



ESaTDOR

European Seas and Territorial Development, Opportunities and Risks

ANNEX 2 to the Draft Final Report: Arctic Ocean Regional Profile

Applied Research 2013/1/5

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Sea Profile: the Arctic Ocean

1. Introduction

In the last few years there has been growing acknowledgement that the seas which surround Europe offer significant opportunities for - and potential risks to - territorial development. The sea provides resources on and in its waters and on and under the sea bed that can be harnessed as the basis for territorial development; it enables the flow of goods, services and people, connecting different parts of Europe to each other and the wider global community; and it provides an important environmental asset that needs careful management not least because the health of the sea is critical to efforts to combat climate change. However, different stakeholders have different priorities in terms of what uses and priorities should be privileged in different parts of the maritime environment and few have an overview of the range of issues that require consideration in making such judgements in an informed way.

Whilst there has been a growing recognition of the need for improved planning of maritime space, as exemplified by the growth of integrated coastal zone management and marine spatial planning, more broadly little has yet been done to explore the potentials and challenges of planning for these areas, particularly in relation to their transnational and cross border dimensions. As a step forward, this ESPON project aims to explore the territorial development opportunities and risks facing the seas of Europe by distilling key land/sea and transnational interconnections. Each European regional sea has its own specific characteristics in terms of territorial development opportunities and risks, and uses different governance structures to manage competing claims. This report focuses on one of the six regional seas which are covered by the project and provides a profile of the Arctic Ocean.

Each Regional Sea Profile report is subdivided into two parts. The first part seeks to provide a detailed characterisation of the regional sea as it exists today. The second part starts to look to the future and describes the potential opportunities and risks pertaining to each sea, and sets out policy recommendations that can help guide territorial development within the region.

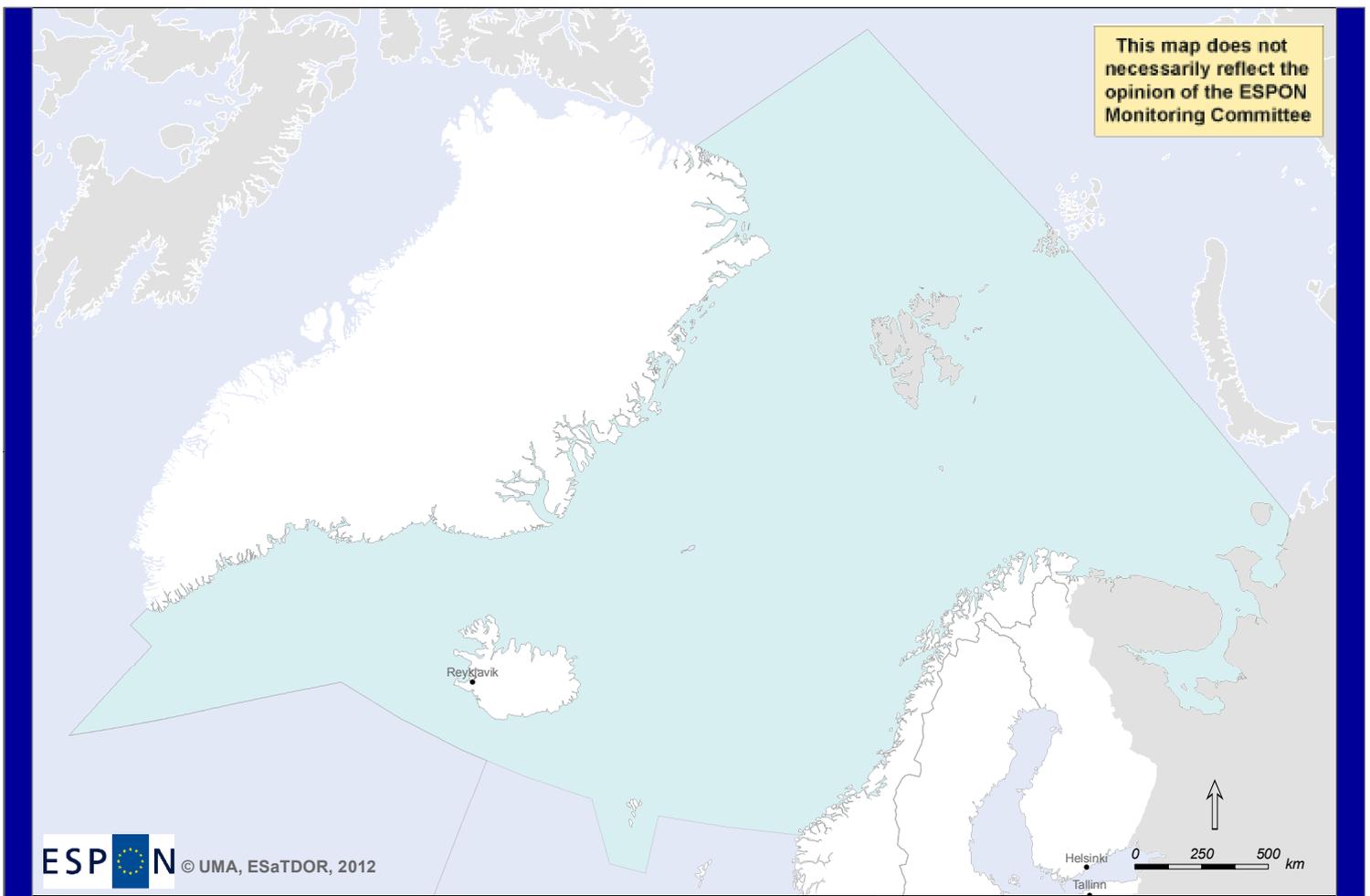
Part 1 begins with a brief section which provides contextual information including a description of how the boundaries of the regional sea have been defined for the purposes of this project. In some instances this has been relatively straightforward. In others we have had to make pragmatic decisions as varying boundary definitions are in use and in some areas are still very much contested. The second section then describes in more detail key thematic characteristics of each regional sea focusing on the maritime economy, transport, energy and undersea infrastructure and the environment. This characterisation reflects the existing situation and is based around a standardised series of maps which draw upon the limited number of data sets we have uncovered that relate to these themes where there is good European wide coverage. The maps have, in some cases, been supplemented by local information which is seen as being an exemplar of good practice and which might have relevance to other European regional seas in terms of improving data coverage and mapping to inform policy development.

One of the critical characteristics of all of the regional seas is that the effective management of both the opportunities and risks will require cross boundary and transnational cooperation between the members states of the EU, members of the European Economic Area and potential accession countries and other countries who share a common interest in a particular sea. The configuration of

interested nation states varies from regional sea to regional sea, although how transnational and cross boundary issues are being managed at the present time is reflected on in the governance section. Here a limited number of case studies are used to explore the effectiveness (or otherwise) of various maritime governance regimes designed to address specific cross border and transnational issues.

The final section of the first part provides an overall characterisation of the regional seas based on composite maps of flows, economic significance and environmental pressures. The purpose of these composite maps is to characterise the maritime regions covering both land and sea in terms of intensity of use and land sea interactions. Drawing upon these composite maps a baseline typology of maritime regions is presented which classifies these areas as European Core, Regional Hub, Transition, Rural and Wilderness based on their current attributes.

In the second part of the report the focus shifts to the future and it comprises two elements. First we summarise key opportunities and risks for future territorial development for the regional sea based on the understanding of current and potential land sea interactions. Second this assessment leads to a set of policy recommendations targeted at different stakeholder groups related to future planning and development in the region.




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Thematic data:
Land boundaries: © EuroGeographics Association and ESRI. Regional level: NUTS0.
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AR1. Arctic Ocean Boundaries (defined for ESaTDOR Project)

PART 1

2. Context

This section gives first a brief description and justification of the selected regional sea boundary for the Arctic. This is followed some general descriptive commentary on sea region based on some selected maps in order to provide an introductory characterisation of the sea.

Regional Sea boundaries

The Arctic Ocean is located in the Northern Hemisphere and mostly in the Arctic North Polar Region. The Ocean is bordered by Greenland, Canada, Alaska, Russia, and Norway. These are the littoral states. Eight countries are regarded as Arctic countries; these are Canada, Denmark with the Faroe Islands and Greenland, Iceland, Norway, Finland, Sweden, the Russian Federation and the United States. According to The Arctic Ocean Review Project (<http://www.aor.is/>) there is no agreed upon definition of the geographical extent of the Arctic. What the AOR project defines as the “Arctic marine environment” comprises an area of 20 million sq km. This includes the central Arctic Ocean, and in addition, the surrounding seas: the Bering Sea, the East Siberian Sea, the Chukchi Sea, the Beaufort Sea, the Davis Strait, Baffin Bay and Labrador Sea, the Greenland Sea, the waters around Iceland and the Faroe Islands, and northern parts of the Norwegian Sea, the Barents Sea, the Kara Sea, and the Laptev Sea. The boundaries used here for the Arctic Ocean maritime region are consistent with those for OSPAR region I¹, see Map AR1.

