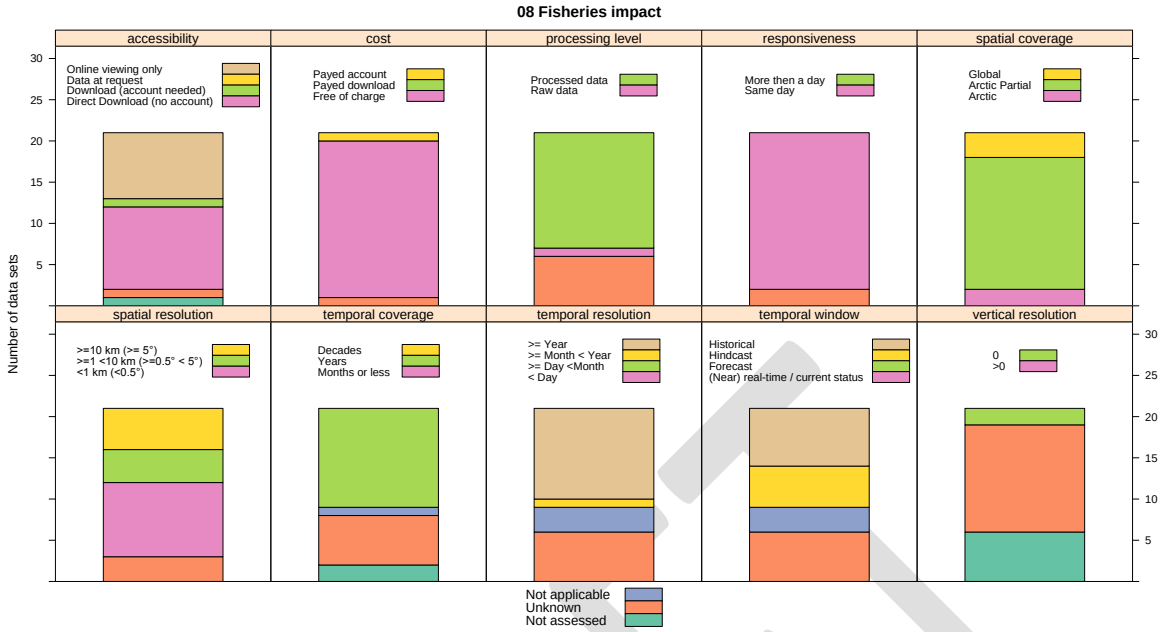

Figure 64. *Quality indicators for the datasets used and considered for use in the 'fisheries impact' challenge. Colour-codes of specific categories are presented above each indicator. Generic categories (i.e. relevant to all indicators) are presented at the bottom of this figure.*

6.8.3 Data adequacy

The adequacy indicators for the datasets used and considered for use in this challenge show that most data is adequate for use (*Figure 65*). Half of the datasets considered for this challenge were actually used. There were no known budget restrictions leading to unusable data. For a few datasets there were crucial time limitations. These were related to the additional effort required to retrieve the right data from the source in a usable context (layout, format). As far as known, all data formats had to be converted before use and was processed for this challenge. Spatial coverage of most datasets only partly matched the required region of the Arctic Sea Basin. There were a few datasets that fully matched the area and one dataset did not match at all. Spatial resolution of most datasets was limited, which in some cases lead to unusable data. As far as known, temporal coverage of the datasets had a (limited) match and for one dataset there was no match. The temporal resolution of most datasets matched. As far as known, most datasets had a limited necessity to this challenge and a smaller part was essential.

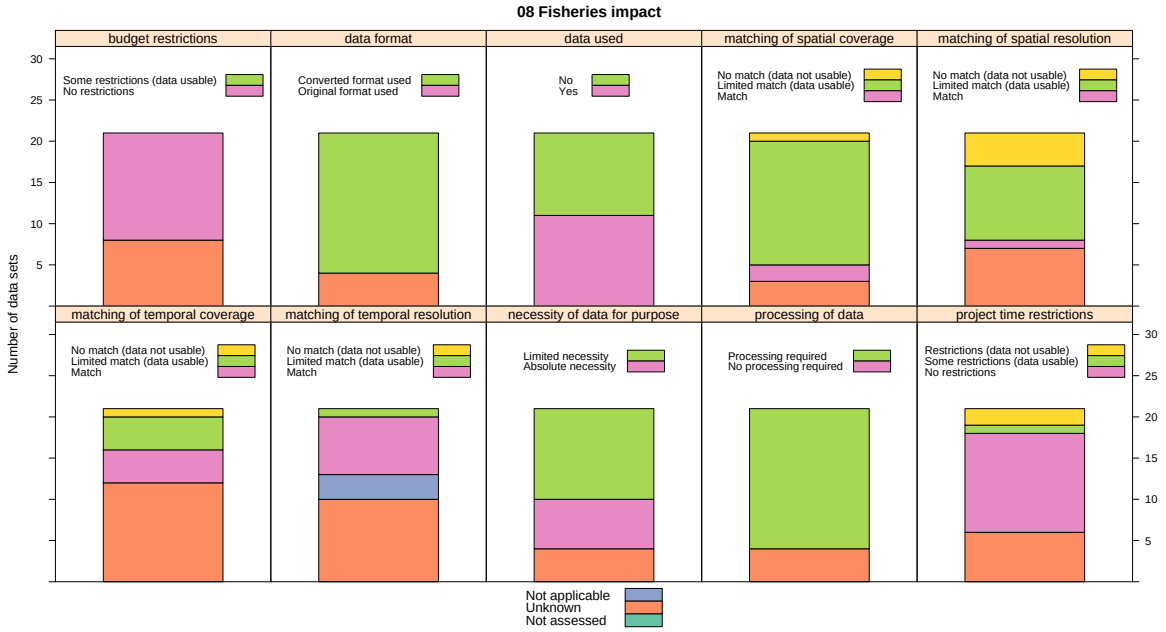

Figure 65. *Adequacy indicators for the datasets used and considered for use in the 'fisheries impact' challenge. Colour-codes of specific categories are presented above each indicator. Generic categories (i.e. relevant to all indicators) are presented at the bottom of this figure.*

6.9 River input (WP10)

6.9.1 Challenge description and main results

Data availability for Rivers Challenge

The objective for the River Challenge of the Sea Basin Checkpoint Arctic project is to provide time series of the annual input into the Arctic Ocean of: water; water temperature; sediment; total nitrogen and phosphates; and salmon and eel.

Data Gaps

The data availability is very different for the requested parameters. Most data is available for the volume of water discharge. For some large Russian rivers time series are quite long, more than 70 years, up to more than 100 years. But many time series are relatively short, a few decades in many cases, and often incomplete. It is worrying that stations have been closed and data is delayed.

The data availability for the other parameters is much worse. Water quality monitoring is expensive, especially at remote sites. Therefore measurements are erratic, time series are short and measurement protocols differ between sites.

Bring and Destouni (2009) have also studied the status of the Arctic monitoring effort. They conclude that especially the water quality monitoring is fragmented and this restricts environmental modellers, policy makers and the public in their ability to integrate accessible data and accurately assess bio-geochemical changes in the Arctic environment. They note that the recent PARTNERS project (now continued as the Arctic-GRO) improves the situation, but large areas remain unmonitored. They show that there is a significant difference between the characteristics of the monitored and unmonitored areas which limits the possibilities to generalize hydrological and hydrochemical impact assessments based on monitoring data. Even if the quality monitoring were at a level comparable to the quantity monitoring, the short time series still poses a significant problem.

6.9.1.1 Water volume

In climate research the modelling of the hydrological cycle is of key importance. In the hydrological cycle, the river discharge provides the major link between land and sea. The Arctic Ocean receives

fresh water from several major rivers while the Arctic Ocean is relatively small and well confined by land masses. This makes it the ocean with the largest fresh water influence. The urge to understand the role of the arctic in climate change has led to several initiatives that gather data on the hydrology of the arctic. These initiatives have compiled databases containing the water discharge and in some cases various other parameters for at least the six largest rivers: Ob, Yenisey, Lena, Kolyma, Yukon and Mackenzie, but in some cases also many small streams. The databases that have been identified and used to compile time series are:

- The Arctic Great Rivers Observatory (Arctic-GRO)
- ArcticRIMS
- R-ArcticNET
- ArcticHYCOS
- HYDAT – Wateroffice Canada
- NWIS United States Geological Survey

All these databases are freely accessible; in some cases registration is required.

Arctic-GRO

This project is an international effort to collect and analyse a time series of water samples from the six largest Arctic rivers using identical sampling and analysis protocols. This project focuses on gathering a complete dataset on the discharge and constituent loads. The following data-sets have been gathered:

- Arctic-GRO II constituent data (2012-2016): Ongoing; 28 campaigns carried out every other month on the six Great Arctic Rivers
- Arctic-GRO I constituent data (2009-2011): Completed; 15 comprehensive campaigns with a focus on freshet (i.e. spring thaw), late summer, and under-ice periods; daily samples over the freshet
- PARTNERS constituent data (2004-2007): Completed; 17 comprehensive campaigns
- This is the only identified data source that provides data on all requested physical parameters for the major rivers (Water volume and temperature, Sediment, Total nitrogen and Phosphates).

ArcticRIMS

The ArcticRIMS project is a monitoring system for the hydrological cycle. Therefore its database contains data like precipitation, runoff, snow cover and air temperature. For this challenge only the discharge data are directly relevant and were considered. It appears that the ArcticRIMS discharge data is linked to the R-ArcticNET discharge data.

R-ArcticNET

The R-ArcticNET database contains the monthly averaged discharges of all large and most small arctic rivers. The database is hosted at the Water Systems Analysis Group of the University of New Hampshire. The most recent data in this database is from 2003. It is probably no longer maintained as the people who worked on this dataset are now contributing to ArcticHYCOS, which contains a superset of the Arctic discharge data. Also the ART-Russia Temperature Dataset is hosted here.

ArcticHYCOS

The Arctic-HYCOS project aims to improve the monitoring of freshwater fluxes and pollutants into the Arctic Ocean with the objective of improving climate predictions in the Northern Hemisphere and assessing the pollution of Arctic coastal areas and the open Arctic Ocean. Currently there is a database with monthly and daily discharge data for all large rivers and many small ones. Currently suitable monitoring stations are being identified to observe the total flow to the Arctic Ocean. There are ambitions to extend the database with additional parameters (temperature), but first observation methods need to be standardized (Looser BfG, pers. comm. 2016). This dataset is hosted as a special subset of the global runoff database at the Global Runoff Data Centre at the Bundesanstalt fuer Gewaesserkunde (BfG) in Germany.

National agencies

All previously described datasets contain discharge data gathered by the national agencies: United States Geological Survey (USGS), Wateroffice Canada and the State Hydraulic Institute (SHI) of

Russia. Therefore basically they contain the same data, albeit with potentially different post processing and data gaps. The USGS and Wateroffice Canada offer download websites where the data can be downloaded directly from the collecting agency. Apart from discharge also some suspended sediment concentration measurements were found.

Discharge time series

Time series for the yearly discharge have been created by averaging the monthly averaged discharge over a year. The stations marked as 'downstream station' for all rivers in the ArcticHycos dataset have been processed. This is the most complete dataset in terms of spatial and temporal coverage and other datasets only contain copies of a subset of this data. Therefore no additional data from other datasets has been used. The datasets for the large Russian rivers typically start early 20th century or even late 19th century. This makes these rivers interesting for long-term trend detection in climate studies. However, the recent years discharges are missing, observations stop approximately after 2010. This data will probably be delivered by the SHI in the future (Looser BfG, pers. comm. 2016). The record typically starts in the 60's and 70's for the North American rivers and recent observations are available.

6.9.1.2 Water temperature

Two sets of temperature data have been used to compile temperature time series. The Arctic-GRO database contains temperature, but is only relatively recent and focuses on the six largest rivers. Furthermore Lammers et al. (2007) have compiled a temperature dataset for 17 Russian drainage basins. This data covers a period from 1929 to 2003.

The data have not been averaged over the years as the distribution of samples over the year is not uniform for all data. This would cause a strong deviation of the average from the true average.
In the figures below the water temperature is presented per river from the datasets described above. The Mackenzie and Yukon rivers only present data from the Arctic GRO database as no data on this rivers was available in Lammers et al. (2007).

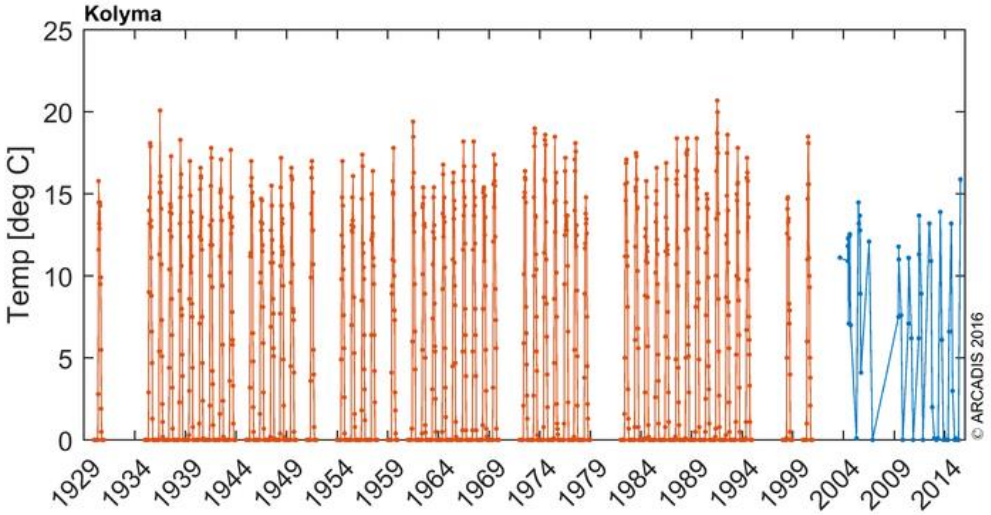

Figure 66 *Water temperature in the Kolyma river from 1929 to 2014 in °C, derived from two different datasets: Lammers et al., 2007 (1929 to 2003) and the Arctic GRO database (2004 to 2014).*

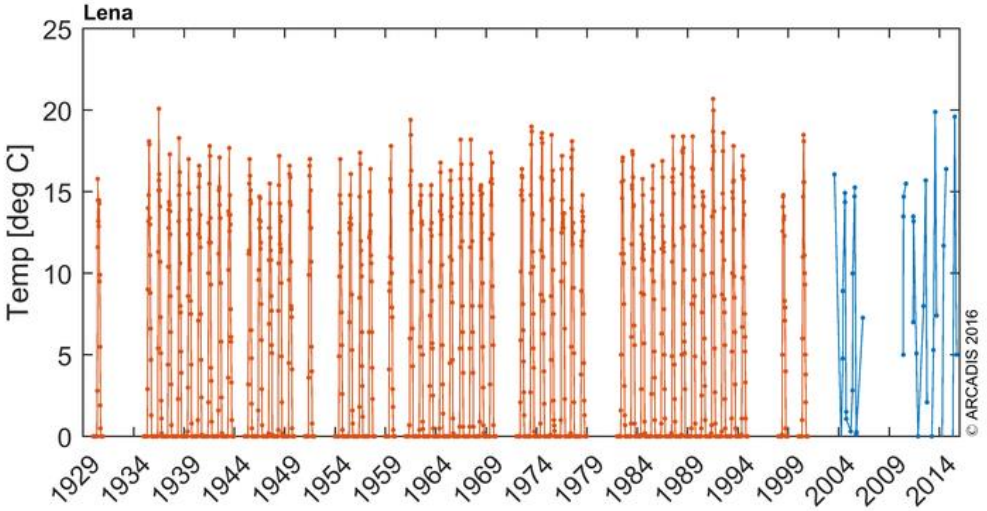

Figure 67. *Water temperature in the Lena river from 1929 to 2014 in °C, derived from two different datasets: Lammers et al., 2007 (1929 to 2003) and the Arctic GRO database (2004 to 2014).*

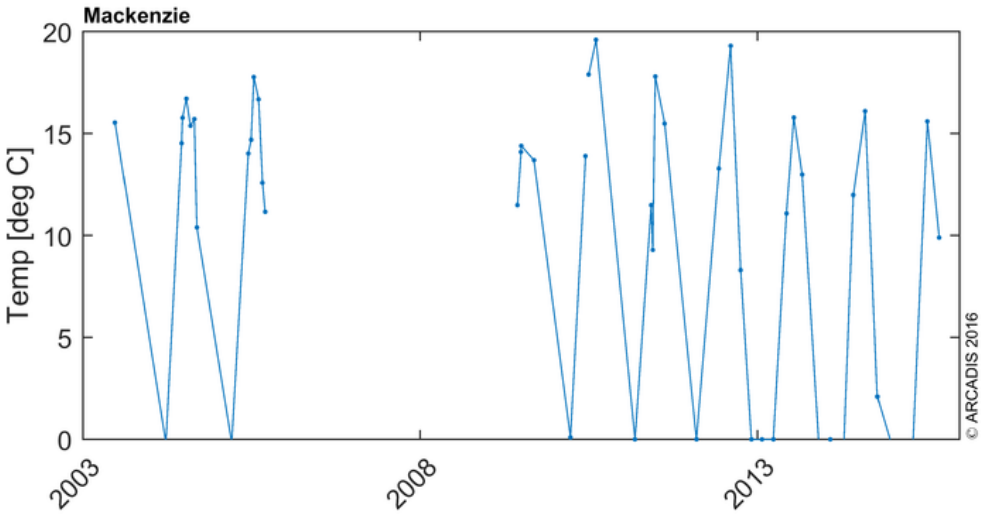

Figure 68. *Water temperature in the Mackenzie river from 2004 to 2014 in °C, derived the Arctic GRO database (2004 to 2014).*

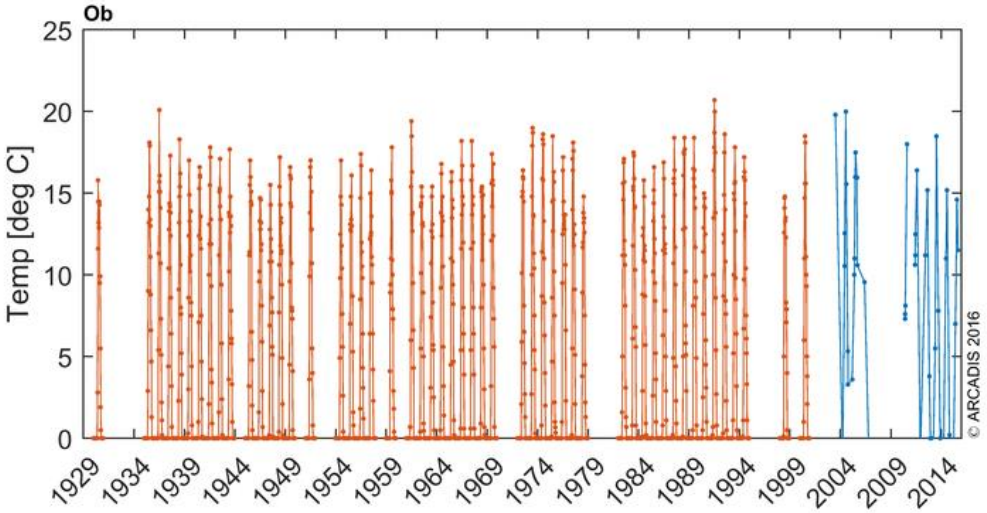

Figure 69. *Water temperature in the Ob river from 1929 to 2014 in °C, derived from two different datasets: Lammers et al., 2007 (1929 to 2003) and the Arctic GRO database (2004 to 2014).*

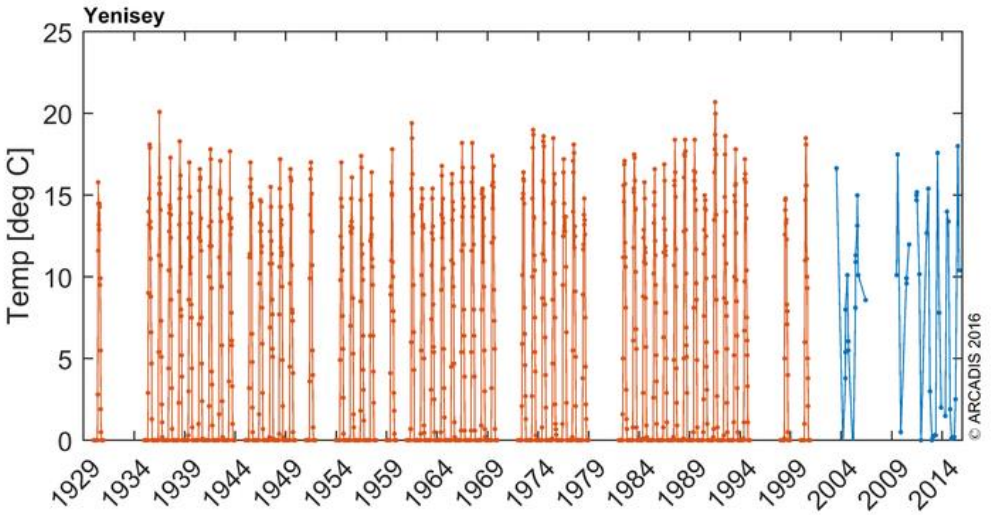

Figure 70. *Water temperature in the Yenisey river from 1929 to 2014 in °C, derived from two different datasets: Lammers et al., 2007 (1929 to 2003) and the Arctic GRO database (2004 to 2014).*

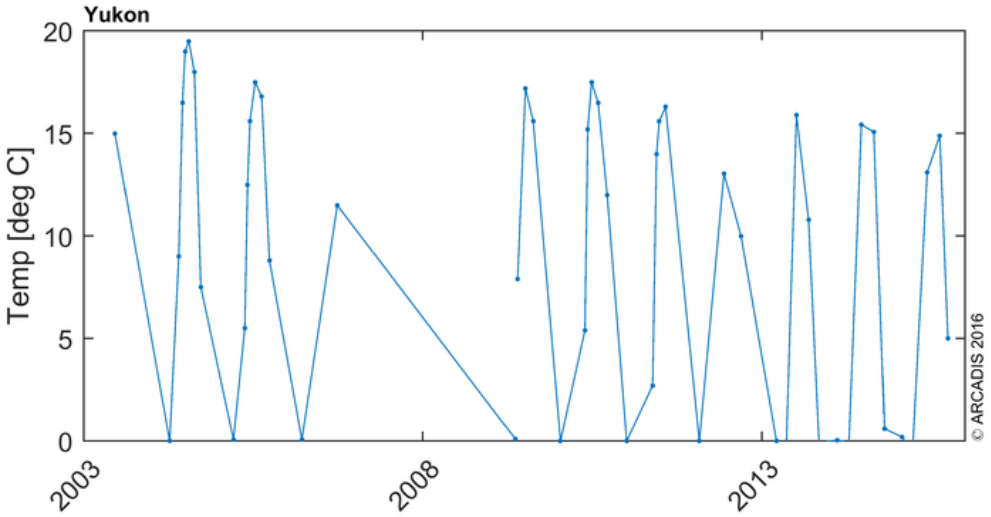

Figure 71. *Water temperature in the Yukon river from 2004 to 2014 in °C, derived the Arctic GRO database (2004 to 2014).*

6.9.1.3 Sediment time series

Measured datasets for sediment discharge have not been identified, the best assessment of the yearly sediment output of rivers into the Arctic Ocean probably comes from Overeem and Syvitsky (2008) who use discharge information to model the sediment output.
The most useful information on sediment discharge consists of suspended sediment concentration (SSC) measurements. These measurements are labour intensive and therefore scarce.

These concentration measurements can provide a basis to estimate the total suspended sediment discharge to the Arctic Ocean. If few concentration measurements are available a multiplication of the SSC and water discharge is very inaccurate. Instead, a relation between discharge and SSC can be established, which can be used to calculate the suspended sediment discharge.

The bed load sediment discharge to the Arctic Ocean remains unobserved. The suspended load is often the largest part of the total sediment load. Turowski et al. (2010) report on the ratio of suspended to bed load and find that extrapolation of the total load based on the suspended load is inaccurate.

SSC datasets are available in HYDAT, the USGS database and the Arctic-GRO dataset. For the Yukon (USGS) the data starts from 1976. The Arctic-GRO dataset starts from 2003. The FAO-Aquastat database contains average sediment yields for catchments worldwide, among which many Arctic Catchments. It doesn't contain time series however and it is not updated.

Instead of presenting time series of the sediment discharge, time series of the suspended sediment concentration are shown.

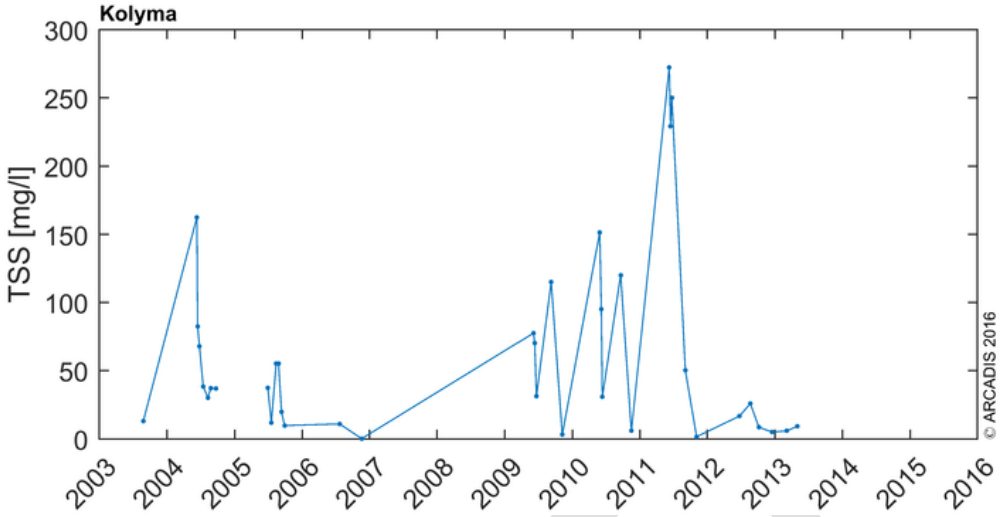

Figure 72. *Time series of the Suspended Sediment concentrations in mg/l for the Kolyma river, from 2004 to 2015, derived from the datasets as described above.*

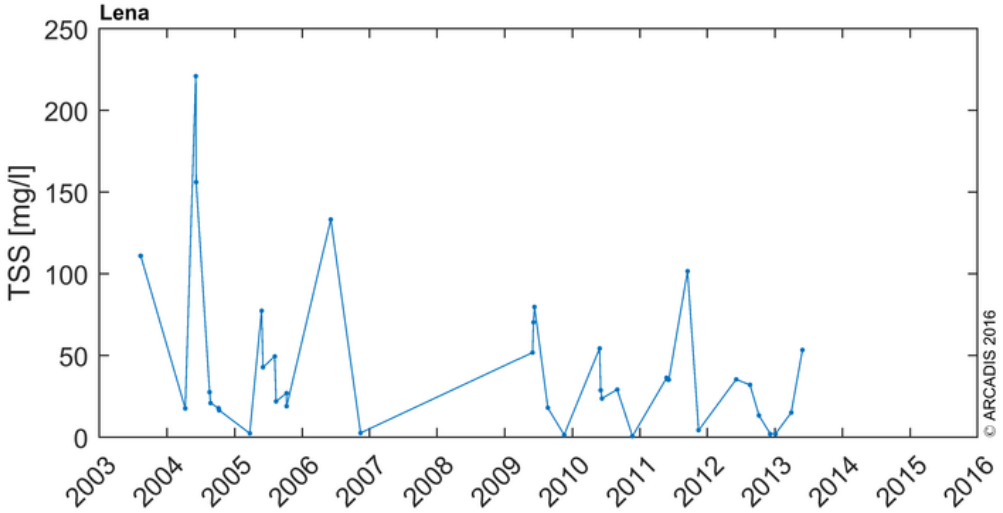

Figure 73. *Time series of the Suspended Sediment concentrations in mg/l for the Lena river, from 2004 to 2015, derived from the datasets as described above.*

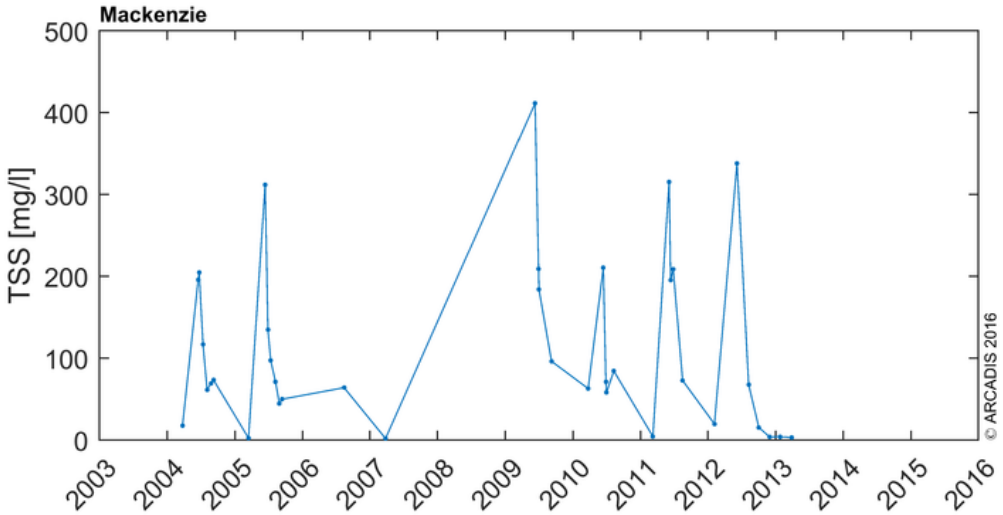

Figure 74. *Time series of the Suspended Sediment concentrations in mg/l for the Mackenzie river, from 2004 to 2015, derived from the datasets as described above.*

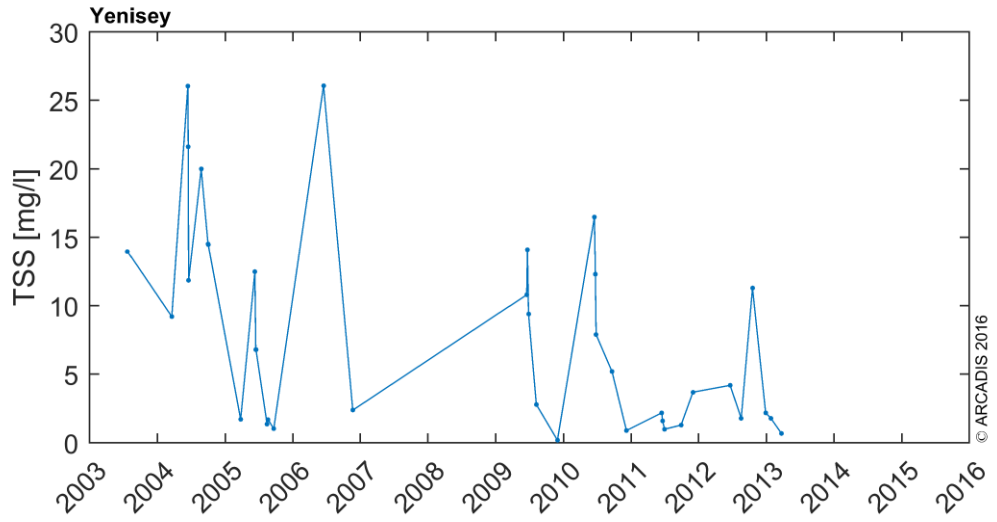

Figure 75. *Time series of the Suspended Sediment concentrations in mg/l for the Yenisey river, from 2004 to 2015, derived from the datasets as described above.*

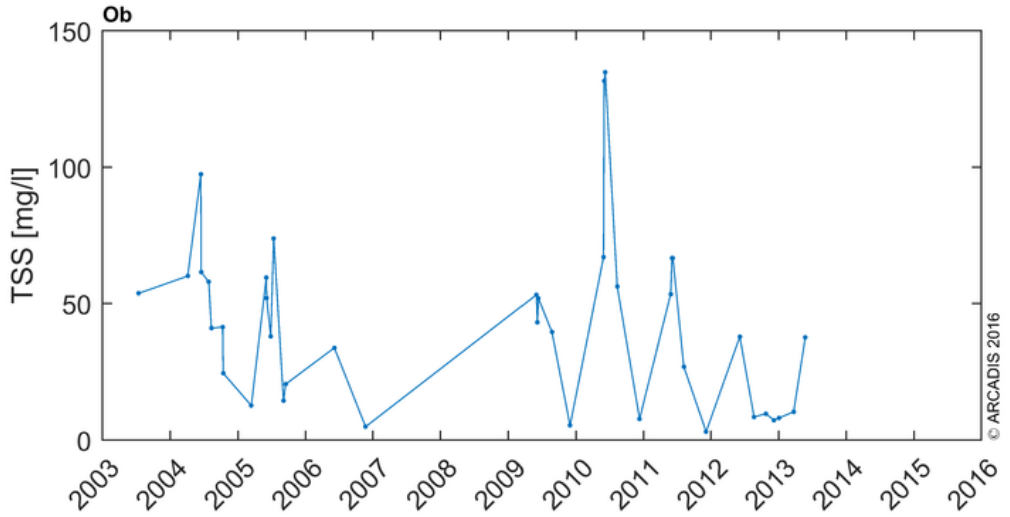

Figure 76. *Time series of the Suspended Sediment concentrations in mg/l for the Ob river, from 2004 to 2015, derived from the datasets as described above.*

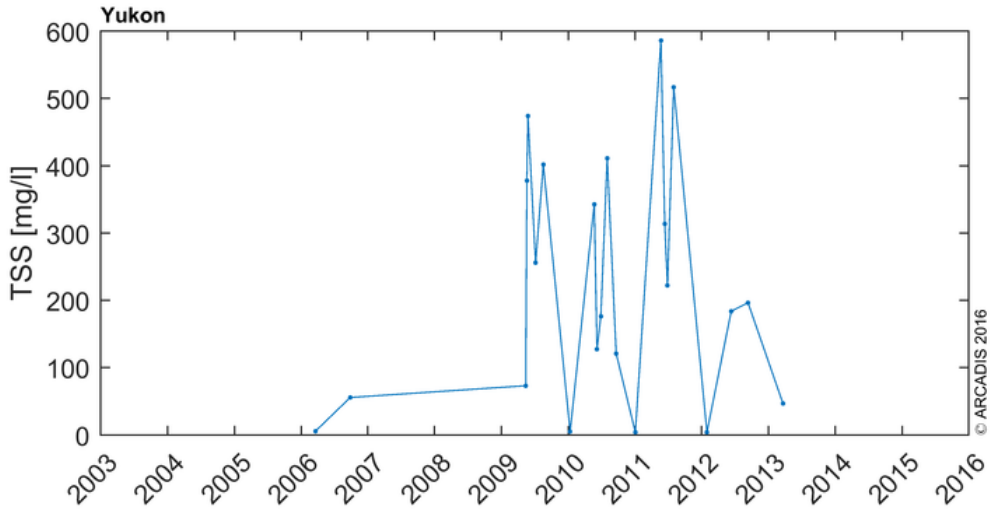

Figure 77. *Time series of the Suspended Sediment concentrations in mg/l for the Yukon river, from 2004 to 2015, derived from the datasets as described above.*

6.9.1.4 Nitrogen and Phosphorous discharge time series

Water quality measurements like Phosphorus and Nitrogen data are rather scarce for Arctic Rivers. A variety of Assessment Reports, most commonly primary literature, were publicly available for both Nitrogen and Phosphorus. However, since most of the Assessment Reports were primarily literature articles although they contained useful data and analysis, the datasets were typically specific and of low resolution. The data source that was the most helpful was the Arctic-GRO. This dataset contains measurements of different forms of Phosphorus and Nitrogen as well as a variety of chemical constituents including Total Suspended Solids, Silicon Dioxide, Sodium, Potassium, Magnesium, Calcium, Arsenic, Barium, Lithium, Rubidium, and Strontium. This database focuses on the six largest rivers, this source and other sources however did not focus significantly on the smaller rivers. The data found at the Arctic-GRO focuses primarily on the past few years and seems to be increasing over time. This data has also already been post processed and the laboratory techniques are described in detail. The main problem with this Arctic Great Rivers Observatory site is that although a variety of chemical constituents are measured over time, it is difficult to calculate the Total Nitrogen and Total Phosphorus from the measurements noted. Total Nitrogen is the sum of the total dissolved nitrogen (TDN) and particulate organic nitrogen (PON). Total dissolved nitrogen is the sum of nitrate-N, nitrite-N and ammonia-N. Note that in the spreadsheet the nitrate-N (NO3) include both NO2 –N and NO3-N. Total Phosphorous is the sum of the total dissolved phosphorus and particulate phosphorus. The particulate phosphorus is not in the dataset, therefore the total dissolved phosphorus is best representation of the total phosphorus in this dataset.

6.9.1.5 Salmon and eel abundance and migration in Arctic waters

Salmon

Information on salmon is available, as well as data, but the data is site-specific and local. No major overview exists of input and output for all major rivers in the Arctic system. For this reason, we chose to focus on the Yukon river area, as data is available.

Salmon in the Arctic is not common, on the Pacific side chum, pink, sockeye, coho and chinook salmon have been encountered and Atlantic salmon on the Atlantic side (Irvine et al., 2009; Verspoor et al., 2007). Data on the in- and outflow of salmon in the main Arctic rivers is sparse and very much scattered spatially as well as temporally. The same goes for general abundance datasets. The bulk of the (online) available data stems from the Alaskan and Canadian rivers or coastal areas.

Chinook salmon only reproduces once in their life, after which they die. The adult fish swimming upriver will not return to the sea, however the hatchlings will. On the website for the Alaskan department for Fish and Game, fish counts can retrieved for multiple species and rivers, as an example we have chosen the Yukon River and chinook salmon:

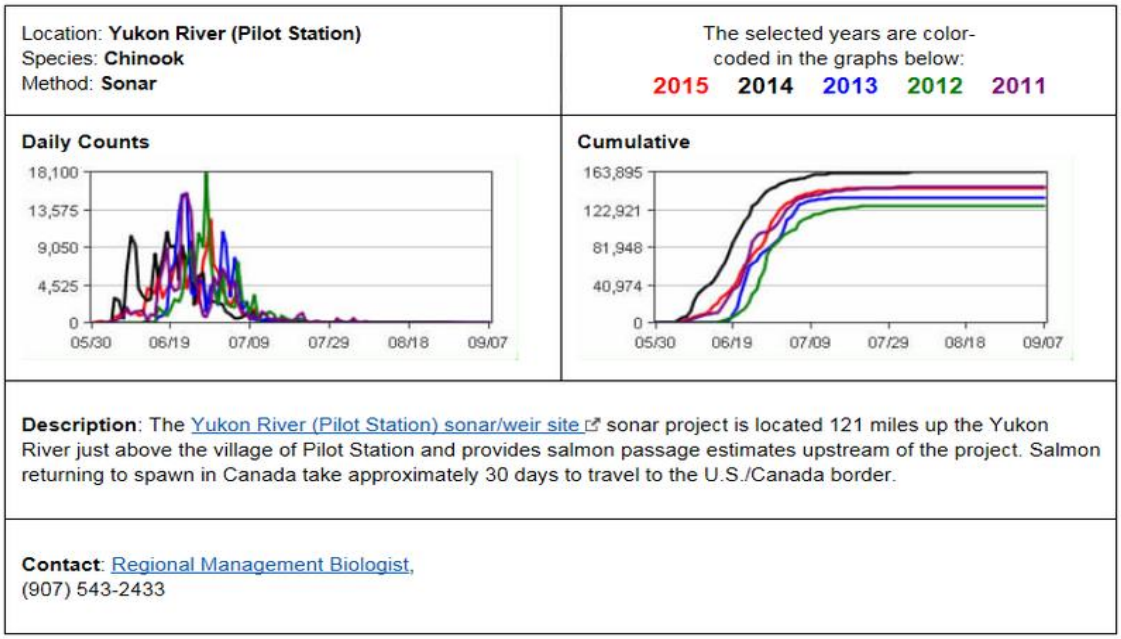

Figure 78. *Time series for inflow of salmon from 2011 to 2015, measured from a sonar site on the Yukon River. Source: http://www.adfg.alaska.gov/sf/FishCounts/index.cfm?adfg=main.home*

In the "Yukon river salmon 2014 season summary and 2015 season outlook" (JTC, 2015) a figure is shown of the relative amount of juvenile chinook salmon. As described in this summary: "*Yukon River Chinook salmon are the predominate stock group in the northern Bering Sea (Murphy et al., 2009); and stock-specific juvenile abundance estimates in the Northern Bering Sea has been used to provide an early indicator of Canadian-origin Chinook salmon production to inform preseason management decisions. The juvenile index in 2011 and 2012 will be the primary contributors to the 2015 return as Chinook salmon typically return to the Yukon River after spending 3 to 4 years in the ocean*." (JTC, 2015).

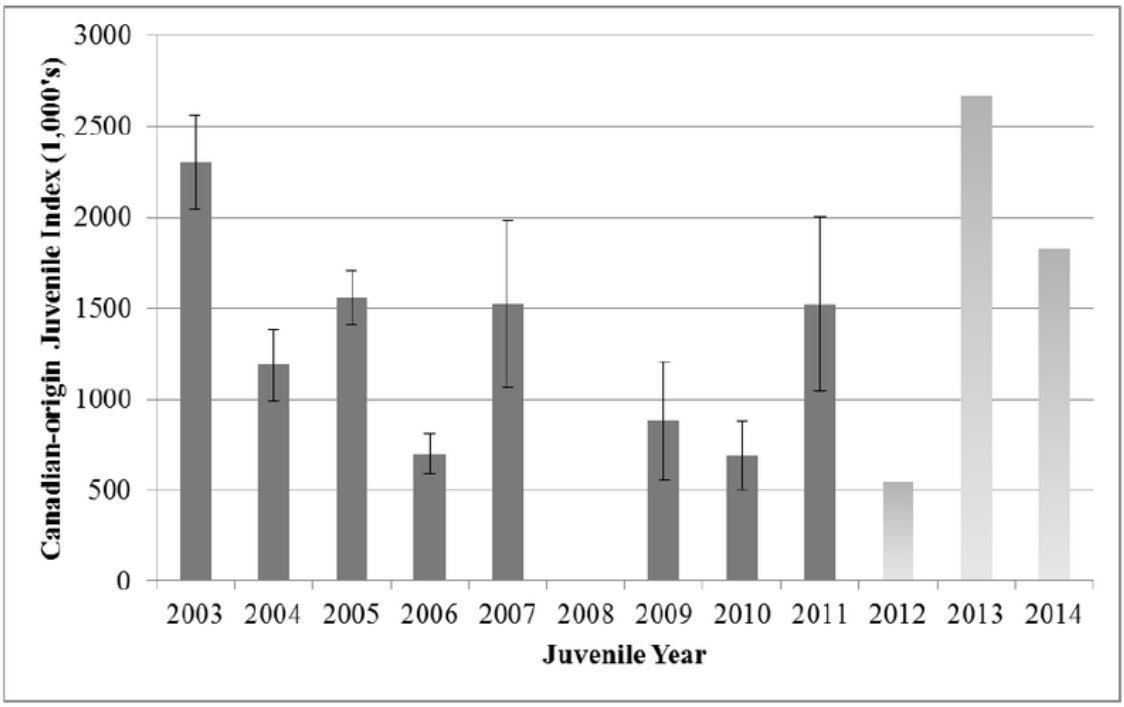

Figure 79. *Relative abundance of juvenile Chinook salmon estimated from catch rates in pelagic trawl research surveys in the Northern Bering Sea (60N-65N). Note: Error bars identify the 80% confidence interval of the abundance estimates. The 2012-2014 estimates are preliminary and subject to change. Source: JTC (2015).*

When the input and output is known, the a replacement line can be drawn:

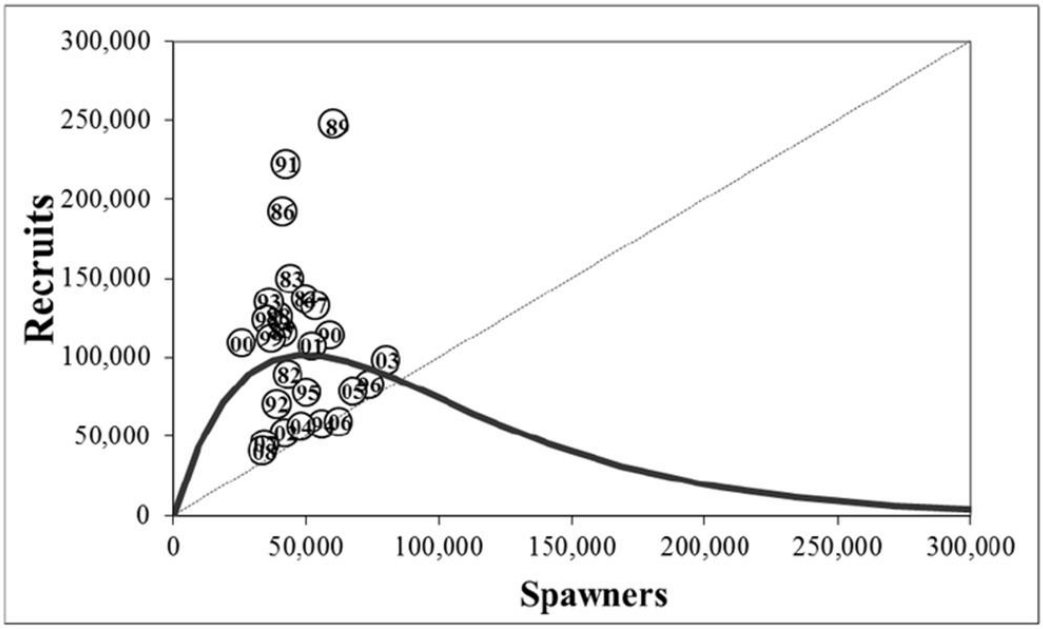

Figure 80. *Yukon River Canadian-origin Chinook salmon recruits versus spawners, Ricker curve, and 1:1 replacement line. Brood years 1982-2008 are included. Source: JTC, 2015.*

Eel

European or Atlantic Eel (*Anguilla anguilla*) do not have a major distribution in the Arctic Area, see the figure below. No data was found on the in- or outflow of Eel in one of the major Arctic River basins in this habitat. American Eel (*Anguilla rostrata*) is also not found further north than Greenland and Iceland (see figure below) and no information on the in-or outflow in the major Arctic river basins was found.