The Bering Strait connects the Arctic Ocean with the Pacific Ocean and the Greenland Sea is the chief link with the Atlantic Ocean. A sparse network of air, ocean, river, and land routes circumscribes the Arctic Ocean. The greatest inflow of water comes from the Atlantic by way of the Norwegian Current, which then flows along the Eurasian coast. The Arctic Ocean is divided into two basins, the Eurasian Basin, and the North American Basin, by the Lomonosov Ridge. There are also submarine ridges between the Arctic and Atlantic Oceans. This results in a large stagnant pool of cold water at the bottom of the Arctic Ocean, since land and submarine ridges block water from flowing out. The main current in the Arctic Ocean is the East Greenland current. This current is strong due to the number of rivers that flow into the Arctic Sea, the low rate of evaporation, and the land and submarine ridges surrounding the ocean.

The Arctic Ocean is rich in natural resources such as fish, oil and gas, marine mammals and minerals. The sub-Arctic parts of the Arctic area support some of the largest fish stocks and fisheries in the world, notably in the Barents, Norwegian, Iceland and Bering seas. The most important Arctic fish species is polar cod which is found mainly in the low Arctic zone around the periphery of the central Arctic Ocean. Extensive oil and gas activity has occurred in the Arctic, mainly on land and mostly in Russia but off-shore activities are expected to increase both in Norwegian and Russian sectors in the future. The US Geological Survey estimates that the Arctic contains up to 30 per cent of the world’s undiscovered gas and 13 per cent of the world’s undiscovered oil resources (Gautier et al, 2009). The main concern surrounding offshore oil and gas activities in the Arctic is the risk of major accidents involving large-scale oil spills which may destroy the ecosystem.

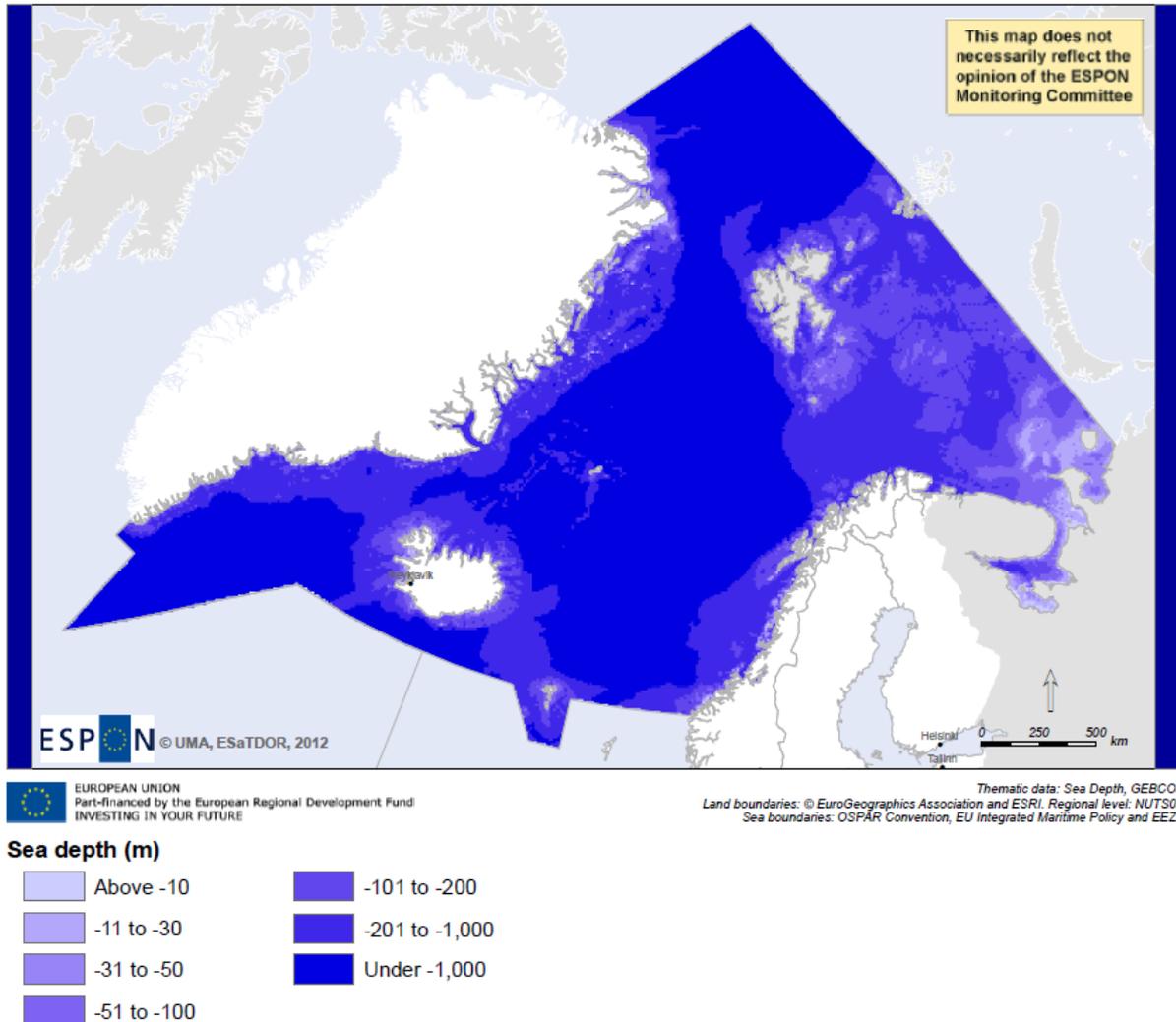
¹ OSPAR is used since it is an internationally accepted framework which works under the umbrella of customary international law as codified by the 1982 United Nations Convention on the Law of the Seas (UNCLOS) (<http://www.ospar.org/>).

Characterisation of the Arctic Ocean

Sea depth

The Arctic Ocean is the smallest and shallowest of the world's five major oceans. The average depth of the ocean is approximately 1000m/3400 ft, and the very deepest point is in the Eurasian basin 5450m/17900 ft (http://www.encyclopedia.com/topic/Arctic_Ocean.aspx).

Map AR2 Sea depth of the Arctic Ocean



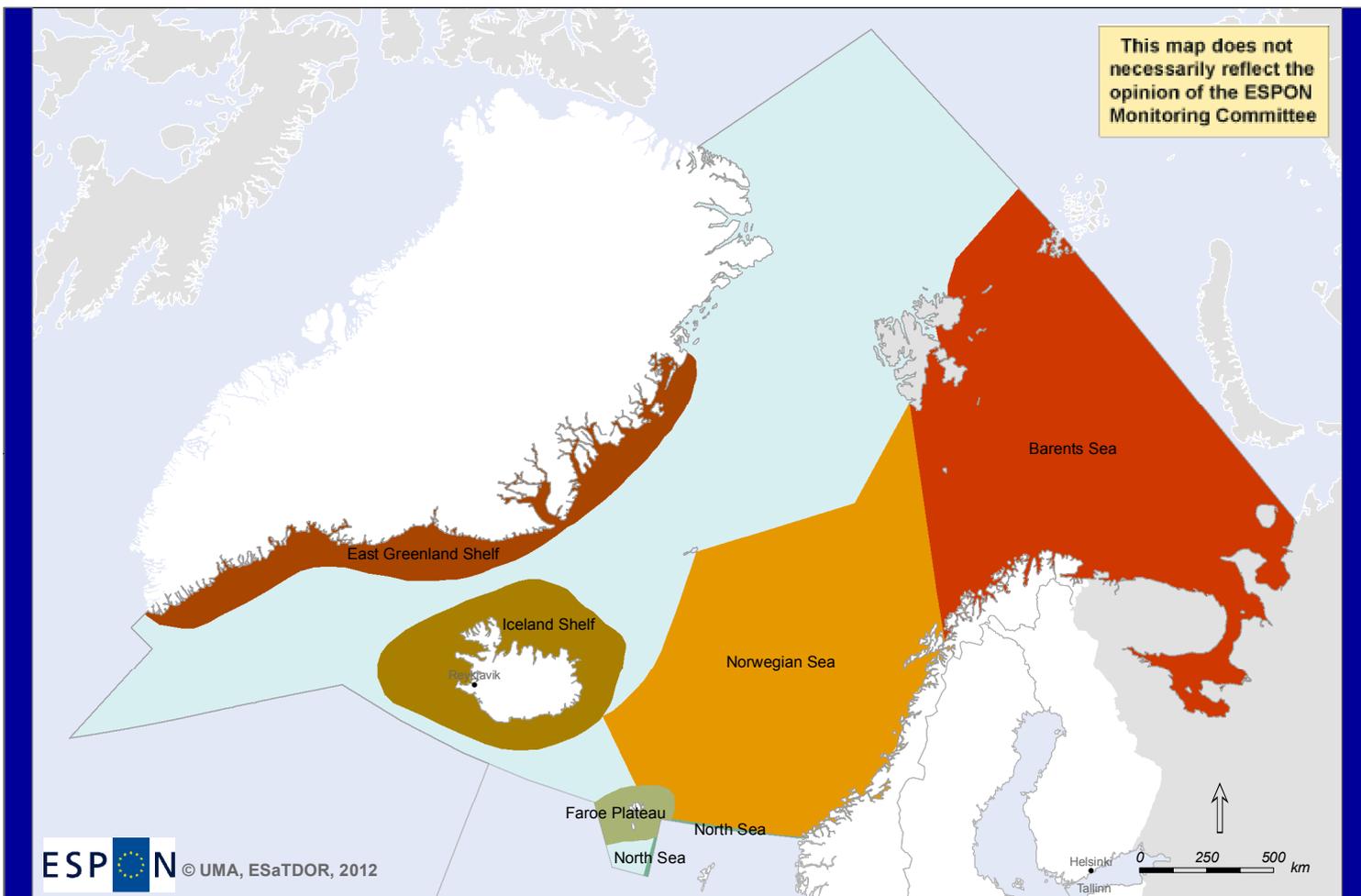
The Arctic Ocean is encircled by shallow shelf waters. In the Northeast Atlantic these include the Barents Sea off Norway's northern coast and the Kola Peninsula in northwest Russia. Progressing eastward and northward from there is: the island of Novaya Zemlya (off Russia's northern coast — with its Eastern shore on the Kara Sea); the Laptev Sea (off Russia's central northern coast), the East Siberian Sea (off Russia's northeast coast), the Chukchi Sea (north of the Bering Straits), Beaufort Sea (north of Alaska and western Canada), and lastly the Lincoln Sea and the Wandel Sea (also known as the McKinley Sea), both of which are north of Greenland.

The Arctic marine ecosystem

According to the UNEP – WCMC Global map of Large Marine eco-regions there are several large marine ecosystems in the Arctic Ocean – the Barents Sea, The Norwegian Sea, the Faroe Plateau, The Iceland Shelf and East Greenland Shelf, see Map AR3. Large marine ecosystems (LMEs)² are regions of the world's oceans, encompassing coastal areas from river basins and estuaries to the seaward boundaries of continental shelves and the outer margins of the major ocean current systems. They are characterized by distinct bathymetry, hydrography, productivity, and trophically dependent populations (<http://www.aor.is/>).

The Arctic Ocean is a unique but fragile marine ecosystem which is slow to change and to recover from disruptions or damage. Major threats to Arctic biodiversity are climate change, unsustainable fishing practices and overharvesting which is occurring for some species in some sectors of the Arctic, such as walrus and whales and sea mammals such as polar bears, seals and whales, and sea birds. The acidity of the ocean is also increasing and coral species may disappear (Øseth 2010). The pack ice is thinning and the Arctic Ocean may become ice free for the first time in human history already in 2030 - 2040 (ACIA, Hønneland 2012). This will reduce the planet's average albedo and may result in global warming through a positive feedback mechanism.

² The system of LMEs has been developed by the US National Oceanic and Atmospheric Administration (NOAA) to identify areas of the oceans for conservation purposes and as a tool for enabling ecosystem-based management of resources within ecologically-bounded transnational areas (<http://www.noaa.gov/>). This will be done in an international context and consistent with customary international law as reflected in 1982 UN Convention on the Law of the Sea.




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Thematic data: UNEP, WCMC.
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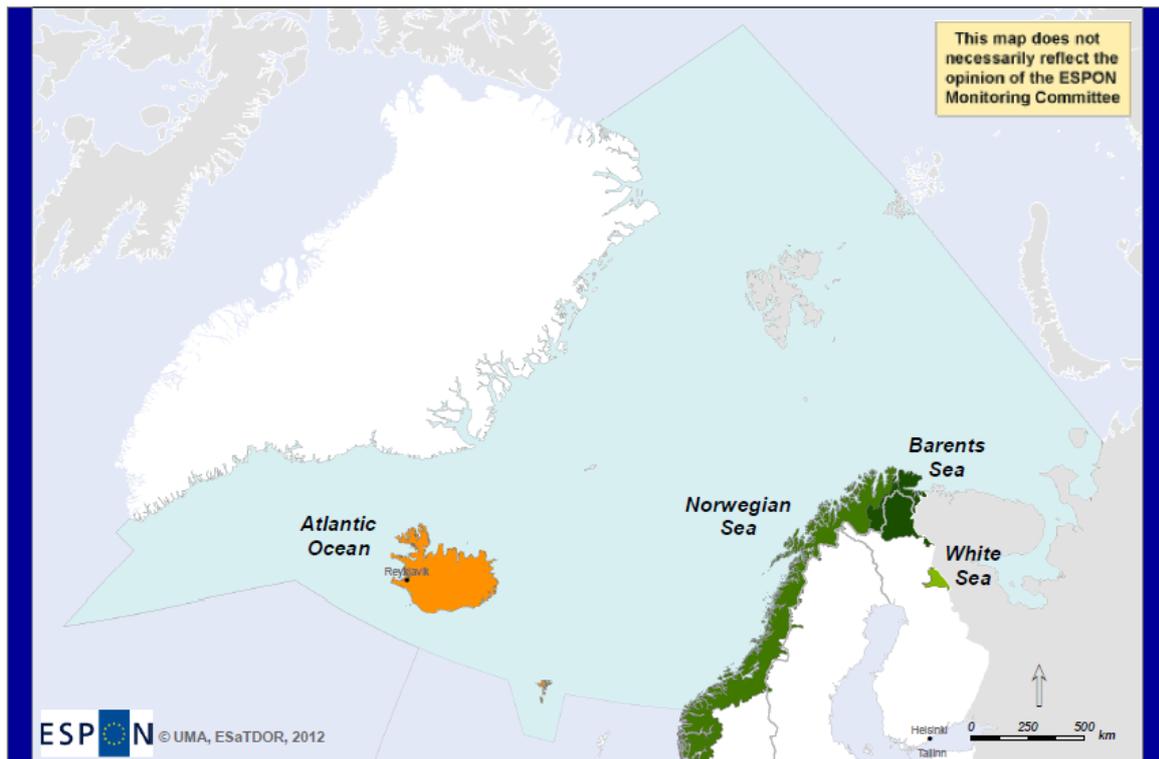
AR3. Large Marine Ecosystems in the Arctic Ocean region

- | | |
|---|---|
|  Baltic Sea |  Faroe Plateau |
|  Barents Sea |  Iberian Coastal |
|  Black Sea |  Iceland Shelf |
|  Canary Current |  Mediterranean Sea |
|  Celtic-Biscay Shelf |  North Sea |
|  East Greenland Shelf |  Norwegian Sea |

Water catchment areas and population contained within catchments

Map AR4a shows the population at NUTS3 and in the catchment boundaries of the different seas included within the ESPON space. The number of population present within each catchment is weighted by the area of the catchment to get the population density per catchment. As can be seen in Map AR4a the population density per catchment is almost six times higher for Iceland than for Norway. This may imply more human activities effecting terrestrial runoff which have substantial effects on the marine system in Iceland than in Norway.