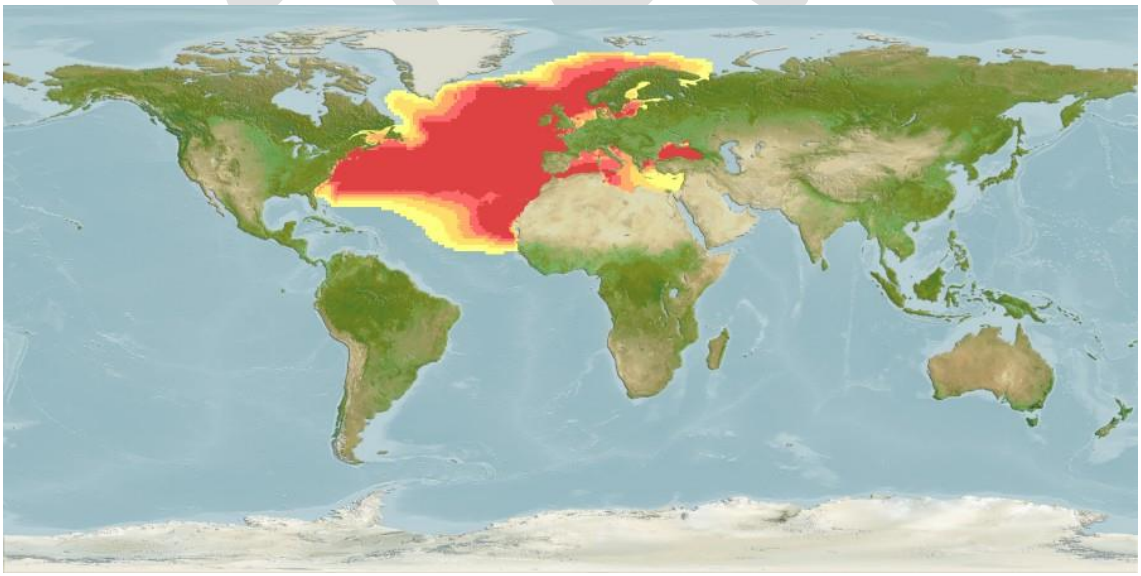

Figure 81. *Native habitat of European Eel, source: Fishbase.org.*

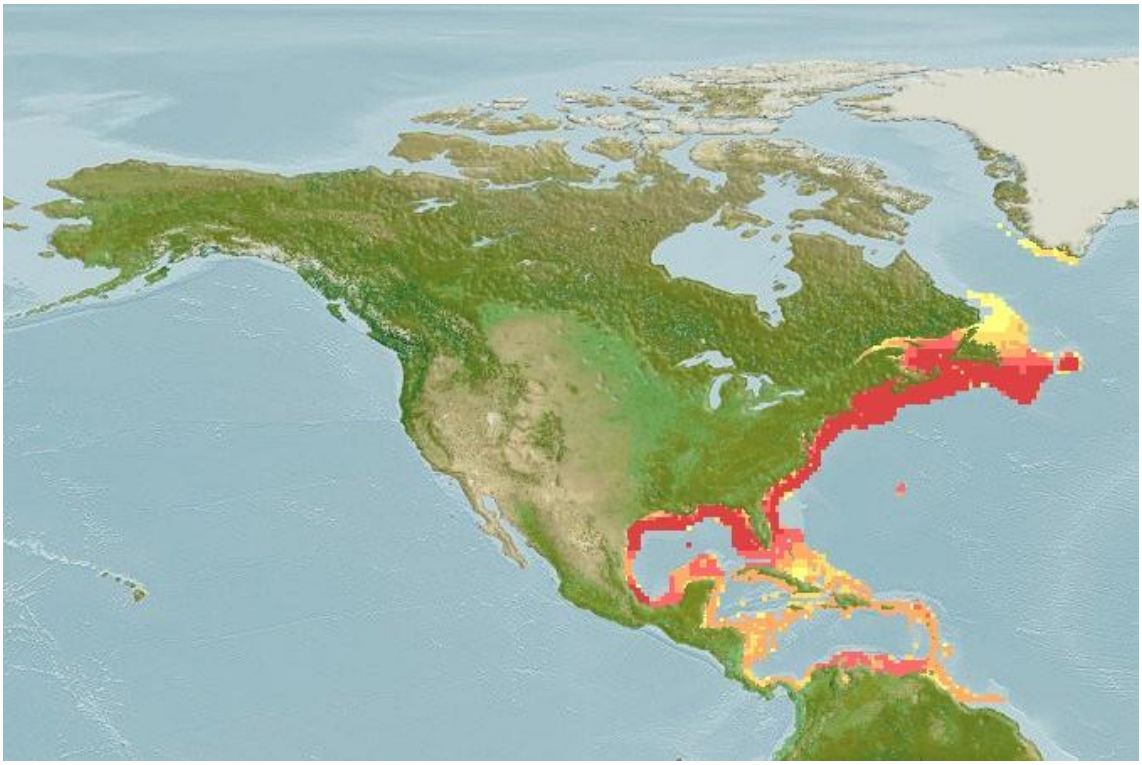

Figure 82. *Native habitat of American Eel, source: Fishbase.org.*

No other true eels live in the Arctic Area. However, a species which could be compared to both eel and salmon is the Arctic Lamprey (*Lethenteron camtschaticum*), an anadromous fish with an eel-like appearance. The distribution is almost circumpolar, as can be seen in the figure below. However, data on this species' in- and outflow is scarce. In Alaska, the Arctic Lamprey is quite abundant, however no specific data on recruitment or migration is available (ADFG, Arctic Lamprey https://www.adfg.alaska.gov/static/species/speciesinfo/_aknhp/Arctic_lamprey.pdf).

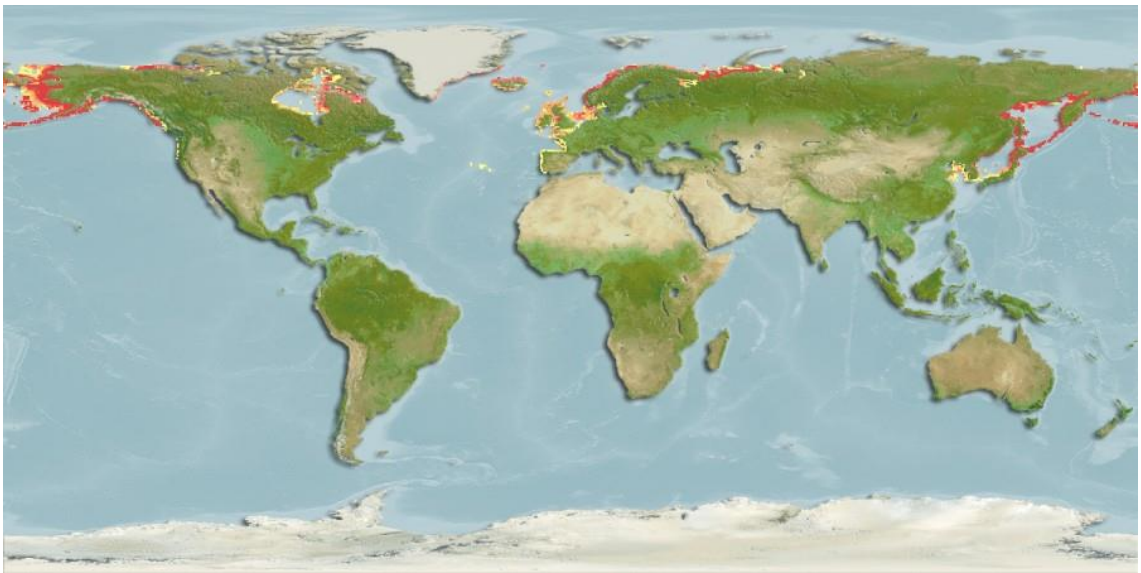

Figure 83. *Native habitat of Arctic Lamprey, source: Fishbase.org.*

6.9.2 Data quality

Figure 84 shows the quality indicators for the datasets considered for this challenge. The accessibility of the data is good (as far as known). Most data could be directly downloaded with no account required. As far as known, all datasets were available within a day and free of charge. Most data formats had to be converted (processed) before use in this challenge. The spatial coverage for most datasets is part of the Arctic. The spatial resolution of the data is in most cases not applicable. The datasets mostly cover decades. Temporal resolution varies considerably from more than daily up to

less than yearly. Datasets mostly reflect historical conditions. There are no known datasets with a vertical resolution of > 0 (i.e. measured at certain depth or height).

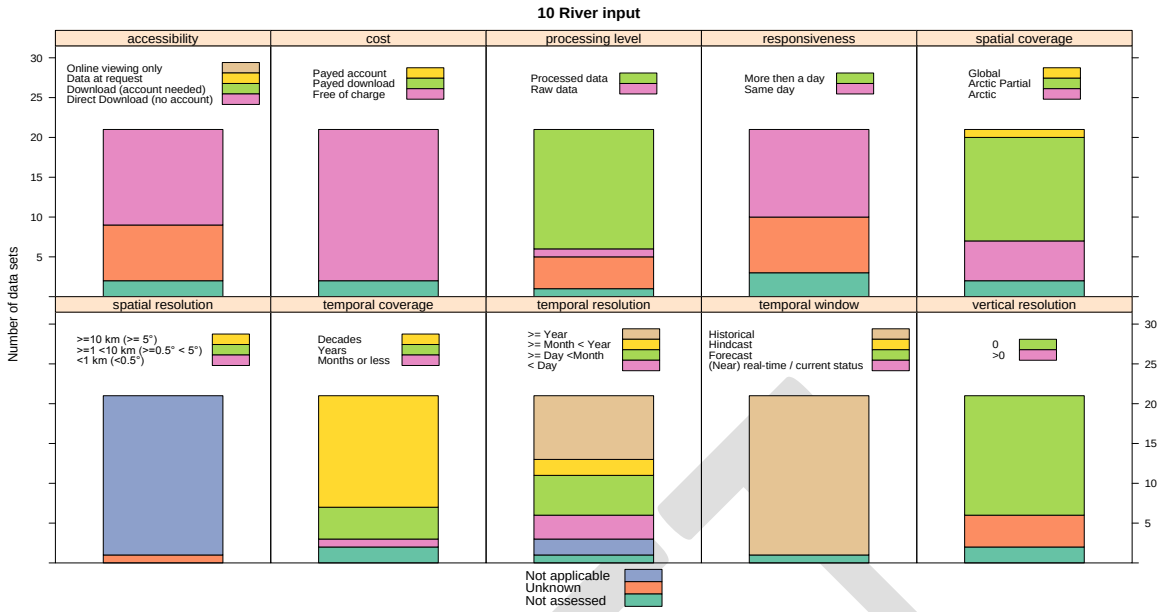

Figure 84. *Quality indicators for the datasets used and considered for use in the 'river input' challenge. Colour-codes of specific categories are presented above each indicator. Generic categories (i.e. relevant to all indicators) are presented at the bottom of this figure.*

6.9.3 Data adequacy

The adequacy indicators for the datasets used and considered for use in this challenge show that most data is adequate for use (*Figure 85*). Most datasets considered for this challenge were used. There were no budget restrictions leading to unusable data. For some datasets there were crucial time limitations. As far as known, most data formats had to be converted before use and was processed for this challenge. Spatial coverage of most datasets only partly matched the required region of the Arctic Sea Basin. There were a few datasets that fully matched the area. Spatial resolution of the datasets was not applicable. Temporal coverage of the datasets matched and the temporal resolution had a limited match or complete match. Most datasets had a limited necessity to this challenge and a substantial part was essential.

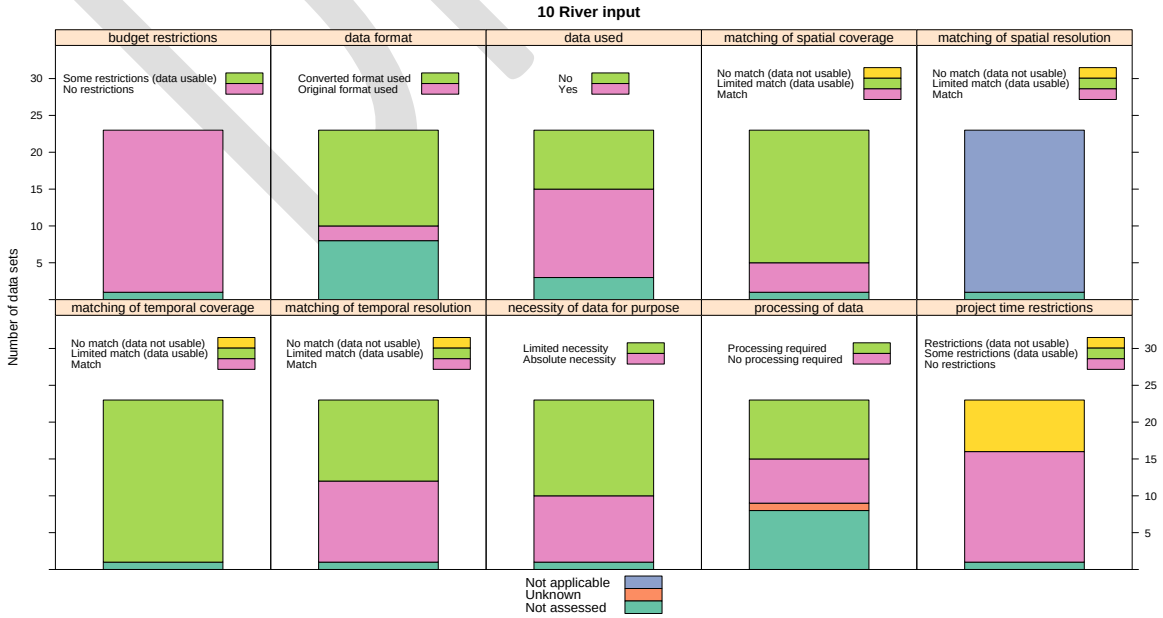

Figure 85. *Adequacy indicators for the datasets used and considered for use in the 'river input' challenge. Colour-codes of specific categories are presented above each indicator. Generic categories (i.e. relevant to all indicators) are presented at the bottom of this figure.*

6.10 Bathymetry (WP11)

6.10.1 Challenge description

The availability of reliable information on bathymetry is essential for the maintenance of navigational safety. Hydrographic survey and the publication of navigational charts is an important priority for national hydrographic agencies. This is supported by the work of local port and harbour authorities who are responsible for navigational safety within their port and harbour limits. Many coastal and estuarine areas are very dynamic as a result of prevailing coastal processes and bathymetries may change rapidly as a result of changes in seabed morphology. In such areas, up-to-date hydrographic information is very important in ensuring that vessels can access and leave ports and harbours safely. A good knowledge of navigable depths in ports and harbours is also important commercially as accessibility is a key competitive advantage, particularly as the draughts of vessels continue to increase.

Based on bathymetric data and information that are publically available, objectives of the Bathymetry Challenge, are to:

1. evaluate sea basin water depth with level of certainty, where possible;
2. Identify areas where water depths are not able to be identified with certainty, due either to a lack of bathymetric data or to the low quality of data available; and
3. Identify priority areas for further surveying to ensure safer vessel navigation, for both existing and future navigational needs.

Activities include the gathering and integration of available datasets and mapping coverages, including bathymetric and shipping data from European and national databases; EMODnet portals; SeaDataNet; Copernicus marine service; ACCESS; ICES; NOAA National Geophysical Data Center; Marine Cadastre; Geographic Information Network of Alaska; Bureau of Ocean Energy Management; USGS Alaska Geospatial Data Committee; US Coast Guard; National Weather Service; and European Marine Observation and Data Network.

In this challenge the identifications of available bathymetry datasets for the study area is discussed. After identification the datasets are requested and raw datasets are received from NOAA and USGS on the 11 August 2016.

Next step is to review the raw datasets and mapping, analyse them for data quality and continuity, and combine useable data. The combined datasets will provide a single source for available and useable data, and also identify areas where data is either not available or of an uncertain quality or unusable.

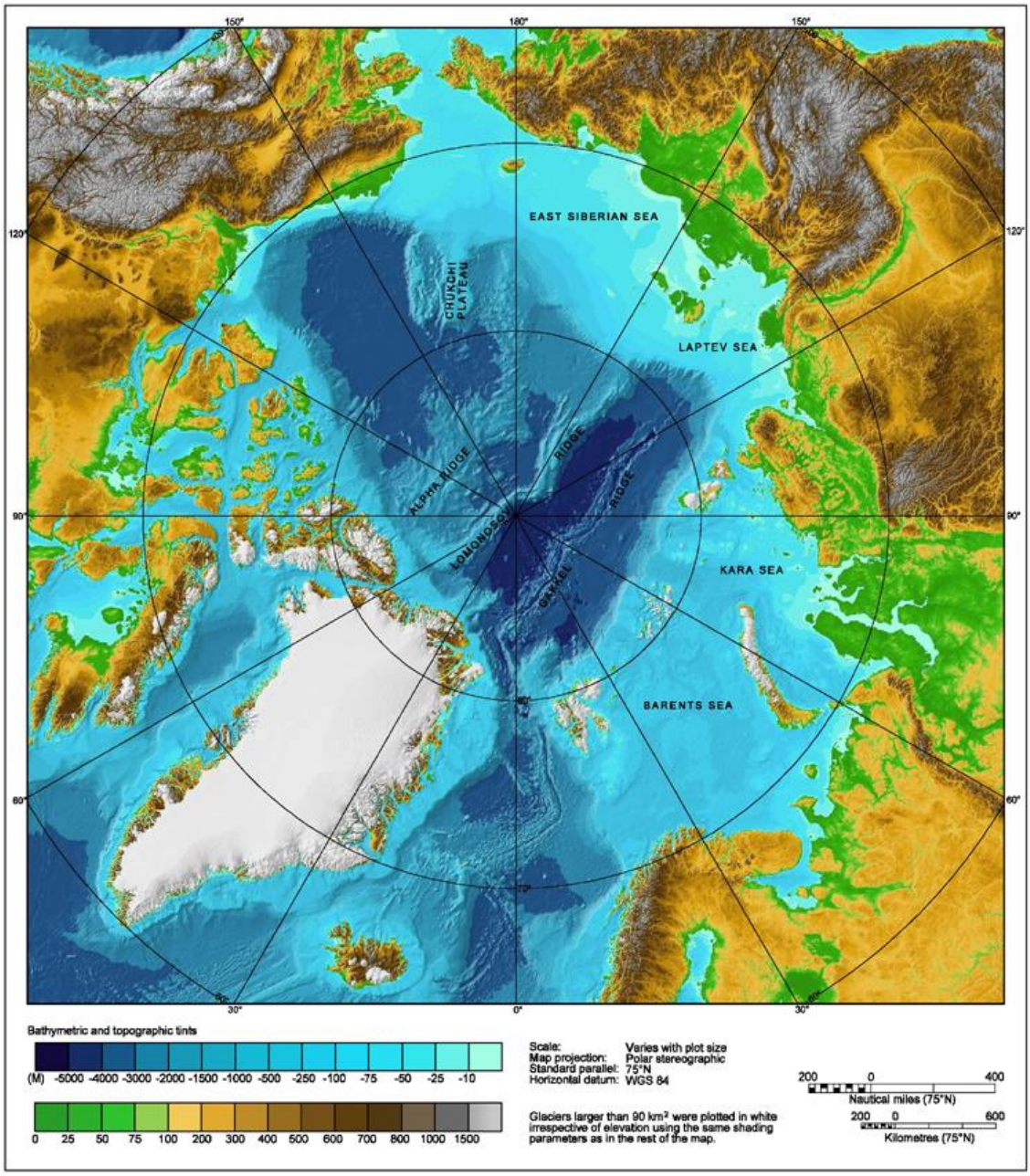

Figure 86. *Bathymetric map of the Arctic Ocean (http://www.ngdc.noaa.gov/mgg/image/IBCAO_betamap.jpg).*

6.10.2 Data quality

Figure 87 shows the quality indicators for the datasets considered for this challenge. The accessibility of the data is good as all data could be directly downloaded with no account required. All datasets were free of charge and, as far as known, available within a day. Most data formats had to be converted (processed) before use in this challenge. All datasets specifically cover (part of) the Arctic. The spatial resolution of the data is in most cases low (>10 km). The datasets mostly cover years. As far as known, temporal resolution is > year, reflecting historical conditions. There are currently no datasets listed in the CMS with a vertical resolution of > 0 (i.e. measured at multiple depths or heights).

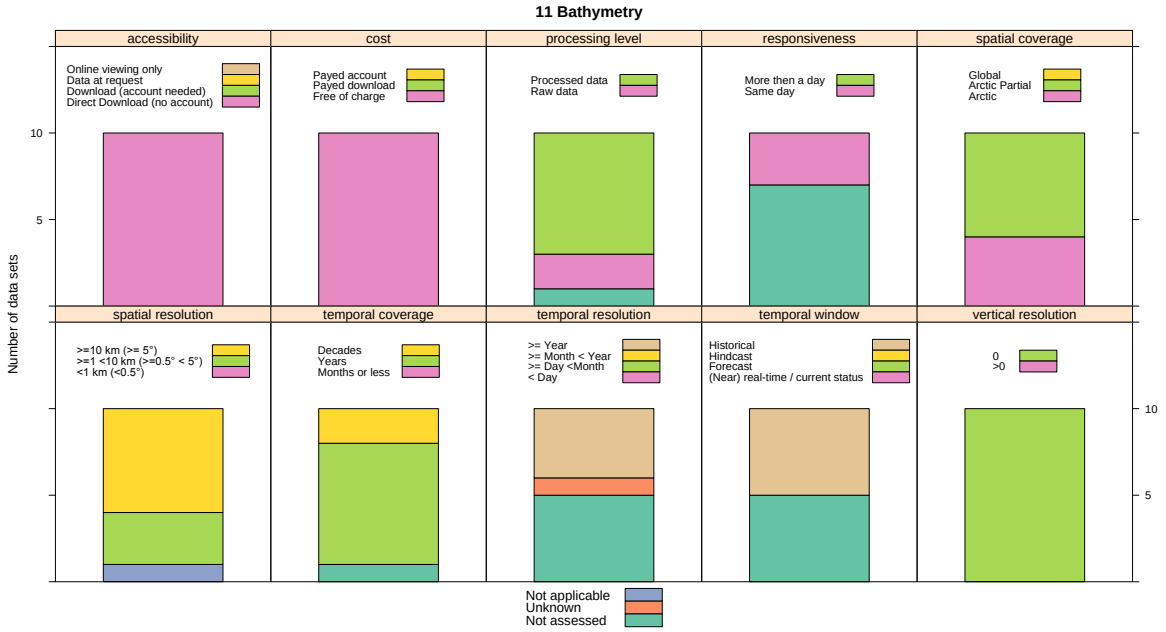

Figure 87. *Quality indicators for the datasets used and considered for use in the 'bathymetry' challenge. Colour-codes of specific categories are presented above each indicator. Generic categories (i.e. relevant to all indicators) are presented at the bottom of this figure.*

6.10.3 Data adequacy

The adequacy indicators for the datasets used and considered for use in this challenge show that most data is not yet assessed (*Figure 88*). The datasets that have been assessed for this challenge were all used. There were no budget restrictions or time limitations leading to unusable data. The data was processed for this challenge. Spatial coverage and – resolution and temporal coverage of the used datasets had a limited match. Temporal resolution of the datasets was not applicable.

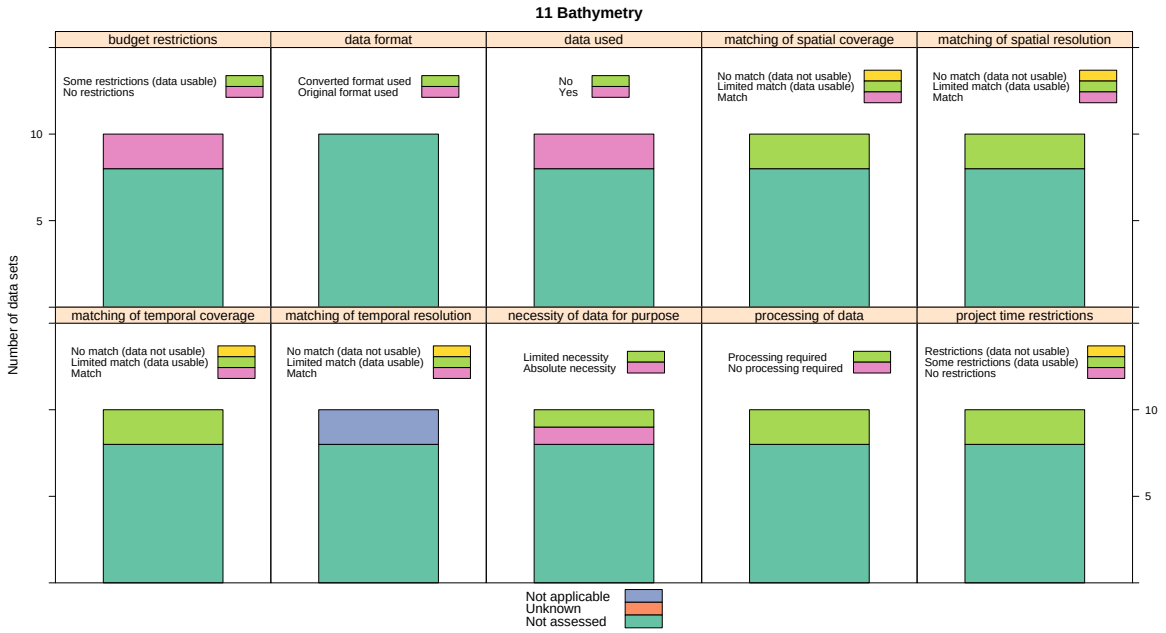

Figure 88. *Adequacy indicators for the datasets used and considered for use in the 'bathymetry' challenge. Colour-codes of specific categories are presented above each indicator. Generic categories (i.e. relevant to all indicators) are presented at the bottom of this figure.*

6.11 Alien species (WP12)

6.11.1 Challenge description

The Alien Species Challenge provides information on the distribution, introduction and impacts of alien species on the ecosystem and economy of the Arctic. Desired information on alien species includes taxonomy, geography, introduced range and year of introduction, life history details, vector or reason for introduction and impacts. Maps will be constructed showing the origin and/or introduction of species within the Arctic, in case this information was available.
From the search for information from databases, it appeared that there is no actual or complete list on Arctic alien species available. Therefore, scientific literature was consulted to construct a list of species, which now accounts 94 species (58 crustaceans, 13 algae, 9 Chordata, 14 others). Required information for these species is being looked up in databases. For well-known invasive species compiled information could be found that was relevant for this challenge, however, for many species information could not be found, or was only partly available. Most databases that deal with alien species do not include the Arctic region, whereas databases that concern the Arctic region, do not, or only partly cover the species identified to be alien.

An Excel table of invasive species in the Arctic is constructed including the following information: Group, Scientific Name, Common name, Year first record, Region First record, Arctic region, Vector, Pathway, Invasive, References (incl. AphiaID), Match type, occurrence in Marine, Brackish and/or Freshwater environment. The table below gives an overview of the species in the Excel table.

Table 6 Overview of invasive species in the Arctic

Group	Scientific Name	Year first record	Region First record	Arctic region	Pathway
Algae	*Ceramium sinicola*			Alaska (Prince William Sound)	
Macroalgae	*Codium fragile*	1974	Southwest Iceland		Shipping
Marcoalgae	*Caulacanthus ustulatus*			Alaska (Hogg Bay, Prince William Sound)	
Marcoalgae	*Chroodactylon ornatum*			Alaska (Prince William Sound)	
Marcoalgae	*Dumontia contorta*			Canada (James Bay and Ellesmere and Baffin Islands)	
Marcoalgae	*Fucus cottonii*			Alaska (Prince William Sound)	
Marcoalgae	*Fucus serratus*	1900	Southwest Iceland	Iceland, Faroe Islands, and Norway	Shipping
Marcoalgae	*Microspongium globosum*			Alaska (Prince William Sound)	
Marcoalgae	*Sargassum muticum*			Alaska (Puget Sound), SE Alaska	
Phytoplankton	*Heterosigma akashiwo*	1987	Southwest Iceland		Shipping
Phytoplankton	*Mediopyxis helysia*	2007	West Iceland		Shipping
Phytoplankton	*Neodenticula seminae*	2002	North Iceland	Iceland, Nordic seas	Currents
Phytoplankton	*Stephanopyxis turris*	1997	Southwest Iceland		Shipping
Bryozoa	*Schizoporella unicornis*			Alaska (Kodiak, Valdez and Tatilek in Prince William Sound, Ketchikan, and Sitka)	
Fish	*Acanthogobius flavimanus*			Alaska (Port Valdez)	
Fish	*Dallia pectoralis*			Alaska (Anchorage; FW)	
Fish	*Esox lucius*			Alaska (Anchorage; FW)	
Fish	*Oncorhynchus mykiss*	1983	Southwest Iceland		Aquaculture
Fish	*Platichtys flesus*	1999	Southwest Iceland	Iceland	Shipping/ currents
Fish	*Salvelinus fontinalis*			SE Alaska	
Tunicata	*Botrylloides schlosseri*			Alaska (Sitka Sound and Puget Sound)	
Tunicata	*Botrylloides violaceus*			Alaska (Tatilek in Prince William Sound, Ketchikan, Sitka, and in Kachemak Bay	
Tunicata	*Ciona intestinalis*	2007	Southwest Iceland	Straumsvík, SW Iceland	Shipping
Amphipoda	*Ampelisca abdita*			Alaska (Port Valdez)	
Amphipoda	*Crassicorophium*			Canada (Port of Churchill)	

Group	Scientific Name	Year first record	Region First record	Arctic region	Pathway
	bonellii				
Amphipoda	*Gammarus cf. tigrinus*			Svalbard	
Amphipoda	*Gammarus cf. zaddachi*			Svalbard	
Amphipoda	*Gammarus daiberi*			Alaska (Port Valdez)	
Amphipoda	*Grandidierella japonica*			Alaska (Port Valdez)	
Amphipoda	*Jassa marmorata*			Canada (Port of Churchill)	Shipping
Amphipoda	*Monocorophium acherusicum*			Alaska (Port Valdez)	
Amphipoda	*Sinocorophium heteroceratum*			Alaska (Port Valdez)	
Cirripedia	*Amphibalanus amphitrite*			Canada (Port of Churchill)	
Cirripedia	*Amphibalanus eburneus*			Canada (Port of Churchill)	
Cirripedia	*Amphibalanus improvisus*			Canada (Port of Churchill) for HF and Svalbard for BW	
Cirripedia	*Amphibalanus reticulatus*			Canada (Port of Churchill)	
Cirripedia	*Austrominius modestus*			Canada (Port of Churchill) (HF) and Svalbard (BW)	
Cirripedia	*Balanus trigonus*			Canada (Port of Churchill)	
Cirripedia	*Conchoderma virgatum*			Canada (Port of Churchill)	
Cirripedia	*Megabalanus cf. spinosus*			Canada (Port of Churchill)	
Cirripedia	*Megabalanus cf. tintinnabulum*			Canada (Port of Churchill)	
Cirripedia	*Megabalanus coccopoma*			Canada (Port of Churchill)	
Cladocera	*Acantholeberis curvirostris*			Canada (Port of Churchill)	
Cladocera	*Evadne nordmanni*			Svalbard	
Cladocera	*Podon leuckartii*			Svalbard	
Copepoda	*Acartia clausii*			Svalbard	
Copepoda	*Acartia tonsa*			Svalbard	
Copepoda	*Acartiella sinensis*			Alaska (Port Valdez)	
Copepoda	*Anomalocera patersoni*			Svalbard	
Copepoda	*Calanus helgolandicus*			Svalbard	
Copepoda	*Centropages hamatus*			Svalbard	
Copepoda	*Centropages typicus*			Canada (Port of Churchill), Svalbard	
Copepoda	*Eurytemora affinis*			Svalbard	
Copepoda	*Heterolaophonte ströemi*			Canada (Port of Churchill)	
Copepoda	*Isias clavipes*			Svalbard	
Copepoda	*Limnoithona tetraspina*			Alaska (Port Valdez)	
Copepoda	*Metridia lucens*			Svalbard	
Copepoda	*Nitokra lacustris*			Canada (Port of Churchill)	
Copepoda	*Oithona davisae*			Alaska (Port Valdez)	
Copepoda	*Parapontella brevicornis*			Svalbard	
Copepoda	*Paronychocamptus huntsmani*			Canada (Port of Churchill)	
Copepoda	*Pseudodiaptimus forbesi*			Alaska (Port Valdez)	
Copepoda	*Pseudodiaptimus marinus*			Alaska (Port Valdez)	
Copepoda	*Schizopera clandestina?*			Canada (Port of Churchill)	
Copepoda	*Sinocalanus doerrii*			Alaska (Port Valdez)	
Copepoda	*Temora longicornis*			Svalbard	
Copepoda	*Tortanus dextrilobatus*			Alaska (Port Valdez)	
Crustacea	*Caprella mutica*			Alaska (SE Alaska and Aleutian Islands)	
Crustacea	*Chionoecetes opilio*			Barents Sea (Russia, Norway, and Svalbard)	
Crustacea	*Paralithodes camtschaticus*			Barents Sea (Russia and Norway)	

Group	Scientific Name	Year first record	Region First record	Arctic region	Pathway
Decapoda	*Cancer irroratus*	2006	Southwest Iceland	SW and W coasts of Iceland	Shipping
Decapoda	*Cancer pagarus*			Svalbard	
Decapoda	*Carcinus maenas*			Svalbard	
Decapoda	*Crangon crangon*	2003	Southwest Iceland	S, W, and SE coasts of Iceland, Svalbard	Shipping/ Currents
Decapoda	*Hemigrapsus takanoi*			Svalbard	
Isopoda	*Eurydice pulchra*			Svalbard	
Isopoda	*Idotea linearis*			Svalbard	
Macroalgae	*Bonnemaisonia hamifera*	1978	Northwest Iceland		Shipping
Mysida	*Acanthomysis bowmani*			Alaska (Port Valdez)	
Mysida	*Mesopodopsis slabberi*			Svalbard	
Nematoda	*Axonolaimidae*			Canada (Port of Churchill)	
Foraminiferan	*Trochammina hadai*			Alaska (Prince William Sound)	
Hydroid	*Garveia franciscana*			Alaska (Homer)	
Mollusc	*Cerastoderma edule*	1948	Southwest Iceland	West coast of Iceland	Shipping
Mollusc	*Mya arenaria*	1958	Southeast Iceland	Alaska (Kodiak, Yukon-Kuskokwim delta, Prince William Sound, and Puget Sound), Iceland	Shipping
Nematoda	*Ascolaimus sp.*			Canada (Port of Churchill)	
Nematoda	*Daptonema tenuispiculum*			Canada (Port of Churchill)	
Nematoda	*Geomonhystera sp.*			Canada (Port of Churchill)	
Nematoda	*Prochromadora orleji*			Canada (Port of Churchill)	
Plant	*Cotula coronopifolia*			Alaska	
Polychaeta	*Heteromastus filiformis*			Alaska (Valdez)	
Polychaeta	*Scolelepis sp.*			Svalbard	
Polychaeta	*Spiophanes kroeyeri*			Svalbard	
Sponge	*Cliona thoosina*			Alaska (Prince William Sound and Kachemak Bay)	

For each species, information as described above should be provided. As an example, information is shown below for the species *Jassa marmorata.*

Example: Jassa marmorata

Primary transport vectors

In natural conditions *Jassa marmorata* only partakes in short-distance dispersal during its juvenile stage. Adults, once settled into an area, tend to remain a local invasive species at the site of inoculation. Ship hull fouling and ballast water are the two main transport vectors associated with dispersal of *Jassa marmorata*.

- Ship hull fouling: A possible explanation for why this transport vector is associated with the spread of *Jassa marmorata* is the preferred habitat characteristics of a fouling community. Fouling communities attach themselves to hard surfaces in the upper 5 meters of the water column. Preferably with a continuous flow of water that provides inflow of food. This makes the hull of a ship an ideal location for *Jassa marmorata* to settle.
- Ballast water: Many *Jassa marmorata* habitats can be found in harbours. The ships in these harbours take up ballast water and can unintentionally take up juvenile *Jassa* into the ballast tank. When they then discharge the ballast water upon arrival at the other harbour the non-native species is introduced into the area. Crustacea are the most successful phylum for introduction in marine systems due to several distinct characteristics that they have. Their small size, morphology, and tolerance for wide ranges in salinity and temperature enhance their ability to survive introduction into new areas. In addition to this, their exoskeleton increases their chances of surviving the pressures caused by the uptake and transport of the ballast water.

Invasion history of the Arctic Ocean

Kröncke conducted a maritime expedition in 1991 to assess the macrobenthos composition, abundance and biomass in the Arctic Ocean; the dataset contains a total number of 61 occurrences of *Jassa marmorata* within the Arctic Ocean (*Figure 89*). However, concerns have been raised regarding the reliability of the data submitted by Kröncke from the maritime expedition of 1991. During the expedition macrofauna was sampled at 30 stations, at depths of 1018-4478 m. A total of 42 species were found, of which *Jassa marmorata* was the most common species. However, Russian colleagues of Kröncke have remarked that it is highly unlikely that *Jassa marmorata* was found in such deep water because it is not in accordance with their general habitat preference. They have proposed a more probable cause for the high number of *Jassa marmorata* occurrences, which is that the species had (perhaps beforehand) taken up residence inside the rinsing water pump system of the Polarstern (the German polar research vessel used by Kröncke during the expedition. The equipment used on the boat may have been "contaminated" with *Jassa marmorata*, and could have affected the outcome of the measurements, making it impossible to verify the accuracy of the data.

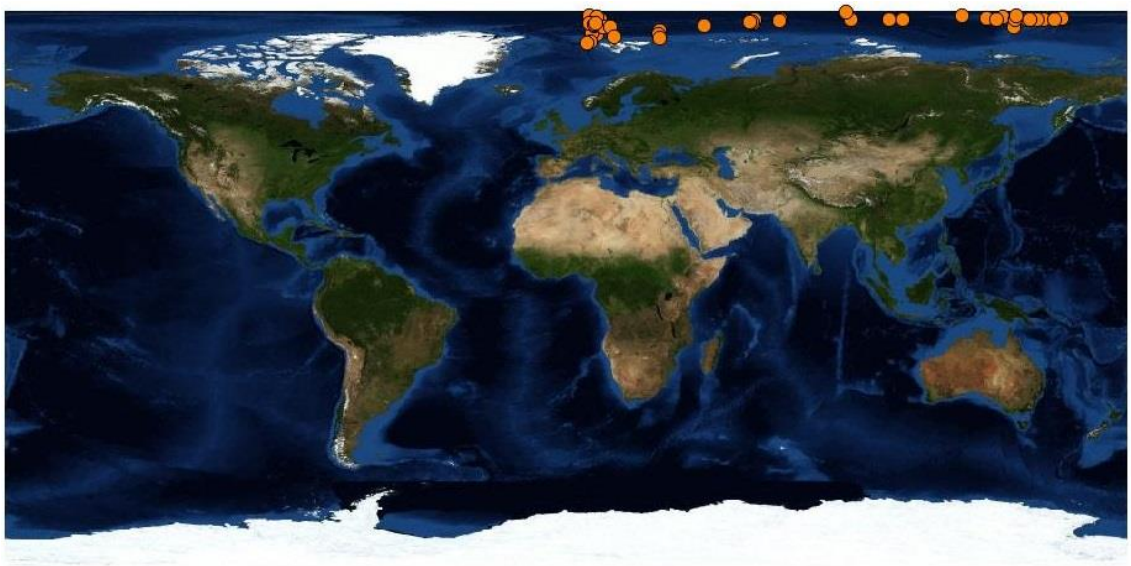

Figure 89 *The occurrences of Jassa marmorata in the Arctic Ocean (Kröncke, 1994). Map from: GBIF Occurrence Download (www.gbif.org).*

6.11.2 Data quality

Figure 87 shows the quality indicators for the datasets considered for this challenge. The accessibility of the data is good as nearly all data could be directly downloaded with no account required. All datasets were free of charge and, as far as known, available within a day. Some data formats had to be converted (processed) before use in this challenge, but mostly raw data was used. Spatial coverage ranges from (part of) the Arctic to global coverage. The spatial resolution of the data is in most cases low (>10 km). As far as known, the temporal coverage is years or decades, temporal resolution is > year or not applicable and the temporal window either real time/current status or historical. There are a few datasets with a vertical resolution of > 0 (i.e. measured at certain depth or height).

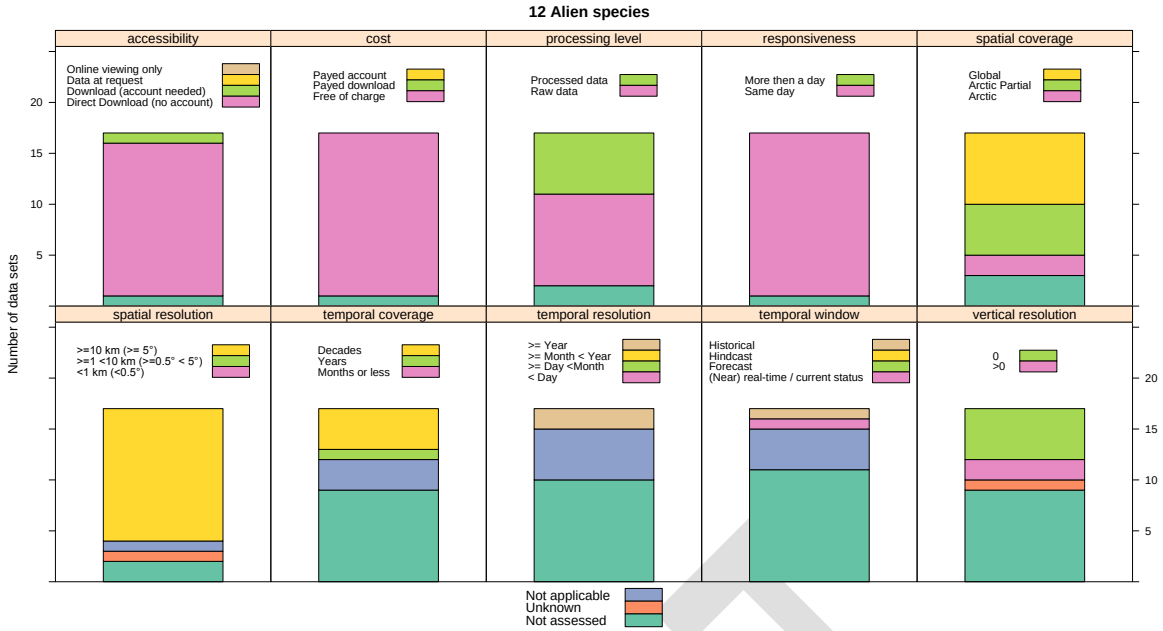

Figure 90. *Quality indicators for the datasets used and considered for use in the 'alien species' challenge. Colour-codes of specific categories are presented above each indicator. Generic categories (i.e. relevant to all indicators) are presented at the bottom of this figure.*

6.11.3 Data adequacy

The adequacy indicators for the datasets used and considered for use in this challenge show that most data is adequate for use (*Figure 91*). Note that many datasets were not yet assessed. Most datasets assessed and considered for this challenge were used. There were no budget restrictions or time limitations to the assessed datasets. As far as known, original data formats were used and most data was processed for this challenge. Spatial and temporal coverage and – resolution of the datasets varies greatly. There are datasets in the CMS used for this challenge that partly match the required region of the Arctic Sea Basin, fully match the area, or did not match at all. Temporal coverage and – resolution is limited for some datasets but did not lead to unusable data. For some datasets these indicators are not applicable. Most datasets had a limited necessity to this challenge.

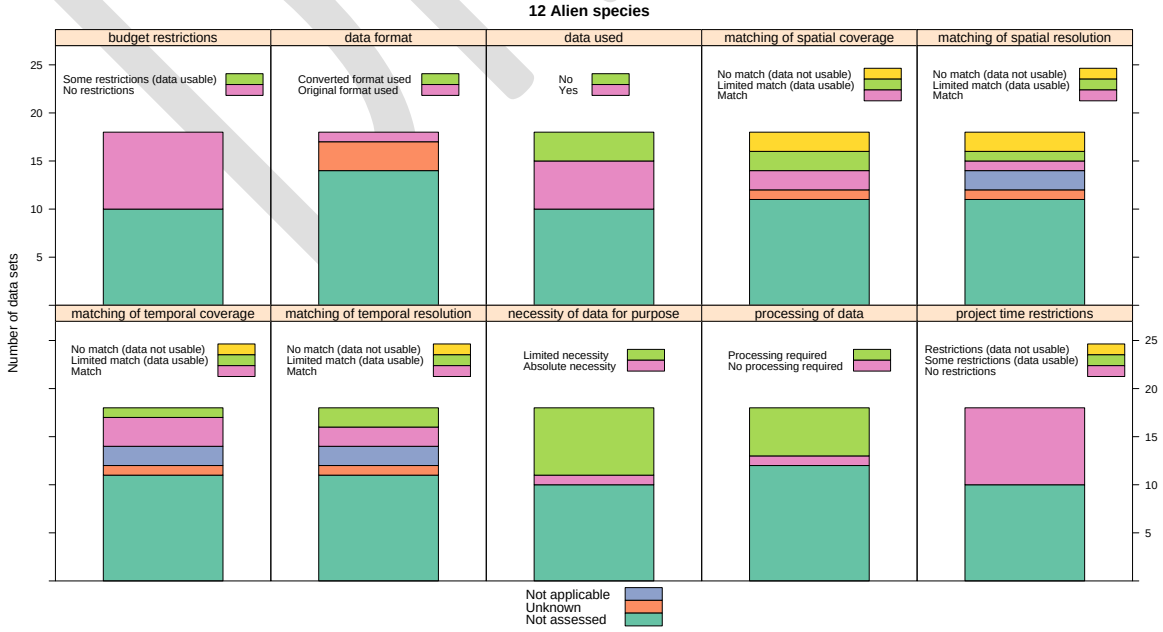

Figure 91. *Adequacy indicators for the datasets used and considered for use in the 'alien species' challenge. Colour-codes of specific categories are presented above each indicator. Generic categories (i.e. relevant to all indicators) are presented at the bottom of this figure.*

6.12 New information

This first DAR includes the information provided by the outcome of the challenges (September 2016), as described in the sections above. For the updated version of the DAR (i.e. the second DAR), which is to be delivered 20 months after this first version, any new and relevant information will be taken into account. This will at least include the feedback and comments of the Commission and the Panel and updates from each of the challenges.

7 General findings based on CMS

7.1 Introduction

This chapter describes some generic findings based on the information in the CMS from both the challenges (Chapter 6) and the literature review (Chapter 4). It will cover overarching aspects that are not dealt with in the remaining chapters of the DAR, namely: data usage (how often is data used), a case study on the quality versus adequacy of specific indicators and how the original purpose of a dataset relates to the additional purposes for which it is used.

7.2 Dataset usage

The usage of a dataset can be considered as an indicator for 'popularity'. Assuming that adequate datasets are (re)used more often than less adequate datasets, usage can also be used as a proxy for adequacy in addition to the indicators presented before (Annex 2).

Figure 92 shows to how many assessment reports datasets are linked in the CMS, in other words, how often the dataset is (considered to be) used. It shows that some datasets (n = 24) listed in the CMS are currently not used by any of the assessment reports listed (and assessed) in the CMS. Most datasets (n = 170) are only used once. There are quite a few datasets that are used twice (n = 36) and only a handful that are used even three times (n = 4). The datasets that are used three times are: taxonomical data (World Register of Marine Species), World Database of Protected Areas, Arctic Register of Marine Species (MarBEF) and river flow (R-ArcticNet).

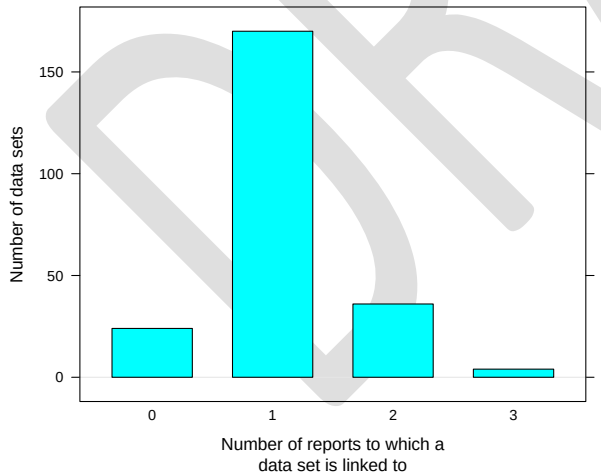

Figure 92. *Number of reports to which datasets are linked in the CMS. Just over 50 datasets are not linked to an assessment report. Most datasets are linked to only one assessment report, a few dozen to two reports, and only a handful is linked to three reports. There are no datasets that are linked to more than three assessment reports.*

The usage of datasets can also be studied at the level of the data source, giving an indication of 'popular' data sources. The CMS does not allow for hierarchical data source information. For instance, the United States Geological Survey Water Quality and United States Geological Survey Bathymetric Maps are both listed as separate data sources, whereas they could also be considered to be two branches of the same data source. Keeping this nuance in mind, *Figure 93* shows the number of times datasets from specific sources are linked to an assessment report (note that each data source could

hold multiple datasets and that each dataset can be linked to multiple assessment reports). Copernicus, DataBasin.org and Arctic-GRO are the top three data sources with respect to data usage in studies related to the Arctic that are evaluated here.

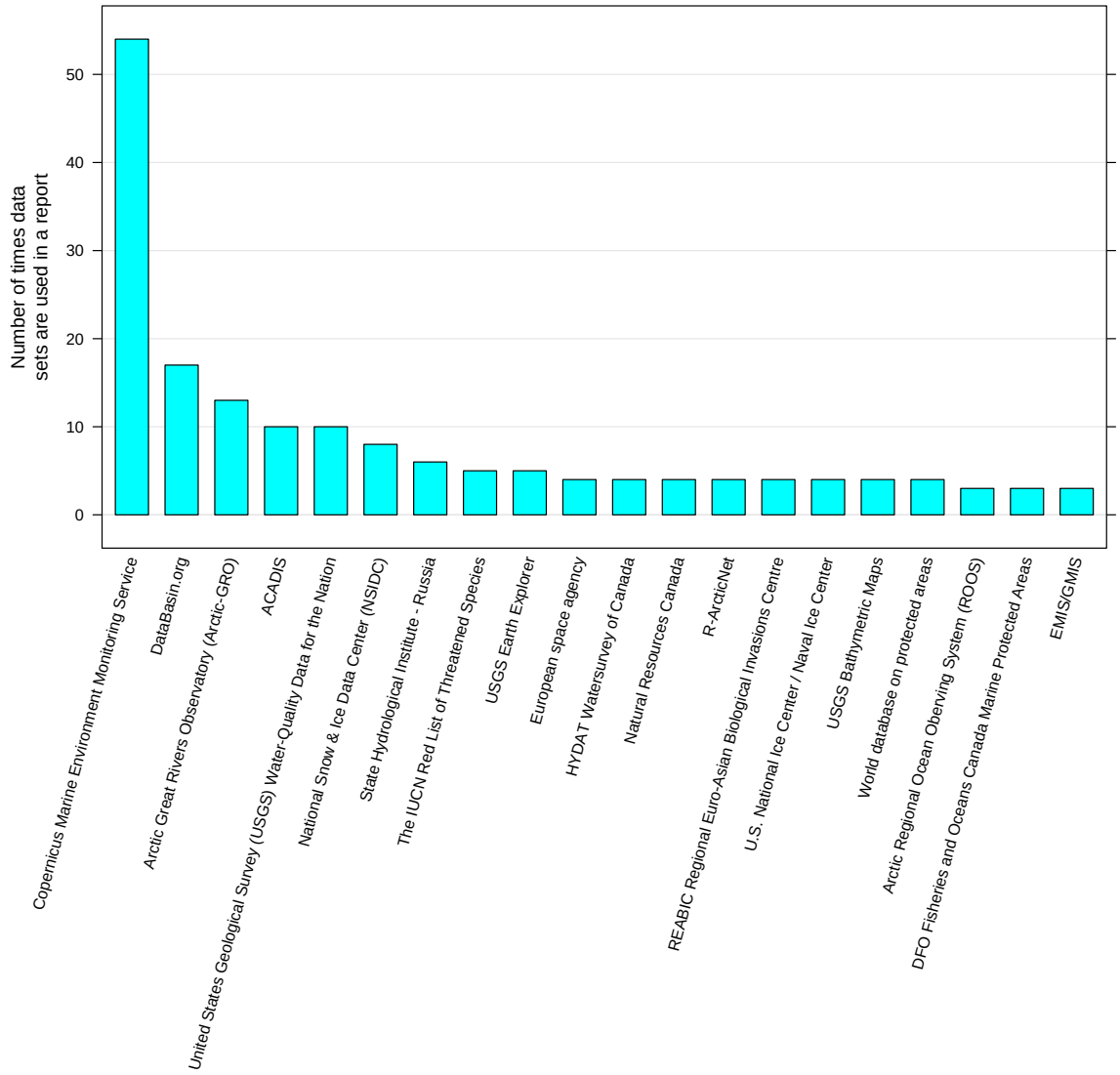

Figure 93. *Number of times datasets are used / considered for use in an assessment report, reported per data source (Note that each source could hold multiple datasets). An indication of the popularity of data sources in the evaluated assessment reports. Only the top 20 data sources are listed.*

7.3 Spatial and temporal quality versus adequacy

Spatial and temporal aspects of datasets are one of the few aspects for which both the quality of data is described and the adequacy assessed. We have therefore a unique opportunity to directly compare quality and the adequacy of spatial and temporal aspects of the datasets evaluated in the project at hand. These and other aspects of adequacy will be presented and discussed in more detail in the following chapters, where they will be specified per WP, per user type, per parameter and per purpose.

Quality is assessed for both the coverage (extent) and the resolution in space and time. The resolution is used in the current project as a proxy for accuracy as well, assuming that the resolution will be

associated with the accuracy (i.e., data will not be presented in a higher resolution when the accuracy does not allow for this).

In many cases spatial coverage is either not applicable or unknown and in some cases not assessed, which is illustrated by the lower-left quadrant of the matrix shown in *Figure 94*. The top-right quadrant is the most informative in *Figure 94* as this shows the relation between the spatial coverage of data and its usability. Only a small number of datasets the spatial coverage does not match with the requirements of the assessment report; this is apparently the case when data only partially covers the Arctic. The data that best matches the assessment report has the lowest fraction of data that only covers the Arctic partially (and thus relatively more data that covers the Arctic or the entire globe) (*Figure 94*).

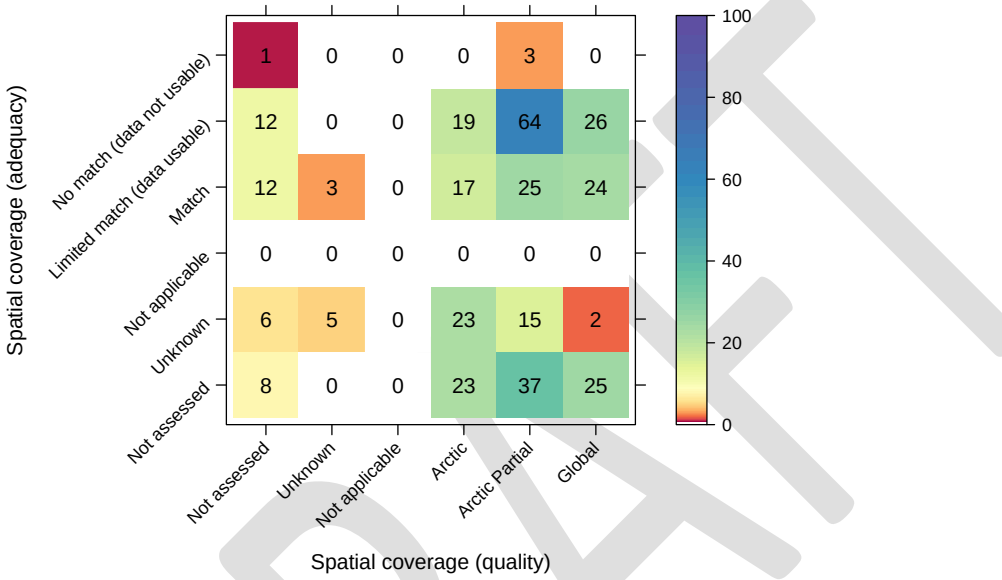

Figure 94. *Relation between the quality and adequacy of spatial coverage. Numbers are number of adequacy evaluations (there are multiple datasets, each of which can be evaluated for adequacy multiple times).*

In many cases spatial resolution is either not applicable or unknown and in some cases not assessed, which is illustrated by the lower-left quadrant of the matrix shown in *Figure 95*. The top-right quadrant is the most informative in *Figure 95* as this shows the relation between the spatial resolution of data and its usability. In most cases there is a limited match between the required and available resolution: in other words, the resolution is not ideal but can be worked with. In some cases there is a match where the resolution is sufficient for the purpose for which it is used. In only a few cases (n = 7) the resolution is not sufficient. Analysing the top-right quadrant (a 3x3 matrix) with Fisher's Exact test for count data, we find that the resolution quality is associated with its adequacy (the higher the resolution the more likely it is adequate).

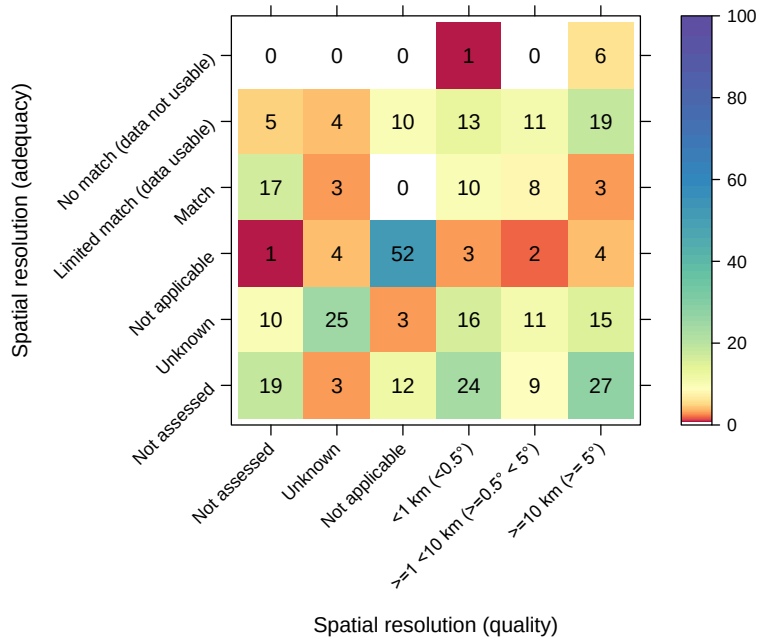

Figure 95. *Relation between the quality and adequacy of spatial resolution. Numbers are number of adequacy evaluations (there are multiple datasets, each of which can be evaluated for adequacy multiple times).*

In many cases temporal resolution is either not applicable or unknown and in some cases not assessed, which is illustrated by the lower-left quadrant of the matrix shown in *Figure 96*. The top-right quadrant is the most informative in *Figure 96* as this shows the relation between the temporal coverage of data and its usability. This quadrant shows that there are only a small number of datasets that cover only period of time of multiple months or less, which only gives a limited match with the needs expressed in the assessment reports in which they are used. A large number of datasets covers a period of years and slightly less datasets cover a period of multiple decades. There is no clear distinction between the datasets that cover a period of years when compared to those covering decades with respect to adequacy. However, this does not mean that there is no association between the purpose for which data is used and the required temporal coverage.

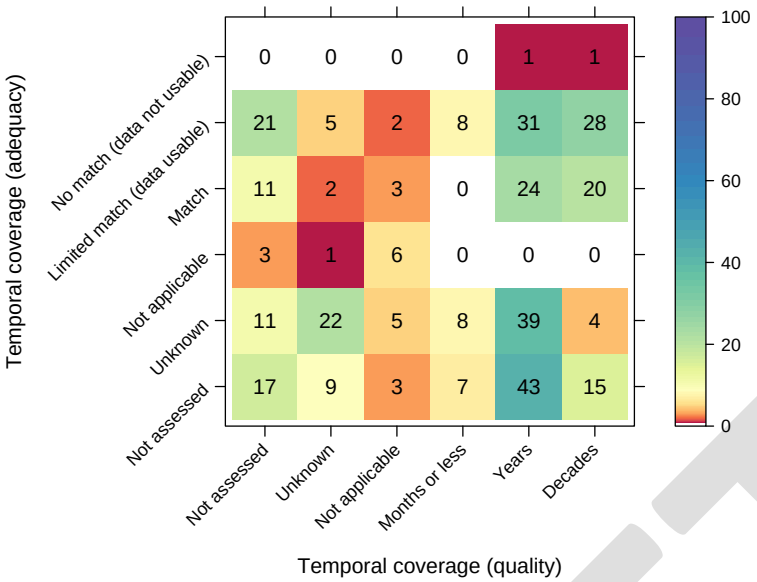

Figure 96. *Relation between the quality and adequacy of temporal coverage. Numbers are number of adequacy evaluations (there are multiple datasets, each of which can be evaluated for adequacy multiple times).*

In many cases temporal resolution is either not applicable or unknown and in some cases not assessed, which is illustrated by the lower-left quadrant of the matrix (3x3) shown in *Figure 97*. The top-right quadrant (4x3) is the most informative in *Figure 97* as this shows the relation between the temporal resolution of data and its usability. It would appear that temporal resolution is generally not an issue for most datasets, as there is mostly a (limited) match with the data requirements. There is no association between the resolution quality and adequacy found with Fisher's Exact test for count data on the top right quadrant (4x3) of *Figure 97*. This does not mean that there is no association between the purpose and temporal resolution requirements.

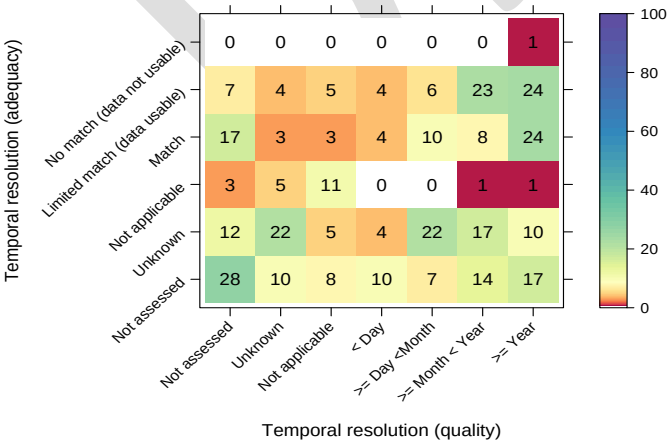

Figure 97. *Relation between the quality and adequacy of temporal resolution. Numbers are number of adequacy evaluations (there are multiple datasets, each of which can be evaluated for adequacy multiple times).*

7.4 Original versus additional purpose

One of the objectives of the project at hand is to evaluate whether data can and is being reused, particularly for multiple purposes. Therefore, for each dataset the original purpose(s) was/were logged (i.e., the purpose for which the dataset was generated) in the CMS. These purposes are selected from a predefined list, where the purposes are closely related (but not identical) to the challenges specified for the project at hand. For each assessment report we logged the additional purpose(s) (the purpose of the assessment described in the report). For each dataset link to such an assessment report, we can now compare its original purpose with its additional purpose.

Information on the original and additional purpose is aggregated from the CMS and illustrated in *Figure 98*. This 'heatmap' shows that for many datasets the original purpose is unknown. This is because many data sources don't indicate with what purpose the datasets are generated. There is also a small number of datasets for which the original purpose is not yet assessed. *Figure 98* furthermore shows high numbers diagonally, indicating that many datasets are used for the same purpose as for which they were generated. There are several additional purposes that use datasets that were generated with a multitude of other original purposes; most notable are the additional purposes 'oil spill response', 'marine spatial planning' and 'assessment of climate change'. Not surprisingly, there is also a large overlap between the original and additional purposes 'assessment of stocks' and 'fisheries management'.

There are also datasets that are hardly reused for different purposes (*Figure 98*). Most notable are datasets generated with the original purposes 'assessment of coastal evolvement', 'assessment of riverine input' and 'marine spatial planning' (these are only reused for the same or at most one more additional purpose).

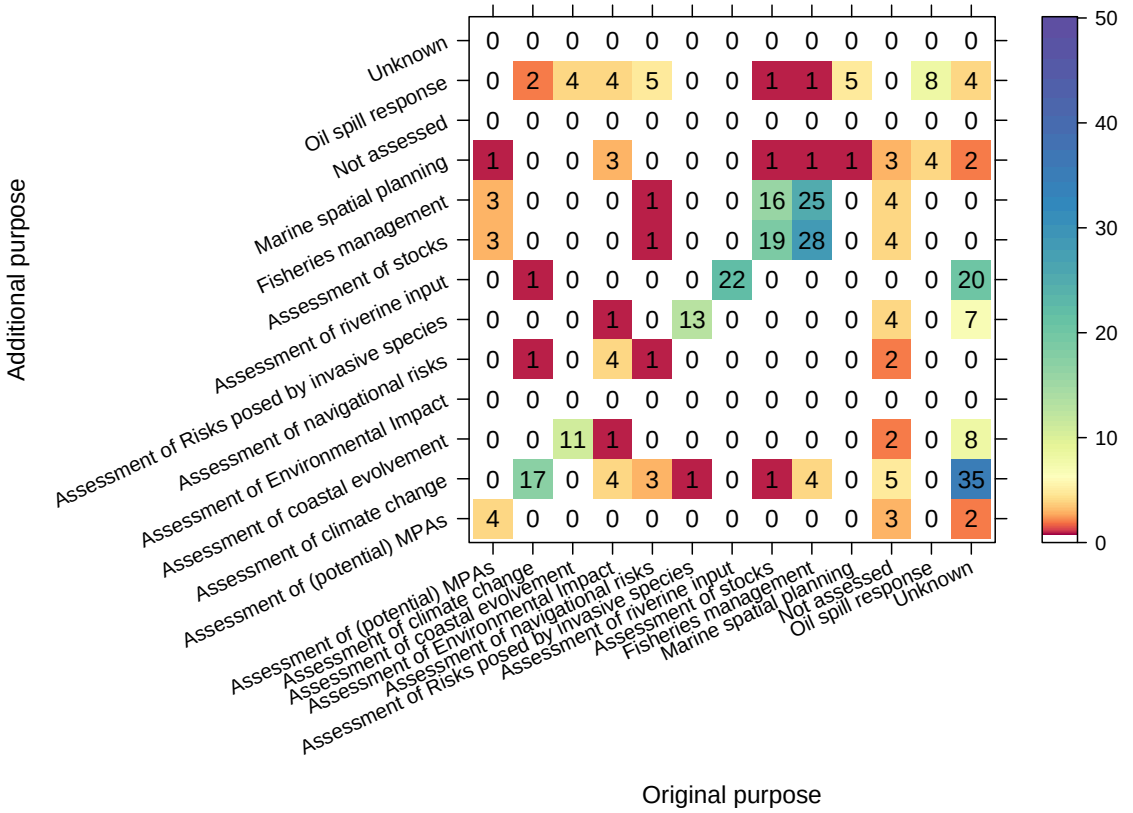

Figure 98. *Original purpose (purpose for which a dataset was generated) versus additional purpose (purpose for which a dataset was used). Numbers are number of datasets (note that each dataset can have multiple original and multiple additional purposes).*

Part 1: Users

8 Data adequacy in the Arctic sea basin from a user's perspective

8.1 Introduction

This chapter describes the data adequacy from a user's perspective. It provides a view of the monitoring effort in the Arctic sea basin, looking at the needs of user types - fisheries managers, coastal protection authorities, national authorities responsible for MSFD, ports, shipping, offshore energy exploration, pipeline laying etc. The next two chapters will look at the same but from either a parameters perspective (temperature, bathymetry, sea level rise etc.) or purpose perspective (marine spatial planning, oil spill response, etc.).

Section 5.2.6 explains in detail how adequacy is evaluated for specific datasets used in specific assessment reports for specific indicators (see also Annex 2) and how they are presented in bar plots. This chapter aggregates the adequacy assessment at the level of data user types. As user types are not explicitly registered in the CMS, a linkage table between user types and 'additional purpose' (where the latter is registered in the CMS) is needed. The following section of this chapter (8.2) describes how this linkage table was derived and how it was used. The next section (8.3) will discuss each adequacy indicator which is specified per user type.

8.2 Linking the data quality and adequacy to users

The results of the literature review and challenges provide information on the data adequacy per purpose (see Section 5.2.6). These results are used in this chapter, focussing on the needs of user types. Therefore the purposes need to be linked to the need of the users. First, a list of user types is defined. Then these user types are linked to the purposes in a contingency table (Table 7) based on input from the experts from each of the challenges. Only direct strong links are marked with an 'X'. Based on this table information the data adequacy is aggregated to the level of user types. For each user type, this is done by selecting the data adequacy evaluations of the assessment reports for which at least one of its additional purposes matches with that of the selected user type in the table below.

Table 7. Linkages between user types and purpose, as used for the presentation of data adequacy for user types.

Users \ Purpose	Assessment of Environmental	Marine spatial planning	Assessment of (potential) MPAs	Oil spill response	Assessment of climate change	Assessment of coastal evolvement	Fisheries management	Assessment of stocks	Assessment of riverine input	Assessment of navigational risks	Assessment of Risks posed by invasive	
Fisheries managers	X	X	X		X		X	X			X	
Fishing industry	X	X	X		X		X	X		X	X	
Coastal protection authorities		X		X	X	X			X			
National auth. responsible for MSDF	X	X	X					X	X		X	
Port authorities	X	X		X	X				X	X	X	
Shipping owners	X	X		X	X				X	X	X	
Offshore renewable energy sector	X	X	X									
Oil and gas industry	X	X	X	X								
Pipeline laying / trenching industry	X	X	X									
Cable laying industry	X	X	X									
Consultants / engineers	X	X	X	X	X	X	X	X	X	X	X	
Researchers / scientists	X	X	X	X	X	X	X	X	X	X	X	
Nature and conservation organisations	X	X	X	X	X		X	X	X		X	
Tourism industry	X	X	X		X					X		
Arctic indigenous people	X	X	X		X	X	X	X			X	

8.3 Adequacy assessment results

Adequacy is presented per indicator in bar plots below:

- 'budget restrictions' *Figure 99*
- 'data format' *Figure 100*
- 'data used' *Figure 101*
- 'matching of spatial coverage' *Figure 102*
- 'matching of spatial resolution' *Figure 103*
- 'matching of temporal coverage' *Figure 104*
- 'matching of temporal resolution' *Figure 105*
- 'necessity of data for purpose' *Figure 106*
- 'processing of data' *Figure 107*
- 'project time restrictions' *Figure 108*

A general observation for all indicators is that there is little variation in how the scores are distributed for each user type. This is probably because for each user type dataset evaluation for multiple purposes has been selected (see Table 7). Although adequacy scores per purpose is considerably more variable (see Chapter 10), this is apparently levelled out when multiple purposes are combined (as is done for the user types). This is partly the result of the method used here for aggregating information per user type, but also makes sense as it can be expected that data adequacy is much more dictated by the requirements of a specific purpose, rather than the user that uses the data for this purpose.

Another general observation is that the bar height in the bar plots are highly variable amongst the user types. This variance cannot be explained by the number of linkages in Table 7. Instead it is the result of a combination of factors: the variance in the amount of available literature written with specific purposes; variance in the number of datasets (considered to be) used in each assessment report; and the number of linkages as presented in Table 7.

Figure 99 shows that budget restrictions are rarely documented. There are some cases where budget caused restrictions, but these are hardly visible in the bar plot. It should be noted that it is not likely that assessment reports (other than the reports on the challenges) would report on budget restrains for specific datasets. There is no clear difference found for this dataset adequacy indicator between the different user types.

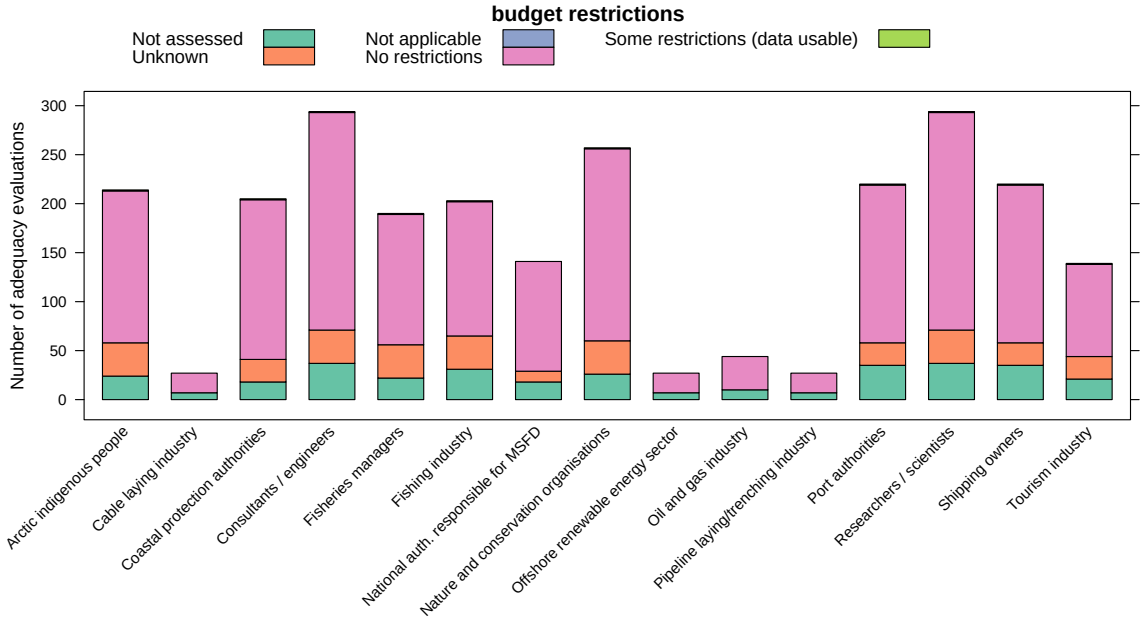

Figure 99. *Adequacy indicator 'budget restrictions' per user type. Numbers on the y-axis are the number of dataset adequacy evaluations (note that each user type will use multiple datasets and each dataset may be evaluated more than once).*

Figure 100 shows that for many studies it is unknown whether the original data format is used, or whether the data format had to be converted before it could be used. For the reports for which it is known, most data formats had to be converted before use. There is no clear difference found for this dataset adequacy indicator between the different user types.

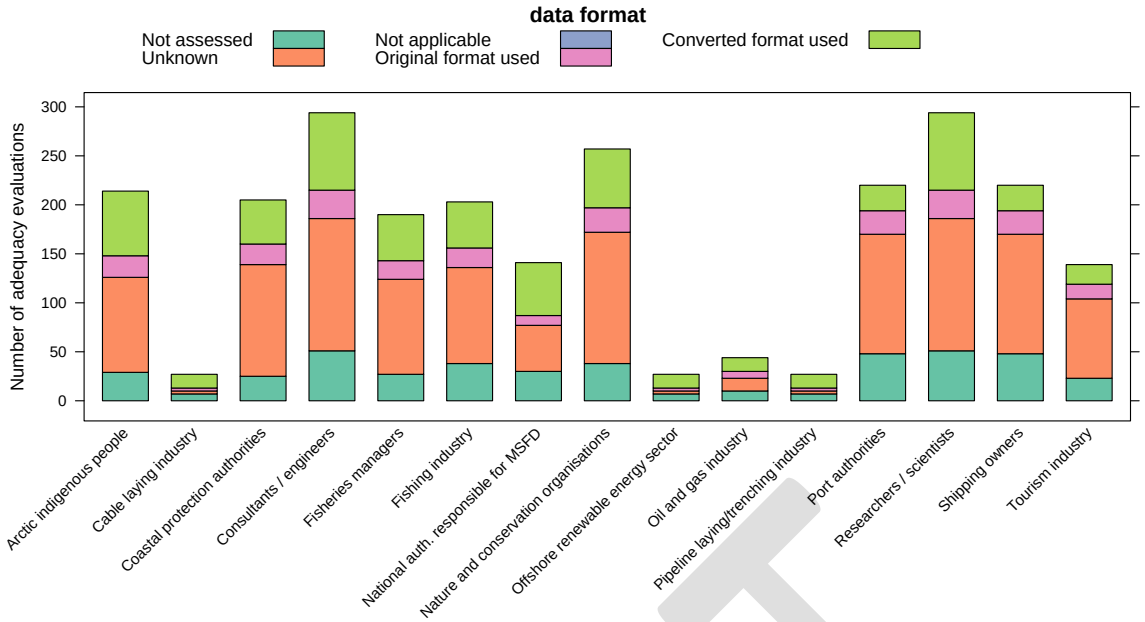

Figure 100. *Adequacy indicator 'data format' per user type. Numbers on the y-axis are the number of dataset adequacy evaluations (note that each user type will use multiple datasets and each dataset may be evaluated more than once).*

Figure 101 shows that approximately half of the assessed dataset evaluations concerns datasets that have not actually been used in an assessment report. It is just considered for use. It are mostly the challenge reports that have documented datasets that were not used. User types that are associated to more data set evaluations (and where data availability is expected to be greater), have a larger proportion of data evaluation in which data was not used. This is most likely caused by the higher selectivity with higher data availability.

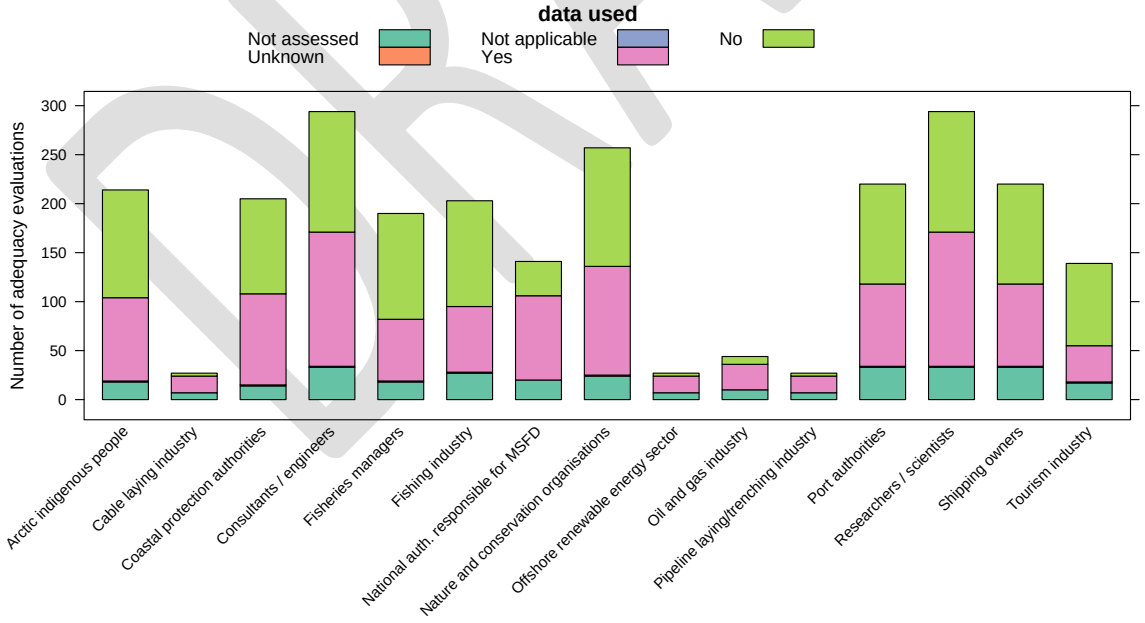

Figure 101. *Adequacy indicator 'data used' per user type. Numbers on the y-axis are the number of dataset adequacy evaluations (note that each user type will use multiple datasets and each dataset may be evaluated more than once).*

Figure 102, *Figure 103*, *Figure 104* and *Figure 105* show the matching of spatial and temporal resolution and coverage with requirements. They all show similar results: in a few cases there is no match. In many cases there is a limited match, where the data is still usable. In a similar amount (but

slightly less) of cases there was a sufficient match. There is no clear difference found for these dataset adequacy indicators between the different user types. The most notable difference is that users with lower number of data evaluations (e.g. cable laying industry, oil and gas industry, etc.) there are proportionally more data sets that have a full match with the required spatial coverage.

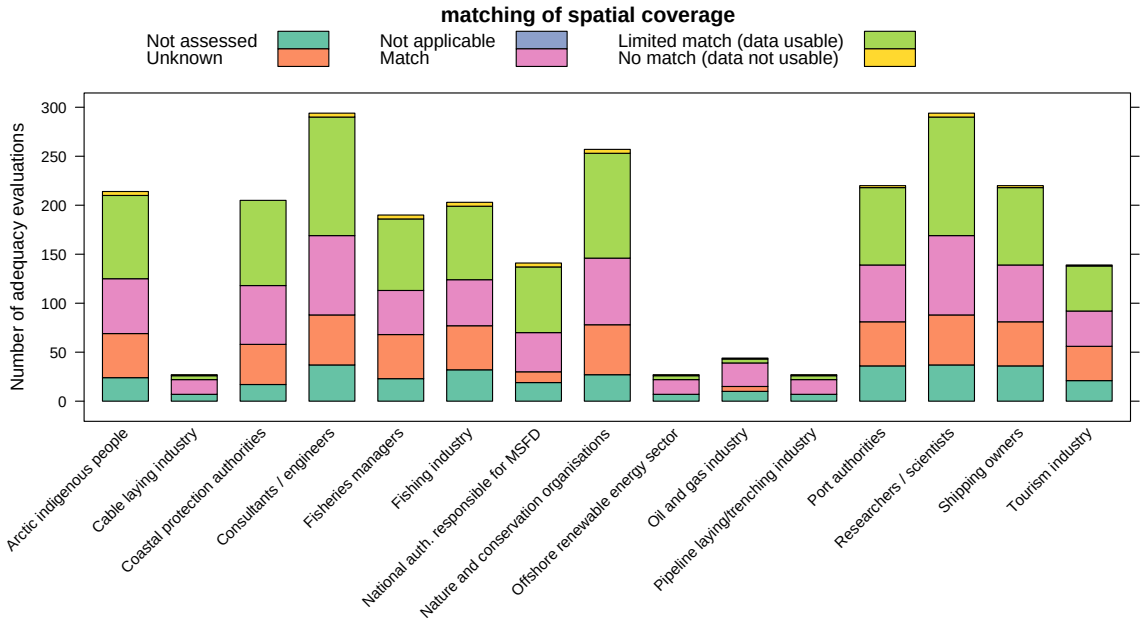

Figure 102. *Adequacy indicator 'matching of spatial coverage' per user type. Numbers on the y-axis are the number of dataset adequacy evaluations (note that each user type will use multiple datasets and each dataset may be evaluated more than once).*

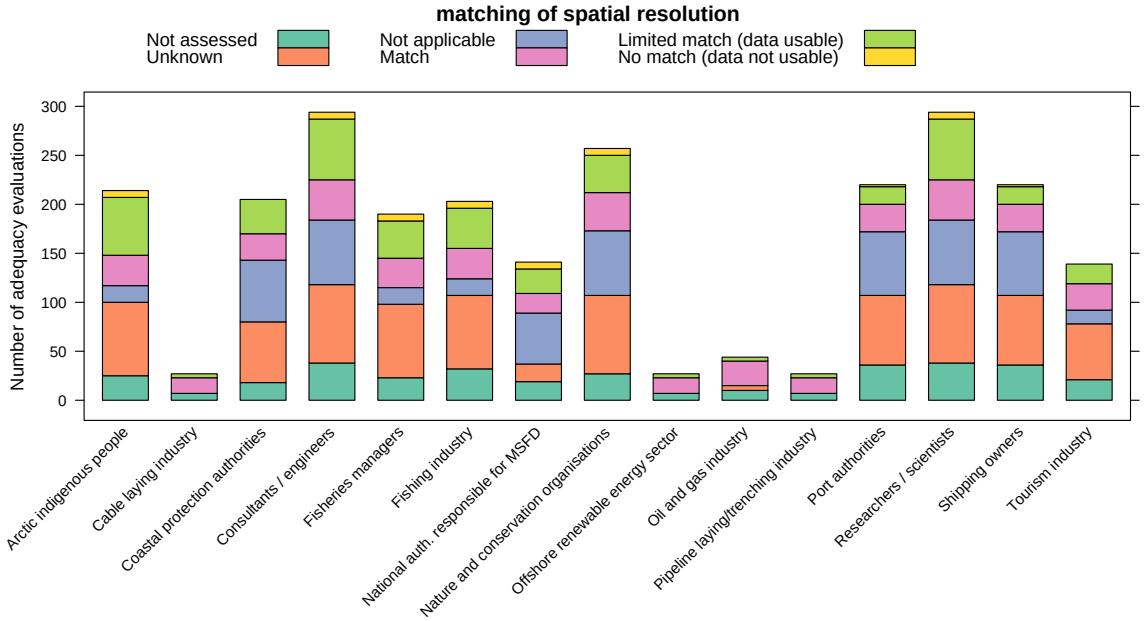

Figure 103. *Adequacy indicator 'matching of spatial resolution' per user type. Numbers on the y-axis are the number of dataset adequacy evaluations (note that each user type will use multiple datasets and each dataset may be evaluated more than once).*

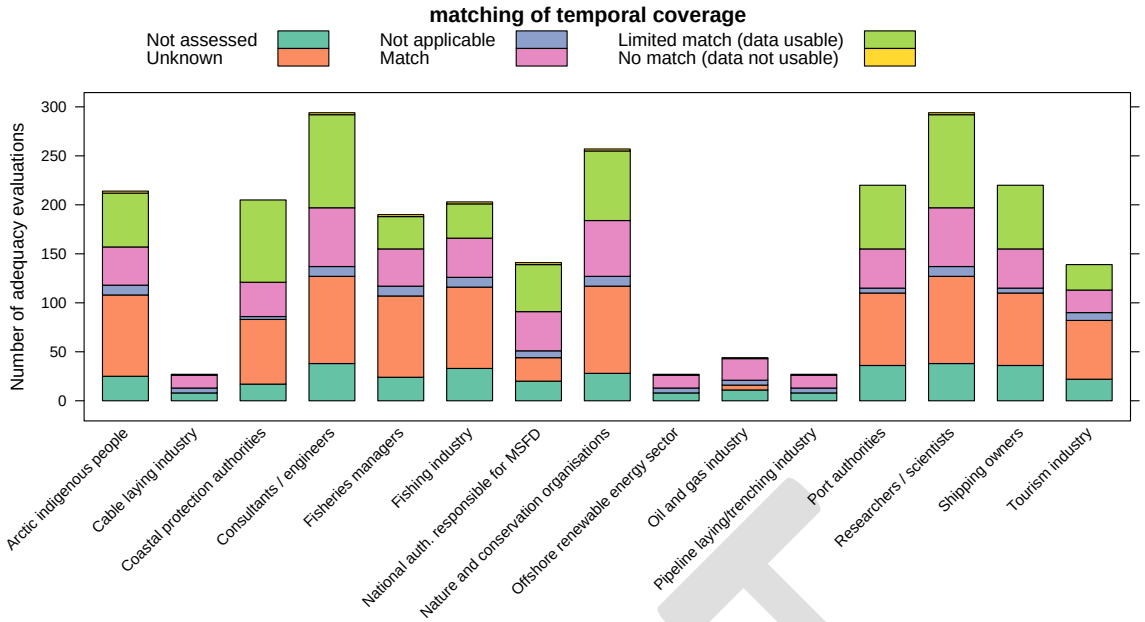

Figure 104. *Adequacy indicator 'temporal coverage' per user type. Numbers on the y-axis are the number of dataset adequacy evaluations (note that each user type will use multiple datasets and each dataset may be evaluated more than once).*

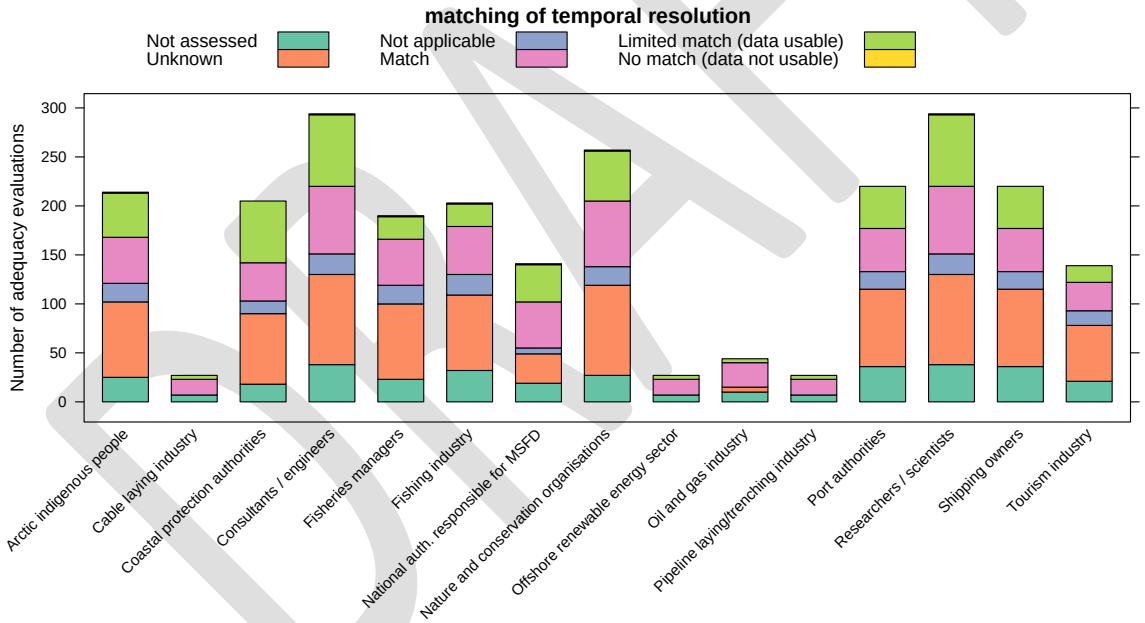

Figure 105. *Adequacy indicator 'temporal resolution' per user type. Numbers on the y-axis are the number of dataset adequacy evaluations (note that each user type will use multiple datasets and each dataset may be evaluated more than once).*

Figure 106 shows the necessity of the evaluated dataset for the purposes for which they were used. In most cases the necessity was limited, meaning that these reports could have achieved their objectives without the dataset in question (although this could have led to a less satisfactory result). But in some cases there was an absolute need for the dataset, i.e., the user would have failed their objective without the respective dataset. There is no clear difference found for this dataset adequacy indicator between the different user types.

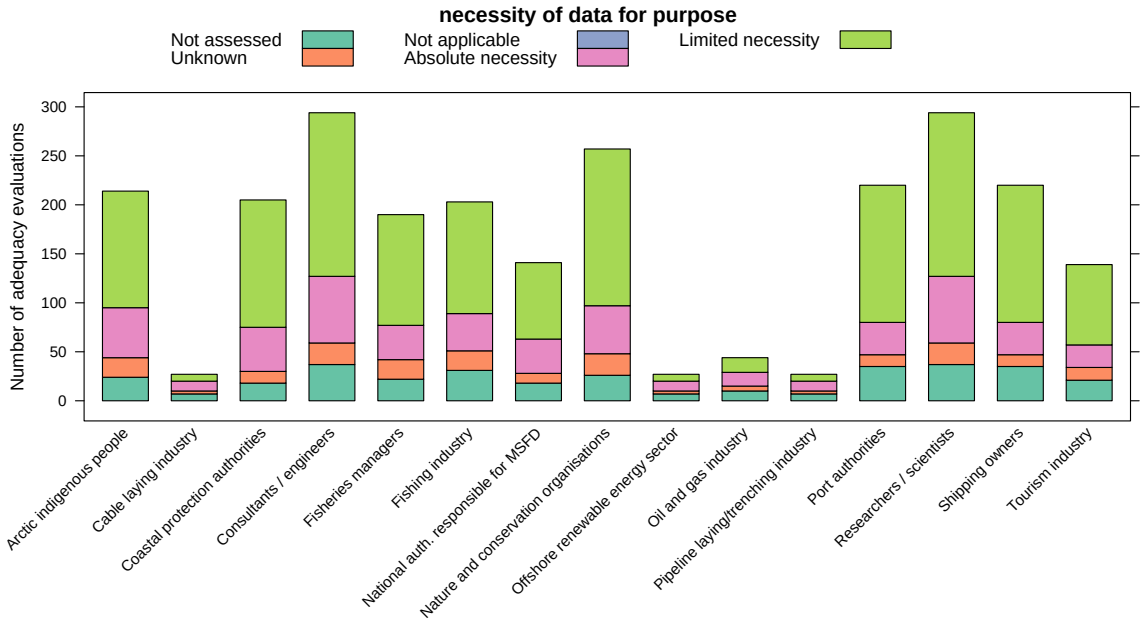

Figure 106. *Adequacy indicator 'necessity of data for purpose' per user type. Numbers on the y-axis are the number of dataset adequacy evaluations (note that each user type will use multiple datasets and each dataset may be evaluated more than once).*

Figure 107 shows that only for a few datasets, the data could be used without processing (other than converting the data format, which is covered by the indicator 'data format'). Most datasets required processing, which can be expected. For quite a number of evaluations, it is not known whether data is processed (i.e., it is not reported). There is no clear difference found for this dataset adequacy indicator between the different user types.