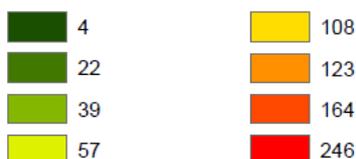
Map AR4a Water catchment areas and population contained within catchments



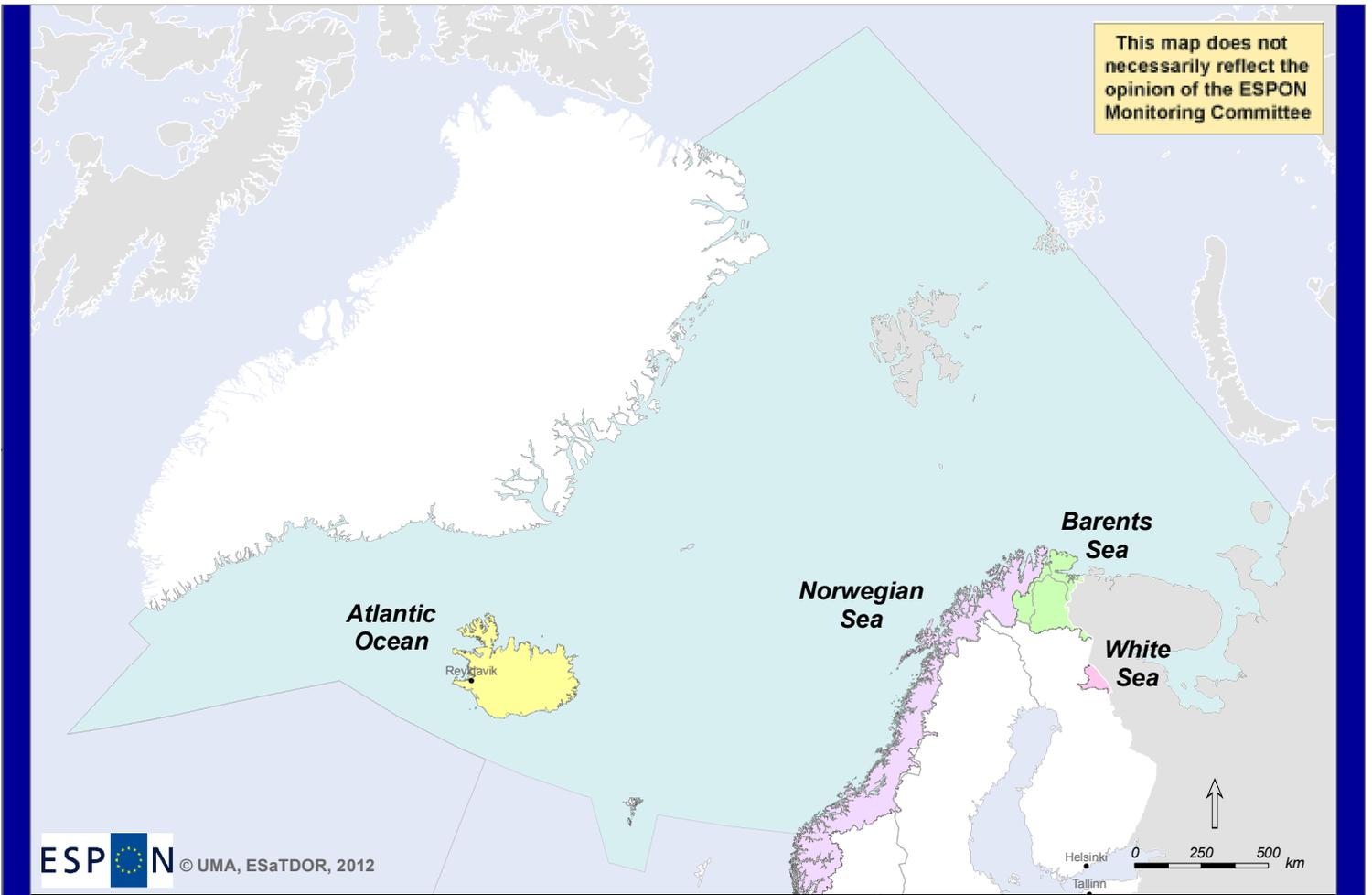
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Thematic data: Water catchments, UNEP; EUROSTAT, 2008.
Land boundaries: © EuroGeographics Association and ESRI. Regional level: NUTS3.
Sea boundaries: OSPAR Convention, EU Integrated Maritime Policy and EEZ.

Population within catchment (persons/km²)



Map AR4b shows the population density in coastal regions on NUTS 3 level compared to the mean national population density for the year 2008 based on EUROSTAT data. It identifies the areas that have a population density below or above the national mean population density. As can be seen in the map all coastal regions in the Arctic part of Norway have a population density somewhat below the national average. This is due to the fact that the Arctic Ocean mainly covers the coastal regions in the northern part of the country which is most sparsely populated. For Iceland the capital region, Reykjavik has a population density slightly above the national average whereas the rest of the country is somewhat below.




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Thematic data: Water catchments, UNEP; EUROSTAT, 2008.
 Land boundaries: © EuroGeographics Association and ESRI. Regional level: NUTS2.
 Sea boundaries: OSPAR Convention, EU Integrated Maritime Policy and EEZ.

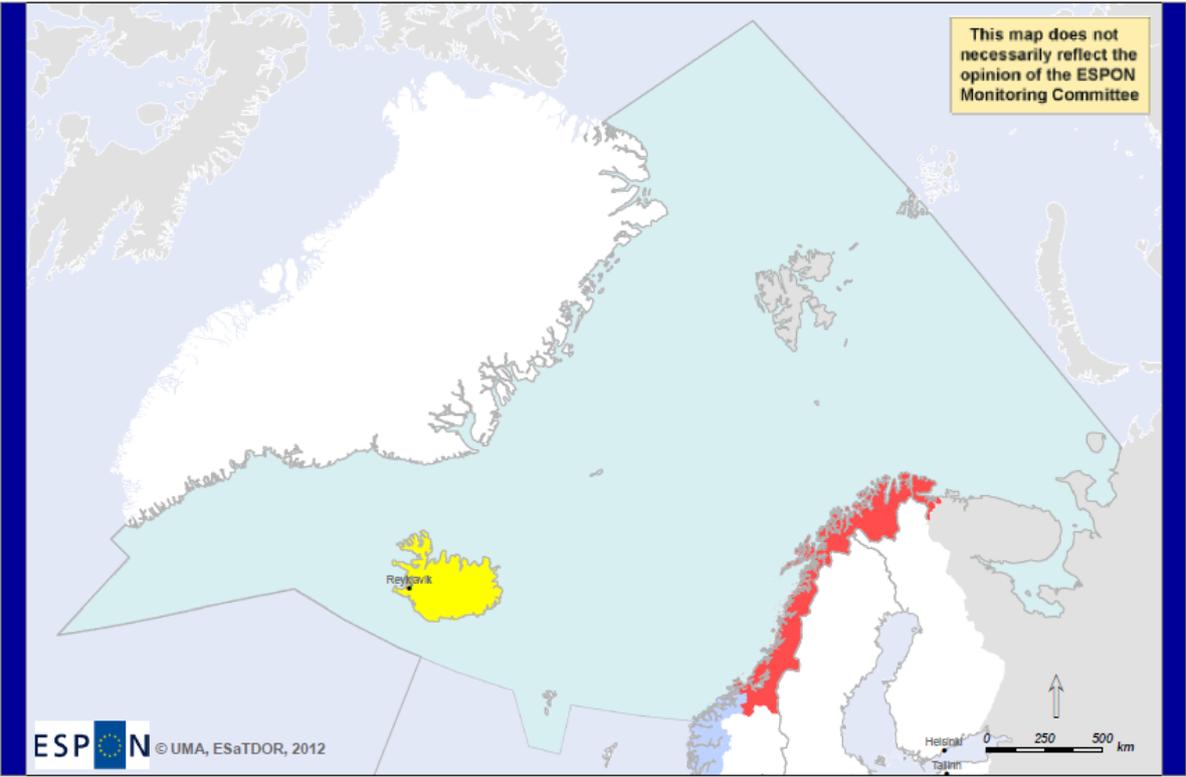
AR4b. Population density per NUTS2 within catchment (persons/km²)



GDP in coastal regions (compared to national averages)

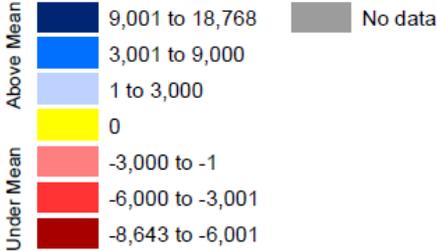
Map AR5a shows the GDP of the year 2009 in coastal (NUTS 2) regions compared to national averages. The Unit is in euro/inhabitant. All coastal regions in Northern Norway and parts of mid-Norway have a GDP somewhat below the national average (between 3001-6000 euro/inhabitant). The western part of Norway is slightly above mean (1-3000 euro/inhabitant). This mainly reflects the different industrial structures between the regions. Iceland is a small country with only 320 thousand inhabitants and is defined as one NUTS2 level; therefore the national average GDP is used.