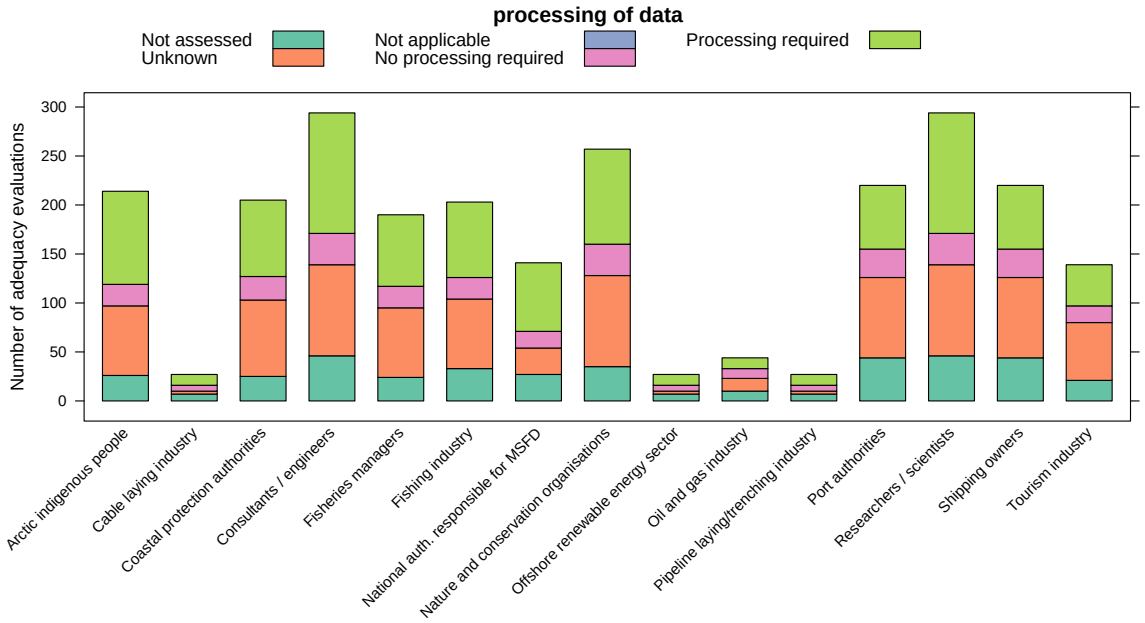

Figure 107. *Adequacy indicator 'processing of data' per user type. Numbers on the y-axis are the number of dataset adequacy evaluations (note that each user type will use multiple datasets and each dataset may be evaluated more than once).*

Figure 108 shows that in most cases there are no project time restriction (indicating that data can be retrieved within the available project time), There are some cases where time was a constraint, but data could still be used and even a smaller fraction where data could not be retrieved within project time. The latter was the case for WP challenge reports only (in other reports, datasets that could not

be retrieved in time are probably not documented at all). There is no clear difference found for this dataset adequacy indicator between the different user types.

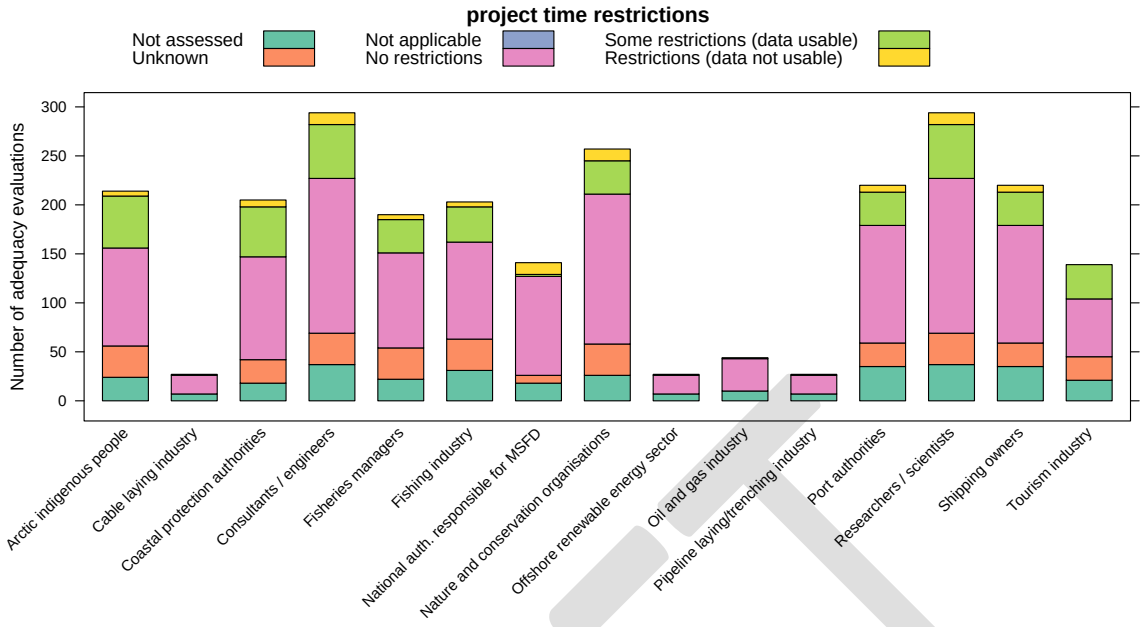

Figure 108. *Adequacy indicator 'project time restrictions' per user type. Numbers on the y-axis are the number of dataset adequacy evaluations (note that each user type will use multiple datasets and each dataset may be evaluated more than once).*

Part 2: Parameters

9 Data adequacy in the Arctic sea basin per parameter

9.1 Introduction

This chapter describes the data adequacy from a parameter-perspective. It provides a view of the monitoring effort in the Arctic sea basin per parameter (temperature, bathymetry, sea level rise, etc.).

Section 5.2.6 explains in detail how adequacy is evaluated for specific datasets used in specific assessment reports for specific indicators (see also Annex 2) and how they are presented in bar plots. For each dataset the P02 parameter (SeaDataNet agreed parameters, e.g. 'skin temperature of the water column') is registered. This chapter aggregates the adequacy assessment at the level of dataset P03 parameter groups (SeaDataNet agreed parameter Groups, e.g. 'Water column temperature and salinity'), as the specific P02 parameters will result in very long lists. It should be noted that P02 parameters can be linked to multiple P03 parameter groups, which means that specific adequacy scores can reoccur in different P03 parameter groups.

In contrast to the dataset adequacy specified per user type, we do find contrast between the different parameter groups, when it comes to data adequacy. These will be discussed individually for each adequacy indicator below. The number of adequacy evaluations of datasets (on the y-axis in the bar plots below) is also variable amongst the parameters. The height of the bar depends on the number of datasets that are listed in the CMS for a specific parameter and the number of times this dataset is evaluated. It is thus an indication of the combination of the availability and usage of the datasets per parameter. The following section (9.2) will discuss each adequacy indicator which is specified per parameter.

9.2 Adequacy assessment results

Figure 109 shows whether there were any budget restrictions for datasets of specific P03 parameter groups. Generally, there were no restrictions, or this was not reported (unknown). Only the P03 parameter group 'Habitat' had some restrictions with respect to budget. Specifically, this concerns the essential fish habitats Arctic data from the Arctic Integration Portal, which was evaluated by WP05 (climate change) as such. In this specific case, the budget restriction was not caused by the costs of the dataset (which is free), but in the budget needed to process the data.

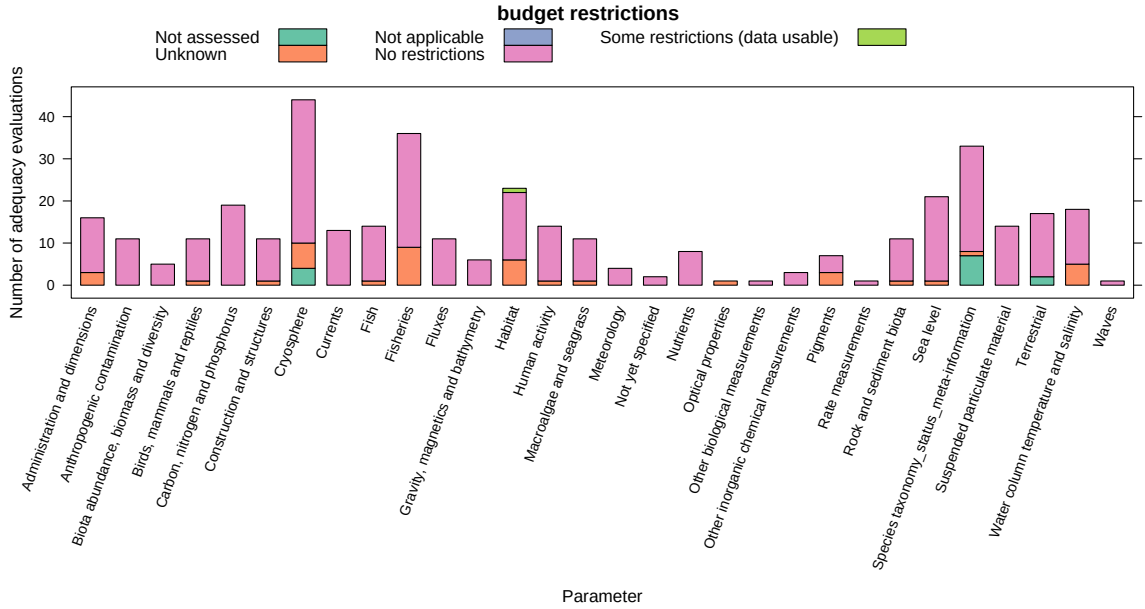

Figure 109. *Adequacy indicator 'budget restrictions' listed per P03 parameter. Note that each parameter can hold multiple datasets and each dataset may have been evaluated more than once for adequacy.*

Most dataset could be used directly in their original (file) format (although in many cases it was unknown if the data required reformatting before analyses, i.e., it is not stated by the assessment report) (*Figure 110*). For some specific parameter groups the original format could relatively often be used directly: 'Cryosphere', 'Pigments', 'Rate measurements', 'Species taxonomy and/or meta-information', 'Water column temperature and salinity'.

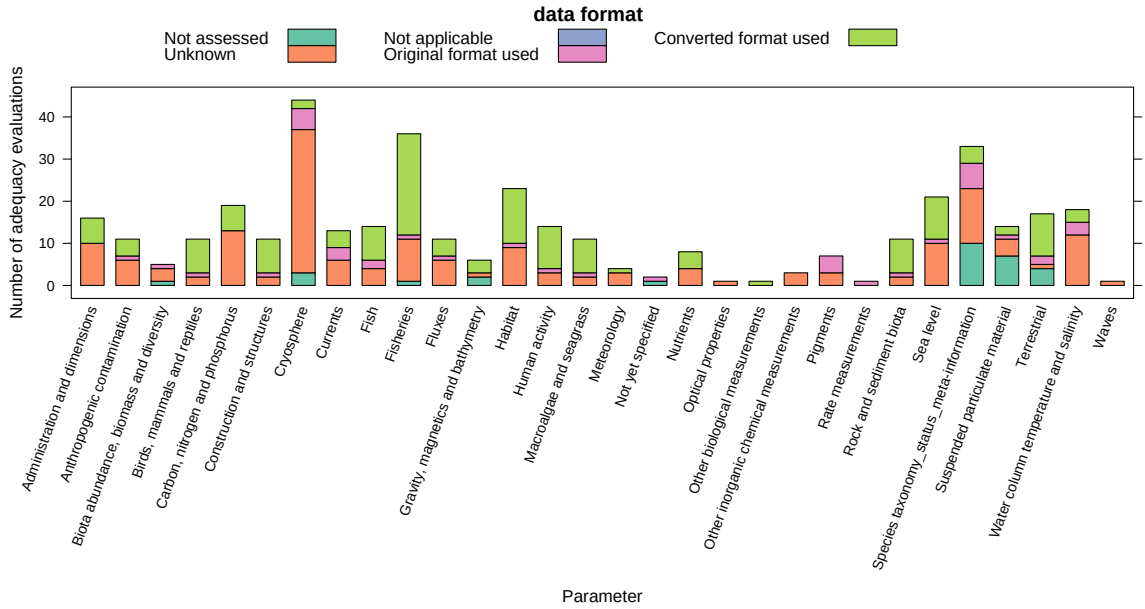

Figure 110. *Adequacy indicator 'data format' listed per P03 parameter. Note that each parameter can hold multiple datasets and each dataset may have been evaluated more than once for adequacy.*

Figure 111 shows that in many cases datasets are considered for use, but are actually not used. This is mostly the case for datasets associated to the challenges, but also in some cases to other assessment reports (e.g., assessment reports that suggest certain datasets without actually using these). Generally the fraction of datasets that are not used per parameter group is associated with the number of evaluations for that parameter group (i.e., when more datasets are evaluated, more are actually not used). This has probably to do with the availability of data. The higher the availability of data, the more selective a user can be, and the more likely a dataset is to be rejected for use. Some

notable parameter groups for which all the datasets were not used are: 'Optical properties', 'Pigments', 'Rate measurements' and 'Waves'.

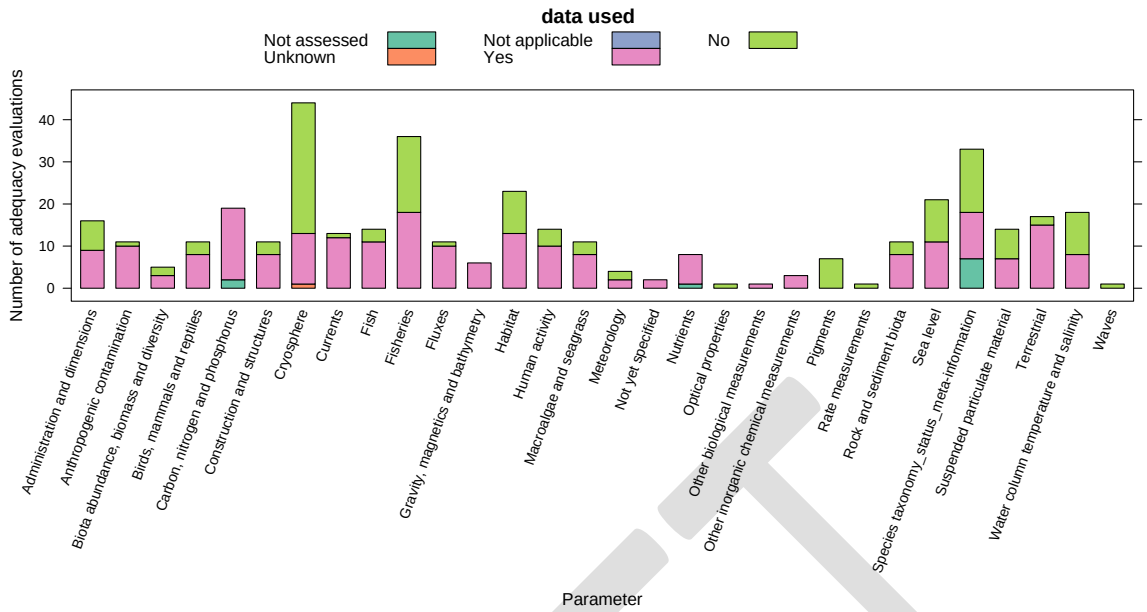

Figure 111. *Adequacy indicator 'data used' listed per P03 parameter. Note that each parameter can hold multiple datasets and each dataset may have been evaluated more than once for adequacy.*

Figure 112 shows if the spatial coverage of datasets is sufficient for the purpose for which this is used. Since the focus of the present study is the Arctic, there should generally be an overlap between the datasets that have been included in the CMS and their suitability for purposes in the Arctic. Indeed there are only a limited number of datasets for which there is no overlap between the region of interest (in this case the Arctic) and the region represented in the data (this is the case for the parameter groups 'Administration and dimensions', 'Fisheries' and 'Species taxonomy…'). How the adequacy for spatial coverage relates to the quality indicator for spatial coverage is described in more detail in Section 7.3. There are only a few parameters for which all datasets gave a limited match for spatial coverage, where the most notable are: 'Carbon, nitrogen and phosphorous' and 'Nutrients' both related to the river input challenge.

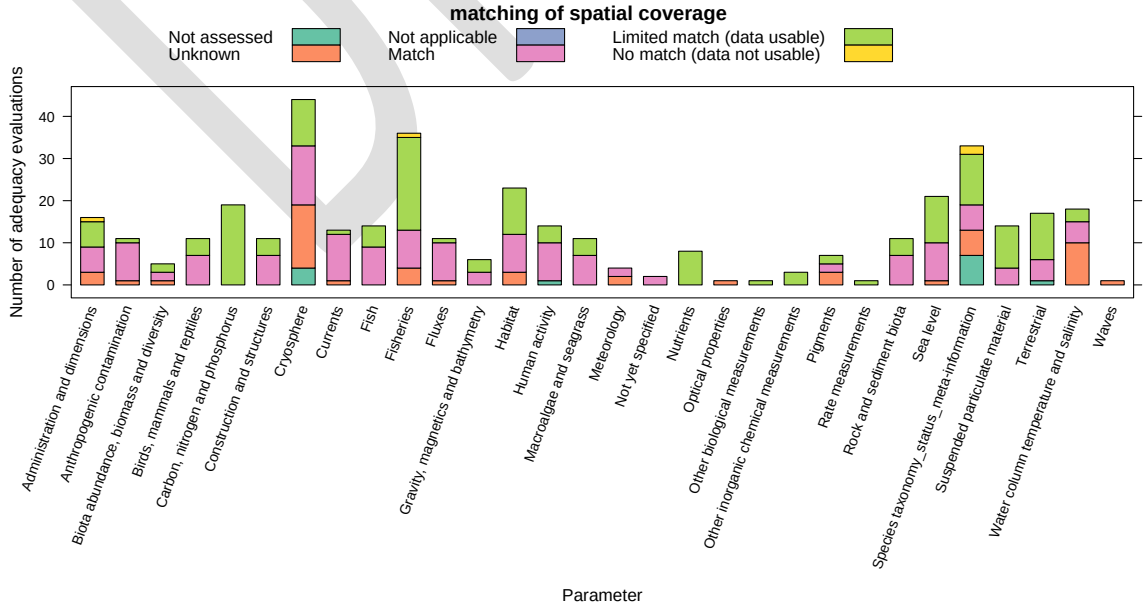

Figure 112. *Adequacy indicator 'matching of spatial coverage' listed per P03 parameter. Note that each parameter can hold multiple datasets and each dataset may have been evaluated more than once for adequacy.*

Figure 113 shows how the spatial resolution of datasets for specific parameters matches with the required resolution. The results to some extent comparable with those found for the matching of spatial coverage (*Figure 112*). The main difference is that the spatial resolution is often not applicable for datasets, whereas this is not the case for the spatial coverage. This is for instance the case for data that represent a specific site or point location (i.e., data is not gridded).

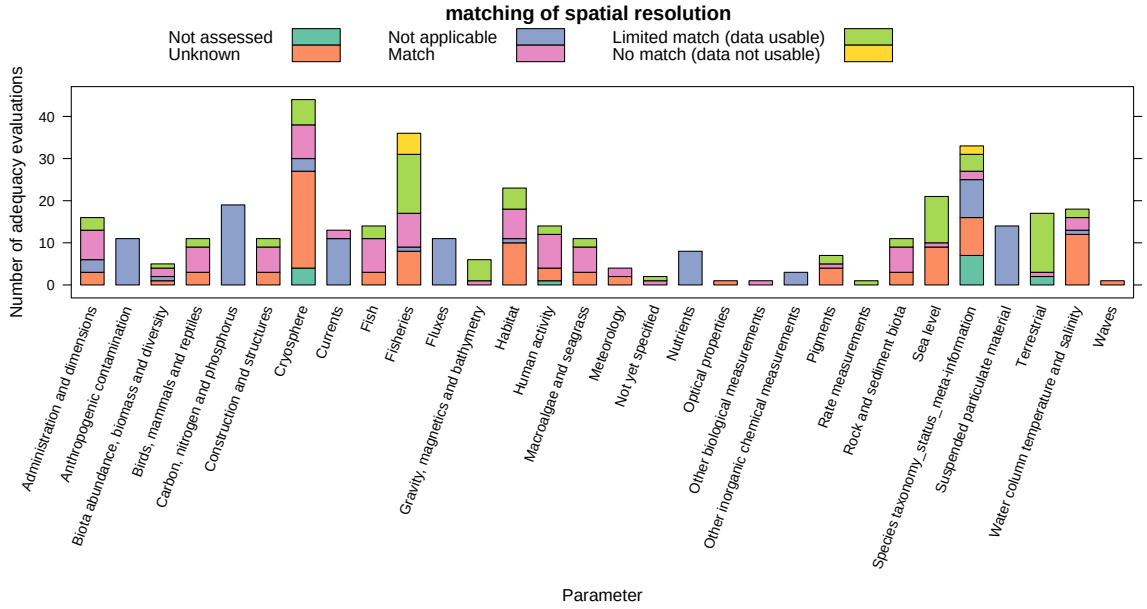

Figure 113. *Adequacy indicator 'matching of spatial resolution' listed per P03 parameter. Note that each parameter can hold multiple datasets and each dataset may have been evaluated more than once for adequacy.*

The usability of dataset caused by its temporal coverage is highly variable among the P03 parameter groups (*Figure 114*). For most parameters, the available datasets have a match with the required temporal coverage of a limited one at best. Only the 'Fisheries' parameter group contains two datasets that have no match with required coverage: 'Ship traffic lines fishing vessels' (from ArcGIS) and 'Bottom Trawling and Dredging by Marine Ecoregion' (from DataBasin.org). Most datasets appear to represent specific time periods, as only a small fraction is scored as 'not applicable'.

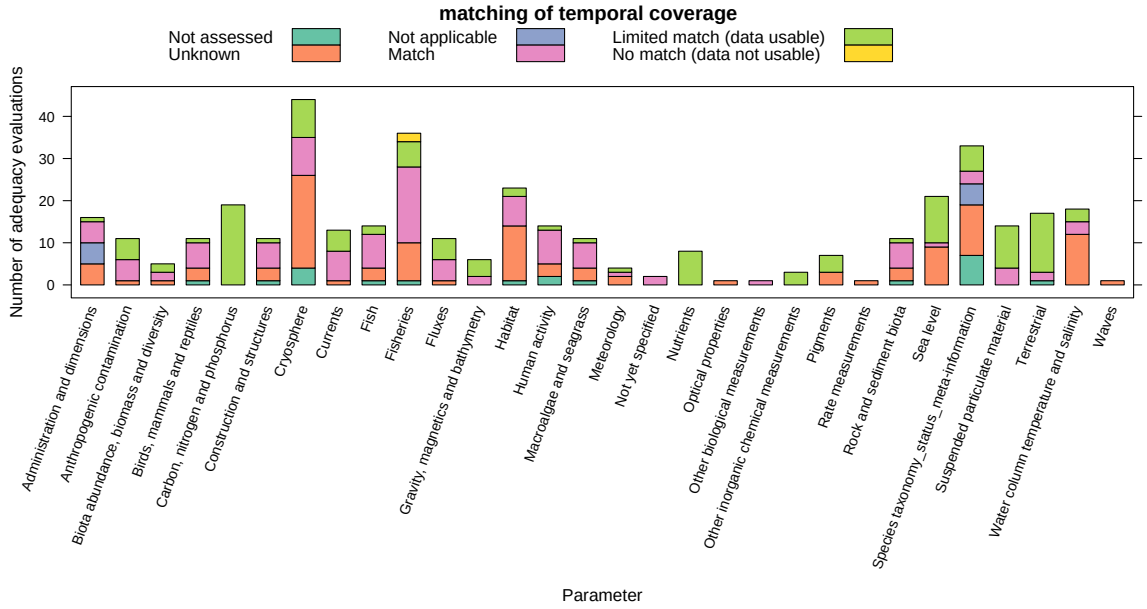

Figure 114. *Adequacy indicator 'matching of temporal coverage' listed per P03 parameter. Note that each parameter can hold multiple datasets and each dataset may have been evaluated more than once for adequacy.*

The usability of dataset caused by its temporal resolution is highly variable among the p03 parameter groups (*Figure 115*). For most parameters, the available datasets have a match with the required temporal coverage of a limited one at best. Only the 'Fisheries' parameter group contains a dataset that has no match with required resolution: 'Bottom Trawling and Dredging by Marine Ecoregion' (from DataBasin.org). Most datasets appear to contain some form of temporal resolution (i.e., time-series), as only a small fraction is scored as 'not applicable'.

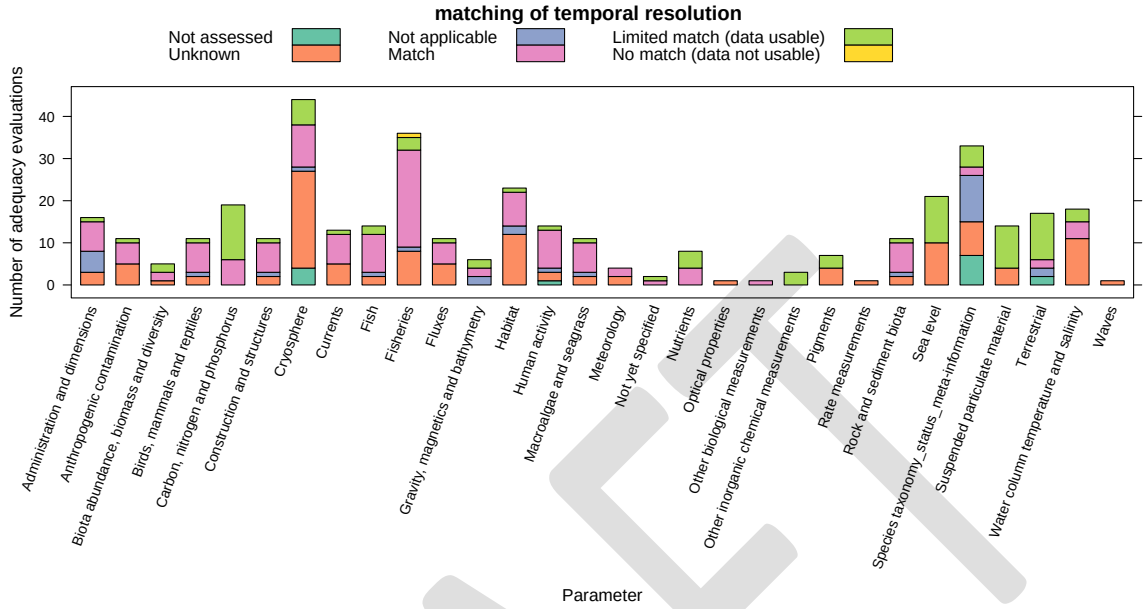

Figure 115. *Adequacy indicator 'matching of temporal resolution' listed per P03 parameter. Note that each parameter can hold multiple datasets and each dataset may have been evaluated more than once for adequacy.*

For most P03 parameters the datasets had limited necessity (*Figure 116*). This indicates that the objectives described in the assessment reports, for which the datasets are evaluated, can also be achieved without the dataset. This could mean that multiple similar datasets are available from which the most adequate can be selected. It could also mean that the objectives of the assessment report are formulated such that there are little data requirements. Although there are some differences among the parameter groups, there is no evident explanation for why this is the case.

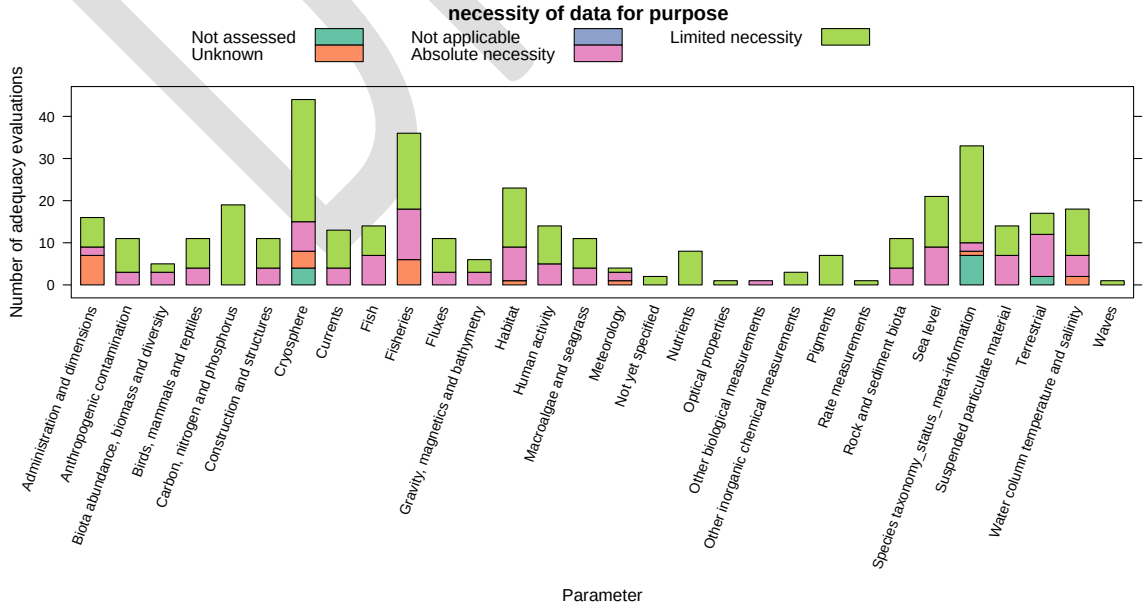

Figure 116. *Adequacy indicator 'necessity of data for purpose' listed per P03 parameter. Note that each parameter can hold multiple datasets and each dataset may have been evaluated more than once for adequacy.*

In most cases datasets required processing before it could be used for its purpose in an assessment report (*Figure 117*). This was specifically so for all datasets related to the P03 parameters 'Carbon, nitrogen and phosphorous', 'Nutrients', 'Other biological measurements' and 'Rate measurements'. For 'Anthropogenic contamination', 'Currents', 'Fluxes' and 'Pigments' no processing was required for most datasets (when the unknowns are disregarded).

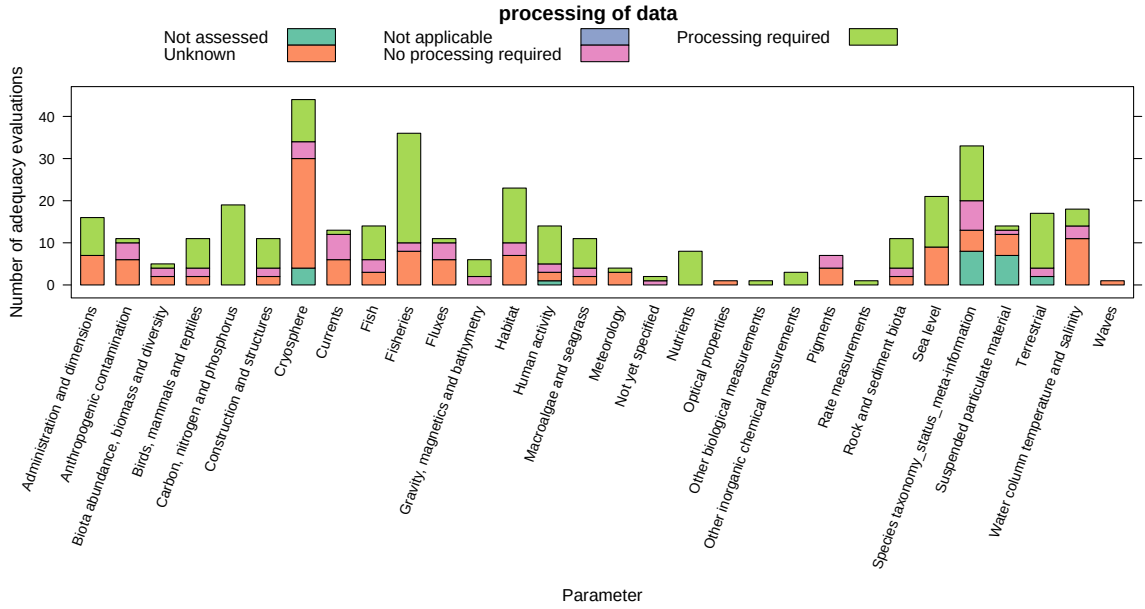

Figure 117. *Adequacy indicator 'processing of data' listed per P03 parameter. Note that each parameter can hold multiple datasets and each dataset may have been evaluated more than once for adequacy.*

For most evaluated datasets, there were no restrictions caused by (lack of) the availability of project time (*Figure 118*). The category 'Some restrictions' applies relatively often for the P03 parameter groups 'Sea level' and 'Terrestrial'. Datasets associated with the parameter groups 'Fisheries', 'Habitat' and 'Suspended particulate material' were in some cases unusable due to project time restrictions.

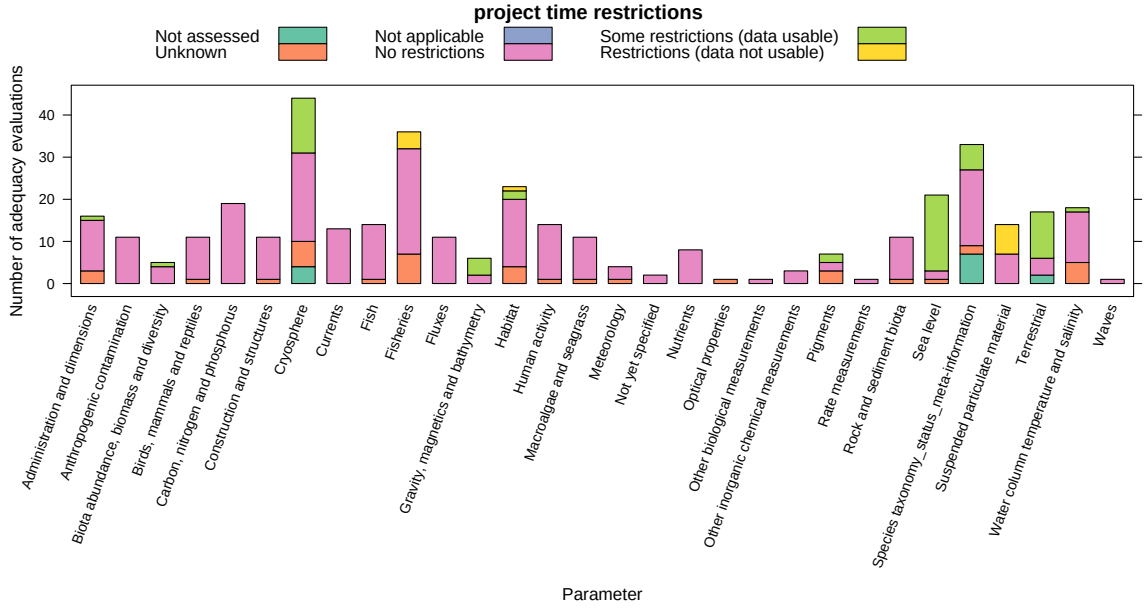

Figure 118. *Adequacy indicator 'project time restrictions' listed per P03 parameter. Note that each parameter can hold multiple datasets and each dataset may have been evaluated more than once for adequacy.*

Part 3: Purposes

10 Data adequacy in the Arctic sea basin per purpose

10.1 Introduction

This part focuses on the adequacy of datasets per purpose. Although originally not within the scope of the project, this third part was added to the DAR. As explained before, this is because it is expected that there is more contrast in adequacy between the purposes rather than that between user types. The adequacy per purpose is discussed per adequacy indicator in the section below. The adequacy indicators are introduced in Section 5.2.6 and a full list is given in Annex 2.

Note that the purposes listed here are what we have defined as 'additional purposes'. This means that the datasets are evaluated for the purpose for which they were used in an assessment report. An evaluation per original purpose (the purpose for which a dataset is generated) is not included in the DAR. A generic analysis of original versus additional purpose is presented in Section 7.4. This is why there are no evaluations for the additional purpose 'Environmental impact assessment', which was considered (relevant but) out of scope.

This part includes information from both the literature review and the challenges, in contrast to Chapter 6 which presents only the results of the challenges.

10.2 Adequacy assessment results

Budget is generally not a restriction (*Figure 119*), although a single dataset (used in the climate change challenge) had some restrictions. As described before in Section 9.2 the restriction was not caused by the costs of the dataset (which was free of charge) but the budget required to process the data.

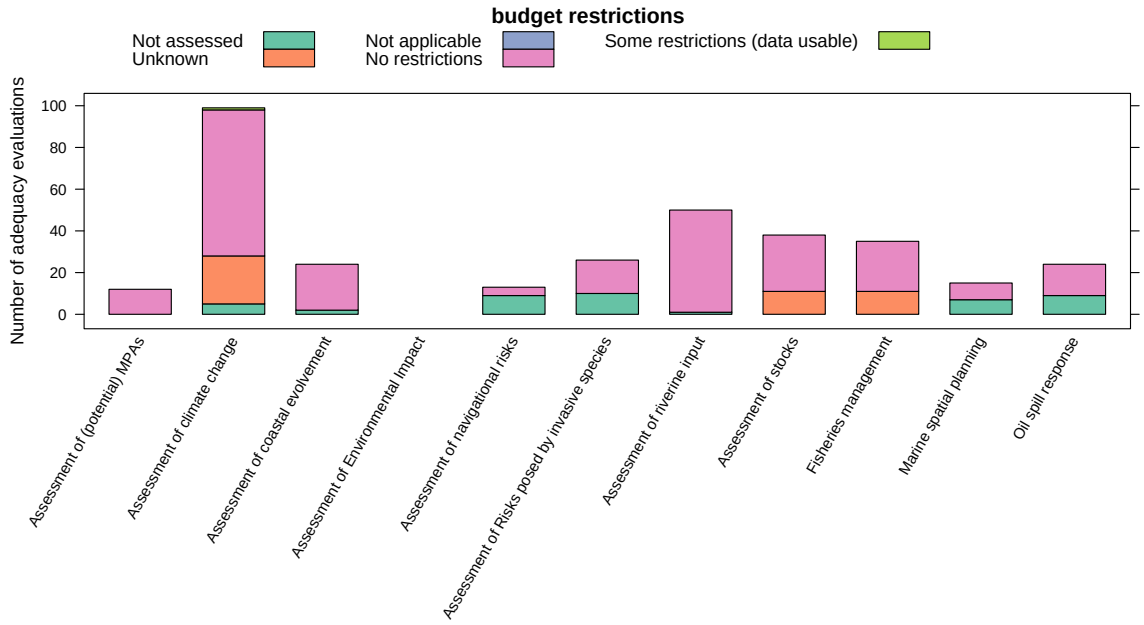

Figure 119. *Adequacy indicator 'budget restrictions' listed per additional purpose (i.e., the purpose for which the data was used). Note that for each purpose, multiple datasets may have been used and each dataset may have been evaluated more than once.*

For some purposes (invasive species and oil spill response), all datasets could be used in its original (file/data) format (*Figure 120*), when the unknowns are disregarded. For most purposes, there is a mix of datasets which do or don't require a conversion of the file format. An exception is formed by the purposes 'stock assessment' and 'fisheries management', for which all datasets required conversion of the data (when unknowns are disregarded).

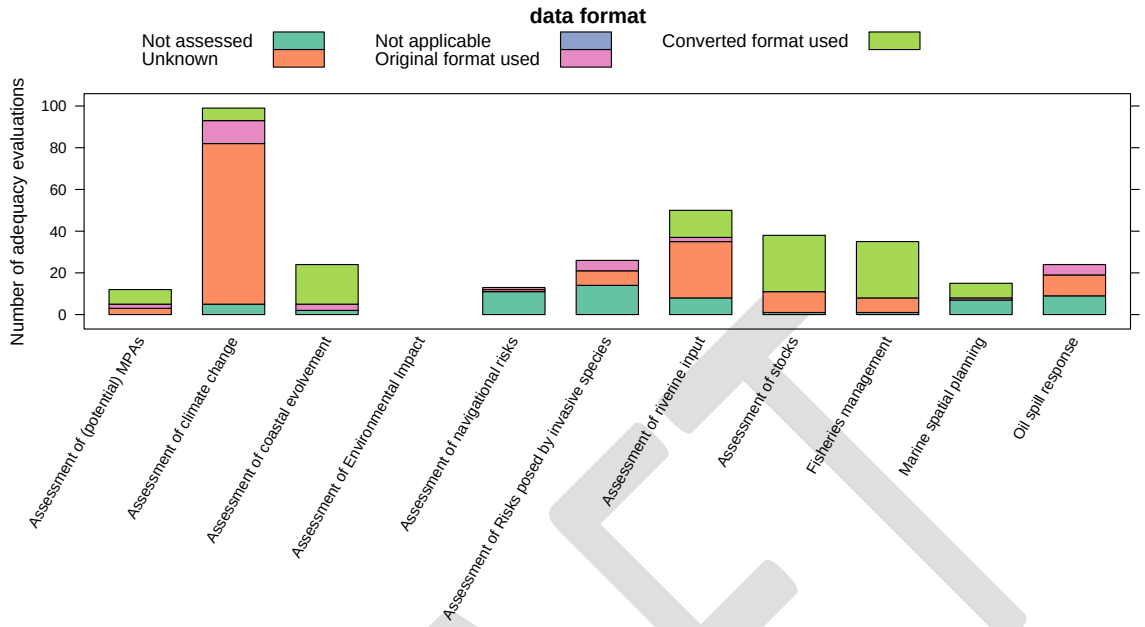

Figure 120. *Adequacy indicator 'data format' listed per additional purpose (i.e., the purpose for which the data was used). Note that for each purpose, multiple datasets may have been used and each dataset may have been evaluated more than once.*

Most purposes have a relatively small fraction of datasets that are not used (*Figure 121*) and have thus only been considered for use. This is partly related to the availability of data. Note that for the purpose of 'climate change' most adequacy evaluations are available. This is also the purpose with the largest portion of datasets that have not actually been used. Higher availability of data can make users more selective in the data they choose to use.

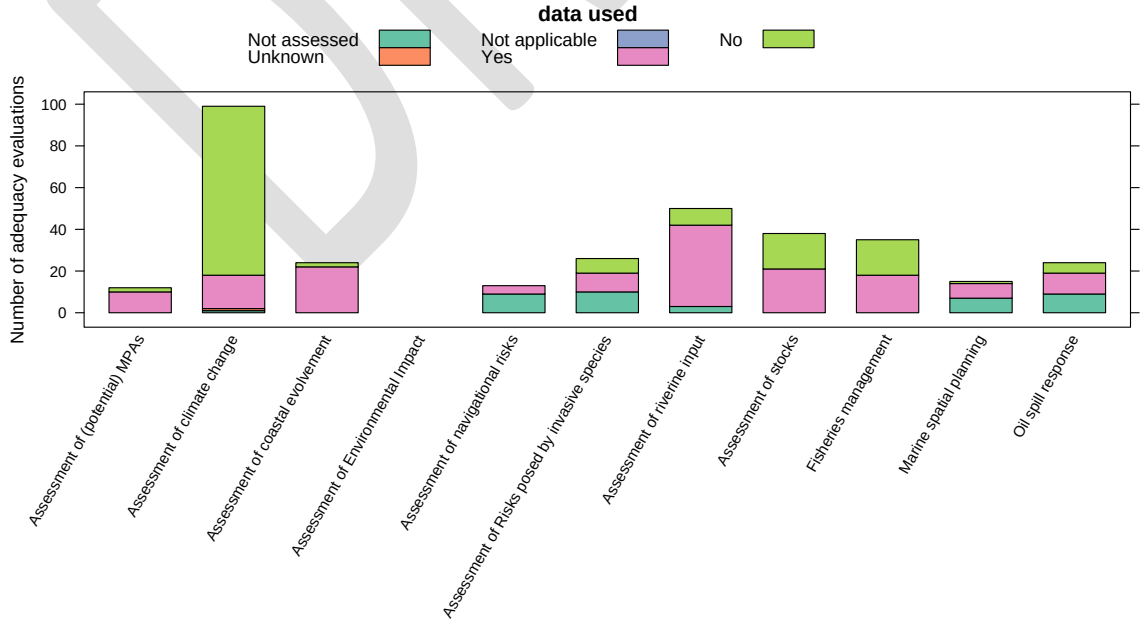

Figure 121. *Adequacy indicator 'data used' listed per additional purpose (i.e., the purpose for which the data was used). Note that for each purpose, multiple datasets may have been used and each dataset may have been evaluated more than once.*

Most purposes use or consider datasets that have at least a partial match of spatial coverage (*Figure 122*). This means that there is a partial overlap between the region required for the purpose (in the present scope this is generally the full Arctic) and the region that is covered by the dataset. For most purposes there is also a mix of datasets with a partial or full match of spatial coverage. A notable contrast is found for the 'invasive species' purpose, where datasets either appear to have a full match or no match at all (there is little in between). The purposes 'stock assessment' and 'fisheries management' have a relatively large amount of datasets with a limited match.

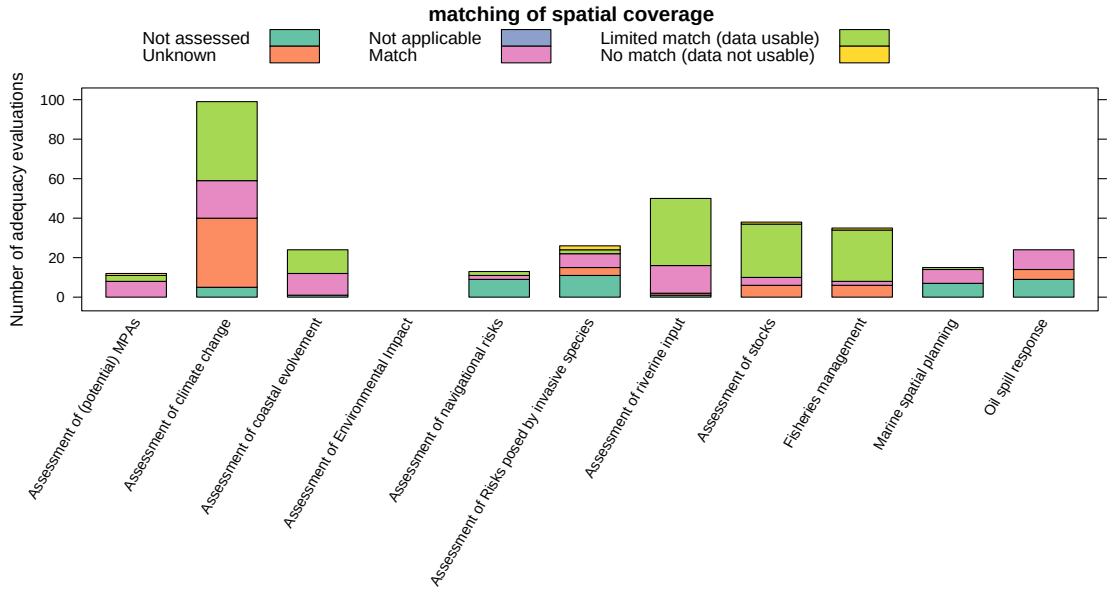

Figure 122. *Adequacy indicator 'matching of spatial coverage' listed per additional purpose (i.e., the purpose for which the data was used). Note that for each purpose, multiple datasets may have been used and each dataset may have been evaluated more than once.*

The matching of required spatial resolution and available resolution has a strong contrast among the purposes (*Figure 123*). The 'river input' purpose shows that spatial resolution is not applicable for most datasets. As for that purpose mostly site-specific data is required (and data is not gridded), spatial resolution is obviously not applicable.

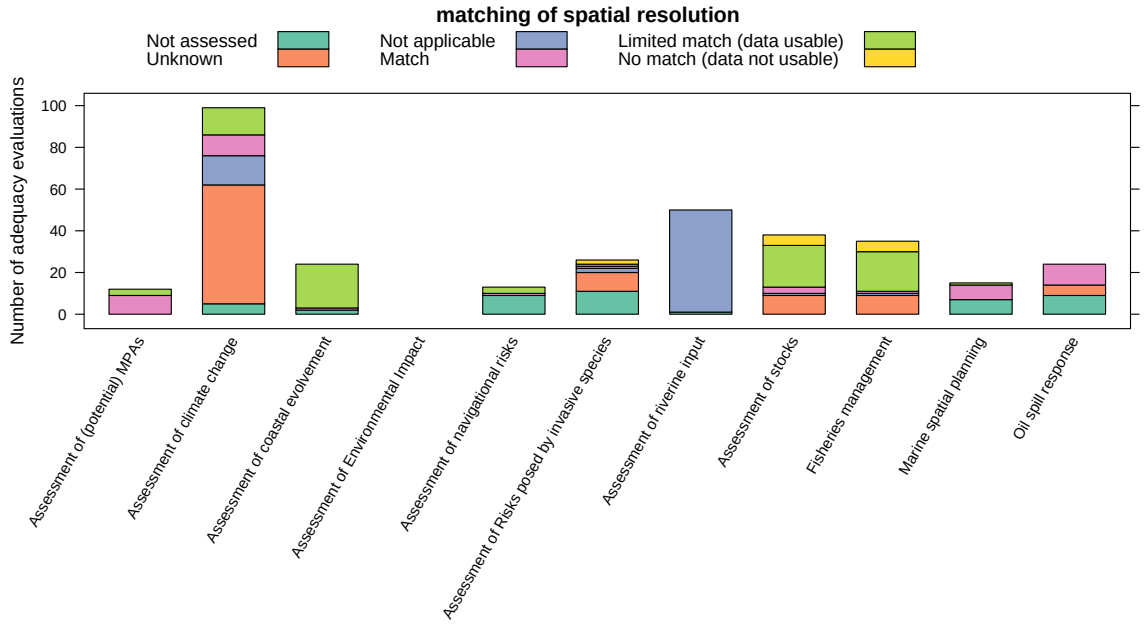

Figure 123. *Adequacy indicator 'matching of spatial resolution' listed per additional purpose (i.e., the purpose for which the data was used). Note that for each purpose, multiple datasets may have been used and each dataset may have been evaluated more than once.*

Figure 124 shows the matching of the required temporal period and the period that is covered by the datasets. For the purpose 'coastal evolvement' there is often a limited match of the temporal coverage. Apparently for that purpose, datasets only cover part of the required time period. The same is true for the purposes 'climate change' and 'river input', but to a lesser extent. For the purpose 'MPA', datasets often don't cover the temporal aspect as 'not applicable' is a relatively common score for that purpose.

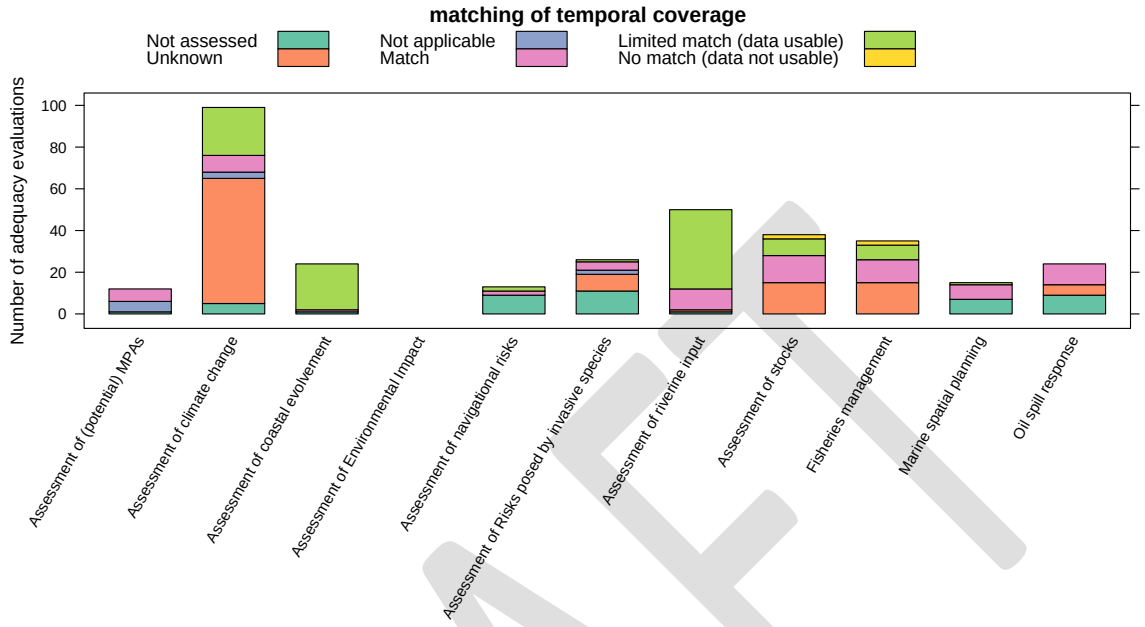

Figure 124. *Adequacy indicator 'matching of temporal coverage' listed per additional purpose (i.e., the purpose for which the data was used). Note that for each purpose, multiple datasets may have been used and each dataset may have been evaluated more than once.*

The temporal resolution of datasets mostly have a limited match with the requirements of the purposes 'coastal evolvement' and 'river input' (*Figure 125*). In quite a number of cases the adequacy of available temporal resolution is unknown, this is most notable for the purpose 'climate change'. For a limited number of cases, temporal resolution is not applicable (i.e., datasets are no time-series).

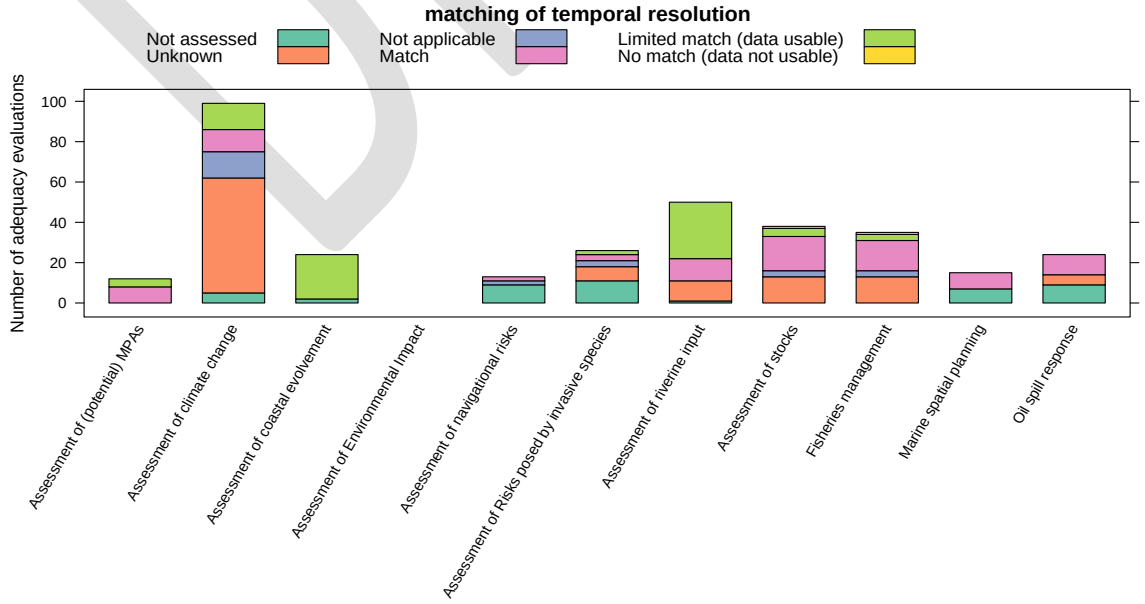

Figure 125. *Adequacy indicator 'matching of temporal resolution' listed per additional purpose (i.e., the purpose for which the data was used). Note that for each purpose, multiple datasets may have been used and each dataset may have been evaluated more than once.*

There is a limited necessity for most datasets that have been evaluated (*Figure 126*). This means that the objective of the study, which is described in the assessment report for which the dataset adequacy is evaluated, can be achieved without the respective dataset. It seems that purposes with high availability of datasets (such as 'climate change') also reduce the necessity of such datasets. All purposes have one or more datasets which the necessity is absolute. Of course, this Figure does not show if all required datasets are available for all purposes.

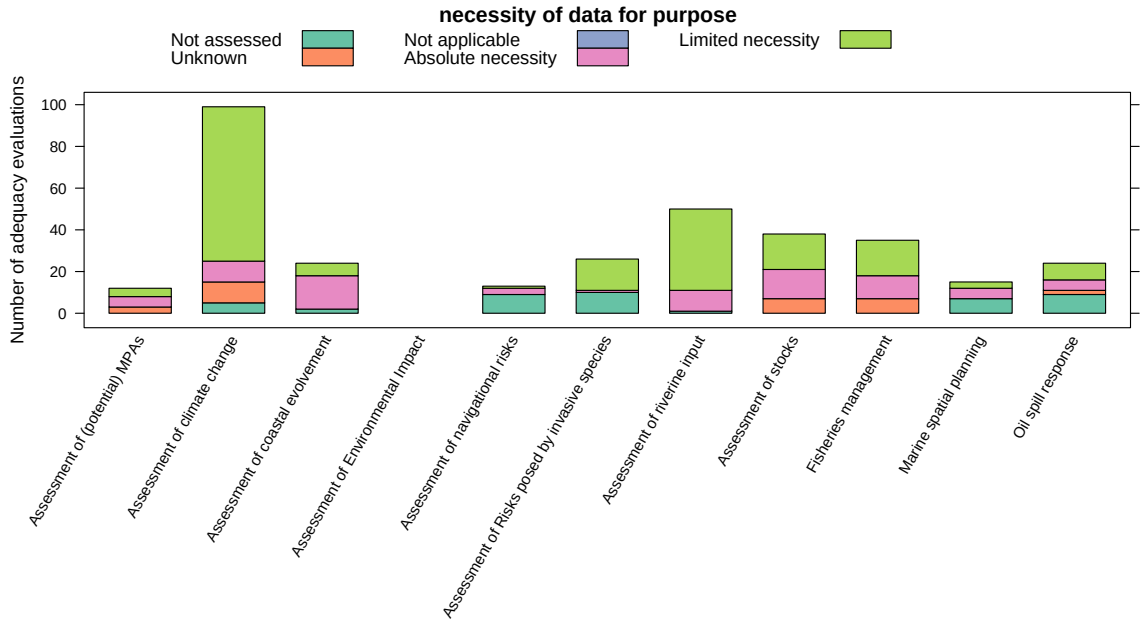

Figure 126. *Adequacy indicator 'necessity of data for purpose' listed per additional purpose (i.e., the purpose for which the data was used). Note that for each purpose, multiple datasets may have been used and each dataset may have been evaluated more than once.*

There are very few datasets that don't require processing when it is used for a specific purpose (*Figure 127*). *Figure 127* shows some slight differences between purposes, but they are not very distinct. Only for the 'oil spill' purpose all datasets don't require processing (when 'unknown', and 'not assessed' datasets are ignored).

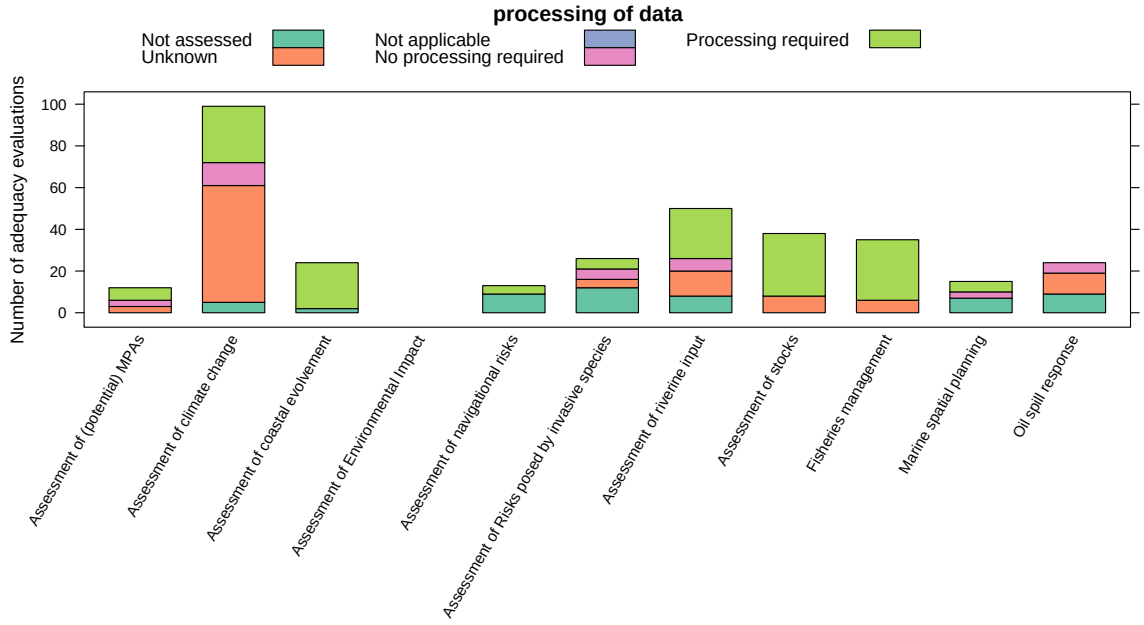

Figure 127. *Adequacy indicator 'processing of data' listed per additional purpose (i.e., the purpose for which the data was used). Note that for each purpose, multiple datasets may have been used and each dataset may have been evaluated more than once.*

Figure 128 shows that available project time can restrict dataset usage. These restrictions also seem to vary between the different purposes. Both the purposes 'climate change' and 'coastal evolvement' dealt with datasets that had some restrictions timewise, but could still be used. The 'river input', 'stock assessment' and 'fisheries management' purposes all considered using datasets but eventually didn't because of the limited available time within the project in which it had to be used.

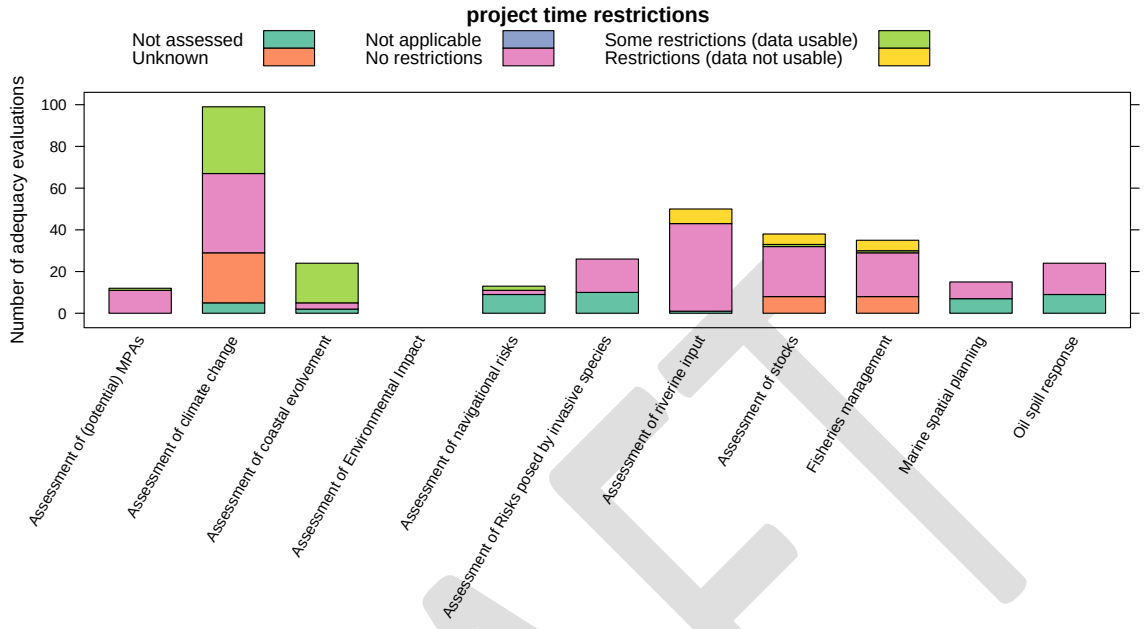

Figure 128. *Adequacy indicator 'project time restrictions' listed per additional purpose (i.e., the purpose for which the data was used). Note that for each purpose, multiple datasets may have been used and each dataset may have been evaluated more than once.*

11 Conclusions and recommendations

The evaluation for this first DAR takes into account the literature survey (Chapter 4 and De Vries et al., 2016) and the outcome of the challenges (Chapter 6). For the updated version of the DAR, new and relevant information will be taken into account, which will at least include the feedback and comments of the Commission and the Panel (WP14) and will be presented in a separate report.

Using the structure for collecting information on data adequacy as presented in Chapter 5, allows for the presentation and analysis of the adequacy from many different angles and perspectives. Some of these perspectives have been presented in Chapters 8 (users perspective), 9 (parameters perspective) and 10 (purpose perspective). Chapter 6 presents the data adequacy per challenge: 6.2 Wind farm siting (WP02); 6.3 Marine protected areas (WP03); 6.4 Oil platform leak (WP04); 6.5 Climate change (WP05); 6.6 Coasts (WP06); 6.7 Fisheries management (WP07); 6.8 Fisheries impact (WP08); 6.9 River input (WP10); 6.10 Bathymetry (WP11) and 6.11 Alien species (WP12). Rather than repeating all the findings for each different perspective, this Chapter will focus on general and overarching conclusions and recommendations, based on what has been presented in the previous Chapters. Note that value judgment will be avoided in the conclusions. The adequacy classification does not indicate a 'good' or 'bad' dataset, it merely indicates how suitable the dataset was for specific purposes.

In general we have found that the datasets that are available and have been evaluated in the present study usually have a quality that has a limited match with the requirements for the purpose for which it is used. For the spatial and temporal aspects, in most cases there was an association between the quality (i.e., resolution and coverage) and data requirements (match of quality for a specific purpose). As (for at least most WPs in the present project) the focus is on the entire Arctic region, a partial mismatch can be expected for many European data sources (such as EMODnet) which only focus on the European part of the Arctic. Only a small fraction of datasets were in some cases classified as unsuitable for specific purposes.

Within the scope of this study we identified some data sources and data sets that are particularly 'popular' for Arctic based studies, which indicates that those datasets are reused. It was also found that the original purpose for which data was generated is often not reported or not known. When it is known, it is often (re)used for the same purpose. For some original purposes, the datasets are reused for multiple additional purposes and some additional purposes use data generated with multiple original purposes.

Distinction between the purpose of data use provides more contrast in data quality requirements (i.e., adequacy) then distinction between data user types. Therefore the analysis is more valuable for the first perspective than for the second perspective.

Chapter 7 presents information from the CMS in ways that were originally outside the project's scope, but give noteworthy insights that are complementary to what is presented in the other Chapters. Additional analyses (e.g., data costs versus project budget restrictions, differences of data quality and adequacy between data that has been used and data that has only been considered for use) are possible, meaningful and potentially insightful. As this is currently outside the project's scope such analyses could be part of future work.

In the description of the adequacy as logged in the CMS (see section 8.3 (users), 9.2 (parameters) and 10.2 (purposes)), some noteworthy aspects have been highlighted in this first DAR. These aspects will be discussed with the project challenge leaders and analysed in more detail in the second DAR (or corrected if necessary).

As adequacy evaluations become more meaningful when a dataset is evaluated multiple times (i.e., getting the perspective from multiple assessment reports), the CMS will become more powerful when

it is kept up to date and new data adequacy evaluations are continuously added. To some extent this will be achieved in the second DAR. However, continuing maintenance and supplementing of the CMS beyond the project could further strengthen the evaluation of dataset adequacy.

12 Quality Assurance

IMARES utilises an ISO 9001:2008 certified quality management system (certificate number: 187378-2015-AQ-NLD-RvA). This certificate is valid until 15 September 2018. The organisation has been certified since 27 February 2001. The certification was issued by DNV Certification B.V. Furthermore, the chemical laboratory of the Fish Division has NEN-EN-ISO/IEC 17025:2005 accreditation for test laboratories with number L097. This accreditation is valid until 1th of April 2017 and was first issued on 27 March 1997. Accreditation was granted by the Council for Accreditation. The scope can be found at the website of the Council for Accreditation (www.rva.nl).

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Justification

Report Final draft
Project Number: 4313100028

The scientific quality of this report has been peer reviewed by a colleague scientist and a member of the Management Team of IMARES.

Approved: Dr. Ruud H. Jongbloed
Senior Research Scientist

Signature:

Date: date

Approved: Dr. ir. Tammo P. Bult
Director

Signature:

Date: date

Annex 1 Dataset quality indicators

Table 1.1
Dataset quality indicators, their scoring options and explanation

Indicator	Possible responses	Explanation
Spatial coverage	Global Arctic Arctic Partial Unknown Not assessed	This indicates which spatial region the dataset covers
Temporal coverage	Decades Years Month or less Unknown Not assessed Not applicable	This indicates which time period the dataset covers
Accessibility	Direct Download (no account) Download (account needed) Data at request Online viewing only Unknown Not assessed	This indicates the ease of access of the dataset
Costs	Free of charge Payed account Payed download Unknown Not assessed	This indicates the costs associated with the dataset
Service level	Service quality statement available Service quality statement Not available Unknown Not assessed	This indicates whether the data source provides a service quality statement
Responsiveness	Same day More than a day Unknown Not assessed	This indicates the speed with which the information is disseminated
Processing level	Raw data Processed data Unknown Not assessed	This indicates the level of processing of the data as provided from the source
Spatial resolution	>=10 km (>= 5°) >=1 <10 km (>=0.5° < 5°) <1 km (<0.5°) Unknown Not assessed Not applicable (e.g. site, river)	This indicates the spatial resolution of the dataset

Indicator	Possible responses	Explanation
Temporal resolution	>= Year >= Month < Year >= Day <Month <Day Unknown Not Assessed Not applicable (no time series)	This indicates the temporal resolution (time interval) of the data in the set
Temporal window	Forecast Hindcast (Near) real-time Historical Unknown Not assessed Not applicable	This indicates what the 'temporal window' of the dataset is
Vertical resolution	0 >0 Unknown Not assessed	This indicates whether the dataset has a vertical spatial resolution (height) or not
Is the original purpose for which the data was collected known? (If yes, select purpose from available list)	Yes No Not assessed	This indicates whether the original purpose (the purpose for which the data is generated) is known

Some notable indicators that we are aware of (i.e., identified in the earlier SBC projects) but will not be evaluated in the Arctic SBC are:

- Accuracy. Although the accuracy of positional and temporal information is highly relevant, it is generally captured by the precision (i.e., the resolution) in which the data is provided. In the present study only the resolution (precision) is scored. The resolution is assumed to be a proxy for accuracy.
- Completeness. It will be virtually impossible to evaluate the completeness of all datasets in the identified data sources. This should be addressed case specific in the other WPs (when incompleteness is encountered).
- Lineage. This indicator describes the life-cycle of a dataset, from where and how it was collected up to how it is disseminated. Although some specific aspects will be addressed (e.g. level of processing) in the current study, the complete lineage cannot be scored with a proper single closed question.
- Visibility. This indicator should give information on the visibility of the dataset. It is difficult to determine an objective indicator for visibility. Although the Mediterranean Sea SBC project has come up with such an objective indicator it is very laborious and gives only limited information and is therefore not included in the Arctic SBC
- User-friendliness. While accessing several datasets it became apparent that the user-friendliness, with which data is offered by data sources, is highly variable. Unfortunately, user-friendliness is also hard to score subjectively. An option would be to set up a rating system, where multiple users could rate the user-friendliness. To get a balanced idea of the user-friendliness this would require the rating of a large number of users which is not feasible in the context of the current project.

Annex 2 Dataset adequacy indicators

Adequacy indicators apply to the adequacy of a dataset for the use with a specific purpose in a specific assessment report. Some of the indicators are similar to the quality indicators. However, when assessing the adequacy it is determined whether the provided quality is sufficient for the purpose of the assessment report.

Table 2.1
Dataset adequacy indicators, their scoring options and explanation

Indicator	Possible responses	Explanation
Data used	Yes No Unknown Not assessed	This indicates whether a dataset was only considered to be used in an assessment report, or was actually used.
Processing of data	No processing required Processing required Unknown Not assessed	This indicates if the dataset required any processing for its use in the assessment report.
Data format	Original format used Converted format used Unknown Not assessed	This indicates whether a dataset was used directly in the file/data format as provided by the source, or reformatting was required.
Necessity of data for purpose	Absolute necessity Limited necessity Unknown Not assessed	This indicates the level of necessity of the dataset for the purpose in the assessment report in which it was used.
Matching of spatial coverage	Match Limited match (data usable) No match (data not usable) Unknown Not assessed	This indicates whether the spatial coverage of the dataset as required for the purpose of the assessment report matches with that of the dataset as provided.
Matching of temporal coverage	Match Limited match (data usable) No match (data not usable) Unknown Not assessed	This indicates whether the temporal coverage of the dataset as required (required time period) for the purpose of the assessment report matches with that of the dataset as provided (available time period).
Matching of spatial resolution	Match Limited match (data usable) No match (data not usable) Unknown Not assessed Not applicable (e.g. site, river)	This indicates whether the spatial resolution of the dataset as required for the purpose of the assessment report matches with that of the dataset as provided.
Matching of temporal resolution	Match Limited match (data usable) No match (data not usable) Unknown Not assessed Not applicable (i.e. no time series)	This indicates whether the temporal resolution of the dataset as required for the purpose of the assessment report matches with that of the dataset as provided.

Indicator	Possible responses	Explanation
Budget restrictions	No restrictions Some restrictions (data usable) Restrictions (data not usable) Unknown Not assessed	This indicates whether the project of the assessment report in which the dataset was considered or used had budget restrictions that could affect the usability of the dataset.
Project time restrictions	No restrictions Some restrictions (data usable) Restrictions (data not usable) Unknown Not assessed	This indicates whether the project of the assessment report in which the dataset was considered or used had time (or planning) restrictions that could affect the usability of the dataset (e.g. data could not be obtained in time).

Annex 3 Data sources as currently listed in the CMS

Table 3.1
Data sources as currently identified and listed in the CMS

Data source name	URL	Comment
Aarhus university department of bioscience marine ecology roskilde	https://www.bodc.ac.uk/data/information_and_inventories/edmed/org/729/	Denmark
ACADIS	http://nsidc.org/acadis	ACADIS is a collaborative project between the University Corporation for Atmospheric Research (UCAR), the National Center for Atmospheric Research (NCAR), and the National Snow and Ice Data Center (NSIDC). ACADIS developed the Arctic Data Explorer - offering accessible, multi-faceted and efficient navigation of interdisciplinary Arctic data.
Alaska Department of Fish and Game		
AquaNIS	http://www.corpi.ku.lt/databases/index.php/aquanis/	
Arctic Geographical Information System (ArkGIS)	http://arkgis.org/	
Arctic Great Rivers Observatory (Arctic-GRO)	http://arcticgreatrivers.org/data.html	
Arctic Integration Portal		
Arctic Regional Ocean Observing System (ROOS)	http://www.arctic-roos.org/	
ArcticData	http://www.arcticdata.is	A web portal housed under the Arctic Portal, where spatial datasets with attached attribute data from CAFF and PAME are being made available to the public and research community to access and use as needed.
ArcticRIMS		
Argos cls	http://www.argos-system.org/?nocache=0.3616816425917363	Worldwide tracking and environmental monitoring by satellite
Biotic	http://www.marlin.ac.uk/biotic	
British oceanographic data centre (bodc)	http://www.bodc.ac.uk/	
Canadian Ice Service	http://www.ec.gc.ca/glaces-ice/?lang=En	
Center of the Ice Hydrological and Meteorological Information of the AARI	http://www.aari.nw.ru/index_en.html	
Centre d'etudes techniques maritimes et fluviales (cetmef)	https://www.bodc.ac.uk/data/information_and_inventories/edmed/org/555/	French portal
Cnes	https://cnes.fr/en/web/CNES-en/3773-about-cnes.php	CNES is the French government agency responsible for shaping and implementing France's space policy in

Data source name	URL	Comment
		Europe.
Collecte localisation satellite	http://www.cls.fr/web/en/115-ground-segments-and-operations.php	French portal but probably also Arctic data?
Complex systems research center (csrc) university of new hampshire	http://www.csrc.sr.unh.edu/dataprod.shtml	The Complex Systems Research Center (CSRC) at the University of New Hampshire investigates "the effects of human disturbance on the Earth's biogeochemical processes
Copernicus Marine Environment Monitoring Service	http://marine.copernicus.eu/	
DAISIE Delivering Alien Invasive Species Inventories for Europe	http://www.europe-aliens.org/	
Danish Geodata Agency (Geodatastyrelsen)	http://gst.dk/	
Danish Meteorological Institute	http://www.dmi.dk/en/vejr/	
Data support section of the computational and information systems laboratory at the national center for atmospheric research	http://rda.ucar.edu/	CISL's mission is to support and advance the geosciences with world-class computing, data management and research in mathematics and computational science
DataBasin.org	http://databasin.org/	Searchable data-portal by CBI (global, free)
DFO Fisheries and Oceans Canada Marine Protected Areas		
Dg environment joint research centre eurostat european environment agency	http://ec.europa.eu/eurostat/web/environmental-data-centre-on-natural-resources	Eurostat's Environmental Data Centre on Natural Resources (EDCNR) is an online repository for a broad range of data on Natural Resources in Europe.
EASIN European Alien Species Information Network	http://easin.jrc.ec.europa.eu/	
Eea	http://www.eea.europa.eu/data-and-maps	European environment agency
EMIS/GMIS		
Emodnet bathymetry	http://www.emodnet.eu/bathymetry	
Emodnet chemistry	http://www.emodnet.eu/chemistry	
Emodnet Coastal mapping	http://www.emodnet.eu/coastal-mapping	
Emodnet geology	http://www.emodnet.eu/geology	
Emodnet Human activities	http://www.emodnet.eu/human-activities	
Emodnet physics	http://www.emodnet.eu/physics	
Emodnet seabed habitats	http://www.emodnet.eu/seabed-habitats	
European Atlas of the Seas	http://ec.europa.eu/maritimeaffairs/atlas/maritime_atlas/	
European centre for medium-range weather forecasts	http://www.ecmwf.int/	global weather forecasts
European global ocean observing	http://eurogoos.eu/	

Data source name	URL	Comment
system (eurogoos)		
European space agency	http://www.esa.int/ESA	
European space agency – Climate Change Initiative	http://esa-cci.nersc.no/?q=products	
FAO Aquastat		
Food and agriculture organization of the united nations fisheries and aquaculture department	http://www.fao.org/fishery/geoinfo/en	
Gebco	http://www.gebco.net/	bathymetry of the world's oceans
General NOAA Operational Modeling Environment	http://response.restoration.noaa.gov/gnome	
GeoBasis - ZERO		
GISIN Global Invasive Species Information Network	http://www.gisin.org/	
Global Marine Networks	http://www.globalmarinenet.com/free-grib-file-downloads/	Wind and wave forecasts
Global Sea Level Observing System (GLOSS)		
GRDC Global Runoff Data Centre Discharge Data		
GRID Arendal		
Hadley Centre		
Havforskningsinstituttet IMR Institute of Marine Research		
HYDAT Watersurvey of Canada		
Iccat	https://www.iccat.int/en/introduction.htm	Atlantic tuna
ICES data portal	http://ecosystemdata.ices.dk/	
ICES library, Data Outputs	http://ices.dk/publications/library/Pages/default.aspx	Searchable data-portal from ICES
Ifremer	http://wwz.ifremer.fr/institut_eng	French institute
Ifremer ERSAT	http://cersat.ifremer.fr/oceanography-from-space/our-domains-of-research/sea-ice	
Ifremer idmsismer	https://www.bodc.ac.uk/data/information_and_inventories/edmed/org/486/	
Insu	http://www.insu.cnrs.fr/	French institute. INSU coordinates strategic planning for European astronomy (ASTRONET) and collaborates in the development of European observation networks (RESIFEPOS, ERA-MIN, ICOS, IAGOS, EMSO, etc).
Insu (i national sciences de l'univers) serv d'obs en milieu littoral – somlit	http://www.insu.cnrs.fr/node/1247	part of INSU
Integrated Climate Data Center - ICDC		

Data source name	URL	Comment
- Hamburg University		
Isac – institute of atmospheric sciences and climate	http://www.isac.cnr.it/	
ISC The CABI Invasive Species Compendium	http://www.cabi.org/isc/	
Jrc – institute for environment and sustainability (ies)	https://ec.europa.eu/jrc/en/institutes/ies	
Marbef – marine biodiversity and ecosystem functioning	http://www.marbef.org/	
Mareano	http://www.mareano.no/kart/mareano.html	
Marine renewable integrated application platform	http://www.marina-platform.info/	
Marine traffic	http://www.marinetraffic.com/en/	
Mercator ocean	http://www.mercator-ocean.fr/	
MESMA Geoportal	http://mesma.ucc.ie/geoportal/	
Met office	http://www.metoffice.gov.uk/	
Meteo france	http://www.meteofrance.com/	
Miljødirektoratet.NO		
MPAtlas: Russia		
Naalakkersuisut		
Nansen Environmental and Remote Sensing Center (NERSC)	http://thredds.nersc.no/	
National and Kapodistrian university of Athens department of physics atmospheric modeling and weather forecasting group	http://forecast.uoa.gr/about.php	
National oceanic and atmospheric administration (noaa)	http://www.noaa.gov/	
National Snow & Ice Data Center (NSIDC)		
Natura2000	http://natura2000.eea.europa.eu/	
Natural England Database	http://www.naturalengland.org.uk/ourwork/conservation/biodiversity/threats/nonnativeaudit.aspx	
Netherlands institute of ecology centre for estuarine and marine ecology (nioo-ceme)	http://data.nioo.knaw.nl/imis.php?module=dataset&dasid=665	
NOAA Bathymetric Dataset		
NOAA Data Catalog		
NOAA Data Catalog Version 2.23		
NOBANIS The European Network on Invasive Alien Species	https://www.nobanis.org/	
Norges geologiske undersøkelse NGU		

Data source name	URL	Comment
Northwest Atlantic Fisheries Organisation		
Norwegian Metoerological Institute (Met.no) forecast data		
Norwegian Petroleum Directorate	http://www.npd.no	
Oceanographic data center	https://www.nodc.noaa.gov/OC5/regional_climate/	
Open Street Map		
OSPAR map of MPAs	http://carto.mpa.ospar.org/1/ospar.map	
PANGAEA	http://www.pangaea.de	
Permanent service for mean sea level	http://www.psmsl.org/data/obtaining/map.html	
Polar Data Catalogue Metadata and Data Entry	https://www.polardata.ca	
Ramsar	http://www.ramsar.org/sites-countries/the-ramsar-sites	
R-ArcticNet	http://www.r-arcticnet.sr.unh.edu/v4.0/index.html	
REABIC Regional Euro-Asian Biological Invasions Centre		
SAHFOS	http://www.sahfos.ac.uk/	
Sea Ice remote Sensing (NASA)		
Seadatanet – pan-european infrastructure for marine data 2	http://seadatanet.maris2.nl/v_cdi_v3/search.asp	
Seadatanet – pan-european infrastructure for marine data management	http://www.seadatanet.org/	
SeaLifeBase	http://www.sealifebase.org/	
Service contract concerning coastal erosion evaluation of the needs for action	http://www.eurosion.org/database/index.html	Link to GIS database doesn't seem to work
SINTEF Oil Weathering Model		
Soil carbon and material fluxes across the eroding Alaska Beaufort		
State Hydrological Institute - Russia		
STECF data dissemination		
SWARP portal	http://swarp.oceandatalab.com/	
Systeme d'observation du niveau des eaux littorales	http://www.sonel.org/?lang=en	
The Arctic Biodiversity Data Service (ABDS) Data Portal	http://geo.abds.is/geonetwork/srv/eng/catalog.search#/home	
The Arctic Monitoring and Assessment Programme (AMAP)	http://www.amap.no/	AMAP is one of six Working Groups of the Arctic Council.
The Arctic Portal	http://www.arcticportal.org	The Arctic Portal is a comprehensive gateway to Arctic information and data

Data source name	URL	Comment
		on the internet, increasing information sharing and co-operation among Arctic stakeholders and granting exposure to Arctic related information and data.
The Arctic Science Portal	http://www.arctic.gov/portal/index.html	This portal can be thought of as a library of links (URLs) to websites where Arctic data are made publicly available. Main focus is on the US Arctic.
The IUCN Red List of Threatened Species	http://www.iucnredlist.org/	
The Sustaining Arctic Observing Networks (SAON)	http://www.arcticobserving.org	The SAON process was initiated by the Arctic Council (AC) in 2007. Its goal is to enhance Arctic-wide observing activities by facilitating partnerships and synergies among existing observing and data networks ("building blocks"), and promoting sharing and synthesis of data and information.
U.S. National Ice Center / Naval Ice Center	http://www.natice.noaa.gov/Main_Products.htm	
Unesco	http://whc.unesco.org/en/list/	
Unified Federal Service for Observation and Control of Environmental Pollution (OGSNK) and GSN		Data source predates the internet era. The data cannot be found online. It is referenced in several assessment reports.
United Nations environment programme global environment monitoring system (unepgems)	http://www.gemstat.org/	
United States Geological Survey (USGS) Water-Quality Data for the Nation	http://waterdata.usgs.gov/nwis/qw	
University of hawaii sea level center	http://ilikai.soest.hawaii.edu/uhslc/data.html	
University of new hampshire	http://www.unh.edu/	
USA NOAA National Marine Protected Areas Center		
USGS Arctic Bathymetry		
USGS Bathymetric Maps		
USGS Earth Explorer		
USGS Store		
WCO	http://www.westernchannelobservatory.org.uk/	
World database on protected areas	http://www.protectedplanet.net/	
World Ocean Database	http://www.nodc.noaa.gov/OC5/WOD/pr_wod.html	
WoRMS World Register of Marine Species	http://www.marinespecies.org/	
Wwf	http://www.worldwildlife.org/pages/conservation-science-data-and-tools	

Annex 4 Full list of datasets in CMS

Table 4.1

Datasets currently listed in the CMS sorted by parameter and linked to its data source

P02 parameter	dataset name	data sources
(ADUN) Administrative units	EBSA Arctic	Convention on Biological Diversity CBD
(ADUN) Administrative units	ECAREG database	Department of Fisheries and Oceans, Canada
(ADUN) Administrative units	Marine Protected Areas - management plan active (marin_vp_oppstart)	Miljødirektoratet.NO
(ADUN) Administrative units	Marine Protected Areas - management plan inactive (marin_vp_ikke_oppstart	Miljødirektoratet.NO
(ADUN) Administrative units	Marine Protected Areas - proposed (foreslatt_vern_utm33)	Miljødirektoratet.NO
(ADUN) Administrative units	MPAtlas - Russia	MPAtlas: Russia
(ADUN) Administrative units	Open Street Map OSM topographic data Arctic countries	Open Street Map
(ADUN) Administrative units	AMAP Boundary	The Arctic Biodiversity Data Service (ABDS) Data Portal
(ADUN) Administrative units	MPA inventory 2014	USA NOAA National Marine Protected Areas Center
(ADUN) Administrative units	World Database of Protected Areas WDPA	World database on protected areas
(ALAT) Horizontal spatial co-ordinates	Bowhead Whale Subsistence Sensitivity Mapping	Barrow Area Information Database (BAID) Geospatial Datasets, Barrow, AK, USA
(ALAT) Horizontal spatial co-ordinates	length of coastline	CIA World Factbook
(ALAT) Horizontal spatial co-ordinates	DataBasin Alaska Arctic Vegetation	DataBasin.org
(ALAT) Horizontal spatial co-ordinates	DataBasin Arctic Field Research Projects	DataBasin.org
(ALAT) Horizontal spatial co-ordinates	DataBasin Circumpolar Arctic Bioclimate Subzones	DataBasin.org
(ALAT) Horizontal spatial co-ordinates	DataBasin Circumpolar Arctic Lake Cover (% water coverage)	DataBasin.org
(ALAT) Horizontal spatial co-ordinates	DataBasin Circumpolar Arctic Landscape	DataBasin.org
(ALAT) Horizontal spatial co-ordinates	DataBasin Circumpolar Arctic Region Floristic Provinces	DataBasin.org
(ALAT) Horizontal spatial co-ordinates	DataBasin Circumpolar Arctic Substrate Chemistry	DataBasin.org
(ALAT) Horizontal spatial co-ordinates	DataBasin Circumpolar Arctic Vegetation	DataBasin.org
(ALAT) Horizontal spatial co-ordinates	Natura2000 MPA	Natura2000
(ALAT) Horizontal spatial co-ordinates	NRCAN (Natural Resources Canada), 2010. GeoBase orthoimage 2005–2010. http://www.geobase.ca/geobase/en/data/imager	Natural Resources Canada

P02 parameter	dataset name	data sources
	y/imr/index.html	
(ALAT) Horizontal spatial co-ordinates	NRCAN, 2012. National topographic data base (NTDB) of Canada, Toporama. ftp://ftp2.cits.rncan.gc.ca/pub/bndt/50k_shp_en/	Natural Resources Canada
(ALAT) Horizontal spatial co-ordinates	OSPAR MPAs	OSPAR map of MPAs
(ALAT) Horizontal spatial co-ordinates	Ramsar sites	Ramsar
(ALAT) Horizontal spatial co-ordinates	relative size of international waters	Sea around us
(ALAT) Horizontal spatial co-ordinates	IUCN Red List of Threatened Species Extent	The IUCN Red List of Threatened Species
(ALAT) Horizontal spatial co-ordinates	UNESCO world heritage list MPA	Unesco
(ALAT) Horizontal spatial co-ordinates	International MPA coverage data	United Nations Millennium Development Goals Indicators
(ALAT) Horizontal spatial co-ordinates	WDPA MPA	World database on protected areas
(APDA) Horizontal platform movement	MarineTraffic ship positions, velocity and heading	Marine traffic
(ASLV) Sea level	INSITU_ARC_NRT_OBSERVATIONS_013_031_sea_surface_height_above_sea_level	Copernicus Marine Environment Monitoring Service
(ASLV) Sea level	SEALEVEL_ARC_SLA_L3_NRT_OBSERVATIONS_008_025	Copernicus Marine Environment Monitoring Service
(ASLV) Sea level	SEALEVEL_GLO_MDT_L4_REF_OBSERVATIONS_008_013	Copernicus Marine Environment Monitoring Service
(ASLV) Sea level	SEALEVEL_GLO_MSS_L4_REF_OBSERVATIONS_008_015	Copernicus Marine Environment Monitoring Service
(ASLV) Sea level	SEALEVEL_GLO_REF20YTO7Y_L4_OBSERVATIONS_008_034	Copernicus Marine Environment Monitoring Service
(ASLV) Sea level	SEALEVEL_GLO_SLA_L3_NRT_OBSERVATIONS_008_017	Copernicus Marine Environment Monitoring Service
(ASLV) Sea level	SEALEVEL_GLO_SLA_L3_REP_OBSERVATIONS_008_018	Copernicus Marine Environment Monitoring Service
(ASLV) Sea level	SEALEVEL_GLO_SLA_MAP_L4_NRT_OBSERVATIONS_008_026	Copernicus Marine Environment Monitoring Service
(ASLV) Sea level	SEALEVEL_GLO_SLA_MAP_L4_REP_OBSERVATIONS_008_027	Copernicus Marine Environment Monitoring Service
(ASLV) Sea level	Permanent Service for Mean Sea Level (PSMSL)	Global Sea Level Observing System (GLOSS)
(ASLV) Sea level	Permenant Service for Mean Sea Level	Permanent service for mean sea level
(ASLV) Sea level	UH Sea Level Center (UHSLC) Tide Gauge Data Quality" Daily Data"	University of hawaii sea level center
(ASLV) Sea level	UH Sea Level Center (UHSLC) Tide Gauge Data Quality" Hourly"	University of hawaii sea level center
(ATEM) Atmospheric emissions	AMAP gridded_Hg_emissions_2010v1	The Arctic Monitoring and Assessment Programme (AMAP)

P02 parameter	dataset name	data sources
(ATEM) Atmospheric emissions	AMAP gridded_Hg_emissions_2010v1_sector_subsets_2jan2014	The Arctic Monitoring and Assessment Programme (AMAP)
(BDRV) Biodiversity indices	CAFF Arctic Biodiversity Assessment	Conservation of Arctic Flora and Fauna (CAFF)
(BDRV) Biodiversity indices	Top 10 species (biodiversity)	Mareano
(BRDA) Bird counts	Marine Important Bird Areas in Alaska	Audobon Alaska
(BRDD) Bird taxonomy-related abundance per unit area of surface	US FWS Alaska Bird Colony Locations	US Fish and Wildlife Service Migratory Bird Management
(CDTA) Air temperature	Air temperatures	eKlima (from Norwegian Meteorological Institute)
(CDTA) Air temperature	natice 15-Day WISIF Graphs (temperature)	U.S. National Ice Center / Naval Ice Center
(CNTX) Phytoplankton generic biomass in water bodies	ARCTIC_REANALYSIS_BIO_002_005_mole_concentration_of_phytoplankton_expressed_as_nitrogen_in_sea_water	Copernicus Marine Environment Monitoring Service
(COGE) Coastal geomorphology	Geomorphology: coastal cliff recession	GeoBasis - ZERO
(COGE) Coastal geomorphology	Geomorphology: topographic beach profile	GeoBasis - ZERO
(COGE) Coastal geomorphology	Bank Height of 48 Sampling Locations Along the Beaufort Sea Coast, Alaska	Soil carbon and material fluxes across the eroding Alaska Beaufort
(COGE) Coastal geomorphology	Coastal Type of of 48 Sampling Locations Along the Beaufort Sea Coast, Alaska	Soil carbon and material fluxes across the eroding Alaska Beaufort
(COGE) Coastal geomorphology	Erosion Rate of 48 Sampling Locations Along the Beaufort Sea Coast, Alaskaa	Soil carbon and material fluxes across the eroding Alaska Beaufort
(COGE) Coastal geomorphology	ASTER GLOBAL DEM	USGS Earth Explorer
(COGE) Coastal geomorphology	Global 30 Arc-Second Elevation (GTOPO30)	USGS Earth Explorer
(COGE) Coastal geomorphology	Global Multi-resolution Terrain Elevation Data 2010 (GMTED2010)	USGS Earth Explorer
(COGE) Coastal geomorphology	Interferometric Synthetic Aperture Radar (IFSAR) Alaska	USGS Earth Explorer
(COGE) Coastal geomorphology	Light Detection and Ranging (LIDAR)	USGS Earth Explorer
(COGE) Coastal geomorphology	Map showing Beaufort Sea coastal erosion and accretion between Flaxman Island and the Canadian border, northeastern Alaska thirty-year coastline comparison, sediment volumes released, and physiographi	USGS Store
(CORG) Particulate total and organic carbon concentrations in the water column	Arctic-GRO Particulate carbon	Arctic Great Rivers Observatory (Arctic-GRO)
(CPWC) Chlorophyll pigment concentrations in water bodies	ARCTIC_REANALYSIS_BIO_002_005_mass_concentration_of_chlorophyll_in_sea_water	Copernicus Marine Environment Monitoring Service
(CPWC) Chlorophyll pigment concentrations in water bodies	INSITU_ARC_NRT_OBSERVATIONS_013_031_mass_concentration_of_chlorophyll_a_in_sea_water	Copernicus Marine Environment Monitoring Service