Map AR5a GDP in coastal regions (compared to national averages)

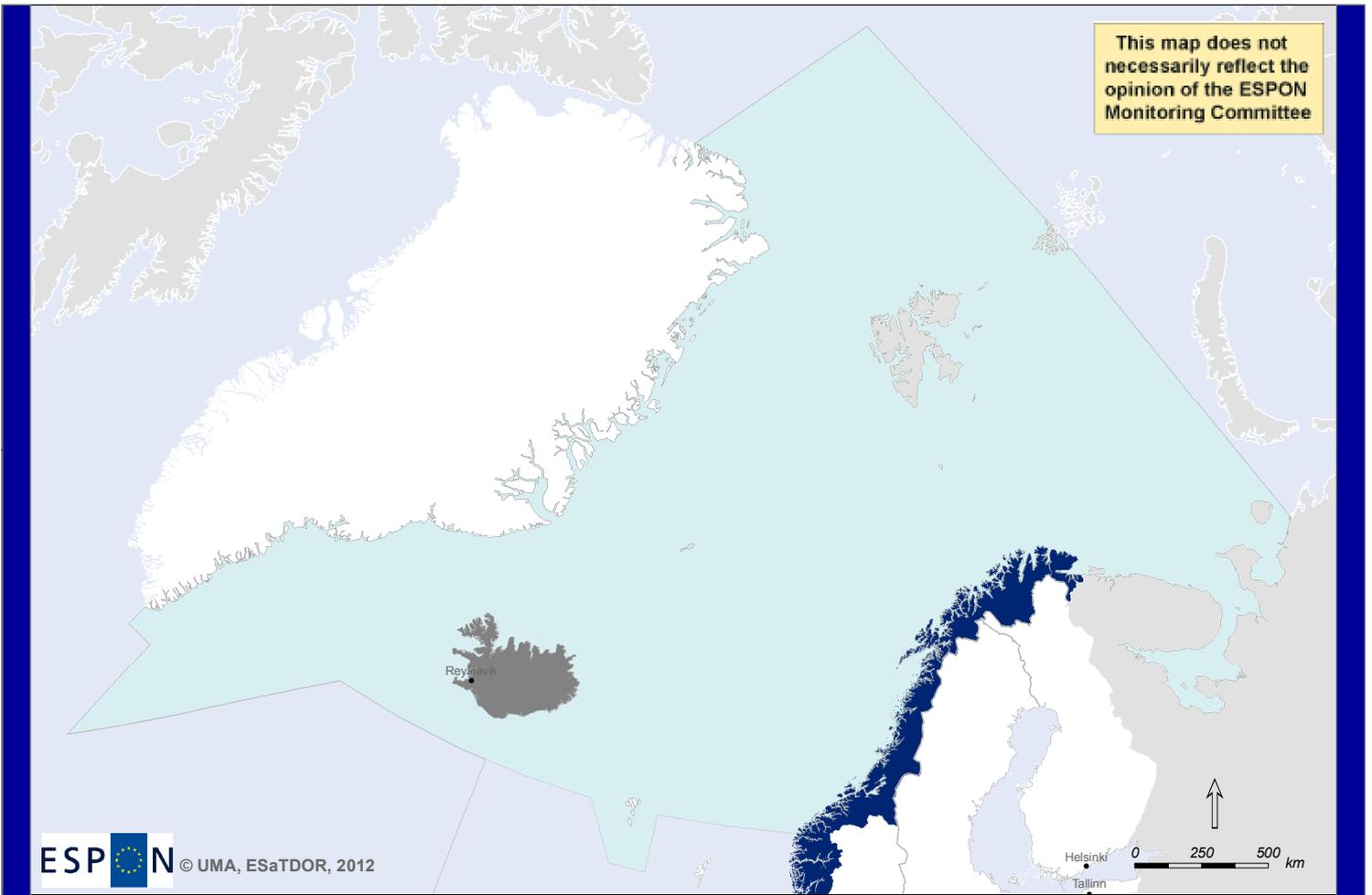


EUROPEAN UNION Part-financed by the European Regional Development Fund INVESTING IN YOUR FUTURE Thematic data: GDP, EUROSTAT, 2009; STATISTICS NORWAY, 2009. Land boundaries: © EuroGeographics Association and ESRI. Regional level: NUTS2. Sea boundaries: OSPAR Convention, EU Integrated Maritime Policy and EEZ.

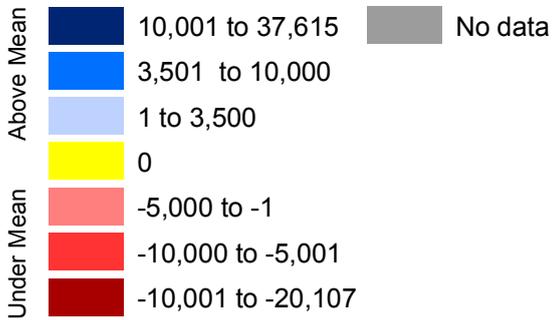
GDP in coastal regions (euros/inhabitant compared to national averages)



Comparing average coastal GDP in Arctic Ocean regions with the average for all coastal regions contained within ESPON space, Map AR5b shows that the Arctic regions performs relatively well, with average GDP being much higher than the European (ESPON) average (although it should be noted that only data for Norway was used in this case). This may be due to the existence of higher value-added maritime activities on the Norwegian coast, such as offshore supply and shipbuilding.



AR5b. GDP in Arctic coastal regions (Euros/inhabitant compared to ESPON Seas coastal regions average)



3. Thematic sections

Marine Economy

During the last decades there has - especially within economics and economic geography - been a focus on positive effects due to the clustering of industrial activities. The existence of strong industrial clusters is for instance assumed to be essential for regional economic growth. There are, however, several challenges connected with the measurement of economic clusters. In the ESaTDOR project the grouping of economic activities into different sectors is partly based on definitions used in a recent Norwegian research project, which studied the following industrial clusters with relation to the sea: Sea Food, Maritime and Travelling³. Data for the ESaTDOR project were provided by the European Cluster Observatory⁴. However, because data are only available on NUTS2 level it is not easy to decide on which activities to include in the presentation. Some activities may coincidentally take place in a coastal region and should therefore be left out—whereas others are genuine maritime activities. We decided to present employment data on *Fisheries, Shipbuilding, Other traditional maritime sectors, Other sectors associated with the maritime cluster, Transport and Tourism*.⁵ Below we will describe employment in Iceland and the part of Norway which is bordering the Arctic Ocean when it comes to some of these different economic activities. It should be emphasized that employment data alone does not give a full picture of the economic contribution of a sector. For instance, relatively labour intensive sectors will have more employees than capital intensive sectors even if their contributions to GDP are the same.

Fisheries

According to Statistics Norway, in 2008 the catch of Norwegian fisheries in the Norwegian Sea, the Barents Sea and in the area around Svalbard was equal to 592 046 tonnes within the territorial waters and 932 527 tonnes beyond the 12 nautical miles zone. These catches amounted to more than 60 per cent of all catches by Norwegian vessels.⁶ The Icelandic catches were in 2007 about 60 per cent of the Norwegian catches.⁷ Employment in the fisheries industrial sector⁸ as percentage of

³ <http://etkunnskapsbasertnorge.wordpress.com/hovedside-2/summary-in-english/>

⁴ (<http://www.clusterobservatory.eu/index.html#lview=aboutobservatory;url=/about-observatory/>)

⁵ As there is some overlap between these three industrial clusters, we categorized them into the following eight groups: *Tourism, Fish, Shipbuilding, Other traditional maritime sectors, Other sectors associated with the maritime cluster, Oil and gas, Insurance and other services, Construction*. In addition to activities which were listed in the three industrial clusters, we also listed the following four groups: Transport, Defense Activities, Other energy production and Other mining and quarrying.

⁶

http://statbank.ssb.no/statistikbanken/Default_FR.asp?Productid=10.05&PXSid=0&nvl=true&PLanguage=0&tlside=selecttable/MenuSelP.asp&SubjectCode=10.