P02 parameter	dataset name	data sources
(CPWC) Chlorophyll pigment concentrations in water bodies	OCEANCOLOUR_ARC_CHL_L3_NRT_OBSERVATIONS_009_047	Copernicus Marine Environment Monitoring Service
(CPWC) Chlorophyll pigment concentrations in water bodies	OCEANCOLOUR_ARC_CHL_L3_REP_OBSERVATIONS_009_069	Copernicus Marine Environment Monitoring Service
(CPWC) Chlorophyll pigment concentrations in water bodies	OCEANCOLOUR_ARC_OPTICS_L3_NRT_OBSERVATIONS_009_046	Copernicus Marine Environment Monitoring Service
(CPWC) Chlorophyll pigment concentrations in water bodies	Chlorophyll Concentration (MODIS-A)	EMIS/GMIS
(CRYS) Snow and ice mass, thickness and extent	DAILY ICE MAP FROM SSMI, NERSC	Arctic Regional Ocean Observing System (ROOS)
(CRYS) Snow and ice mass, thickness and extent	Regional Ice Charts	Arctic Regional Ocean Observing System (ROOS)
(CRYS) Snow and ice mass, thickness and extent	SEASONAL ICE EXTENT IN Mill SQ.Km	Arctic Regional Ocean Observing System (ROOS)
(CRYS) Snow and ice mass, thickness and extent	canadian Sea Ice information	Canadian Ice Service
(CRYS) Snow and ice mass, thickness and extent	RADARSAT-1 ICE	Canadian Space Agency
(CRYS) Snow and ice mass, thickness and extent	Ice chart Western Arctic	CIS (Canadian Ice Service, division of the Meteorological Service of Canada (MSC))
(CRYS) Snow and ice mass, thickness and extent	ARCTIC_ANALYSIS_FORECAST_PHYS_002_001_a_sea_ice_thickness	Copernicus Marine Environment Monitoring Service
(CRYS) Snow and ice mass, thickness and extent	ARCTIC_REANALYSIS_PHYS_002_003_sea_ice_thickness	Copernicus Marine Environment Monitoring Service
(CRYS) Snow and ice mass, thickness and extent	SEAICE_ARC_SEAICE_L4_NRT_OBSERVATIONS_011_002	Copernicus Marine Environment Monitoring Service
(CRYS) Snow and ice mass, thickness and extent	SEAICE_ARC_SEAICE_L4_NRT_OBSERVATIONS_011_003	Copernicus Marine Environment Monitoring Service
(CRYS) Snow and ice mass, thickness and extent	DataBasin Circum-Arctic Map of Permafrost and Ground Ice Conditions	DataBasin.org
(CRYS) Snow and ice mass, thickness and extent	ESA CryoSat	European space agency
(CRYS) Snow and ice mass, thickness and extent	grl54619-sup-0002-ds01.gz (from McMillan et al. (2016))	European space agency
(CRYS) Snow and ice mass, thickness and extent	Arctic Sea Ice Extent_IARC_JAXA	IARC-JAXA information system (IJIS)
(CRYS) Snow and ice mass, thickness and extent	AMSR-E ASI 6.25 km Sea Ice Concentration Data, V5.5	Integrated Climate Data Center - ICDC - Hamburg University
(CRYS) Snow and ice mass, thickness and extent	Arctic Sea Ice Extent_NASA Goddard	NASA Goddard Sea Ice Remote Sensing
(CRYS) Snow and ice mass, thickness and extent	Sea Ice cover	National Atlas of Canada
(CRYS) Snow and ice mass, thickness and extent	NSIDC - World Glacier Inventory, Version 1	National Snow & Ice Data Center (NSIDC)
(CRYS) Snow and ice mass, thickness and extent	Sea ice extent	National Snow & Ice Data Center (NSIDC)
(CRYS) Snow and ice mass,	Sea Ice Index	National Snow & Ice Data Center

P02 parameter	dataset name	data sources
thickness and extent		(NSIDC)
(CRYS) Snow and ice mass, thickness and extent	SSM/I sea ice concentration data	National Snow & Ice Data Center (NSIDC)
(CRYS) Snow and ice mass, thickness and extent	Unified Sea Ice Thickness Climate Data Record Collection Spanning 1947-2012	National Snow & Ice Data Center (NSIDC)
(CRYS) Snow and ice mass, thickness and extent	Arctic Sea Ice Extent_OSI SAF	OSI SAF
(CRYS) Snow and ice mass, thickness and extent	- Greenland ICESat mass balance maps (from Zwally et al. (2011))	Sea Ice remote Sensing (NASA)
(CRYS) Snow and ice mass, thickness and extent	SMMR/SSMI derived sea ice concentration	Sea Ice remote Sensing (NASA)
(CRYS) Snow and ice mass, thickness and extent	Arctic Climate Issues 2011: Changes in Arctic Snow, Water, Ice and Permafrost	The Arctic Monitoring and Assessment Programme (AMAP)
(CRYS) Snow and ice mass, thickness and extent	Arctic Sea Ice Extent_Cryosphere today	The Cryosphere Today, University of Illinois at Urbana-Champaign
(CRYS) Snow and ice mass, thickness and extent	natice 15-Day WISIF Graphs	U.S. National Ice Center / Naval Ice Center
(CRYS) Snow and ice mass, thickness and extent	natice Daily Ice Edge GRIB Files	U.S. National Ice Center / Naval Ice Center
(CRYS) Snow and ice mass, thickness and extent	natice MIZ (PNG) Files	U.S. National Ice Center / Naval Ice Center
(CRYS) Snow and ice mass, thickness and extent	Arctic Sea Ice Extent_Uni of Bremen	University of Bremen
(DOCC) Dissolved organic carbon concentration in the water column	Arctic-GRO DOC	Arctic Great Rivers Observatory (Arctic-GRO)
(DOCC) Dissolved organic carbon concentration in the water column	USGS DOC	United States Geological Survey (USGS) Water-Quality Data for the Nation
(DOXY) Dissolved oxygen parameters in the water column	ARCTIC_REANALYSIS_BIO_002_005_mass_concentration_of_oxygen_in_sea_water	Copernicus Marine Environment Monitoring Service
(DOXY) Dissolved oxygen parameters in the water column	INSITU_ARC_NRT_OBSERVATIONS_013_031_moles_of_oxygen_per_unit_mass_in_sea_water	Copernicus Marine Environment Monitoring Service
(EWSB) Wind strength and direction	Global Ocean Wind Observations Climatology REPROCESSED (Monthly means) (2007-2012)	Copernicus Marine Environment Monitoring Service
(EWSB) Wind strength and direction	WIND_GLO_WIND_L3_NRT_OBSERVATIONS_012_002	Copernicus Marine Environment Monitoring Service
(EWSB) Wind strength and direction	WIND_GLO_WIND_L4_NRT_OBSERVATIONS_012_004_wind	Copernicus Marine Environment Monitoring Service
(EWSB) Wind strength and direction	WIND_GLO_WIND_L4_REP_OBSERVATIONS_012_003_wind	Copernicus Marine Environment Monitoring Service
(EWSB) Wind strength and direction	ESA EnviSat Wind	European space agency
(EWSB) Wind strength and direction	GMN Wind	Global Marine Networks
(EWSB) Wind strength and direction	Cross-Calibrated Multi-Platform Ocean Surface Wind Vector L3.0 First-Look Analyses	Physical Oceanography Distributed Active Archive Center (PODAAC)

P02 parameter	dataset name	data sources
(FATX) Fish abundance in water bodies	Yukon Fish and Fish Habitat Atlas	Community Mapping Network
(FATX) Fish abundance in water bodies	Abundance indices of 0-group cod, haddock, capelin, herring, and redfish	Havforskningsinstituttet IMR Institute of Marine Research
(FATX) Fish abundance in water bodies	North east arctic cod_age specific survey index_Barents Sea	ICES report (Jakobsen, T., Korsbrekke, K., Mehl, S., and Nakken, O. 1997. Norwegian combined acoustic and bottom trawl surveys)
(FATX) Fish abundance in water bodies	Marine Ecology and Stock Assessment (MESA)	NOAA Alaska Fisheries Science Center
(FCST) Fish and shellfish catch statistics	Harvest information for Alaska communities	Alaska Department of Fish and Game
(FCST) Fish and shellfish catch statistics	Statistics commercial fisheries Canada	DFO Fisheries and Oceans Canada Marine Protected Areas
(FCST) Fish and shellfish catch statistics	Fisheries catches EUROSTAT for NEA	Dg environment joint research centre eurostat european environment agency
(FCST) Fish and shellfish catch statistics	Commercial fish landings with Good Environmental Status information	Eea
(FCST) Fish and shellfish catch statistics	Fish catches emodnet NEA	Emodnet Human activities
(FCST) Fish and shellfish catch statistics	Global capture production FAO	Food and agriculture organization of the united nations fisheries and aquaculture department
(FCST) Fish and shellfish catch statistics	Catch and effort ICCAT	Iccat
(FCST) Fish and shellfish catch statistics	Catch statistics ICES for NEA	ICES data portal
(FCST) Fish and shellfish catch statistics	North east arctic cod_catch at age_annual estimates_1985-2003	ICES Report of the Arctic Fisheries Working Group 2004
(FCST) Fish and shellfish catch statistics	Catch and landings reports NOAA	National oceanic and atmospheric administration (noaa)
(FCST) Fish and shellfish catch statistics	NAFO fisheries statistics	Northwest Atlantic Fisheries Organisation
(FCST) Fish and shellfish catch statistics	Fisheries catches Arctic	Seas Around Us
(FCST) Fish and shellfish catch statistics	Fisheries landings and discards STECF for NEA	STECF data dissemination
(FEFF) Fishing effort	Ship traffic lines fishing vessels	Arctic Geographical Information System (ArkGIS)
(FEFF) Fishing effort	Bottom Trawling and Dredging by Marine Ecoregion	DataBasin.org
(FEFF) Fishing effort	Fisheries effort EUROSTAT for NEA	Dg environment joint research centre eurostat european environment agency
(FEFF) Fishing effort	Regional fishing effort and capacity EEA	Eea
(FEFF) Fishing effort	Fishing fleet EU	European Atlas of the Seas
(FEFF) Fishing effort	NAFO Fisheries effort	Northwest Atlantic Fisheries Organisation
(FEFF) Fishing effort	Fisheries effort STECF for NEA	STECF data dissemination

P02 parameter	dataset name	data sources
(GP080) Fishing by-catch	Fisheries observer data Canada	DFO Fisheries and Oceans Canada Marine Protected Areas
(GP080) Fishing by-catch	ICES workinggroup report Bycatch of Protected Species	ICES library, Data Outputs
(HBCH) Habitat characterisation	Aarhus - Oil Spill Sensitivity Atlas (greenland)	Aarhus university department of bioscience marine ecology roskilde
(HBCH) Habitat characterisation	Essential Fish Habitats Arctic	Arctic Integration Portal
(HBCH) Habitat characterisation	Seabed habitats emodnet NEA	Emodnet seabed habitats
(HBCH) Habitat characterisation	Vulnerable biotopes Mareano	Mareano
(HBCH) Habitat characterisation	Habitats and biotopes MESMA	MESMA Geoportal
(HBCH) Habitat characterisation	Map protected areas Greenland	Naalakkersuisut
(HBCH) Habitat characterisation	Marine Landscapes	Norges geologiske undersÃ¸kelse NGU
(HBCH) Habitat characterisation	Polar Bear Maternal Den Habitat	the United States Geological Survey (USGS)
(HBEX) Habitat extent	Salt Marsh Abundance by Marine Ecoregion	DataBasin.org
(HBEX) Habitat extent	Subsea permafrost and sea ice extent in the northern hemisphere	DataBasin.org
(HBEX) Habitat extent	Tree line in the northern hemisphere	DataBasin.org
(HBEX) Habitat extent	U.S. FWS Threatened & Endangered Species Active Critical Habitat Report	ECOS Environmental Conservation Online System, U.S. Fish & Wildlife Service
(HEAV) Wave height estimates	GMN Wave	Global Marine Networks
(HEAV) Wave height estimates	Jason-1 Altimeter Geophysical Data	Physical Oceanography Distributed Active Archive Center (PODAAC)
(ICEM) Ice motion and related parameters	ARCTIC_ANALYSIS_FORECAST_PHYS_002_001_a_sea_ice_velocity	Copernicus Marine Environment Monitoring Service
(ICEM) Ice motion and related parameters	ARCTIC_REANALYSIS_PHYS_002_003_sea_ice_velocity	Copernicus Marine Environment Monitoring Service
(ICEM) Ice motion and related parameters	SEAICE_ARC_SEAICE_L3_REP_OBSERVATIONS_011_010	Copernicus Marine Environment Monitoring Service
(ICEM) Ice motion and related parameters	Sea Ice Concentration SIC_CRDP (SSMI, Arctic & Antarctic)	Integrated Climate Data Center - ICDC - Hamburg University
(ICEM) Ice motion and related parameters	Sea Ice Thickness SIT_CRDP (Arctic)	Integrated Climate Data Center - ICDC - Hamburg University
(ICEM) Ice motion and related parameters	Arctic Ice Charts	Nansen Environmental and Remote Sensing Center (NERSC)
(ICEM) Ice motion and related parameters	NERSC neXtSIM coupled ice ocean model	Nansen Environmental and Remote Sensing Center (NERSC)
(ICEM) Ice motion and related parameters	Polar Pathfinder Daily 25 km EASE-Grid Sea Ice Motion Vectors	National Snow & Ice Data Center (NSIDC)
(IPHY) Snow and ice physical	ACADIS Physical/chemical and biological measurements of properties of sea ice and	ACADIS

P02 parameter	dataset name	data sources
properties and characteristics	under-ice water collected near Barrow	
(IPHY) Snow and ice physical properties and characteristics	SEAICE_ARC_SEAICE_L4_NRT_OBSERVATIONS_011_008_sea_ice_surface_temperature	Copernicus Marine Environment Monitoring Service
(IRBO) Stable isotope enrichment in biota	ACADIS Arctic cod fatty acid concentration and stable carbon isotope data from Arctic Alaska	ACADIS
(LIBI) Biota lipid concentrations	ACADIS Arctic cod fatty acid concentration and stable carbon isotope data from Arctic Alaska	ACADIS
(LIBI) Biota lipid concentrations	ACADIS Ice seal fatty acid concentrations and stable carbon isotopes of individual fatty acids from the Bering Sea and Arctic Alaska	ACADIS
(MBAN) Bathymetry and Elevation	Bathymetry data for Hudson Bay	Gebco
(MBAN) Bathymetry and Elevation	GEBCO_2014 Grid	Gebco
(MBAN) Bathymetry and Elevation	One Stop Datashop (OSDS) Continental Shelf Programme	GRID Arendal
(MBAN) Bathymetry and Elevation	NRCAN, 2011. CanVec version 9, hydrography theme. ftp://ftp2.cits.rncan.gc.ca/pub/canvec/.	Natural Resources Canada
(MBAN) Bathymetry and Elevation	NOAA Bathymetric Data Viewer	NOAA Bathymetric Dataset
(MBAN) Bathymetry and Elevation	IBCAO	NOAA Data Catalog
(MBAN) Bathymetry and Elevation	IBCAO Gridded Bathymetric Data	NOAA Data Catalog
(MBAN) Bathymetry and Elevation	ICBAO Contour Data Files	NOAA Data Catalog
(MBAN) Bathymetry and Elevation	International Bathymetric Chart of the Arctic Ocean, Version 2.23	NOAA Data Catalog Version 2.23
(MBAN) Bathymetry and Elevation	batharcst	USGS Arctic Bathymetry
(MBAN) Bathymetry and Elevation	anadbath	USGS Bathymetric Maps
(MBAN) Bathymetry and Elevation	berchuk	USGS Bathymetric Maps
(MBAN) Bathymetry and Elevation	chukbath	USGS Bathymetric Maps
(MBAN) Bathymetry and Elevation	nosbath	USGS Bathymetric Maps
(MBAN) Bathymetry and Elevation	Beaufort Sea coastal erosion, sediment flux, shoreline evolution, and the erosional shelf profile	USGS: Map showing Beaufort Sea coastal erosion, sediment flux, shoreline evolution, and the erosional shelf profile
(NOYS) Acoustic noise in the water column	ACADIS Passive acoustic data from Davis Strait - C1	ACADIS
(NOYS) Acoustic noise in the water column	ACADIS Passive acoustic data from Davis Strait - C6	ACADIS
(NTOT) Particulate total and organic nitrogen concentrations in the water	Arctic-GRO Particulate nitrogen	Arctic Great Rivers Observatory (Arctic-GRO)

P02 parameter	dataset name	data sources
column		
(NTRA) Nitrate concentration parameters in the water column	Arctic-GRO Nitrate	Arctic Great Rivers Observatory (Arctic-GRO)
(NTRA) Nitrate concentration parameters in the water column	ARCTIC_REANALYSIS_BIO_002_005_mole_concentration_of_nitrate_in_sea_water	Copernicus Marine Environment Monitoring Service
(NTRA) Nitrate concentration parameters in the water column	GSN Nitrate	Unified Federal Service for Observation and Control of Environmental Pollution (OGSNK) and GSN
(NTRA) Nitrate concentration parameters in the water column	GEMSTAT nitrate	United nations environment programme global environment monitoring system (unepgems)
(NTRA) Nitrate concentration parameters in the water column	USGS Nitrate	United States Geological Survey (USGS) Water-Quality Data for the Nation
(PHOS) Phosphate concentration parameters in the water column	Arctic Great Rivers Observatory Project River Biogeochemistry Dataset	Arctic Great Rivers Observatory (Arctic-GRO)
(PHOS) Phosphate concentration parameters in the water column	ARCTIC_REANALYSIS_BIO_002_005_mole_concentration_of_phosphate_in_sea_water	Copernicus Marine Environment Monitoring Service
(PPAB) Light absorption in the water column	OCEANCOLOUR_ARC_OPTICS_L3_REP_OBSERVATIONS_009_068	Copernicus Marine Environment Monitoring Service
(PPRD) Primary production in the water column	Primary Production (SEAWIFS)	EMIS/GMIS
(PSAL) Salinity of the water column	ARCTIC_ANALYSIS_FORECAST_PHYS_002_001_a_sea_water_salinity	Copernicus Marine Environment Monitoring Service
(PSAL) Salinity of the water column	ARCTIC_REANALYSIS_PHYS_002_003_sea_water_salinity	Copernicus Marine Environment Monitoring Service
(PSAL) Salinity of the water column	INSITU_ARC_NRT_OBSERVATIONS_013_031_sea_water_salinity	Copernicus Marine Environment Monitoring Service
(PSAL) Salinity of the water column	INSITU_ARC_TS_REP_OBSERVATIONS_013_037_sea_water_salinity	Copernicus Marine Environment Monitoring Service
(PSST) Skin temperature of the water column	SEAICE_ARC_SEAICE_L4_NRT_OBSERVATIONS_011_008_sea_surface_temperature	Copernicus Marine Environment Monitoring Service
(PSST) Skin temperature of the water column	SST_ARC_SST_L4_NRT_OBSERVATIONS_010_008_b	Copernicus Marine Environment Monitoring Service
(PSST) Skin temperature of the water column	HadSST.3.1.1.0.median.zip	Hadley Centre
(PSST) Skin temperature of the water column	Sea Ice and Sea Surface Temperature dataset (HadISST1)	Hadley Centre
(PSST) Skin temperature of the water column	ODYSSEA L3 SST data product: SST_GLO_SST_L3_NRT_OBSERVATIONS_010_010	MyOcean
(PSST) Skin temperature of the water column	Extended Reconstructed Sea Surface Temperature (ERSST) v4	National oceanic and atmospheric administration (noaa)
(PSST) Skin temperature of the water column	ARK-XXVII_3_phys_oce_XCTD.tab	Pangaea
(RFVL) Horizontal velocity of	INSITU_ARC_NRT_OBSERVATIONS_013_031_se	Copernicus Marine Environment

P02 parameter	dataset name	data sources
the water column (currents)	a_water_velocity	Monitoring Service
(RFVL) Horizontal velocity of the water column (currents)	NERSC TOPAZ coupled ice ocean model output	Nansen Environmental and Remote Sensing Center (NERSC)
(RFVL) Horizontal velocity of the water column (currents)	Met.no ROMS Nowcast Forecast Model Output Norwegian Sea (4 km)	Norwegian Metoerological Institute (Met.no) forecast data
(RVDS) River flow and discharge	Arctic GRO - River Discharge	Arctic Great Rivers Observatory (Arctic-GRO)
(RVDS) River flow and discharge	ArcticRIMS Water Discharge River	ArcticRIMS
(RVDS) River flow and discharge	Arctic Runoff Data Base	GRDC Global Runoff Data Centre Discharge Data
(RVDS) River flow and discharge	ART-Russia River temperature paper page	R-ArcticNet
(RVDS) River flow and discharge	R-ArcticNet River Flow	R-ArcticNet
(RVDS) River flow and discharge	USGS Water Discharge River	United States Geological Survey (USGS) Water-Quality Data for the Nation
(SATM) Shellfish morphology, age and physiology	ICES-WGSFD Geographical dataset Surface abrasion from Fisheries	ICES library, Data Outputs
(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	AquaNIS introduction of non-indigenous species per region	AquaNIS
(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	benthic species presence	Arctic Register of Marine Species (ARMS)
(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	BIOTIC - Biological Traits Information Catalogue. Marine Life Information Network.	Biotic
(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	DAISIES invasive species presence in European regions	DAISIE Delivering Alien Invasive Species Inventories for Europe
(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	DataBasin Arctic char (Salvelinus alpinus) distribution and status by HUC8	DataBasin.org
(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	DataBasin Arctic cisco (Coregonus autumnalis) distribution and status by HUC8	DataBasin.org
(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	DataBasin Arctic grayling (Thymallus arcticus) distribution and status by HUC8	DataBasin.org
(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	DataBasin Arctic lamprey (Lampetra camtschatica) distribution and status by HUC8	DataBasin.org
(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	EASIN Geodatabase	EASIN European Alien Species Information Network
(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	EASIN-Lit	EASIN European Alien Species Information Network
(SBC_ARCTIC01) Species taxonomy, status and/or meta-	GISIN List	GISIN Global Invasive Species

P02 parameter	dataset name	data sources
information		Information Network
(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	benthic species presence	Global Biodiversity Information Facility
(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	Biological data from IMR (geographical data, sea birds, sea mammals, fish, etc.)	Havforskningsinstituttet IMR Institute of Marine Research
(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	ARMS: Arctic Register of Marine Species	MarBEF
(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	Alaska Environmental Sensitivity Index (ESI) maps	National oceanic and atmospheric administration (noaa)
(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	NOBANIS invasive alien species	NOBANIS The European Network on Invasive Alien Species
(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	Benthic species presence	Ocean Biogeographic Information Systems
(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	Iobis taxanomic records	Ocean Biogeographic Information Systems
(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	Aquatic Invasions	REABIC Regional Euro-Asian Biological Invasions Centre
(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	BioInvasions Records	REABIC Regional Euro-Asian Biological Invasions Centre
(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	Management of Biological Invasions	REABIC Regional Euro-Asian Biological Invasions Centre
(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	The AquaInvader Database	REABIC Regional Euro-Asian Biological Invasions Centre
(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	benthis species presence	SeaLifeBase
(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	SeaLifeBase	SeaLifeBase
(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	USGS Ocean Biogeographic Information System USA (OBIS-USA)	The Arctic Science Portal
(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	IUCN Red List of Threatened Species (species range, geographical data)	The IUCN Red List of Threatened Species
(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	IUCN Red List of Threatened Species Status	The IUCN Red List of Threatened Species
(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	WoRMS taxonomical data	WoRMS World Register of Marine Species
(SIXX) Concentration of silicon species in the water column	Arctic-GRO Silicon	Arctic Great Rivers Observatory (Arctic-GRO)

P02 parameter	dataset name	data sources
(SIXX) Concentration of silicon species in the water column	GEMSTAT silicon	United nations environment programme global environment monitoring system (unepgems)
(SIXX) Concentration of silicon species in the water column	USGS silicon	United States Geological Survey (USGS) Water-Quality Data for the Nation
(TDNT) Dissolved total and organic nitrogen concentrations in the water column	Arctic-GRO Total nitrogen	Arctic Great Rivers Observatory (Arctic-GRO)
(TDPX) Dissolved total or organic phosphorus concentration in the water column	Arctic-GRO Phosphorous	Arctic Great Rivers Observatory (Arctic-GRO)
(TDPX) Dissolved total or organic phosphorus concentration in the water column	GSN Phosphorous	Unified Federal Service for Observation and Control of Environmental Pollution (OGSNK) and GSN
(TDPX) Dissolved total or organic phosphorus concentration in the water column	GEMSTAT phosphorous	United nations environment programme global environment monitoring system (unepgems)
(TDPX) Dissolved total or organic phosphorus concentration in the water column	USGS Phosphorous	United States Geological Survey (USGS) Water-Quality Data for the Nation
(TEMP) Temperature of the water column	Arctic GRO - River Temperature	Arctic Great Rivers Observatory (Arctic-GRO)
(TEMP) Temperature of the water column	ARCTIC_ANALYSIS_FORECAST_PHYS_002_001_a_sea_water_potential_temperature	Copernicus Marine Environment Monitoring Service
(TEMP) Temperature of the water column	ARCTIC_REANALYSIS_PHYS_002_003_sea_water_potential_temperature	Copernicus Marine Environment Monitoring Service
(TEMP) Temperature of the water column	INSITU_ARC_NRT_OBSERVATIONS_013_031_sea_water_temperature	Copernicus Marine Environment Monitoring Service
(TEMP) Temperature of the water column	INSITU_ARC_TS_REP_OBSERVATIONS_013_037_sea_water_temperature	Copernicus Marine Environment Monitoring Service
(TEMP) Temperature of the water column	Sea Surface Temperature (MODIS-T)	EMIS/GMIS
(TEMP) Temperature of the water column	Arctic Regional Climatology: temperature statistical mean 1Â° grid	Oceanographic data center
(TEMP) Temperature of the water column	North Atlantic Ocean Heat Content	Oceanographic data center
(TEMP) Temperature of the water column	USGS Water Temperature River	United States Geological Survey (USGS) Water-Quality Data for the Nation
(TRAN) Transport activity	Cumulative human impacts: raw stressor data (2008 and 2013)	KNB Data Repository
(TRAN) Transport activity	ABDS	The Arctic Science Portal
(TSED) Concentration of suspended particulate material in the water column	Arctic GRO - Suspended Sediment Concentration	Arctic Great Rivers Observatory (Arctic-GRO)
(TSED) Concentration of suspended particulate material	Global river sediment yields database	FAO Aquastat

P02 parameter	dataset name	data sources
in the water column		
(TSED) Concentration of suspended particulate material in the water column	Sediment values for the Mackenzie River	HYDAT Watersurvey of Canada
(TSED) Concentration of suspended particulate material in the water column	Suspended Sediment Flux Mackenzie	HYDAT Watersurvey of Canada
(TSED) Concentration of suspended particulate material in the water column	Suspended Sediment Flux Kolyma	State Hydrological Institute - Russia
(TSED) Concentration of suspended particulate material in the water column	Suspended Sediment Flux Lena	State Hydrological Institute - Russia
(TSED) Concentration of suspended particulate material in the water column	Suspended Sediment Flux Ob	State Hydrological Institute - Russia
(TSED) Concentration of suspended particulate material in the water column	Suspended Sediment Flux Pechora	State Hydrological Institute - Russia
(TSED) Concentration of suspended particulate material in the water column	Suspended Sediment Flux Severnaya Dvina	State Hydrological Institute - Russia
(TSED) Concentration of suspended particulate material in the water column	Suspended Sediment Flux Yenisey	State Hydrological Institute - Russia
(TSED) Concentration of suspended particulate material in the water column	sediment flux estimates	State Hydrological Institute (SHI)
(TSED) Concentration of suspended particulate material in the water column		the United States Geological Survey (USGS)
(TSED) Concentration of suspended particulate material in the water column	Suspended Sediment Flux Yukon	United States Geological Survey (USGS) Water-Quality Data for the Nation
(WSTR) Wind stress and shear	WIND_GLO_WIND_L4_NRT_OBSERVATIONS_012_004_wind_stress	Copernicus Marine Environment Monitoring Service
(WSTR) Wind stress and shear	WIND_GLO_WIND_L4_REP_OBSERVATIONS_012_003_wind_stress	Copernicus Marine Environment Monitoring Service
(WVSP) Spectral wave data parameters	ESA EnviSat Wave	European space agency
(ZATX) Zooplankton taxonomy-related abundance per unit volume of the water column	ACADIS Canada_Basin_Zooplankton_2003_2006_Rutzen_Hopcroft	ACADIS
(ZATX) Zooplankton taxonomy-related abundance per unit volume of the water column	ACADIS Chukchi_Zooplankton_1976_Pavshtiks	ACADIS
(ZATX) Zooplankton taxonomy-related abundance per unit volume of the water column	ACADIS Frobisher_Bay_Zooplankton_1967-1971_Grainger	ACADIS
(ZATX) Zooplankton taxonomy-related abundance per unit volume of the water	ACADIS Zooplankton Composition and Abundance in the Laptev Sea and adjacent Nansen Basin, summer, 1993 (Polarstern ARK-	ACADIS

P02 parameter	dataset name	data sources
column	IX/4)	
Not yet specified	CABI	ISC The CABI Invasive Species Compendium
Not yet specified	Canadian Protected Areas	Natural Resources Canada
Not yet specified	Aerial Surveys of Arctic Marine Mammals (ASAMM)	NOAA Alaska Fisheries Science Center
Not yet specified	NOAA ERMA Arctic List of Datasets	NOAA Arctic ERMA
Not yet specified	Global Forecast System Analysis	NOAA National Center for Environmental Information
Not yet specified	NOAA Environmental Sensitivity Index Maps	NOAA Office of Response and Restoration
Not yet specified	Met.no WAM10km Wave model	Norwegian Metoerological Institute (Met.no) forecast data
Not yet specified	SINTEF Oil Weathering Model	SINTEF Oil Weathering Model

Annex 5 References in literature to inadequate data

Table 5.1

Overview of references to inadequate data per purpose, indicating reasons for inadequacy

Purpose	Reluctance to release data	Time to obtain data	Lack of measure-ments	Lack of accuracy/ precision	References
Assessment of environmental impact			x		AMAP (1998); CAFF (2010); OSPAR (2009)
Marine spatial planning (WP02)			x		Vassily et al. (2011); Hoel (2010)
Assessment of (potential) MPAs (WP03)			x		CAFF (2010); Boertmann et al. (2010)
Oil spill response (WP04)		x	x		Wynja et al. (2015); US-MMS (2009)
Assessment of climate change (WP05)			x	x	Houghton et al. (1995); Oliver-Smith (2009)
Assessment of coastal evolvement (WP06)			x	x	Lantuit et al. (2012); Proshutinsky *et al*. (2004)
Fisheries management and impact assessment, including stock assessment (WP07 & WP08)	x		x		Gerritsen et al. (2013); Jennings and Lee (2012); Lambert et al. (2012); Lee et al. (2010); Piet and Hintzen (2012); EEA (2015)
Assessment of riverine input (WP10)	x		x		ArcticRIMS (2016)
Assessment of navigational risks (WP11)			x		Arctic Council (2009, 2015)
Assessment of risks posed by invasive species (WP12)			x		Chan et al. (2015) Goldsmit et al (2014)

Table 5.2

Overview of references to inadequate data per parameter

Description
Activities: Information on a spatial scale of activities present in OSPAR Region I (Arctic waters) is sparse (OSPAR, 2009).
Baseline coastal information (e.g. shoreline form, substrate, and vegetation type): There is a large information gap regarding Arctic shorelines (Wynja et al., 2015).
Bathymetry: Adequate data was available to quantify the length and variability of the Northern Sea Route (NSR) navigation season (Stephenson et al., 2014). Data availability and quality was sufficient for development of a digital seafloor geomorphic features map, although new, higher resolution, bathymetric data would improve the map (Harris et al., 2014).
Biodiversity: The Arctic Climate Impact Assessment clearly demonstrated a general lack of information on quantified effects of climate change on biodiversity (CAFF, 2010). The information on marine and coastal biological diversity of the Russian Arctic is sufficient for a preliminary outline of future marine spatial planning (Vassily et al., 2011). In Norway, a set of indicators are monitored over time, deriving adequate data to assess whether planned objectives are achieved (Hoel, 2010). Chan *et al*. (2015) could not determine the invasion status of Canadian Arctic species with confidence due to insufficient baseline biodiversity information for Canada's Arctic coastal systems. Data is lacking, particularly with respect to benthic invertebrate biodiversity (Archambault et al., 2010; Piepenburg et al., 2011)
Chlorophyl-a: Lack of satellite based Chl-a data due to clouds or ice (Jeffries *et al*., 2015).
Coastal erosion: Datasets are restricted spatially and most of the database segments were characterized using discrete measurements of erosion along the coastline that were then extrapolated to the rest of the segment (Lantuit et al., 2012). In remote areas, north of 80°N, records were often unavailable and the erosion data was generated from maps of sea ice cover.
Ecosystem services: Better (detailed and accurate) data on the nature, extent and value of Arctic ecosystem services (e.g. subsistence, cultural uses, shoreline protection) are needed (UNEP, 2014).
Fisheries data (e.g. harvests, effort): In Russia, data is not available, confidential or fabricated (University of Alaska Fairbanks, 1996).
Fishing gear type: The VMS data itself contain no information on the gear type used (Gerritsen et al., 2013). Data has to be gathered from other sources. Full information on the gears used by non-UK vessels could not be accessed (Lambert et al., 2012).
Hydrographic data: The quality of the data varies widely from modern, high resolution hydrographic surveys to no sounding information in some areas (Arctic Council, 2009).
Ice data: The needs of mariners for ice information are currently met by a number of organizations, including national ice services that produce information for the Arctic that is generally freely available as a public service funded by tax-payers; academic institutions that provide ice information as part of an ongoing research program or to support field research campaigns; and commercial ice information services that provide services that are specific to individual clients with particular needs. As more ships venture into the Arctic and the demand for ice information and related services increases, there will be increasing pressure on the resources of ice information providers (Arctic Council, 2009). NOAA (2014) reports the following: "Accurate weekly sea ice information is important for many stakeholders to operate in the marine environment, including the U.S. Coast Guard, Arctic coastal communities and Alaska Native populations, the oil and gas and fishing industries, first responders to emergencies, and scientific researchers. Current sea ice forecasts are based primarily on satellite data, simple sea ice drift calculations, and Arctic weather models. Generating timely forecasts depends on the ability to collect basic observations and rapidly process the information. To improve weekly sea ice forecasts, NOAA is developing and refining higher spatial resolution regional sea ice models for Alaska waters that can assimilate both weather and sea ice observations." A compilation of National Ice Center (NIC) sea ice datasets is provided by Fetterer (2006), offering a valuable record of ice conditions that supplements records from other sources.
Non-indigenous Species (NIS): Inadequate data on NIS in the Arctic Ocean (Goldsmit et al., 2014; Chan *et al*., 2015). The Arctic Ocean is the least sampled of the world´s oceans (Arctic Council 2009).
Pollution levels: inadequate data coverage/significant data gaps, in particular for Alaska and parts of Russia (AMAP, 1998).
Population status: Studies of the status of char populations in Arctic regions are generally lacking. Insufficient or no data to provide an assessment of Polar bear subpopulation status, especially for the Russian subpopulations (CAFF, 2010).
Population trend data: Population trend data from the Arctic Species Trend Index (ASTI) dataset are not evenly distributed throughout the Arctic region, with gaps in spatial coverage in Russia, Greenland (particularly northern parts) and islands off the northern coast of Canada (Böhm *et al.,* 2012).
Precipitation: The accuracy of precipitation minus evaporation (P-E) reanalysis data over the open ocean, and the river discharge data, is not sufficient to allow robust conclusions to be drawn. The P-E estimates over the Arctic Ocean are less accurate than the other investigated factors (wind, water density, river runoff, etc.) (Proshutinsky et al., 2004).
Reproductive phenology of birds and mammals: The reproductive phenology of birds and mammals appears to be less

responsive to changes in the physical environment but a conclusive comparison among taxa is hampered by the scarcity of data (CAFF, 2010).

River discharge: Real-time river discharge data has been underutilized within the ocean-atmosphere modeling community with typical 3-5 year delays in data posting and a deterioration in gauge networks even in previously well-monitored parts of the globe has been identified by the Arctic-RIMS project (http://rims.unh.edu/background.shtml).

Sea ice: Adequate data was available to quantify the length and variability of the Northern Sea Route (NSR) navigation season (Stephenson et al., 2014). Fetterer (2006) provides a selection of documentation related to National Ice Center (NIC) sea ice charts in digital format. The NIC sea ice chart series begins in 1972, and offers a valuable record of ice conditions that supplements records from other sources, such as passive microwave satellite data. Researchers using the NIC datasets distributed by NSIDC will benefit from understanding how charts are created, what data sources are used, how charts have been digitized in the past, and how chart information has changed over the years (Fetterer, 2006).

Sea level: Sea level observations at some stations have had different locations in summer and winter, some of which were interrupted during replacement. Therefore much of the sea level data collected before 1949–1950 cannot be used because of the absence of a reliable geodetic survey. The existing sea level datasets in the Arctic are relatively short for the analysis of global sea level rise. The Arctic Ocean sea level time series have well pronounced decadal variability which corresponds to the variability of the North Atlantic Oscillation index. Because of the strength of this variability and the relatively short sea level time series, our assessments of sea level trends remain somewhat uncertain (Proshutinsky et al., 2004).

Sensitive areas: A full overview of biologically sensitive areas in the Arctic marine ecosystem, including on the high seas areas beyond national jurisdictions, is lacking (CAFF, 2010).

Snow depth: Our knowledge of snow depth on top of Arctic sea ice is limited (Zygmuntowska et al., 2014).

Species distribution: A lack of data has been identified for the establishment of protected areas for the Northern right whale, the Narwal in East Greenland, and for some other marine mammals (Boertmann et al., 2010). The lack of information about distribution of sponges makes it very difficult to evaluate trends (CAFF, 2010).

Stock assessments: The current availability of stock assessments is not sufficient (EEA, 2015).

Vessel position: Generally, only vessels >15 m are monitored in Europe, and they typically transmit position records at intervals of 2 h. Reported limitations of Vessel Monitoring Systems (VMS) records are: incomplete coverage of vessel activities, long durations between position records, and a lack of information on whether a vessel is actually fishing when the position is reported (Gerritsen *et al*., 2013; Lambert *et al*., 2012). Restrictions on data access and the absence of standardized methods of analysis hamper data exchange and their use in assessment and planning (Lambert *et al*., 2012). For example, Piet and Hintzen (2012) limited their study to their Dutch EEZ only instead of all European waters because there are still confidentiality issues that prevent access to the international VMS data. Only a small proportion of fishing vessels are equipped with Automatic Identification System (AIS) and spatial coverage of the data is incomplete because data are only recorded if a vessel is within VHF range of a base station (Gerritsen et al., 2013). VMS greatly increase the availability of data on the distribution of fishing activity, providing vessel-specific high-resolution data from all fishing grounds used by larger vessels (Jennings and Lee, 2012).

Wave data: Buoys that measure the wave heights and directions are essential for model validation but none of these exist in the Arctic for operational reporting. Because of the necessity to deal with winter ice, a new generation of buoys will have to be developed (Arctic Council, 2009).

Weather data: The coverage of INMARSAT Global Maritime Distress Safety System transmissions, marine safety information in the form of gale and storm warnings is in place but not fully covers the high seas regions of the Arctic (Arctic Council, 2009). The Arctic Council (2009) reports: "Although weather forecasts for the Arctic are based on the same tools using the same techniques as in other areas of the world, the scarcity of observations in the Arctic makes the monitoring of the weather more difficult than in areas with more observations. Meteorological observations in the Arctic rely on drifting buoys placed on top of the sea ice. A new generation of buoys that will withstand multiple freeze-thaw cycles is currently under development and is urgently needed to provide surface observations in the Arctic Ocean. The ability to measure the conditions of the atmosphere and ocean from satellites is, however, developing rapidly and, with adequate surface validation, the quality of weather forecasts will approach the quality used in other areas." NOAA (2014) reports the following: "Weather analysis and prediction capabilities are currently poorer in the Arctic than in other parts of the United States. Major challenges for long-term modeling being addressed by NOAA include the lack of good physical data regarding winds and clouds. Although accurate forecasts and models depend upon the availability of observations, existing observations in the Arctic are very limited in both geographic scope and frequency. The ability of NOAA and its partners to deploy a variety of sensing devices to collect observations, from buoys and other in situ technologies to airborne and satellite sensors, is key to improving weather and sea ice forecasts. Real-time satellite data are critical for accurate forecasting and warning of events, such as rapid sea ice formation and frequent storms that pose major hazards to life, property, and economic activities in the Arctic."

Annex 6 Quality and adequacy scores of datasets used in WPs

This Annex holds two tables, both listing the datasets used, or considered to be used in each of the challenges. The first table lists the datasets and the corresponding P02 parameter and quality indicators. The second table lists the datasets in the same order, showing the adequacy indicators of those dataset for the respective challenges. The labels in both tables match and identical labels refer to the same dataset used in the same challenge. Adequacy assessment for all assessment reports (so not only the challenges but also the assessment reports collected with the structured literature search) are available online (http://www.emodnet-arctic.eu/dashboard).

Table 6.1

Quality indicators of datasets used or considered to be used in specific challenges. Labels indicate the corresponding WP and give unique identifier to each dataset. This identifier corresponds with those in the following table with adequacy indicators.

Label	dataset name	p02 parameter	data source	spatial coverage	spatial resolution	temporal coverage	accessibility	cost	responsiveness	processing level	temporal resolution	temporal window	vertical resolution
WP02.a	Global Ocean Wind Observations Climatology REPROCESSED (Monthly means) (2007-2012)	(EWSB) Wind strength and direction	Copernicus Marine Environment Monitoring Service	Global	<1 km (<0.5°)	Years	Download (account needed)	Free of charge	Same day	Processed data	>= Month < Year	Hindcast	Not assessed
WP02.b	GEBCO_2014 Grid	(MBAN) Bathymetry and Elevation	Gebco	Global	<1 km (<0.5°)	Not applicable	Direct Download (no account)	Free of charge	Same day	Processed data	>= Year	Historical	0
WP02.c	ICES-WGSFD Geographical dataset Surface abrasion from Fisheries	(SATM) Shellfish morphology, age and physiology	ICES library, Data Outputs	Arctic Partial	>=1 <10 km (>=0.5° <5°)	Years	Direct Download (no account)	Free of charge	Same day	Processed data	>= Month < Year	Historical	0
WP02.d	Cumulative human impacts: raw stressor data (2008 and 2013)	(TRAN) Transport activity	KNB Data Repository	Global	>=1 <10 km (>=0.5° <5°)	Years	Direct Download (no account)	Free of charge	Same day	Processed data	>= Year	Historical	0
WP02.e	Cumulative human impacts: raw stressor data (2008 and 2013)	(TRAN) Transport activity	KNB Data Repository	Global	>=1 <10 km (>=0.5° <5°)	Years	Direct Download (no account)	Free of charge	Same day	Processed data	>= Year	Historical	0
WP02.f	Open Street Map OSM topographic data Arctic countries	(ADUN) Administrative units	Open Street Map	Global	<1 km (<0.5°)	Years	Direct Download (no account)	Free of charge	Same day	Processed data	>= Month < Year	Historical	Not assessed
WP02.g	WIND_GLO_WIND_L3_NRT_OBSERVATIONS_012_002	(EWSB) Wind strength and direction	Copernicus Marine Environment Monitoring Service	Global	<1 km (<0.5°)	Years	Download (account needed)	Free of charge	Same day	Processed data	>= Day <Month	Historical	0
WP02.h	World Database of Protected Areas WDPA	(ADUN) Administrative units	World database on protected areas	Global	<1 km (<0.5°)	Years	Direct Download (no account)	Free of charge	Same day	Processed data	>= Month < Year	Historical	Not assessed
WP03.a	MPAtlas - Russia	(ADUN) Administrative units	MPAtlas: Russia	Arctic Partial	<1 km (<0.5°)	Years	Direct Download	Free of charge	Same day	Processed data	>= Year	Historical	Not assessed

Label	dataset name	p02 parameter	data source	spatial coverage	spatial resolution	temporal coverage	accessibility	cost	responsiveness	processing level	temporal resolution	temporal window	vertical resolution
							(no account)						
WP03.b	OSPAR MPAs	(ALAT) Horizontal spatial co-ordinates	OSPAR map of MPAs	Arctic Partial	<1 km (<0.5°)	Not assessed	Direct Download (no account)	Free of charge	Same day	Unknown	Not applicable	Not applicable	0
WP03.c	IUCN Red List of Threatened Species Status	(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	The IUCN Red List of Threatened Species	Global	>=10 km (>= 5°)	Not applicable	Direct Download (no account)	Free of charge	Same day	Raw data	Not applicable	Not applicable	0
WP03.d	IUCN Red List of Threatened Species (species range, geographical data)	(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	The IUCN Red List of Threatened Species	Global	>=1 <10 km (>=0.5° <5°)	Decades	Download (account needed)	Not assessed	More then a day	Processed data	>= Month < Year	Historical	Not assessed
WP03.e	UNESCO world heritage list MPA	(ALAT) Horizontal spatial co-ordinates	Unesco	Not assessed	<1 km (<0.5°)	Not assessed	Not assessed	Not assessed	Not assessed	Raw data	Not applicable	Not applicable	0
WP03.f	MPA inventory 2014	(ADUN) Administrative units	USA NOAA National Marine Protected Areas Center	Arctic Partial	<1 km (<0.5°)	Years	Direct Download (no account)	Free of charge	Same day	Processed data	>= Year	Historical	Not assessed
WP03.g	World Database of Protected Areas WDPA	(ADUN) Administrative units	World database on protected areas	Global	<1 km (<0.5°)	Years	Direct Download (no account)	Free of charge	Same day	Processed data	>= Month < Year	Historical	Not assessed
WP03.h	Natura2000 MPA	(ALAT) Horizontal spatial co-ordinates	Natura2000	Arctic Partial	<1 km (<0.5°)	Not assessed	Data at request	Free of charge	Same day	Raw data	Not applicable	Not applicable	0
WP03.i	WoRMS taxonomical data	(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	WoRMS World Register of Marine Species	Global	Not applicable	Not applicable	Direct Download (no account)	Free of charge	Same day	Raw data	Not applicable	Not applicable	0
WP04.a	NERSC neXtSIM coupled ice ocean model	(ICEM) Ice motion and related parameters	Nansen Environmental and Remote Sensing Center	Arctic	>=1 <10 km (>=0.5° <5°)	Decades	Download (account needed)	Unknown	Same day	Processed data	< Day	Forecast	>0

Label	dataset name	p02 parameter	data source	spatial coverage	spatial resolution	temporal coverage	accessibility	cost	responsiveness	processing level	temporal resolution	temporal window	vertical resolution
			(NERSC)										
WP04.b	NERSC TOPAZ coupled ice ocean model output	(RFVL) Horizontal velocity of the water column (currents)	Nansen Environmental and Remote Sensing Center (NERSC)	Arctic	>=1 <10 km (>=0.5° <5°)	Years	Direct Download (no account)	Free of charge	Same day	Processed data	>= Day <Month	Forecast	>0
WP04.c	Met.no ROMS Nowcast Forecast Model Output Norwegian Sea (4 km)	(RFVL) Horizontal velocity of the water column (currents)	Norwegian Metoerological Institute (Met.no) forecast data	Arctic Partial	>=1 <10 km (>=0.5° <5°)	Years	Direct Download (no account)	Free of charge	Same day	Processed data	>= Year	Forecast	>0
WP04.d	Met.no WAM10km Wave model	Not yet specified	Norwegian Metoerological Institute (Met.no) forecast data	Arctic Partial	>=10 km (>= 5°)	Years	Direct Download (no account)	Free of charge	Same day	Processed data	< Day	Forecast	0
WP04.e	SINTEF Oil Weathering Model	Not yet specified	SINTEF Oil Weathering Model	Global	Not applicable	Decades	Download (account needed)	Payed account	Same day	Processed data	< Day	Forecast	Not assessed
WP05.a	HadSST.3.1.1.0.median.zip	(PSST) Skin temperature of the water column	Hadley Centre	Arctic	Not assessed	Decades	Direct Download (no account)	Free of charge	Same day	Unknown	>= Year	Historical	0
WP05.b	Extended Reconstructed Sea Surface Temperature (ERSST) v4	(PSST) Skin temperature of the water column	National oceanic and atmospheric administration (noaa)	Arctic	Unknown	Decades	Direct Download (no account)	Free of charge	Same day	Processed data	>= Year	Historical	0
WP05.c	Sea Ice Index	(CRYS) Snow and ice mass, thickness and extent	National Snow & Ice Data Center (NSIDC)	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
WP05.d	Unified Sea Ice Thickness Climate Data Record Collection Spanning 1947-2012	(CRYS) Snow and ice mass, thickness and extent	National Snow & Ice Data Center (NSIDC)	Arctic	Unknown	Decades	Direct Download (no account)	Free of charge	Same day	Unknown	Unknown	Historical	Unknown

Label	dataset name	p02 parameter	data source	spatial coverage	spatial resolution	temporal coverage	accessibility	cost	responsiveness	processing level	temporal resolution	temporal window	vertical resolution
WP05.e	Arctic Regional Climatology: temperature statistical mean 1Â° grid	(TEMP) Temperature of the water column	Oceanographic data center	Arctic	>=1 <10 km (>=0.5° <5°)	Months or less	Direct Download (no account)	Free of charge	Same day	Unknown	Not assessed	Historical	Not assessed
WP05.f	North Atlantic Ocean Heat Content	(TEMP) Temperature of the water column	Oceanographic data center	Arctic Partial	Not assessed	Decades	Direct Download (no account)	Free of charge	Same day	Processed data	>= Year	Historical	0
WP05.g	ARK-XXVII_3_phys_oce_XCTD.tab	(PSST) Skin temperature of the water column	Pangaea	Arctic Partial	Not assessed	Months or less	Direct Download (no account)	Free of charge	Same day	Raw data	>= Day <Month	Unknown	>0
WP05.h	Greenland ICESat mass balance maps	(CRYS) Snow and ice mass, thickness and extent	Sea Ice remote Sensing (NASA)	Arctic Partial	Not assessed	Not assessed	Direct Download (no account)	Free of charge	Same day	Processed data	Not assessed	Historical	>0
WP05.i	WoRMS taxonomical data	(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	WoRMS World Register of Marine Species	Global	Not applicable	Not applicable	Direct Download (no account)	Free of charge	Same day	Raw data	Not applicable	Not applicable	0
WP05.j	Arctic Climate Issues 2011: Changes in Arctic Snow, Water, Ice and Permafrost	(CRYS) Snow and ice mass, thickness and extent	The Arctic Monitoring and Assessment Programme (AMAP)	Arctic	Not assessed	Not assessed	Direct Download (no account)	Free of charge	Same day	Processed data	Unknown	Not assessed	Not assessed
WP05.k	SST_ARC_SST_L4_NRT_OBSERVATIONS_010_008_b	(PSST) Skin temperature of the water column	Copernicus Marine Environment Monitoring Service	Arctic	<1 km (<0.5°)	Years	Download (account needed)	Free of charge	Same day	Processed data	>= Day <Month	Historical	0
WP05.l	Essential Fish Habitats Arctic	(HBCH) Habitat characterisation	Arctic Integration Portal	Arctic	>=1 <10 km (>=0.5° <5°)	Unknown	Online viewing only	Free of charge	Same day	Processed data	Unknown	Unknown	Unknown
WP05.m	DAILY ICE MAP FROM SSMI, NERSC	(CRYS) Snow and ice mass, thickness and extent	Arctic Regional Ocean Observing System (ROOS)	Arctic	Unknown	Decades	Direct Download (no account)	Free of charge	Same day	Unknown	Unknown	(Near) real-time / current status	Not assessed

Label	dataset name	p02 parameter	data source	spatial coverage	spatial resolution	temporal coverage	accessibility	cost	responsiveness	processing level	temporal resolution	temporal window	vertical resolution
WP05.n	DAILY ICE MAP FROM SSMI, NERSC	(CRYS) Snow and ice mass, thickness and extent	Arctic Regional Ocean Observing System (ROOS)	Arctic	Unknown	Decades	Direct Download (no account)	Free of charge	Same day	Unknown	Unknown	(Near) real-time / current status	Not assessed
WP05.o	SEASONAL ICE EXTENT IN Mill SQ.Km	(CRYS) Snow and ice mass, thickness and extent	Arctic Regional Ocean Observing System (ROOS)	Arctic	Unknown	Years	Direct Download (no account)	Free of charge	Same day	Processed data	>= Month < Year	Unknown	Unknown
WP05.p	Regional Ice Charts	(CRYS) Snow and ice mass, thickness and extent	Arctic Regional Ocean Observing System (ROOS)	Arctic Partial	Unknown	Unknown	Direct Download (no account)	Free of charge	Same day	Processed data	Unknown	Unknown	Unknown
WP05.q	BIOTIC - Biological Traits Information Catalogue. Marine Life Information Network.	(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	Biotic	Not assessed	>=10 km (>= 5°)	Not assessed	Direct Download (no account)	Free of charge	Same day	Raw data	Not applicable	Not assessed	>0
WP05.r	canadian Sea Ice information	(CRYS) Snow and ice mass, thickness and extent	Canadian Ice Service	Arctic Partial	Unknown	Unknown	Direct Download (no account)	Free of charge	Same day	Processed data	Unknown	(Near) real-time / current status	Unknown
WP05.s	SEALEVEL_GLO_SLA_L3_NRT_OBSERVATIONS_008_017	(ASLV) Sea level	Copernicus Marine Environment Monitoring Service	Global	>=10 km (>= 5°)	Years	Download (account needed)	Free of charge	Same day	Processed data	>= Day <Month	Historical	0
WP05.t	SEALEVEL_GLO_SLA_L3_REP_OBSERVATIONS_008_018	(ASLV) Sea level	Copernicus Marine Environment Monitoring Service	Global	>=1 <10 km (>=0.5° <5°)	Years	Download (account needed)	Free of charge	Same day	Processed data	>= Month < Year	Historical	0
WP05.u	SEALEVEL_ARC_SLA_L3_NRT_OBSERVATIONS_008_025	(ASLV) Sea level	Copernicus Marine Environment Monitoring Service	Arctic	>=10 km (>= 5°)	Years	Download (account needed)	Free of charge	Same day	Processed data	>= Day <Month	Historical	0
WP05.v	SEALEVEL_GLO_SLA_MAP_L4_NRT_OBSERVATIONS_008_026	(ASLV) Sea level	Copernicus Marine Environment Monitoring Service	Global	<1 km (<0.5°)	Years	Download (account needed)	Free of charge	Same day	Processed data	>= Day <Month	Historical	0
WP05.w	SEALEVEL_GLO_REF20YTO7Y_L4_OBSERVATIONS_008_	(ASLV) Sea level	Copernicus Marine Environment	Global	<1 km	Months or	Download (account	Free of	Same	Processed	>= Month	Historical	0

Label	dataset name	p02 parameter	data source	spatial coverage	spatial resolution	temporal coverage	accessibility	cost	responsiveness	processing level	temporal resolution	temporal window	vertical resolution
	034		Monitoring Service		(<0.5°)	less	needed)	charge	day	data	< Year		
WP05.x	SEALEVEL_GLO_SLA_MAP_L4_REP_OBSERVATIONS_008_027	(ASLV) Sea level	Copernicus Marine Environment Monitoring Service	Global	<1 km (<0.5°)	Years	Download (account needed)	Free of charge	Same day	Processed data	>= Month < Year	Historical	0
WP05.y	SEALEVEL_GLO_MDT_L4_REF_OBSERVATIONS_008_013	(ASLV) Sea level	Copernicus Marine Environment Monitoring Service	Global	<1 km (<0.5°)	Months or less	Download (account needed)	Free of charge	Same day	Processed data	>= Month < Year	Historical	0
WP05.z	SEALEVEL_GLO_MSS_L4_REF_OBSERVATIONS_008_015	(ASLV) Sea level	Copernicus Marine Environment Monitoring Service	Global	<1 km (<0.5°)	Months or less	Download (account needed)	Free of charge	Same day	Processed data	>= Month < Year	Historical	0
WP05.aa	INSITU_ARC_NRT_OBSERVATIONS_013_031_sea_surface_height_above_sea_level	(ASLV) Sea level	Copernicus Marine Environment Monitoring Service	Not assessed	Not assessed	Not assessed	Download (account needed)	Free of charge	Same day	Not assessed	Not assessed	Not assessed	Not assessed
WP05.ab	ARCTIC_REANALYSIS_BIO_002_005_mass_concentration_of_chlorophyll_in_sea_water	(CPWC) Chlorophyll pigment concentrations in water bodies	Copernicus Marine Environment Monitoring Service	Arctic	>=10 km (>= 5°)	Years	Download (account needed)	Free of charge	Same day	Processed data	>= Month < Year	Historical	>0
WP05.ac	ARCTIC_REANALYSIS_BIO_002_005_mass_concentration_of_chlorophyll_in_sea_water	(CPWC) Chlorophyll pigment concentrations in water bodies	Copernicus Marine Environment Monitoring Service	Arctic	>=10 km (>= 5°)	Years	Download (account needed)	Free of charge	Same day	Processed data	>= Month < Year	Historical	>0
WP05.ad	OCEANCOLOUR_ARC_CHL_L3_NRT_OBSERVATIONS_009_047	(CPWC) Chlorophyll pigment concentrations in water bodies	Copernicus Marine Environment Monitoring Service	Arctic	>=1 <10 km (>=0.5° <5°)	Years	Download (account needed)	Free of charge	Same day	Processed data	>= Day <Month	Historical	0
WP05.ae	OCEANCOLOUR_ARC_CHL_L3_REP_OBSERVATIONS_009_069	(CPWC) Chlorophyll pigment concentrations in water bodies	Copernicus Marine Environment Monitoring Service	Arctic	>=1 <10 km (>=0.5° <5°)	Years	Download (account needed)	Free of charge	Same day	Processed data	>= Day <Month	Historical	0
WP05.af	OCEANCOLOUR_ARC_OPTICS_L3_NRT_OBSERVATIONS_	(CPWC) Chlorophyll pigment concentrations in	Copernicus Marine Environment	Arctic	>=1 <10 km (>=0.5°	Years	Download (account	Free of charge	Same day	Processed data	>= Day <Month	Historical	0

Label	dataset name	p02 parameter	data source	spatial coverage	spatial resolution	temporal coverage	accessibility	cost	responsiveness	processing level	temporal resolution	temporal window	vertical resolution
	009_046	water bodies	Monitoring Service		<5°)		needed)						
WP05.ag	INSITU_ARC_NRT_OBSERVATIONS_013_031_mass_concentration_of_chlorophyll_a_in_sea_water	(CPWC) Chlorophyll pigment concentrations in water bodies	Copernicus Marine Environment Monitoring Service	Not assessed	Not assessed	Not assessed	Download (account needed)	Free of charge	Same day	Not assessed	Not assessed	Not assessed	Not assessed
WP05.ah	ARCTIC_ANALYSIS_FORECAST_PHYS_002_001_a_sea_ice_thickness	(CRYS) Snow and ice mass, thickness and extent	Copernicus Marine Environment Monitoring Service	Arctic	>=10 km (>= 5°)	Months or less	Download (account needed)	Free of charge	Same day	Processed data	>= Day <Month	Forecast	>0
WP05.ai	ARCTIC_REANALYSIS_PHYS_002_003_sea_ice_thickness	(CRYS) Snow and ice mass, thickness and extent	Copernicus Marine Environment Monitoring Service	Arctic	>=10 km (>= 5°)	Years	Download (account needed)	Free of charge	Same day	Processed data	>= Month < Year	Historical	>0
WP05.aj	SEAICE_ARC_SEAICE_L4_NRT_OBSERVATIONS_011_003	(CRYS) Snow and ice mass, thickness and extent	Copernicus Marine Environment Monitoring Service	Arctic Partial	<1 km (<0.5°)	Years	Download (account needed)	Free of charge	Same day	Processed data	< Day	Historical	0
WP05.ak	SEAICE_ARC_SEAICE_L4_NRT_OBSERVATIONS_011_002	(CRYS) Snow and ice mass, thickness and extent	Copernicus Marine Environment Monitoring Service	Arctic Partial	>=1 <10 km (>=0.5° <5°)	Years	Download (account needed)	Free of charge	Same day	Processed data	>= Day <Month	Historical	0
WP05.al	SEAICE_ARC_SEAICE_L4_NRT_OBSERVATIONS_011_002	(CRYS) Snow and ice mass, thickness and extent	Copernicus Marine Environment Monitoring Service	Arctic Partial	>=10 km (>= 5°)	Years	Download (account needed)	Free of charge	Same day	Processed data	< Day	Historical	0
WP05.am	ARCTIC_ANALYSIS_FORECAST_PHYS_002_001_a_sea_ice_velocity	(ICEM) Ice motion and related parameters	Copernicus Marine Environment Monitoring Service	Arctic	>=10 km (>= 5°)	Months or less	Download (account needed)	Free of charge	Same day	Processed data	>= Day <Month	Forecast	>0
WP05.an	ARCTIC_REANALYSIS_PHYS_002_003_sea_ice_velocity	(ICEM) Ice motion and related parameters	Copernicus Marine Environment Monitoring Service	Arctic	>=10 km (>= 5°)	Years	Download (account needed)	Free of charge	Same day	Processed data	>= Month < Year	Historical	>0
WP05.ao	SEAICE_ARC_SEAICE_L3_REP_OBSERVATIONS_011_010	(ICEM) Ice motion and related parameters	Copernicus Marine Environment Monitoring Service	Arctic	>=1 <10 km (>=0.5° <5°)	Years	Download (account needed)	Free of charge	Same day	Processed data	>= Day <Month	Historical	0
WP05.ap	SEAICE_ARC_SEAICE_L4_NRT_OBSERVATIONS_011_00	(IPHY) Snow and ice physical properties	Copernicus Marine Environment	Arctic	<1 km	Years	Download (account	Free of	Same	Processed	>= Day	Historical	0

Label	dataset name	p02 parameter	data source	spatial coverage	spatial resolution	temporal coverage	accessibility	cost	responsiveness	processing level	temporal resolution	temporal window	vertical resolution
	8_sea_ice_surface_temperature	and characteristics	Monitoring Service		(<0.5°)		needed)	charge	day	data	<Month		
WP05.aq	OCEANCOLOUR_ARC_OPTICS_L3_REP_OBSERVATIONS_009_068	(PPAB) Light absorption in the water column	Copernicus Marine Environment Monitoring Service	Arctic	>=1 <10 km (>=0.5° <5°)	Years	Download (account needed)	Free of charge	Same day	Processed data	>= Day <Month	Historical	0
WP05.ar	ARCTIC_ANALYSIS_FORECAST_PHYS_002_001_a_sea_water_salinity	(PSAL) Salinity of the water column	Copernicus Marine Environment Monitoring Service	Arctic	>=10 km (>= 5°)	Months or less	Download (account needed)	Free of charge	Same day	Processed data	>= Day <Month	Forecast	>0
WP05.as	ARCTIC_REANALYSIS_PHYS_002_003_sea_water_salinity	(PSAL) Salinity of the water column	Copernicus Marine Environment Monitoring Service	Arctic	>=10 km (>= 5°)	Years	Download (account needed)	Free of charge	Same day	Processed data	>= Month < Year	Historical	>0
WP05.at	INSITU_ARC_NRT_OBSERVATIONS_013_031_sea_water_salinity	(PSAL) Salinity of the water column	Copernicus Marine Environment Monitoring Service	Not assessed	Not assessed	Not assessed	Download (account needed)	Free of charge	Same day	Not assessed	Not assessed	Not assessed	Not assessed
WP05.au	INSITU_ARC_TS_REP_OBSERVATIONS_013_037_sea_water_salinity	(PSAL) Salinity of the water column	Copernicus Marine Environment Monitoring Service	Not assessed	Not assessed	Not assessed	Download (account needed)	Free of charge	Same day	Not assessed	Not assessed	Not assessed	Not assessed
WP05.av	SEAICE_ARC_SEAICE_L4_NRT_OBSERVATIONS_011_008_sea_surface_temperature	(PSST) Skin temperature of the water column	Copernicus Marine Environment Monitoring Service	Arctic	<1 km (<0.5°)	Years	Download (account needed)	Free of charge	Same day	Processed data	>= Day <Month	Historical	0
WP05.aw	ARCTIC_ANALYSIS_FORECAST_PHYS_002_001_a_sea_water_potential_temperature	(TEMP) Temperature of the water column	Copernicus Marine Environment Monitoring Service	Arctic	>=10 km (>= 5°)	Months or less	Download (account needed)	Free of charge	Same day	Processed data	>= Day <Month	Forecast	>0
WP05.ax	ARCTIC_REANALYSIS_PHYS_002_003_sea_water_potential_temperature	(TEMP) Temperature of the water column	Copernicus Marine Environment Monitoring Service	Arctic	>=10 km (>= 5°)	Years	Download (account needed)	Free of charge	Same day	Processed data	>= Month < Year	Historical	>0
WP05.ay	INSITU_ARC_NRT_OBSERVATIONS_013_031_sea_water_temperature	(TEMP) Temperature of the water column	Copernicus Marine Environment Monitoring Service	Not assessed	Not assessed	Not assessed	Download (account needed)	Free of charge	Same day	Not assessed	Not assessed	Not assessed	Not assessed

Label	dataset name	p02 parameter	data source	spatial coverage	spatial resolution	temporal coverage	accessibility	cost	responsiveness	processing level	temporal resolution	temporal window	vertical resolution
WP05.az	INSITU_ARC_TS_REP_OBSERVATIONS_013_037_sea_water_temperature	(TEMP) Temperature of the water column	Copernicus Marine Environment Monitoring Service	Not assessed	Not assessed	Not assessed	Download (account needed)	Free of charge	Same day	Not assessed	Not assessed	Not assessed	Not assessed
WP05.ba	DataBasin Arctic Field Research Projects	(ALAT) Horizontal spatial co-ordinates	DataBasin.org	Arctic	<1 km (<0.5°)	Unknown	Direct Download (no account)	Free of charge	Same day	Unknown	Unknown	Unknown	0
WP05.bb	DataBasin Circumpolar Arctic Vegetation	(ALAT) Horizontal spatial co-ordinates	DataBasin.org	Arctic	<1 km (<0.5°)	Unknown	Direct Download (no account)	Free of charge	Same day	Unknown	Unknown	Unknown	Unknown
WP05.bc	DataBasin Alaska Arctic Vegetation	(ALAT) Horizontal spatial co-ordinates	DataBasin.org	Arctic Partial	<1 km (<0.5°)	Unknown	Unknown	Free of charge	Same day	Unknown	Unknown	Unknown	0
WP05.bd	DataBasin Alaska Arctic Vegetation	(ALAT) Horizontal spatial co-ordinates	DataBasin.org	Arctic Partial	<1 km (<0.5°)	Unknown	Unknown	Free of charge	Same day	Unknown	Unknown	Unknown	0
WP05.be	DataBasin Circum-Arctic Map of Permafrost and Ground Ice Conditions	(CRYS) Snow and ice mass, thickness and extent	DataBasin.org	Arctic	>=10 km (>= 5°)	Unknown	Direct Download (no account)	Free of charge	Same day	Unknown	Unknown	Unknown	0
WP05.bf	Subsea permafrost and sea ice extent in the northern hemisphere	(HBEX) Habitat extent	DataBasin.org	Arctic	<1 km (<0.5°)	Years	Direct Download (no account)	Free of charge	Same day	Processed data	>= Month < Year	Historical	Not assessed
WP05.bg	Chlorophyll Concentration (MODIS-A)	(CPWC) Chlorophyll pigment concentrations in water bodies	EMIS/GMIS	Arctic Partial	>=1 <10 km (>=0.5° <5°)	Years	Direct Download (no account)	Free of charge	Same day	Unknown	>= Month < Year	Unknown	Unknown
WP05.bh	Primary Production (SEAWIFS)	(PPRD) Primary production in the water column	EMIS/GMIS	Arctic Partial	>=1 <10 km (>=0.5° <5°)	Years	Direct Download (no account)	Free of charge	Same day	Unknown	>= Month < Year	Unknown	Unknown
WP05.bi	Sea Surface Temperature (MODIS-T)	(TEMP) Temperature of the water column	EMIS/GMIS	Arctic Partial	>=1 <10 km (>=0.5° <5°)	Years	Direct Download (no account)	Free of charge	Same day	Unknown	>= Month < Year	Unknown	Unknown
WP05.bj	Seabed habitats emodnet	(HBCH) Habitat	Emodnet seabed	Arctic	>=1 <10 km (>=0.5°	Unknown	Online	Free of	Same	Processed	Unknown	Unknown	Unknown

Label	dataset name	p02 parameter	data source	spatial coverage	spatial resolution	temporal coverage	accessibility	cost	responsiveness	processing level	temporal resolution	temporal window	vertical resolution
	NEA	characterisation	habitats	Partial	<5°)		viewing only	charge	day	data			
WP05.bk	grl54619-sup-0002-ds01.gz (from McMillan et al. (2016))	(CRYS) Snow and ice mass, thickness and extent	European space agency	Arctic Partial	Not assessed	Years	Download (account needed)	Free of charge	Same day	Unknown	Unknown	Hindcast	Unknown
WP05.bl	Global capture production FAO	(FCST) Fish and shellfish catch statistics	Food and agriculture organization of the united nations fisheries and aquaculture department	Global	>=10 km (>= 5°)	Decades	Direct Download (no account)	Free of charge	Same day	Processed data	>= Year	Historical	Unknown
WP05.bm	Biological data from IMR (geographical data, sea birds, sea mammals, fish, etc.)	(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	Havforskningsinstituttet IMR Institute of Marine Research	Arctic Partial	<1 km (<0.5°)	Years	Direct Download (no account)	Free of charge	Same day	Processed data	>= Month < Year	Historical	Not assessed
WP05.bn	Biological data from IMR (geographical data, sea birds, sea mammals, fish, etc.)	(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	Havforskningsinstituttet IMR Institute of Marine Research	Arctic Partial	<1 km (<0.5°)	Years	Direct Download (no account)	Free of charge	Same day	Processed data	>= Month < Year	Historical	Not assessed
WP05.bo	Sea Ice Concentration SIC_CRDP (SSMI, Arctic & Antarctic)	(ICEM) Ice motion and related parameters	Integrated Climate Data Center - ICDC - Hamburg University	Arctic	Unknown	Years	Data at request	Free of charge	Same day	Unknown	>= Month < Year	Unknown	Unknown
WP05.bp	Sea Ice Thickness SIT_CRDP (Arctic)	(ICEM) Ice motion and related parameters	Integrated Climate Data Center - ICDC - Hamburg University	Arctic	Unknown	Years	Data at request	Free of charge	Same day	Unknown	Unknown	Unknown	Unknown
WP05.bq	ARMS: Arctic Register of Marine Species	(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	MarBEF	Arctic	Unknown	Years	Direct Download (no account)	Free of charge	Same day	Not assessed	Not applicable	Not applicable	0
WP05.br	ARMS: Arctic Register of	(SBC_ARCTIC01) Species taxonomy,	MarBEF	Arctic	Unknown	Years	Direct Download	Free of	Same	Not	Not	Not	0

Label	dataset name	p02 parameter	data source	spatial coverage	spatial resolution	temporal coverage	accessibility	cost	responsiveness	processing level	temporal resolution	temporal window	vertical resolution
	Marine Species	status and/or meta-information					(no account)	charge	day	assessed	applicable	applicable	
WP05.bs	Top 10 species (biodiversity)	(BDRV) Biodiversity indices	Mareano	Arctic Partial	Not applicable	Unknown	Direct Download (no account)	Free of charge	Same day	Unknown	Unknown	Unknown	Unknown
WP05.bt	Vulnerable biotopes Mareano	(HBCH) Habitat characterisation	Mareano	Arctic Partial	>=1 <10 km (>=0.5° <5°)	Unknown	Online viewing only	Free of charge	Same day	Processed data	Unknown	Unknown	Unknown
WP05.bu	Habitats and biotopes MESMA	(HBCH) Habitat characterisation	MESMA Geoportal	Arctic Partial	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
WP05.bv	Arctic Ice Charts	(ICEM) Ice motion and related parameters	Nansen Environmental and Remote Sensing Center (NERSC)	Arctic	Unknown	Months or less	Direct Download (no account)	Free of charge	Same day	Unknown	>= Day <Month	Unknown	Unknown
WP05.bw	Arctic Ice Charts	(ICEM) Ice motion and related parameters	Nansen Environmental and Remote Sensing Center (NERSC)	Arctic	Unknown	Months or less	Direct Download (no account)	Free of charge	Same day	Unknown	>= Day <Month	Unknown	Unknown
WP05.bx	Marine Landscapes	(HBCH) Habitat characterisation	Norges geologiske undersÃ¸kelse NGU	Arctic Partial	<1 km (<0.5°)	Decades	Direct Download (no account)	Free of charge	Same day	Processed data	>= Year	Historical	Not assessed
WP05.by	Permenant Service for Mean Sea Level	(ASLV) Sea level	Permanent service for mean sea level	Global	Not applicable	Years	Direct Download (no account)	Free of charge	Same day	Unknown	>= Month < Year	Historical	0
WP05.bz	SeaLifeBase	(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	SeaLifeBase	Arctic Partial	>=10 km (>= 5°)	Not assessed	Direct Download (no account)	Free of charge	Same day	Raw data	Not assessed	Not assessed	>0
WP05.ca	SeaLifeBase	(SBC_ARCTIC01) Species taxonomy,	SeaLifeBase	Arctic	>=10 km	Not	Direct Download	Free of	Same	Raw data	Not	Not	>0

Label	dataset name	p02 parameter	data source	spatial coverage	spatial resolution	temporal coverage	accessibility	cost	responsiveness	processing level	temporal resolution	temporal window	vertical resolution
		status and/or meta-information		Partial	(>= 5°)	assessed	(no account)	charge	day		assessed	assessed	
WP05.cb	Arctic Climate Issues 2011: Changes in Arctic Snow, Water, Ice and Permafrost	(CRYS) Snow and ice mass, thickness and extent	The Arctic Monitoring and Assessment Programme (AMAP)	Arctic	Not assessed	Not assessed	Direct Download (no account)	Free of charge	Same day	Processed data	Unknown	Not assessed	Not assessed
WP05.cc	IUCN Red List of Threatened Species Extent	(ALAT) Horizontal spatial co-ordinates	The IUCN Red List of Threatened Species	Global	<1 km (<0.5°)	Not applicable	Direct Download (no account)	Free of charge	Same day	Raw data	Not applicable	Not applicable	0
WP05.cd	IUCN Red List of Threatened Species Status	(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	The IUCN Red List of Threatened Species	Global	>=10 km (>= 5°)	Not applicable	Direct Download (no account)	Free of charge	Same day	Raw data	Not applicable	Not applicable	0
WP05.ce	IUCN Red List of Threatened Species (species range, geographical data)	(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	The IUCN Red List of Threatened Species	Global	>=1 <10 km (>=0.5° <5°)	Decades	Download (account needed)	Not assessed	More then a day	Processed data	>= Month < Year	Historical	Not assessed
WP05.cf	natice 15-Day WISIF Graphs (temperature)	(CDTA) Air temperature	U.S. National Ice Center / Naval Ice Center	Arctic	Not applicable	Years	Direct Download (no account)	Free of charge	Same day	Unknown	>= Day <Month	Hindcast	0
WP05.cg	natice Daily Ice Edge GRIB Files	(CRYS) Snow and ice mass, thickness and extent	U.S. National Ice Center / Naval Ice Center	Arctic	Unknown	Years	Direct Download (no account)	Free of charge	Same day	Unknown	>= Day <Month	(Near) real-time / current status	Unknown
WP05.ch	natice 15-Day WISIF Graphs	(CRYS) Snow and ice mass, thickness and extent	U.S. National Ice Center / Naval Ice Center	Arctic Partial	Not applicable	Years	Direct Download (no account)	Free of charge	Same day	Unknown	>= Day <Month	Hindcast	0
WP05.ci	natice 15-Day WISIF Graphs	(CRYS) Snow and ice mass, thickness and extent	U.S. National Ice Center / Naval Ice Center	Arctic Partial	Not applicable	Years	Direct Download (no account)	Free of charge	Same day	Unknown	>= Day <Month	Hindcast	0

Label	dataset name	p02 parameter	data source	spatial coverage	spatial resolution	temporal coverage	accessibility	cost	responsiveness	processing level	temporal resolution	temporal window	vertical resolution
WP05.cj	WoRMS taxonomical data	(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	WoRMS World Register of Marine Species	Global	Not applicable	Not applicable	Direct Download (no account)	Free of charge	Same day	Raw data	Not applicable	Not applicable	0
WP06.a	SEALEVEL_GLO_SLA_L3_NRT_OBSERVATIONS_008_017	(ASLV) Sea level	Copernicus Marine Environment Monitoring Service	Global	>=10 km (>= 5°)	Years	Download (account needed)	Free of charge	Same day	Processed data	>= Day <Month	Historical	0
WP06.b	SEALEVEL_GLO_SLA_L3_REP_OBSERVATIONS_008_018	(ASLV) Sea level	Copernicus Marine Environment Monitoring Service	Global	>=1 <10 km (>=0.5° <5°)	Years	Download (account needed)	Free of charge	Same day	Processed data	>= Month < Year	Historical	0
WP06.c	SEALEVEL_ARC_SLA_L3_NRT_OBSERVATIONS_008_025	(ASLV) Sea level	Copernicus Marine Environment Monitoring Service	Arctic	>=10 km (>= 5°)	Years	Download (account needed)	Free of charge	Same day	Processed data	>= Day <Month	Historical	0
WP06.d	SEALEVEL_GLO_SLA_MAP_L4_NRT_OBSERVATIONS_008_026	(ASLV) Sea level	Copernicus Marine Environment Monitoring Service	Global	<1 km (<0.5°)	Years	Download (account needed)	Free of charge	Same day	Processed data	>= Day <Month	Historical	0
WP06.e	SEALEVEL_GLO_REF20YTO7Y_L4_OBSERVATIONS_008_034	(ASLV) Sea level	Copernicus Marine Environment Monitoring Service	Global	<1 km (<0.5°)	Months or less	Download (account needed)	Free of charge	Same day	Processed data	>= Month < Year	Historical	0
WP06.f	SEALEVEL_GLO_SLA_MAP_L4_REP_OBSERVATIONS_008_027	(ASLV) Sea level	Copernicus Marine Environment Monitoring Service	Global	<1 km (<0.5°)	Years	Download (account needed)	Free of charge	Same day	Processed data	>= Month < Year	Historical	0
WP06.g	SEALEVEL_GLO_MDT_L4_REF_OBSERVATIONS_008_013	(ASLV) Sea level	Copernicus Marine Environment Monitoring Service	Global	<1 km (<0.5°)	Months or less	Download (account needed)	Free of charge	Same day	Processed data	>= Month < Year	Historical	0
WP06.h	SEALEVEL_GLO_MSS_L4_REF_OBSERVATIONS_008_015	(ASLV) Sea level	Copernicus Marine Environment Monitoring Service	Global	<1 km (<0.5°)	Months or less	Download (account needed)	Free of charge	Same day	Processed data	>= Month < Year	Historical	0
WP06.i	GEBCO_2014 Grid	(MBAN) Bathymetry and Elevation	Gebco	Global	<1 km (<0.5°)	Not applicable	Direct Download (no account)	Free of charge	Same day	Processed data	>= Year	Historical	0

Label	dataset name	p02 parameter	data source	spatial coverage	spatial resolution	temporal coverage	accessibility	cost	responsiveness	processing level	temporal resolution	temporal window	vertical resolution
WP06.j	Geomorphology: coastal cliff recession	(COGE) Coastal geomorphology	GeoBasis - ZERO	Arctic Partial	Not applicable	Years	Download (account needed)	Free of charge	Same day	Processed data	>= Year	Historical	Not assessed
WP06.k	Geomorphology: topographic beach profile	(COGE) Coastal geomorphology	GeoBasis - ZERO	Arctic Partial	Not applicable	Years	Download (account needed)	Free of charge	Same day	Processed data	>= Year	Historical	Not assessed
WP06.l	Permanent Service for Mean Sea Level (PSMSL)	(ASLV) Sea level	Global Sea Level Observing System (GLOSS)	Global	Not assessed	Decades	Direct Download (no account)	Free of charge	Same day	Processed data	>= Year	Historical	Not assessed
WP06.m	Permanent Service for Mean Sea Level (PSMSL)	(ASLV) Sea level	Global Sea Level Observing System (GLOSS)	Global	Not assessed	Decades	Direct Download (no account)	Free of charge	Same day	Processed data	>= Year	Historical	Not assessed
WP06.n	International Bathymetric Chart of the Arctic Ocean, Version 2.23	(MBAN) Bathymetry and Elevation	NOAA Data Catalog Version 2.23	Arctic	>=1 <10 km (>=0.5° <5°)	Years	Direct Download (no account)	Free of charge	Not assessed	Processed data	Not assessed	Not assessed	Not assessed
WP06.o	Permenant Service for Mean Sea Level	(ASLV) Sea level	Permanent service for mean sea level	Global	Not applicable	Years	Direct Download (no account)	Free of charge	Same day	Unknown	>= Month < Year	Historical	0
WP06.p	Erosion Rate of 48 Sampling Locations Along the Beaufort Sea Coast, Alaskaa	(COGE) Coastal geomorphology	Soil carbon and material fluxes across the eroding Alaska Beaufort	Arctic Partial	Not applicable	Decades	Download (account needed)	Payed download	Same day	Processed data	>= Year	Historical	Not assessed
WP06.q	Coastal Type of of 48 Sampling Locations Along the Beaufort Sea Coast, Alaska	(COGE) Coastal geomorphology	Soil carbon and material fluxes across the eroding Alaska Beaufort	Arctic Partial	Not applicable	Decades	Download (account needed)	Payed download	Same day	Processed data	>= Year	Historical	Not assessed
WP06.r	Bank Height of 48 Sampling Locations Along the Beaufort Sea Coast, Alaska	(COGE) Coastal geomorphology	Soil carbon and material fluxes across the eroding Alaska Beaufort	Arctic Partial	Not applicable	Decades	Download (account needed)	Payed download	Same day	Processed data	>= Year	Historical	Not assessed
WP06.s	Bank Height of 48 Sampling Locations Along the Beaufort	(COGE) Coastal	Soil carbon and material fluxes	Arctic	Not	Decades	Download (account	Payed downlo	Same	Processed	>= Year	Historical	Not

Label	dataset name	p02 parameter	data source	spatial coverage	spatial resolution	temporal coverage	accessibility	cost	responsiveness	processing level	temporal resolution	temporal window	vertical resolution
	Sea Coast, Alaska	geomorphology	across the eroding Alaska Beaufort	Partial	applicable		needed)	ad	day	data			assessed
WP06.t	Global Multi-resolution Terrain Elevation Data 2010 (GMTED2010)	(COGE) Coastal geomorphology	USGS Earth Explorer	Global	<1 km (<0.5°)	Years	Direct Download (no account)	Free of charge	Same day	Processed data	Not assessed	Historical	Not assessed
WP06.u	Global 30 Arc-Second Elevation (GTOPO30)	(COGE) Coastal geomorphology	USGS Earth Explorer	Global	>=1 <10 km (>=0.5° <5°)	Not assessed	Direct Download (no account)	Free of charge	Same day	Processed data	Not assessed	Historical	Not assessed
WP06.v	Map showing Beaufort Sea coastal erosion and accretion	(COGE) Coastal geomorphology	USGS Store	Arctic Partial	Not applicable	Decades	Download (account needed)	Payed download	Same day	Processed data	>= Year	Historical	Not assessed
WP06.w	Interferometric Synthetic Aperture Radar (IFSAR) Alaska	(COGE) Coastal geomorphology	USGS Earth Explorer	Arctic Partial	<1 km (<0.5°)	Not assessed	Direct Download (no account)	Free of charge	Same day	Processed data	Not assessed	Historical	>0
WP06.x	Light Detection and Ranging (LIDAR)	(COGE) Coastal geomorphology	USGS Earth Explorer	Arctic Partial	<1 km (<0.5°)	Not assessed	Direct Download (no account)	Free of charge	Same day	Processed data	Not assessed	Historical	Not assessed
WP07.a	Fish catches emodnet NEA	(FCST) Fish and shellfish catch statistics	Emodnet Human activities	Arctic Partial	>=10 km (>= 5°)	Years	Online viewing only	Free of charge	Same day	Processed data	>= Month < Year	Hindcast	Unknown
WP07.b	Global capture production FAO	(FCST) Fish and shellfish catch statistics	Food and agriculture organization of the united nations fisheries and aquaculture department	Global	>=10 km (>= 5°)	Decades	Direct Download (no account)	Free of charge	Same day	Processed data	>= Year	Historical	Unknown
WP07.c	Catch statistics ICES for NEA	(FCST) Fish and shellfish catch statistics	ICES data portal	Arctic Partial	>=10 km (>= 5°)	Decades	Direct Download (no account)	Free of charge	Same day	Processed data	>= Year	Historical	Unknown
WP07.d	ICES workinggroup report	(GP080) Fishing by-	ICES library, Data	Arctic	>=10 km	Years	Direct Download	Free of	Same	Processed	>= Year	Historical	Unknown

Label	dataset name	p02 parameter	data source	spatial coverage	spatial resolution	temporal coverage	accessibility	cost	responsiveness	processing level	temporal resolution	temporal window	vertical resolution
	Bycatch of Protected Species	catch	Outputs	Partial	(>= 5°)		(no account)	charge	day	data			
WP07.e	NAFO fisheries statistics	(FCST) Fish and shellfish catch statistics	Northwest Atlantic Fisheries Organisation	Arctic Partial	>=10 km (>= 5°)	Years	Direct Download (no account)	Free of charge	Same day	Processed data	>= Year	Hindcast	Unknown
WP07.f	Fisheries catches Arctic	(FCST) Fish and shellfish catch statistics	Seas Around Us	Arctic	>=10 km (>= 5°)	Years	Direct Download (no account)	Free of charge	Same day	Processed data	>= Year	Historical	Not assessed
WP07.g	Fisheries landings and discards STECF for NEA	(FCST) Fish and shellfish catch statistics	STECF data dissemination	Arctic Partial	>=10 km (>= 5°)	Years	Direct Download (no account)	Free of charge	Same day	Processed data	>= Year	Historical	Not assessed
WP07.h	Harvest information for Alaska communities	(FCST) Fish and shellfish catch statistics	Alaska Department of Fish and Game	Arctic Partial	Not applicable	Years	Direct Download (no account)	Free of charge	Same day	Unknown	>= Year	Historical	Unknown
WP07.i	Bottom Trawling and Dredging by Marine Ecoregion	(FEFF) Fishing effort	DataBasin.org	Global	>=1 <10 km (>=0.5° <5°)	Decades	Direct Download (no account)	Free of charge	Same day	Processed data	>= Year	Historical	Not assessed
WP07.j	Statistics commercial fisheries Canada	(FCST) Fish and shellfish catch statistics	DFO Fisheries and Oceans Canada Marine Protected Areas	Arctic Partial	Unknown	Years	Online viewing only	Free of charge	Same day	Unknown	>= Year	Historical	Unknown
WP07.k	Fisheries observer data Canada	(GP080) Fishing by-catch	DFO Fisheries and Oceans Canada Marine Protected Areas	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
WP07.l	Fisheries catches EUROSTAT for NEA	(FCST) Fish and shellfish catch statistics	Dg environment joint research centre eurostat european environment agency	Arctic Partial	>=10 km (>= 5°)	Years	Direct Download (no account)	Free of charge	Same day	Processed data	>= Year	Historical	Unknown
WP07.m	Catch and effort ICCAT	(FCST) Fish and shellfish catch	Iccat	Arctic	>=10 km	Years	Direct Download	Free of	Same	Unknown	>= Year	Historical	Unknown

Label	dataset name	p02 parameter	data source	spatial coverage	spatial resolution	temporal coverage	accessibility	cost	responsiveness	processing level	temporal resolution	temporal window	vertical resolution
		statistics		Partial	(>= 5°)		(no account)	charge	day				
WP07.n	Catch and landings reports NOAA	(FCST) Fish and shellfish catch statistics	National oceanic and atmospheric administration (noaa)	Arctic Partial	Unknown	Years	Online viewing only	Free of charge	Same day	Processed data	Unknown	Hindcast	Unknown
WP08.a	Essential Fish Habitats Arctic	(HBCH) Habitat characterisation	Arctic Integration Portal	Arctic	>=1 <10 km (>=0.5° <5°)	Unknown	Online viewing only	Free of charge	Same day	Processed data	Unknown	Unknown	Unknown
WP08.b	Seabed habitats emodnet NEA	(HBCH) Habitat characterisation	Emodnet seabed habitats	Arctic Partial	>=1 <10 km (>=0.5° <5°)	Unknown	Online viewing only	Free of charge	Same day	Processed data	Unknown	Unknown	Unknown
WP08.c	Vulnerable biotopes Mareano	(HBCH) Habitat characterisation	Mareano	Arctic Partial	>=1 <10 km (>=0.5° <5°)	Unknown	Online viewing only	Free of charge	Same day	Processed data	Unknown	Unknown	Unknown
WP08.d	MPAtlas - Russia	(ADUN) Administrative units	MPAtlas: Russia	Arctic Partial	<1 km (<0.5°)	Years	Direct Download (no account)	Free of charge	Same day	Processed data	>= Year	Historical	Not assessed
WP08.e	Map protected areas Greenland	(HBCH) Habitat characterisation	Naalakkersuisut	Arctic Partial	Unknown	Unknown	Online viewing only	Free of charge	Same day	Processed data	Unknown	Unknown	Unknown
WP08.f	OSPAR MPAs	(ALAT) Horizontal spatial co-ordinates	OSPAR map of MPAs	Arctic Partial	<1 km (<0.5°)	Not assessed	Direct Download (no account)	Free of charge	Same day	Unknown	Not applicable	Not applicable	0
WP08.g	Fisheries effort STECF for NEA	(FEFF) Fishing effort	STECF data dissemination	Arctic Partial	>=1 <10 km (>=0.5° <5°)	Years	Direct Download (no account)	Free of charge	Same day	Processed data	>= Year	Historical	Not assessed
WP08.h	AMAP Boundary	(ADUN) Administrative units	The Arctic Biodiversity Data Service (ABDS) Data Portal	Arctic	<1 km (<0.5°)	Not applicable	Direct Download (no account)	Free of charge	Same day	Processed data	Not applicable	Not applicable	Not assessed
WP08.i	MPA inventory 2014	(ADUN)	USA NOAA National Marine	Arctic	<1 km	Years	Direct Download	Free of	Same	Processed	>= Year	Historical	Not

Label	dataset name	p02 parameter	data source	spatial coverage	spatial resolution	temporal coverage	accessibility	cost	responsiveness	processing level	temporal resolution	temporal window	vertical resolution
		Administrative units	Protected Areas Center	Partial	(<0.5°)		(no account)	charge	day	data			assessed
WP08.j	World Database of Protected Areas WDPA	(ADUN) Administrative units	World database on protected areas	Global	<1 km (<0.5°)	Years	Direct Download (no account)	Free of charge	Same day	Processed data	>= Month < Year	Historical	Not assessed
WP08.k	WDPA MPA	(ALAT) Horizontal spatial co-ordinates	World database on protected areas	Global	<1 km (<0.5°)	Not assessed	Not assessed	Free of charge	Same day	Unknown	Not applicable	Not applicable	0
WP08.l	Ship traffic lines fishing vessels	(FEFF) Fishing effort	Arctic Geographical Information System (ArkGIS)	Arctic Partial	>=10 km (>= 5°)	Years	Online viewing only	Free of charge	Same day	Processed data	>= Year	Hindcast	Unknown
WP08.m	Statistics commercial fisheries Canada	(FCST) Fish and shellfish catch statistics	DFO Fisheries and Oceans Canada Marine Protected Areas	Arctic Partial	Unknown	Years	Online viewing only	Free of charge	Same day	Unknown	>= Year	Historical	Unknown
WP08.n	Fisheries effort EUROSTAT for NEA	(FEFF) Fishing effort	Dg environment joint research centre eurostat european environment agency	Arctic Partial	>=10 km (>= 5°)	Years	Direct Download (no account)	Free of charge	Same day	Processed data	>= Year	Hindcast	Unknown
WP08.o	Regional fishing effort and capacity EEA	(FEFF) Fishing effort	Eea	Arctic Partial	>=10 km (>= 5°)	Years	Online viewing only	Free of charge	Same day	Processed data	>= Year	Hindcast	Unknown
WP08.p	Fishing fleet EU	(FEFF) Fishing effort	European Atlas of the Seas	Arctic Partial	<1 km (<0.5°)	Years	Online viewing only	Free of charge	Same day	Unknown	>= Year	Hindcast	Unknown
WP08.q	Catch and effort ICCAT	(FCST) Fish and shellfish catch statistics	Iccat	Arctic Partial	>=10 km (>= 5°)	Years	Direct Download (no account)	Free of charge	Same day	Unknown	>= Year	Historical	Unknown
WP08.r	MarineTraffic ship positions, velocity and heading	(APDA) Horizontal platform movement	Marine traffic	Global	<1 km (<0.5°)	Unknown	Download (account needed)	Payed account	Unknown	Raw data	Unknown	Unknown	Unknown