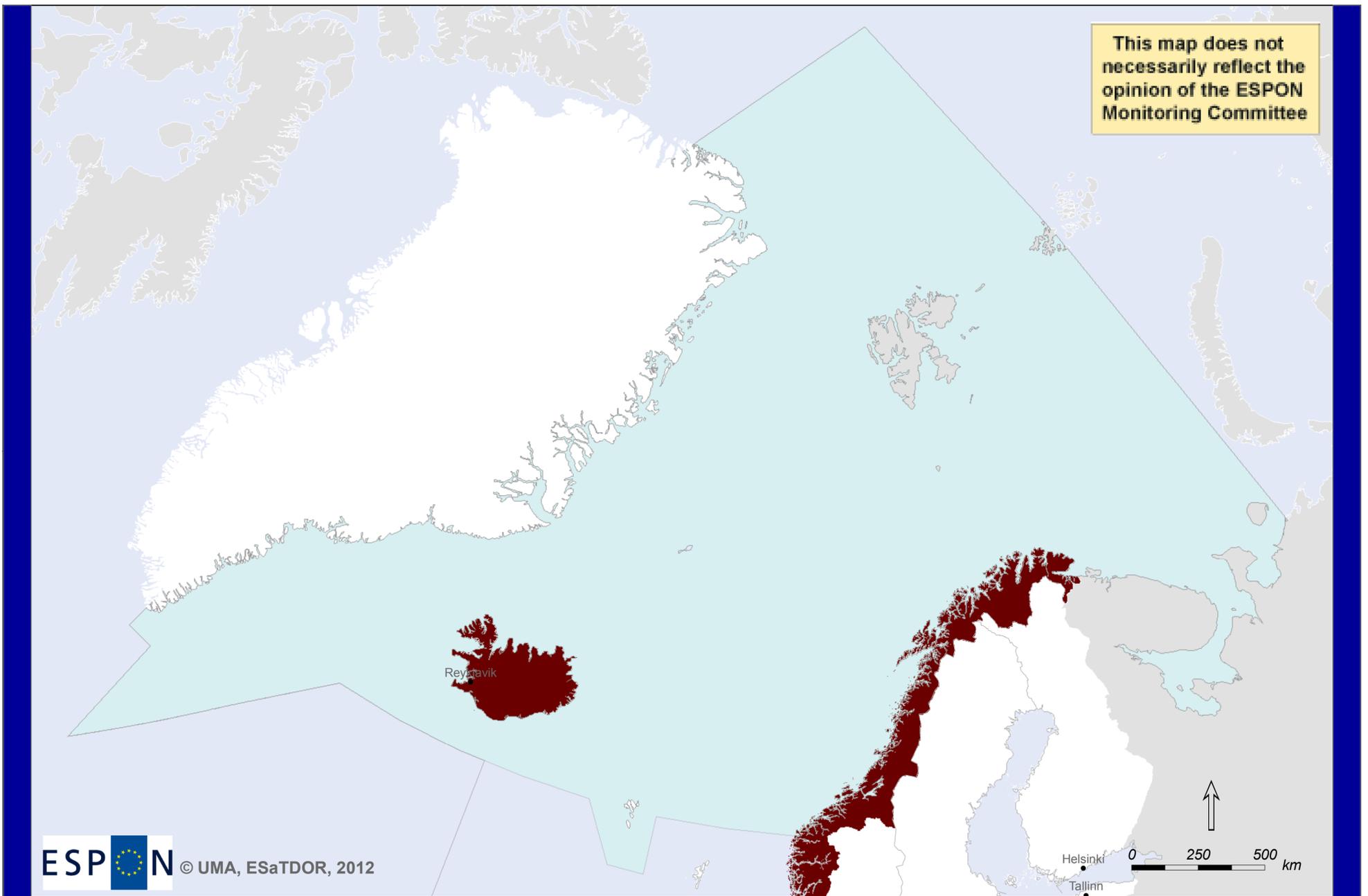
⁷ Food and Agriculture Organization of the United Nations, Fisheries and Aquaculture Department (FAO) http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-DW-09-001/EN/KS-DW-09-001-EN.PDF.

⁸ The fish industrial sector includes Marine and freshwater fishing, Marine and freshwater aquaculture, Processing and preserving of fish, etc, Production of oils and fat, Manufacture of prepared meals and dishes, Manufacture of cordage, rope, twine and netting, Manufacture of machinery for food, beverage and tobacco processing, Repair of other equipment, Wholesale of other food, included fish, crustaceans and mollusks, Retail sale of fish, crustaceans and mollusks in specialized stores, Technical testing and analyses, Research and experimental development on natural sciences and engineering.

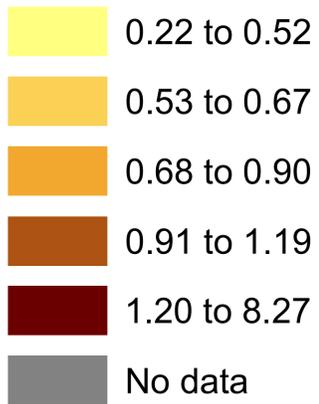
total employment in the NUTS2 regions is relatively high in Iceland (above 8 per cent) and Norway (2-3 per cent) compared to the median in all NUTS2 regions bordering the European seas, see Map AR6b.

According to the Norwegian cluster-project, referred to above, the country's seafood industry is globally leading in several areas. This is among other reasons due to a) technologically leading suppliers in aquaculture and fisheries, b) high research and development capacity compared with other countries as well as c) internationally leading public management of fisheries and aquaculture. Nevertheless, the seafood industry has several challenges, among them a lack of capacity and competence to initiate, manage and exploit results of several research and development projects. The salmon aquaculture value chain has the strongest position regarding human capital, knowledge base, technologies, research and development.⁹

⁹ Tveterås and Asche (2011:5).



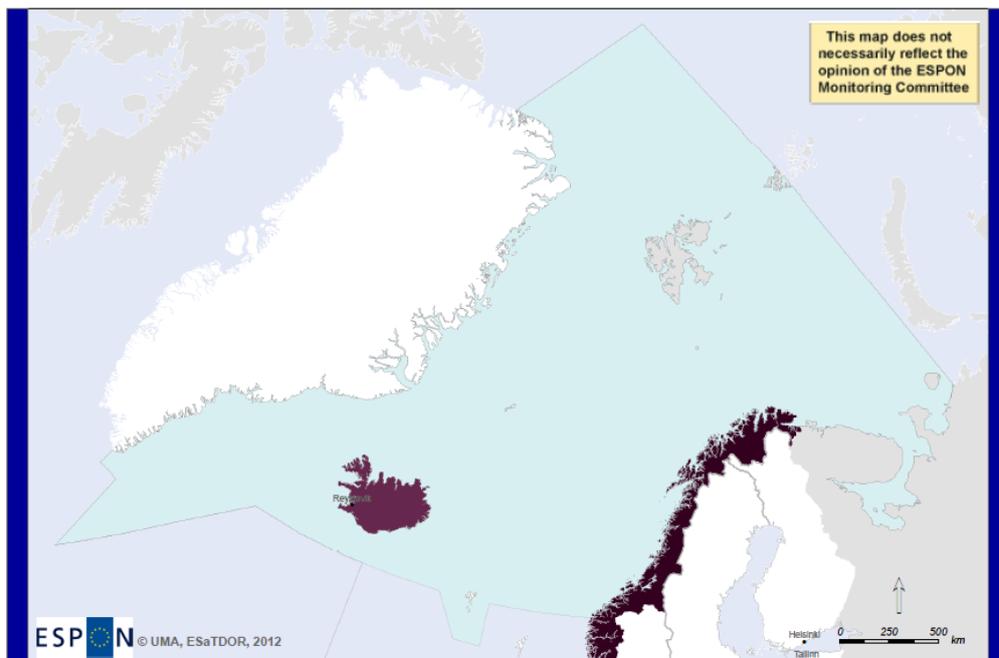
AR6b. Employment in Fisheries, 2009 (percentage of total employment). Arctic Ocean.



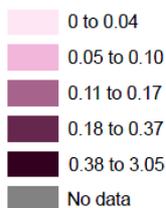
Shipbuilding and other maritime activities

The shipbuilding industrial group includes building of ships, pleasure boats and floating equipment, repair and maintenance of ships and boats. In Iceland as well as in the two northern Norwegian regions employment in this sector is low and below one per cent of total employment within the regions, see Table 1 and Map AR7. Vestlandet, which partly is bordering the Atlantic and partly the Arctic, is, however, an important region for the shipbuilding industry, which is among the oldest industries in Norway. According to the Norwegian cluster project, the maritime industry has been through a significant change-process the last ten years, in which the offshore-based part of the industry has experienced the strongest growth. The off-shore based industry is mainly to be found in Agder and Rogaland and in Vestlandet. Whereas this development started as a consequence of the petroleum activity on the Norwegian continental shelf, in recent years the maritime offshore companies have experienced a relatively stronger growth in foreign markets.¹⁰

Map AR7b Shipbuilding



AR7b. Employment in Shipbuilding 2009, Arctic Ocean (percentage of total employment).