Label	dataset name	p02 parameter	data source	spatial coverage	spatial resolution	temporal coverage	accessibility	cost	responsiveness	processing level	temporal resolution	temporal window	vertical resolution
WP08.s	Habitats and biotopes MESMA	(HBCH) Habitat characterisation	MESMA Geoportal	Arctic Partial	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
WP08.t	Marine Protected Areas - proposed (foreslatt_vern_utm33)	(ADUN) Administrative units	MiljÃ¸direktoratet. NO	Arctic Partial	<1 km (<0.5°)	Years	Direct Download (no account)	Free of charge	Same day	Processed data	>= Year	Historical	Not assessed
WP08.u	NAFO Fisheries effort	(FEFF) Fishing effort	Northwest Atlantic Fisheries Organisation	Arctic Partial	>=10 km (>= 5°)	Years	Direct Download (no account)	Free of charge	Same day	Processed data	>= Year	Hindcast	Unknown
WP10.a	Arctic Great Rivers Observatory Project River Biogeochemistry Dataset	(PHOS) Phosphate concentration parameters in the water column	Arctic Great Rivers Observatory (Arctic-GRO)	Arctic	Unknown	Months or less	Direct Download (no account)	Free of charge	Not assessed	Raw data	>= Day <Month	Historical	Unknown
WP10.b	Arctic Great Rivers Observatory Project River Biogeochemistry Dataset	(PHOS) Phosphate concentration parameters in the water column	Arctic Great Rivers Observatory (Arctic-GRO)	Arctic	Unknown	Months or less	Direct Download (no account)	Free of charge	Not assessed	Raw data	>= Day <Month	Historical	Unknown
WP10.c	Arctic GRO - River Discharge	(RVDS) River flow and discharge	Arctic Great Rivers Observatory (Arctic-GRO)	Arctic	Not applicable	Decades	Direct Download (no account)	Free of charge	Same day	Processed data	>= Day <Month	Historical	0
WP10.d	Arctic GRO - River Temperature	(TEMP) Temperature of the water column	Arctic Great Rivers Observatory (Arctic-GRO)	Arctic	Not applicable	Years	Direct Download (no account)	Free of charge	Same day	Processed data	Not applicable	Historical	0
WP10.e	Arctic GRO - Suspended Sediment Concentration	(TSED) Concentration of suspended particulate material in the water column	Arctic Great Rivers Observatory (Arctic-GRO)	Arctic Partial	Not applicable	Years	Direct Download (no account)	Free of charge	Same day	Processed data	Not applicable	Historical	0
WP10.f	ArcticRIMS Water Discharge River	(RVDS) River flow and discharge	ArcticRIMS	Arctic	Not applicable	Decades	Direct Download (no account)	Free of charge	Same day	Processed data	>= Day <Month	Historical	0
WP10.g	Global river sediment yields database	(TSED) Concentration of suspended particulate material in	FAO Aquastat	Global	Not applicable	Decades	Direct Download	Free of charge	Same day	Processed data	>= Year	Historical	0

Label	dataset name	p02 parameter	data source	spatial coverage	spatial resolution	temporal coverage	accessibility	cost	responsiveness	processing level	temporal resolution	temporal window	vertical resolution
		the water column					(no account)						
WP10.h	Arctic Runoff Data Base	(RVDS) River flow and discharge	GRDC Global Runoff Data Centre Discharge Data	Arctic	Not applicable	Decades	Direct Download (no account)	Free of charge	Same day	Processed data	>= Day <Month	Historical	0
WP10.i	ART-Russia River temperature paper page	(RVDS) River flow and discharge	R-ArcticNet	Arctic Partial	Not applicable	Decades	Direct Download (no account)	Free of charge	Same day	Processed data	>= Day <Month	Historical	Not assessed
WP10.j	USGS Nitrate	(NTRA) Nitrate concentration parameters in the water column	United States Geological Survey (USGS) Water-Quality Data for the Nation	Arctic Partial	Not applicable	Years	Direct Download (no account)	Free of charge	Same day	Unknown	< Day	Historical	Unknown
WP10.k	USGS Phosphorous	(TDPX) Dissolved total or organic phosphorus concentration in the water column	United States Geological Survey (USGS) Water-Quality Data for the Nation	Arctic Partial	Not applicable	Years	Direct Download (no account)	Free of charge	Same day	Unknown	< Day	Historical	Unknown
WP10.l	Suspended Sediment Flux Yukon	(TSED) Concentration of suspended particulate material in the water column	United States Geological Survey (USGS) Water-Quality Data for the Nation	Arctic Partial	Not applicable	Decades	Unknown	Free of charge	Unknown	Processed data	>= Year	Historical	0
WP10.m	Arctic-GRO Nitrate	(NTRA) Nitrate concentration parameters in the water column	Arctic Great Rivers Observatory (Arctic-GRO)	Not assessed	Not applicable	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
WP10.n	Arctic-GRO Phosphorous	(TDPX) Dissolved total or organic phosphorus concentration in the water column	Arctic Great Rivers Observatory (Arctic-GRO)	Not assessed	Not applicable	Not assessed	Not assessed	Not assessed	Not assessed	Unknown	>= Month < Year	Historical	0
WP10.o	USGS Water Temperature	(TEMP) Temperature	United States Geological Survey	Arctic	Not	Decades	Direct Download	Free of	Same	Processed	< Day	Historical	0

Label	dataset name	p02 parameter	data source	spatial coverage	spatial resolution	temporal coverage	accessibility	cost	responsiveness	processing level	temporal resolution	temporal window	vertical resolution
	River	of the water column	(USGS) Water-Quality Data for the Nation	Partial	applicable		(no account)	charge	day	data			
WP10.p	R-ArcticNet River Flow	(RVDS) River flow and discharge	R-ArcticNet	Arctic Partial	Not applicable	Decades	Direct Download (no account)	Free of charge	Same day	Unknown	>= Month < Year	Historical	Unknown
WP10.q	Suspended Sediment Flux Yenisey	(TSED) Concentration of suspended particulate material in the water column	State Hydrological Institute - Russia	Arctic Partial	Not applicable	Decades	Unknown	Free of charge	Unknown	Processed data	>= Year	Historical	0
WP10.r	Suspended Sediment Flux Lena	(TSED) Concentration of suspended particulate material in the water column	State Hydrological Institute - Russia	Arctic Partial	Not applicable	Decades	Unknown	Free of charge	Unknown	Processed data	>= Year	Historical	0
WP10.s	Suspended Sediment Flux Ob	(TSED) Concentration of suspended particulate material in the water column	State Hydrological Institute - Russia	Arctic Partial	Not applicable	Decades	Unknown	Free of charge	Unknown	Processed data	>= Year	Historical	0
WP10.t	Suspended Sediment Flux Pechora	(TSED) Concentration of suspended particulate material in the water column	State Hydrological Institute - Russia	Arctic Partial	Not applicable	Decades	Unknown	Free of charge	Unknown	Processed data	>= Year	Historical	0
WP10.u	Suspended Sediment Flux Kolyma	(TSED) Concentration of suspended particulate material in the water column	State Hydrological Institute - Russia	Arctic Partial	Not applicable	Decades	Unknown	Free of charge	Unknown	Processed data	>= Year	Historical	0
WP10.v	Suspended Sediment Flux Severnaya Dvina	(TSED) Concentration of suspended particulate material in the water column	State Hydrological Institute - Russia	Arctic Partial	Not applicable	Decades	Unknown	Free of charge	Unknown	Processed data	>= Year	Historical	0
WP10.w	Suspended Sediment Flux Severnaya Dvina	(TSED) Concentration of suspended particulate material in	State Hydrological Institute - Russia	Arctic Partial	Not applicable	Decades	Unknown	Free of charge	Unknown	Processed data	>= Year	Historical	0

Label	dataset name	p02 parameter	data source	spatial coverage	spatial resolution	temporal coverage	accessibility	cost	responsiveness	processing level	temporal resolution	temporal window	vertical resolution
		the water column											
WP11.a	NOAA Bathymetric Data Viewer	(MBAN) Bathymetry and Elevation	NOAA Bathymetric Dataset	Arctic Partial	>=1 <10 km (>=0.5° <5°)	Decades	Direct Download (no account)	Free of charge	Same day	Raw data	>= Year	Historical	0
WP11.b	anadbath	(MBAN) Bathymetry and Elevation	USGS Bathymetric Maps	Arctic Partial	>=10 km (>= 5°)	Years	Direct Download (no account)	Free of charge	Not assessed	Processed data	Not assessed	Not assessed	0
WP11.c	One Stop Datashop (OSDS) Continental Shelf Programme	(MBAN) Bathymetry and Elevation	GRID Arendal	Arctic Partial	>=1 <10 km (>=0.5° <5°)	Decades	Direct Download (no account)	Free of charge	Same day	Raw data	>= Year	Historical	0
WP11.d	IBCAO	(MBAN) Bathymetry and Elevation	NOAA Data Catalog	Arctic	>=10 km (>= 5°)	Years	Direct Download (no account)	Free of charge	Same day	Processed data	Unknown	Historical	0
WP11.e	ICBAO Contour Data Files	(MBAN) Bathymetry and Elevation	NOAA Data Catalog	Arctic	>=10 km (>= 5°)	Years	Direct Download (no account)	Free of charge	Not assessed	Processed data	Not assessed	Not assessed	0
WP11.f	IBCAO Gridded Bathymetric Data	(MBAN) Bathymetry and Elevation	NOAA Data Catalog	Arctic	>=1 <10 km (>=0.5° <5°)	Years	Direct Download (no account)	Free of charge	Not assessed	Processed data	Not assessed	Not assessed	0
WP11.g	batharcst	(MBAN) Bathymetry and Elevation	USGS Arctic Bathymetry	Arctic	Not applicable	Not assessed	Direct Download (no account)	Free of charge	Not assessed	Not assessed	Not assessed	Historical	0
WP11.h	berchuk	(MBAN) Bathymetry and Elevation	USGS Bathymetric Maps	Arctic Partial	>=10 km (>= 5°)	Years	Direct Download (no account)	Free of charge	Not assessed	Processed data	>= Year	Not assessed	0
WP11.i	chukbath	(MBAN) Bathymetry and Elevation	USGS Bathymetric Maps	Arctic Partial	>=10 km (>= 5°)	Years	Direct Download (no account)	Free of charge	Not assessed	Processed data	>= Year	Not assessed	0
WP11.j	nosbath	(MBAN) Bathymetry and Elevation	USGS Bathymetric Maps	Arctic Partial	>=10 km (>= 5°)	Years	Direct Download	Free of charge	Not assessed	Processed data	Not assessed	Historical	0

Label	dataset name	p02 parameter	data source	spatial coverage	spatial resolution	temporal coverage	accessibility	cost	responsiveness	processing level	temporal resolution	temporal window	vertical resolution
							(no account)						
WP12.a	AquaNIS introduction of non-indigenous species per region	(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	AquaNIS	Not assessed	>=10 km (>= 5°)	Not assessed	Not assessed	Not assessed	Not assessed	Raw data	>= Year	Historical	0
WP12.b	BIOTIC - Biological Traits Information Catalogue. Marine Life Information Network.	(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	Biotic	Not assessed	>=10 km (>= 5°)	Not assessed	Direct Download (no account)	Free of charge	Same day	Raw data	Not applicable	Not assessed	>0
WP12.c	DAISIES invasive species presence in European regions	(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	DAISIE Delivering Alien Invasive Species Inventories for Europe	Arctic Partial	>=10 km (>= 5°)	Not applicable	Direct Download (no account)	Free of charge	Same day	Raw data	Not applicable	Not applicable	0
WP12.d	CABI	Not yet specified	ISC The CABI Invasive Species Compendium	Arctic Partial	>=10 km (>= 5°)	Not assessed	Direct Download (no account)	Free of charge	Same day	Raw data	>= Year	Not assessed	Unknown
WP12.e	WoRMS taxonomical data	(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	WoRMS World Register of Marine Species	Global	Not applicable	Not applicable	Direct Download (no account)	Free of charge	Same day	Raw data	Not applicable	Not applicable	0
WP12.f	EASIN-Lit	(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	EASIN European Alien Species Information Network	Global	>=10 km (>= 5°)	Not assessed	Direct Download (no account)	Free of charge	Same day	Processed data	Not assessed	Not assessed	Not assessed
WP12.g	EASIN Geodatabase	(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	EASIN European Alien Species Information Network	Arctic Partial	>=10 km (>= 5°)	Not assessed	Direct Download (no account)	Free of charge	Same day	Processed data	Not assessed	Not assessed	Not assessed
WP12.h	GISIN List	(SBC_ARCTIC01) Species taxonomy, status and/or meta-	GISIN Global Invasive Species Information	Global	>=10 km (>= 5°)	Decades	Download (account needed)	Free of charge	Same day	Raw data	Not assessed	Not assessed	Not assessed

Label	dataset name	p02 parameter	data source	spatial coverage	spatial resolution	temporal coverage	accessibility	cost	responsiveness	processing level	temporal resolution	temporal window	vertical resolution
		information	Network										
WP12.i	ARMS: Arctic Register of Marine Species	(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	MarBEF	Arctic	Unknown	Years	Direct Download (no account)	Free of charge	Same day	Not assessed	Not applicable	Not applicable	0
WP12.j	NOBANIS invasive alien species	(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	NOBANIS The European Network on Invasive Alien Species	Arctic Partial	>=10 km (>= 5°)	Not applicable	Direct Download (no account)	Free of charge	Same day	Raw data	Not applicable	Not applicable	0
WP12.k	The AquaInvader Database	(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	REABIC Regional Euro-Asian Biological Invasions Centre	Not assessed	>=10 km (>= 5°)	Not assessed	Direct Download (no account)	Free of charge	Same day	Raw data	Not assessed	Not assessed	Not assessed
WP12.l	BioInvasions Records	(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	REABIC Regional Euro-Asian Biological Invasions Centre	Global	Not assessed	Decades	Direct Download (no account)	Free of charge	Same day	Processed data	Not assessed	Not assessed	Not assessed
WP12.m	Aquatic Invasions	(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	REABIC Regional Euro-Asian Biological Invasions Centre	Global	>=10 km (>= 5°)	Decades	Direct Download (no account)	Free of charge	Same day	Processed data	Not assessed	Not assessed	Not assessed
WP12.n	Management of Biological Invasions	(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	REABIC Regional Euro-Asian Biological Invasions Centre	Global	>=10 km (>= 5°)	Decades	Direct Download (no account)	Free of charge	Same day	Processed data	Not assessed	Not assessed	Not assessed
WP12.o	USGS Ocean Biogeographic Information System USA (OBIS-USA)	(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	The Arctic Science Portal	Global	Not assessed	Not assessed	Direct Download (no account)	Free of charge	Same day	Not assessed	Not assessed	Not assessed	Not assessed
WP12.p	EASIN Geodatabase	(SBC_ARCTIC01) Species taxonomy, status and/or meta-	EASIN European Alien Species Information	Arctic Partial	>=10 km (>= 5°)	Not assessed	Direct Download (no account)	Free of charge	Same day	Processed data	Not assessed	Not assessed	Not assessed

Label	dataset name	p02 parameter	data source	spatial coverage	spatial resolution	temporal coverage	accessibility	cost	responsiveness	processing level	temporal resolution	temporal window	vertical resolution
		information	Network										
WP12.q	SeaLifeBase	(SBC_ARCTIC01) Species taxonomy, status and/or meta-information	SeaLifeBase	Arctic Partial	>=10 km (>= 5°)	Not assessed	Direct Download (no account)	Free of charge	Same day	Raw data	Not assessed	Not assessed	>0
WP12.r	ABDS	(TRAN) Transport activity	The Arctic Science Portal	Arctic	>=10 km (>= 5°)	Not assessed	Direct Download (no account)	Free of charge	Same day	Processed data	Not assessed	(Near) real-time / current status	Not assessed

Table 6.2

Adequacy indicators of datasets used or considered to be used in specific challenges. Labels indicate the corresponding WP and give unique identifier to each dataset. This identifier corresponds with those in the previous table with quality indicators.

Label	data used	processing of data	data format	necessity of data for purpose	matching of spatial coverage	matching of temporal coverage	matching of spatial resolution	matching of temporal resolution	budget restrictions	project time restrictions
WP02.a	Yes	Processing required	Converted format used	Absolute necessity	Match	Limited match (data usable)	Match	Match	No restrictions	No restrictions
WP02.b	Yes	No processing required	Converted format used	Absolute necessity	Match	Match	Limited match (data usable)	Match	No restrictions	No restrictions
WP02.c	Yes	Processing required	Converted format used	Absolute necessity	Limited match (data usable)	Match	Match	Match	No restrictions	No restrictions
WP02.d	Yes	Processing required	Converted format used	Absolute necessity	Match	Match	Match	Match	No restrictions	No restrictions
WP02.e	Yes	Processing required	Converted format used	Limited necessity	Match	Match	Match	Match	No restrictions	No restrictions
WP02.f	Yes	No processing required	Converted format used	Limited necessity	Match	Match	Match	Match	No restrictions	No restrictions
WP02.g	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
WP02.h	No	Processing required	Converted format used	Limited necessity	Match	Match	Match	Match	No restrictions	No restrictions
WP03.a	Yes	Processing required	Converted format used	Absolute necessity	Match	Match	Match	Match	No restrictions	No restrictions
WP03.b	Yes	Processing required	Converted format used	Absolute necessity	Match	Not applicable	Match	Match	No restrictions	No restrictions
WP03.c	Yes	No processing required	Converted format used	Limited necessity	Limited match (data usable)	Not applicable	Limited match (data usable)	Limited match (data usable)	No restrictions	No restrictions
WP03.d	Yes	Processing required	Converted format	Absolute necessity	Match	Match	Match	Limited match	No restrictions	Some restrictions

Label	data used	processing of data	data format	necessity of data for purpose	matching of spatial coverage	matching of temporal coverage	matching of spatial resolution	matching of temporal resolution	budget restrictions	project time restrictions
			used					(data usable)		(data usable)
WP03.e	Yes	Processing required	Converted format used	Limited necessity	Limited match (data usable)	Not applicable	Limited match (data usable)	Limited match (data usable)	No restrictions	No restrictions
WP03.f	Yes	Processing required	Converted format used	Absolute necessity	Match	Not assessed	Match	Match	No restrictions	No restrictions
WP03.g	Yes	No processing required	Original format used	Absolute necessity	Match	Match	Match	Match	No restrictions	No restrictions
WP03.h	No	Processing required	Converted format used	Limited necessity	No match (data not usable)	Not applicable	Match	Match	No restrictions	No restrictions
WP03.i	No	No processing required	Original format used	Limited necessity	Limited match (data usable)	Not applicable	Limited match (data usable)	Limited match (data usable)	No restrictions	No restrictions
WP04.a	Yes	No processing required	Original format used	Absolute necessity	Match	Match	Match	Match	No restrictions	No restrictions
WP04.b	Yes	No processing required	Original format used	Limited necessity	Match	Match	Match	Match	No restrictions	No restrictions
WP04.c	Yes	No processing required	Original format used	Absolute necessity	Match	Match	Match	Match	No restrictions	No restrictions
WP04.d	Yes	No processing required	Original format used	Limited necessity	Match	Match	Match	Match	No restrictions	No restrictions
WP04.e	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
WP05.a	Yes	No processing required	Original format used	Absolute necessity	Match	Match	Match	Match	No restrictions	No restrictions
WP05.b	Yes	No processing required	Original format used	Absolute necessity	Match	Match	Match	Match	No restrictions	No restrictions
WP05.c	Yes	No processing	Original format used	Limited necessity	Match	Limited match	Limited match	Match	No restrictions	No restrictions

Label	data used	processing of data	data format	necessity of data for purpose	matching of spatial coverage	matching of temporal coverage	matching of spatial resolution	matching of temporal resolution	budget restrictions	project time restrictions
		required				(data usable)	(data usable)			
WP05.d	Yes	Unknown	Unknown	Limited necessity	Match	Limited match (data usable)	Unknown	Limited match (data usable)	No restrictions	No restrictions
WP05.e	Yes	Processing required	Original format used	Absolute necessity	Match	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	No restrictions	No restrictions
WP05.f	Yes	Processing required	Converted format used	Absolute necessity	Limited match (data usable)	Match	Match	Match	No restrictions	No restrictions
WP05.g	Yes	Processing required	Converted format used	Absolute necessity	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	No restrictions	No restrictions
WP05.h	Yes	Processing required	Converted format used	Limited necessity	Match	Match	Match	Match	No restrictions	No restrictions
WP05.i	Yes	Processing required	Converted format used	Limited necessity	Limited match (data usable)	Limited match (data usable)	Not applicable	Not applicable	No restrictions	No restrictions
WP05.j	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
WP05.k	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
WP05.l	No	Processing required	Unknown	Limited necessity	Limited match (data usable)	Limited match (data usable)	Not applicable	Not applicable	Some restrictions (data usable)	Some restrictions (data usable)
WP05.m	No	Unknown	Unknown	Limited necessity	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	Unknown	Unknown
WP05.n	No	Processing required	Original format used	Limited necessity	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	No restrictions	No restrictions
WP05.o	No	No processing required	Original format used	Limited necessity	Match	Limited match (data usable)	Not applicable	Limited match (data usable)	No restrictions	No restrictions
WP05.p	No	Unknown	Unknown	Limited necessity	Limited match (data usable)	Unknown	Unknown	Unknown	No restrictions	Unknown

Label	data used	processing of data	data format	necessity of data for purpose	matching of spatial coverage	matching of temporal coverage	matching of spatial resolution	matching of temporal resolution	budget restrictions	project time restrictions
WP05.q	No	Processing required	Unknown	Limited necessity	Limited match (data usable)	Limited match (data usable)	Not applicable	Not applicable	No restrictions	Some restrictions (data usable)
WP05.r	No	Processing required	Unknown	Limited necessity	Limited match (data usable)	Unknown	Unknown	Unknown	No restrictions	Some restrictions (data usable)
WP05.s	No	Unknown	Unknown	Limited necessity	Limited match (data usable)	Unknown	Unknown	Unknown	No restrictions	Some restrictions (data usable)
WP05.t	No	Unknown	Unknown	Limited necessity	Limited match (data usable)	Unknown	Unknown	Unknown	No restrictions	Some restrictions (data usable)
WP05.u	No	Unknown	Unknown	Limited necessity	Limited match (data usable)	Unknown	Limited match (data usable)	Unknown	No restrictions	Some restrictions (data usable)
WP05.v	No	Unknown	Unknown	Limited necessity	Limited match (data usable)	Unknown	Unknown	Unknown	No restrictions	Some restrictions (data usable)
WP05.w	No	Unknown	Unknown	Limited necessity	Limited match (data usable)	Unknown	Unknown	Unknown	No restrictions	Some restrictions (data usable)
WP05.x	No	Unknown	Unknown	Limited necessity	Limited match (data usable)	Unknown	Unknown	Unknown	No restrictions	Some restrictions (data usable)
WP05.y	No	Processing required	Unknown	Limited necessity	Limited match (data usable)	Unknown	Unknown	Unknown	No restrictions	Some restrictions (data usable)
WP05.z	No	Unknown	Unknown	Limited necessity	Limited match (data usable)	Unknown	Unknown	Unknown	No restrictions	Some restrictions (data usable)
WP05.aa	No	Unknown	Unknown	Limited necessity	Match	Limited match (data usable)	Unknown	Unknown	No restrictions	No restrictions
WP05.ab	No	No processing required	Original format used	Limited necessity	Match	Limited match (data usable)	Match	Limited match (data usable)	No restrictions	Some restrictions (data usable)
WP05.ac	No	No processing required	Original format used	Limited necessity	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	No restrictions	Some restrictions (data usable)

Label	data used	processing of data	data format	necessity of data for purpose	matching of spatial coverage	matching of temporal coverage	matching of spatial resolution	matching of temporal resolution	budget restrictions	project time restrictions
WP05.ad	No	Unknown	Unknown	Limited necessity	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
WP05.ae	No	Unknown	Unknown	Limited necessity	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
WP05.af	No	Unknown	Unknown	Limited necessity	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
WP05.ag	No	Unknown	Original format used	Limited necessity	Match	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	No restrictions	No restrictions
WP05.ah	No	Unknown	Unknown	Limited necessity	Unknown	Unknown	Unknown	Unknown	No restrictions	Some restrictions (data usable)
WP05.ai	No	Unknown	Unknown	Limited necessity	Unknown	Unknown	Unknown	Unknown	Unknown	Some restrictions (data usable)
WP05.aj	No	Unknown	Unknown	Limited necessity	Unknown	Unknown	Unknown	Unknown	No restrictions	Some restrictions (data usable)
WP05.ak	No	Unknown	Unknown	Limited necessity	Unknown	Unknown	Unknown	Unknown	No restrictions	Some restrictions (data usable)
WP05.al	No	Unknown	Unknown	Limited necessity	Unknown	Unknown	Unknown	Unknown	No restrictions	Some restrictions (data usable)
WP05.am	No	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
WP05.an	No	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
WP05.ao	No	Unknown	Unknown	Limited necessity	Limited match (data usable)	Unknown	Unknown	Unknown	No restrictions	Some restrictions (data usable)
WP05.ap	No	Unknown	Unknown	Limited necessity	Unknown	Unknown	Unknown	Unknown	No restrictions	Some restrictions (data usable)
WP05.aq	No	Unknown	Unknown	Limited necessity	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
WP05.ar	No	Unknown	Unknown	Limited necessity	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown

Label	data used	processing of data	data format	necessity of data for purpose	matching of spatial coverage	matching of temporal coverage	matching of spatial resolution	matching of temporal resolution	budget restrictions	project time restrictions
WP05.as	No	Unknown	Unknown	Limited necessity	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
WP05.at	No	Unknown	Unknown	Limited necessity	Unknown	Unknown	Unknown	Unknown	No restrictions	No restrictions
WP05.au	No	Unknown	Unknown	Limited necessity	Unknown	Unknown	Unknown	Unknown	No restrictions	No restrictions
WP05.av	No	Unknown	Unknown	Limited necessity	Unknown	Unknown	Unknown	Unknown	No restrictions	Some restrictions (data usable)
WP05.aw	No	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
WP05.ax	No	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
WP05.ay	No	Unknown	Unknown	Limited necessity	Unknown	Unknown	Unknown	Unknown	No restrictions	No restrictions
WP05.az	No	Unknown	Unknown	Limited necessity	Unknown	Unknown	Unknown	Unknown	No restrictions	No restrictions
WP05.ba	No	Processing required	Unknown	Unknown	Limited match (data usable)	Unknown	Not applicable	Not applicable	No restrictions	No restrictions
WP05.bb	No	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
WP05.bc	No	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
WP05.bd	No	Processing required	Unknown	Limited necessity	Limited match (data usable)	Not applicable	Not applicable	Not applicable	No restrictions	No restrictions
WP05.be	No	Unknown	Unknown	Limited necessity	Unknown	Unknown	Unknown	Unknown	No restrictions	No restrictions
WP05.bf	No	Unknown	Unknown	Limited necessity	Match	Unknown	Unknown	Unknown	No restrictions	No restrictions
WP05.bg	No	No processing required	Original format used	Limited necessity	Limited match (data usable)	Limited match (data usable)	Unknown	Unknown	No restrictions	No restrictions
WP05.bh	No	Processing required	Original format used	Limited necessity	Limited match (data usable)	Unknown	Limited match (data usable)	Unknown	No restrictions	No restrictions
WP05.bi	No	Unknown	Unknown	Limited necessity	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown

Label	data used	processing of data	data format	necessity of data for purpose	matching of spatial coverage	matching of temporal coverage	matching of spatial resolution	matching of temporal resolution	budget restrictions	project time restrictions
WP05.bj	No	No processing required	Unknown	Limited necessity	Limited match (data usable)	Unknown	Unknown	Unknown	No restrictions	No restrictions
WP05.bk	No	Unknown	Unknown	Limited necessity	Match	Match	Match	Match	No restrictions	Some restrictions (data usable)
WP05.bl	No	Processing required	Unknown	Limited necessity	Limited match (data usable)	Unknown	Unknown	Unknown	Unknown	No restrictions
WP05.bm	No	Unknown	Unknown	Limited necessity	Unknown	Unknown	Limited match (data usable)	Limited match (data usable)	No restrictions	No restrictions
WP05.bn	No	Processing required	Unknown	Limited necessity	Limited match (data usable)	Unknown	Unknown	Unknown	No restrictions	Some restrictions (data usable)
WP05.bo	No	Unknown	Unknown	Limited necessity	Limited match (data usable)	Unknown	Unknown	Unknown	No restrictions	Some restrictions (data usable)
WP05.bp	No	Unknown	Unknown	Limited necessity	Limited match (data usable)	Unknown	Unknown	Unknown	No restrictions	Some restrictions (data usable)
WP05.bq	No	Unknown	Unknown	Unknown	Unknown	Unknown	Not applicable	Not applicable	No restrictions	No restrictions
WP05.br	No	Unknown	Unknown	Limited necessity	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
WP05.bs	No	No processing required	Not assessed	Limited necessity	Limited match (data usable)	Limited match (data usable)	Not applicable	Limited match (data usable)	No restrictions	Some restrictions (data usable)
WP05.bt	No	Unknown	Unknown	Limited necessity	Limited match (data usable)	Unknown	Unknown	Unknown	Unknown	Unknown
WP05.bu	No	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
WP05.bv	No	Unknown	Unknown	Limited necessity	Limited match (data usable)	Unknown	Unknown	Unknown	No restrictions	Some restrictions (data usable)
WP05.bw	No	Processing required	Unknown	Limited necessity	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	No restrictions	No restrictions

Label	data used	processing of data	data format	necessity of data for purpose	matching of spatial coverage	matching of temporal coverage	matching of spatial resolution	matching of temporal resolution	budget restrictions	project time restrictions
WP05.bx	No	Unknown	Unknown	Limited necessity	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
WP05.by	No	Unknown	Unknown	Limited necessity	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
WP05.bz	No	Processing required	Converted format used	Limited necessity	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	Not applicable	No restrictions	No restrictions
WP05.ca	No	Processing required	Unknown	Limited necessity	Limited match (data usable)	Limited match (data usable)	Not applicable	Not applicable	No restrictions	Some restrictions (data usable)
WP05.cb	No	Processing required	Unknown	Limited necessity	Limited match (data usable)	Limited match (data usable)	Not applicable	Not applicable	No restrictions	No restrictions
WP05.cc	No	Processing required	Unknown	Limited necessity	Limited match (data usable)	Not applicable	Not applicable	Not applicable	No restrictions	Some restrictions (data usable)
WP05.cd	No	Processing required	Unknown	Limited necessity	Limited match (data usable)	Not applicable	Not applicable	Not applicable	No restrictions	Some restrictions (data usable)
WP05.ce	No	Processing required	Unknown	Limited necessity	Limited match (data usable)	Limited match (data usable)	Not applicable	Not applicable	No restrictions	Some restrictions (data usable)
WP05.cf	No	Unknown	Unknown	Limited necessity	Unknown	Unknown	Unknown	Unknown	No restrictions	Unknown
WP05.cg	No	Unknown	Unknown	Limited necessity	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
WP05.ch	No	Unknown	Unknown	Limited necessity	Limited match (data usable)	Unknown	Unknown	Unknown	No restrictions	No restrictions
WP05.ci	No	Processing required	Converted format used	Limited necessity	Match	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	No restrictions	Some restrictions (data usable)
WP05.cj	No	Processing required	Unknown	Limited necessity	Limited match (data usable)	Unknown	Not applicable	Not applicable	No restrictions	Unknown
WP06.a	Yes	Processing required	Converted format used	Absolute necessity	Match	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	No restrictions	Some restrictions (data usable)
WP06.b	Yes	Processing required	Converted format	Absolute necessity	Match	Limited match	Limited match	Limited match	No restrictions	Some restrictions

Label	data used	processing of data	data format	necessity of data for purpose	matching of spatial coverage	matching of temporal coverage	matching of spatial resolution	matching of temporal resolution	budget restrictions	project time restrictions
			used			(data usable)	(data usable)	(data usable)		(data usable)
WP06.c	Yes	Processing required	Converted format used	Limited necessity	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	No restrictions	Some restrictions (data usable)
WP06.d	Yes	Processing required	Converted format used	Absolute necessity	Match	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	No restrictions	Some restrictions (data usable)
WP06.e	Yes	Processing required	Converted format used	Absolute necessity	Match	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	No restrictions	Some restrictions (data usable)
WP06.f	Yes	Processing required	Converted format used	Absolute necessity	Match	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	No restrictions	Some restrictions (data usable)
WP06.g	Yes	Processing required	Converted format used	Limited necessity	Match	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	No restrictions	Some restrictions (data usable)
WP06.h	Yes	Processing required	Converted format used	Absolute necessity	Match	Limited match (data usable)	Match	Limited match (data usable)	No restrictions	Some restrictions (data usable)
WP06.i	Yes	Processing required	Converted format used	Limited necessity	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	No restrictions	Some restrictions (data usable)
WP06.j	Yes	Processing required	Converted format used	Absolute necessity	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	No restrictions	Some restrictions (data usable)
WP06.k	Yes	Processing required	Converted format used	Absolute necessity	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	No restrictions	Some restrictions (data usable)
WP06.l	Yes	Processing required	Original format used	Absolute necessity	Match	Match	Limited match (data usable)	Limited match (data usable)	No restrictions	No restrictions
WP06.m	Yes	Processing required	Converted format used	Absolute necessity	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	No restrictions	Some restrictions (data usable)
WP06.n	Yes	Processing required	Converted format used	Limited necessity	Match	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	No restrictions	Some restrictions (data usable)
WP06.o	Yes	Processing required	Converted format	Absolute necessity	Limited match	Limited match	Limited match	Limited match	No restrictions	Some restrictions

Label	data used	processing of data	data format	necessity of data for purpose	matching of spatial coverage	matching of temporal coverage	matching of spatial resolution	matching of temporal resolution	budget restrictions	project time restrictions
			used		(data usable)	(data usable)	(data usable)	(data usable)		(data usable)
WP06.p	Yes	Processing required	Converted format used	Absolute necessity	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	No restrictions	Some restrictions (data usable)
WP06.q	Yes	Processing required	Original format used	Absolute necessity	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	No restrictions	Some restrictions (data usable)
WP06.r	Yes	Processing required	Original format used	Absolute necessity	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	No restrictions	No restrictions
WP06.s	Yes	Processing required	Converted format used	Absolute necessity	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	No restrictions	No restrictions
WP06.t	Yes	Processing required	Converted format used	Limited necessity	Match	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	No restrictions	Some restrictions (data usable)
WP06.u	Yes	Processing required	Converted format used	Limited necessity	Match	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	No restrictions	Some restrictions (data usable)
WP06.v	Yes	Processing required	Converted format used	Absolute necessity	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	No restrictions	Some restrictions (data usable)
WP06.w	No	Not assessed	Not assessed	Not assessed	Limited match (data usable)	Limited match (data usable)	Not assessed	Not assessed	Not assessed	Not assessed
WP06.x	No	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
WP07.a	Yes	Processing required	Converted format used	Limited necessity	Limited match (data usable)	Match	Limited match (data usable)	Match	No restrictions	No restrictions
WP07.b	Yes	Processing required	Converted format used	Absolute necessity	Limited match (data usable)	Match	Limited match (data usable)	Match	No restrictions	No restrictions
WP07.c	Yes	Processing required	Converted format used	Absolute necessity	Limited match (data usable)	Match	Limited match (data usable)	Match	No restrictions	No restrictions
WP07.d	Yes	Processing required	Converted format used	Limited necessity	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	No restrictions	No restrictions

Label	data used	processing of data	data format	necessity of data for purpose	matching of spatial coverage	matching of temporal coverage	matching of spatial resolution	matching of temporal resolution	budget restrictions	project time restrictions
WP07.e	Yes	Processing required	Converted format used	Absolute necessity	Limited match (data usable)	Match	Limited match (data usable)	Match	No restrictions	No restrictions
WP07.f	Yes	Processing required	Converted format used	Limited necessity	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	No restrictions	No restrictions
WP07.g	Yes	Processing required	Converted format used	Absolute necessity	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	Match	No restrictions	No restrictions
WP07.h	No	Processing required	Not assessed	Unknown	Unknown	Unknown	Not applicable	Unknown	No restrictions	Restrictions (data not usable)
WP07.i	No	Processing required	Unknown	Unknown	Limited match (data usable)	No match (data not usable)	Limited match (data usable)	No match (data not usable)	Unknown	Unknown
WP07.j	No	Unknown	Unknown	Limited necessity	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
WP07.k	No	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Restrictions (data not usable)
WP07.l	No	Processing required	Converted format used	Limited necessity	Limited match (data usable)	Match	Limited match (data usable)	Match	No restrictions	No restrictions
WP07.m	No	Processing required	Converted format used	Limited necessity	Limited match (data usable)	Match	No match (data not usable)	Match	No restrictions	No restrictions
WP07.n	No	Processing required	Converted format used	Absolute necessity	Limited match (data usable)	Match	Limited match (data usable)	Match	No restrictions	Restrictions (data not usable)
WP08.a	Yes	Processing required	Converted format used	Absolute necessity	Limited match (data usable)	Unknown	Limited match (data usable)	Unknown	No restrictions	No restrictions
WP08.b	Yes	Processing required	Converted format used	Absolute necessity	Limited match (data usable)	Unknown	Limited match (data usable)	Unknown	No restrictions	No restrictions
WP08.c	Yes	Processing required	Converted format used	Absolute necessity	Limited match (data usable)	Unknown	Limited match (data usable)	Unknown	No restrictions	No restrictions

Label	data used	processing of data	data format	necessity of data for purpose	matching of spatial coverage	matching of temporal coverage	matching of spatial resolution	matching of temporal resolution	budget restrictions	project time restrictions
WP08.d	Yes	Processing required	Converted format used	Limited necessity	Match	Match	Match	Match	No restrictions	No restrictions
WP08.e	Yes	Processing required	Converted format used	Limited necessity	Limited match (data usable)	Unknown	Unknown	Unknown	Unknown	Some restrictions (data usable)
WP08.f	Yes	Processing required	Converted format used	Limited necessity	Limited match (data usable)	Unknown	Limited match (data usable)	Not applicable	No restrictions	No restrictions
WP08.g	Yes	Processing required	Converted format used	Limited necessity	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	Match	No restrictions	No restrictions
WP08.h	Yes	Processing required	Converted format used	Absolute necessity	Limited match (data usable)	Unknown	Limited match (data usable)	Not applicable	No restrictions	No restrictions
WP08.i	Yes	Processing required	Converted format used	Limited necessity	Limited match (data usable)	Unknown	Unknown	Unknown	No restrictions	No restrictions
WP08.j	Yes	Processing required	Converted format used	Limited necessity	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	No restrictions	No restrictions
WP08.k	Yes	Processing required	Converted format used	Limited necessity	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	Not applicable	No restrictions	No restrictions
WP08.l	No	Unknown	Unknown	Unknown	Limited match (data usable)	No match (data not usable)	Unknown	Match	Unknown	Unknown
WP08.m	No	Unknown	Unknown	Limited necessity	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
WP08.n	No	Processing required	Converted format used	Limited necessity	Limited match (data usable)	Match	No match (data not usable)	Match	No restrictions	No restrictions
WP08.o	No	Unknown	Unknown	Unknown	No match (data not usable)	Unknown	No match (data not usable)	Unknown	Unknown	Unknown
WP08.p	No	Processing required	Converted format used	Unknown	Limited match (data usable)	Match	No match (data not usable)	Match	Unknown	Unknown
WP08.q	No	Processing required	Converted format	Limited necessity	Match	Limited match	No match (data	Match	No restrictions	No restrictions

Label	data used	processing of data	data format	necessity of data for purpose	matching of spatial coverage	matching of temporal coverage	matching of spatial resolution	matching of temporal resolution	budget restrictions	project time restrictions
			used			(data usable)	not usable)			
WP08.r	No	Processing required	Converted format used	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
WP08.s	No	Processing required	Converted format used	Absolute necessity	Unknown	Unknown	Unknown	Unknown	Unknown	Restrictions (data not usable)
WP08.t	No	Unknown	Unknown	Limited necessity	Limited match (data usable)	Unknown	Unknown	Unknown	Unknown	Unknown
WP08.u	No	Processing required	Converted format used	Absolute necessity	Limited match (data usable)	Match	Limited match (data usable)	Match	No restrictions	Restrictions (data not usable)
WP10.a	Yes	Processing required	Converted format used	Limited necessity	Limited match (data usable)	Limited match (data usable)	Not applicable	Match	No restrictions	No restrictions
WP10.b	Yes	Processing required	Converted format used	Limited necessity	Limited match (data usable)	Limited match (data usable)	Not applicable	Match	No restrictions	No restrictions
WP10.c	Yes	No processing required	Converted format used	Limited necessity	Match	Limited match (data usable)	Not applicable	Match	No restrictions	No restrictions
WP10.d	Yes	No processing required	Converted format used	Limited necessity	Limited match (data usable)	Limited match (data usable)	Not applicable	Limited match (data usable)	No restrictions	No restrictions
WP10.e	Yes	Unknown	Converted format used	Limited necessity	Limited match (data usable)	Limited match (data usable)	Not applicable	Limited match (data usable)	No restrictions	No restrictions
WP10.f	Yes	No processing required	Original format used	Limited necessity	Match	Limited match (data usable)	Not applicable	Match	No restrictions	No restrictions
WP10.g	Yes	No processing required	Original format used	Limited necessity	Limited match (data usable)	Limited match (data usable)	Not applicable	Limited match (data usable)	No restrictions	No restrictions
WP10.h	Yes	Processing required	Converted format used	Absolute necessity	Match	Limited match (data usable)	Not applicable	Match	No restrictions	No restrictions
WP10.i	Yes	No processing	Converted format	Absolute necessity	Limited match	Limited match	Not applicable	Match	No restrictions	No restrictions

Label	data used	processing of data	data format	necessity of data for purpose	matching of spatial coverage	matching of temporal coverage	matching of spatial resolution	matching of temporal resolution	budget restrictions	project time restrictions
		required	used		(data usable)	(data usable)				
WP10.j	Yes	Processing required	Converted format used	Limited necessity	Limited match (data usable)	Limited match (data usable)	Not applicable	Match	No restrictions	No restrictions
WP10.k	Yes	Processing required	Converted format used	Limited necessity	Limited match (data usable)	Limited match (data usable)	Not applicable	Match	No restrictions	No restrictions
WP10.l	Yes	Processing required	Converted format used	Limited necessity	Limited match (data usable)	Limited match (data usable)	Not applicable	Limited match (data usable)	No restrictions	No restrictions
WP10.m	Not assessed	Processing required	Converted format used	Limited necessity	Limited match (data usable)	Limited match (data usable)	Not applicable	Match	No restrictions	No restrictions
WP10.n	Not assessed	Processing required	Converted format used	Limited necessity	Limited match (data usable)	Limited match (data usable)	Not applicable	Match	No restrictions	No restrictions
WP10.o	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
WP10.p	No	No processing required	Converted format used	Limited necessity	Match	Limited match (data usable)	Not applicable	Match	No restrictions	No restrictions
WP10.q	No	Not assessed	Not assessed	Absolute necessity	Limited match (data usable)	Limited match (data usable)	Not applicable	Limited match (data usable)	No restrictions	Restrictions (data not usable)
WP10.r	No	Not assessed	Not assessed	Absolute necessity	Limited match (data usable)	Limited match (data usable)	Not applicable	Limited match (data usable)	No restrictions	Restrictions (data not usable)
WP10.s	No	Not assessed	Not assessed	Absolute necessity	Limited match (data usable)	Limited match (data usable)	Not applicable	Limited match (data usable)	No restrictions	Restrictions (data not usable)
WP10.t	No	Not assessed	Not assessed	Absolute necessity	Limited match (data usable)	Limited match (data usable)	Not applicable	Limited match (data usable)	No restrictions	Restrictions (data not usable)
WP10.u	No	Not assessed	Not assessed	Absolute necessity	Limited match (data usable)	Limited match (data usable)	Not applicable	Limited match (data usable)	No restrictions	Restrictions (data not usable)
WP10.v	No	Not assessed	Not assessed	Absolute necessity	Limited match	Limited match	Not applicable	Limited match	No restrictions	Restrictions (data not

Label	data used	processing of data	data format	necessity of data for purpose	matching of spatial coverage	matching of temporal coverage	matching of spatial resolution	matching of temporal resolution	budget restrictions	project time restrictions
					(data usable)	(data usable)		(data usable)		usable)
WP10.w	No	Not assessed	Not assessed	Absolute necessity	Limited match (data usable)	Limited match (data usable)	Not applicable	Limited match (data usable)	No restrictions	Restrictions (data not usable)
WP11.a	Yes	Processing required	Not assessed	Absolute necessity	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	Not applicable	No restrictions	Some restrictions (data usable)
WP11.b	Yes	Processing required	Not assessed	Limited necessity	Limited match (data usable)	Limited match (data usable)	Limited match (data usable)	Not applicable	No restrictions	Some restrictions (data usable)
WP11.c	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
WP11.d	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
WP11.e	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
WP11.f	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
WP11.g	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
WP11.h	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
WP11.i	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
WP11.j	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
WP12.a	Yes	No processing required	Original format used	Absolute necessity	Limited match (data usable)	Limited match (data usable)	Match	Limited match (data usable)	No restrictions	No restrictions
WP12.b	Yes	Processing required	Not assessed	Limited necessity	No match (data	Match	No match (data	Match	No restrictions	No restrictions

Label	data used	processing of data	data format	necessity of data for purpose	matching of spatial coverage	matching of temporal coverage	matching of spatial resolution	matching of temporal resolution	budget restrictions	project time restrictions
					not usable)		not usable)			
WP12.c	Yes	Processing required	Not assessed	Limited necessity	Limited match (data usable)	Not applicable	Not applicable	Not applicable	No restrictions	No restrictions
WP12.d	Yes	Processing required	Not assessed	Limited necessity	Match	Match	Limited match (data usable)	Limited match (data usable)	No restrictions	No restrictions
WP12.e	Yes	Processing required	Unknown	Limited necessity	Match	Not applicable	Not applicable	Not applicable	No restrictions	No restrictions
WP12.f	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
WP12.g	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
WP12.h	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
WP12.i	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
WP12.j	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
WP12.k	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
WP12.l	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
WP12.m	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
WP12.n	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
WP12.o	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed

Label	data used	processing of data	data format	necessity of data for purpose	matching of spatial coverage	matching of temporal coverage	matching of spatial resolution	matching of temporal resolution	budget restrictions	project time restrictions
WP12.p	No	Processing required	Not assessed	Limited necessity	No match (data not usable)	Match	No match (data not usable)	Match	No restrictions	No restrictions
WP12.q	No	Not assessed	Unknown	Limited necessity	Unknown	Unknown	Unknown	Unknown	No restrictions	No restrictions
WP12.r	No	Not assessed	Unknown	Limited necessity	Not assessed	Not assessed	Not assessed	Not assessed	No restrictions	No restrictions

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IMARES (Institute for Marine Resources and Ecosystem Studies) is the Netherlands research institute established to provide the scientific support that is essential for developing policies and innovation in respect of the marine environment, fishery activities, aquaculture and the maritime sector.

The IMARES vision
'To explore the potential of marine nature to improve the quality of life'

The IMARES mission
- To conduct research with the aim of acquiring knowledge and offering advice on the sustainable management and use of marine and coastal areas.
- IMARES is an independent, leading scientific research institute

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