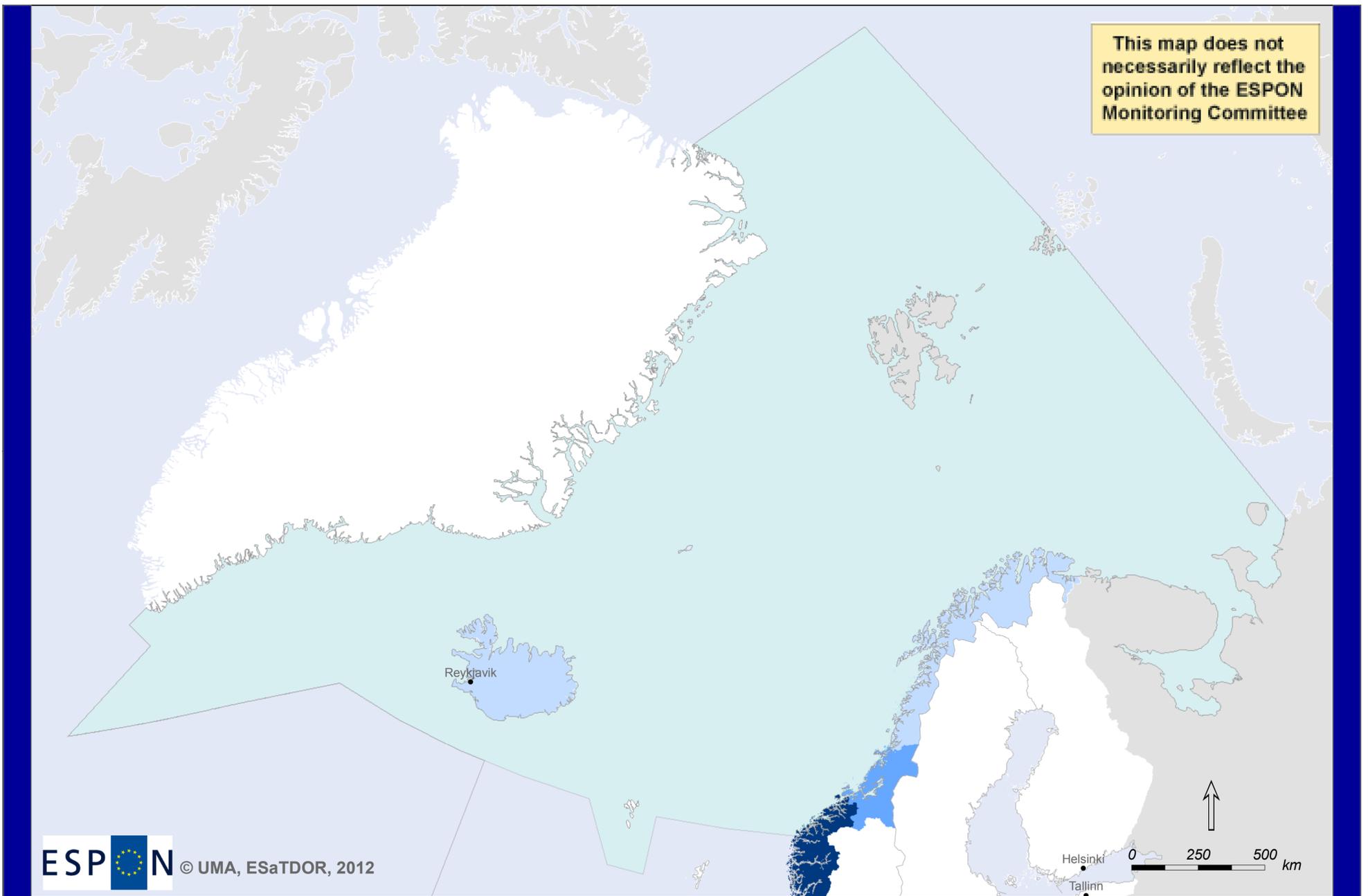
¹⁰ Jakobsen (2011:3).

Other traditional maritime sectors include among others, manufacture of engines and turbines, pumps and compressors, wiring devices, instruments and appliances for measuring, testing and navigation. These sectors are more important for Iceland, Trøndelag and Nord Norge than the shipbuilding industry, see Table 1 and Map AR8b.

Other sectors associated with the maritime cluster are among others manufacture of tubes, pipes, hollow profiles and related fittings, of steel, casting of steel, manufacture of electric lighting equipment. These sectors are relatively important in Island, Vestlandet and Trøndelag, but still below the average and median values for all European coastal NUTS2, see Table 1 and Map AR9b.

Table 1 Employment in different sectors as percentage of total employment within the region

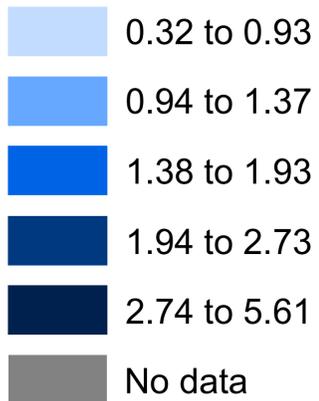
	Island	Vestlandet	Trøndelag	Nord-Norge
Shipbuilding	0,3	3,1	0,8	0,4
Other traditional maritime sectors	1,9	2,6	1,3	0,9
Other sectors associated with the maritime cluster	1,0	1,5	1,2	0,4

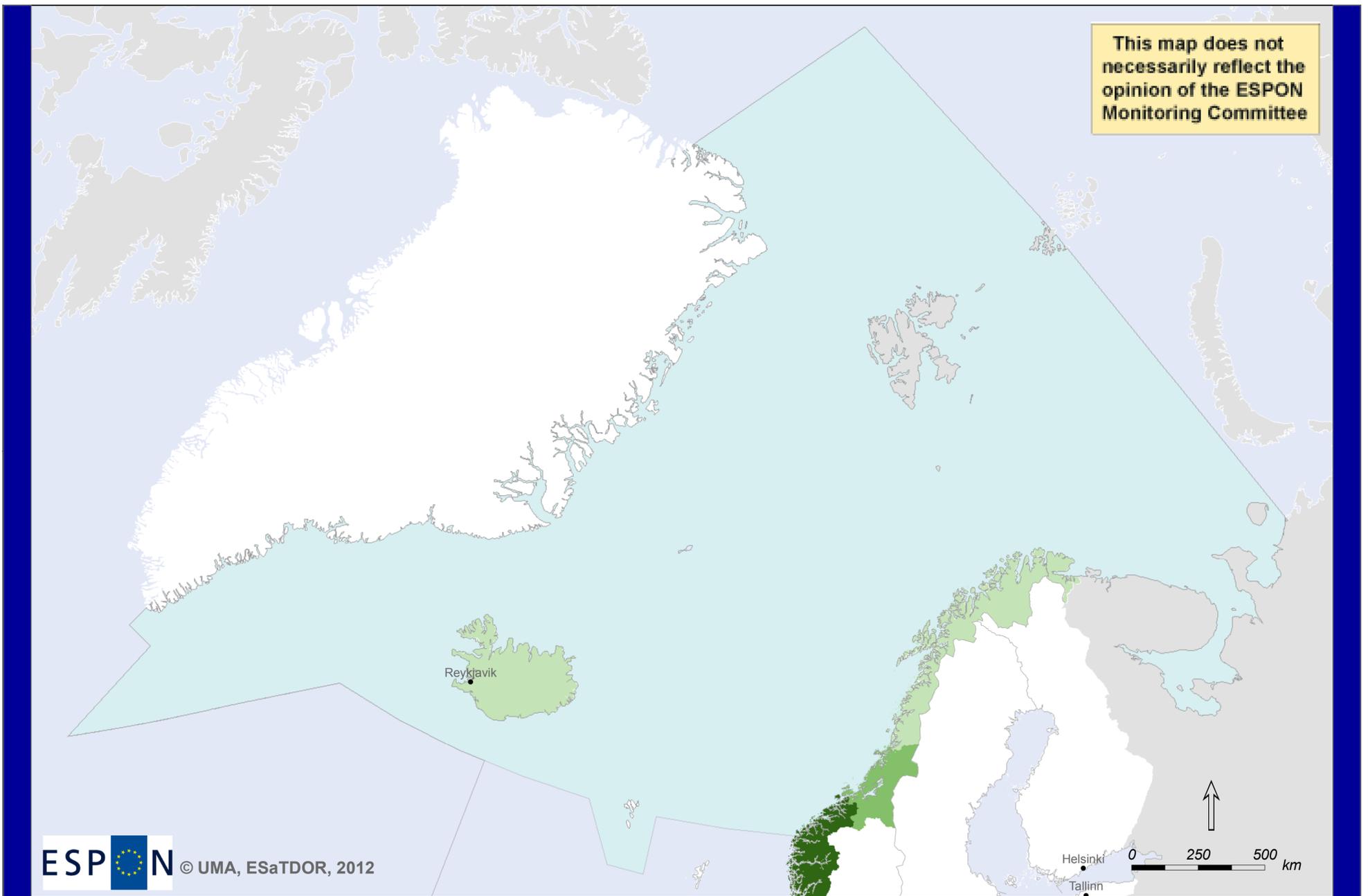



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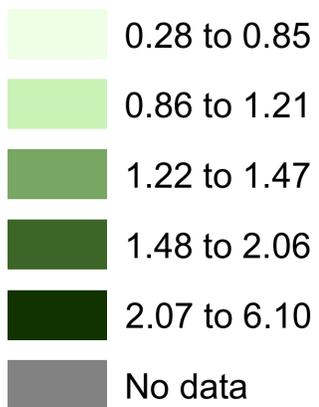
Thematic data: Economic Use, European Cluster Observatory, 2011.
 Land boundaries: © EuroGeographics Association and ESRI. Regional level: NUTS2.
 Sea boundaries: OSPAR Convention, EU Integrated Maritime Policy and EEZ.A

AR8b. Employment in other traditional maritime sectors 2009, Arctic Ocean (% of total employment).





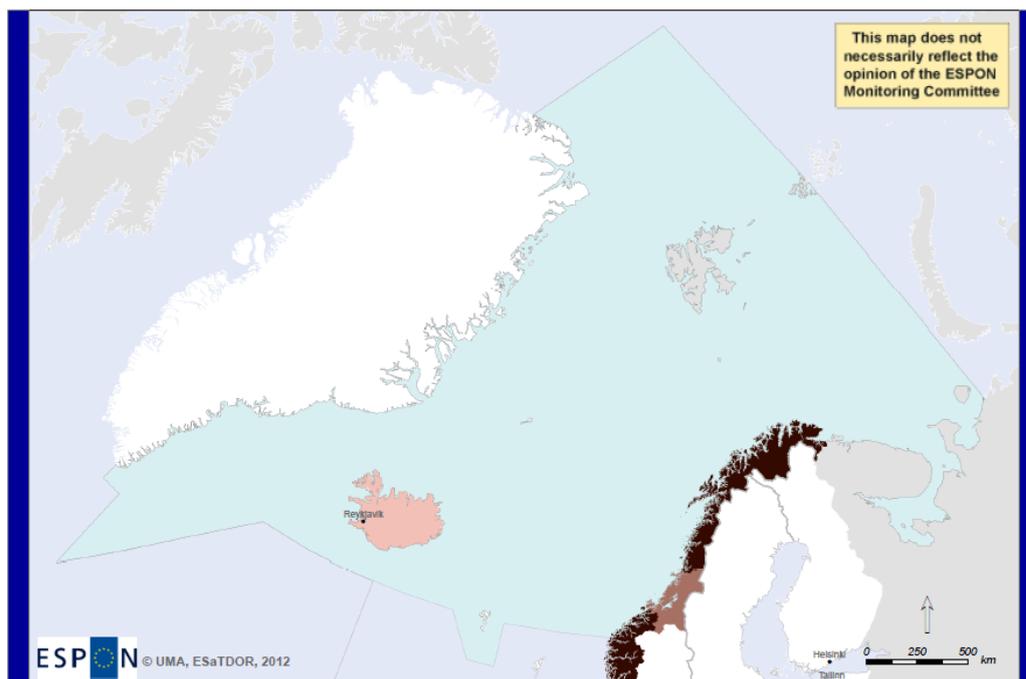
AR9b. Employment in Other sectors associated with the maritime cluster 2009, Arctic Ocean.
(percentage of total employment).



Employment in the transport sector

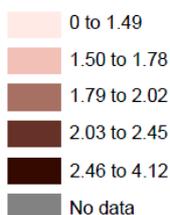
Employment within transport as percentage of total employment contributes to less than 2 per cent of employment in Iceland and Trøndelag and between 2.5 and 3 per cent in Nord-Norge and Vestlandet, see Map AR10b. The data include employment in rail freight transport; freight transport by road; transport via pipeline; inland, sea and coastal freight water transport; warehousing and storage; service activities incidental to land and water transportation; cargo handling and other transportation support activities. Transportation of people is in the data categorized under Tourism.

Map AR10b *Employment in transports as percentage of total employment within the NUTS2 regions*



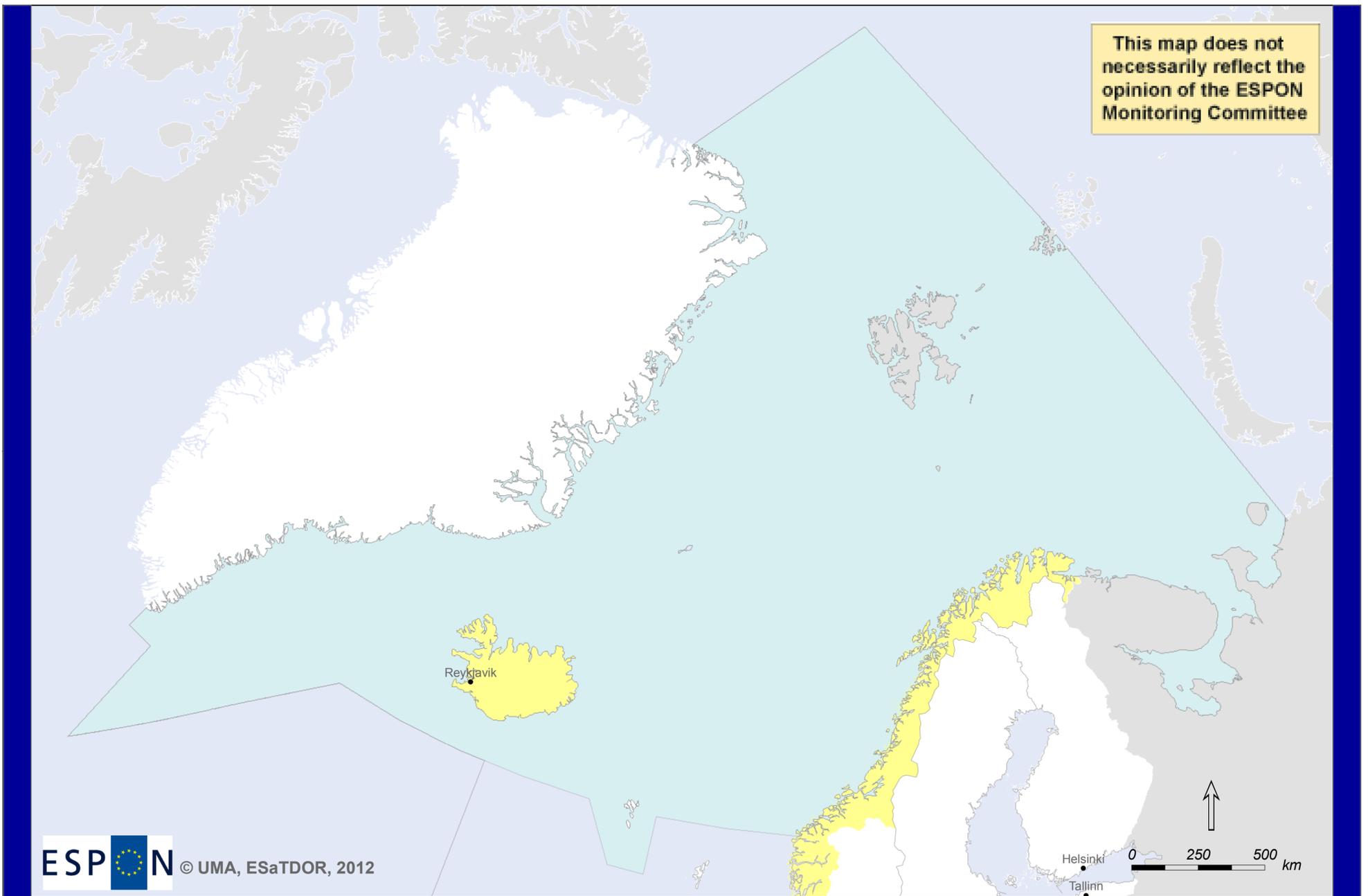
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Thematic data: Economic Use, European Cluster Observatory, 2011.
Land boundaries: © EuroGeographics Association and ESRI. Regional level: NUTS2
Sea boundaries: OSPAR Convention, EU Integrated Maritime Policy and EEZ.

AR10b. Employment in Transport 2009 (percentage of total employment), Arctic Ocean



Tourism

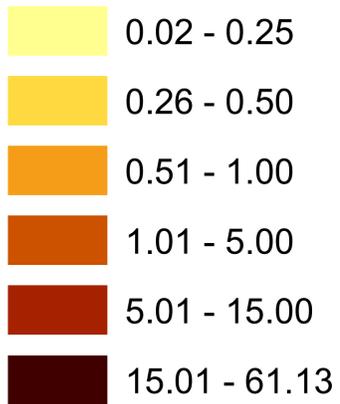
Iceland, Vestlandet, Trøndelag and Nord-Norge have relatively few hotel beds per square km compared to many other coastal regions in Europe, see Map AR11. Nevertheless, employment in the tourist industrial sector is quite important and contributes to 14 per cent in Iceland and 12 per cent of total employment in the three Norwegian regions, see Map AR12b. The Tourism industrial cluster – in addition to passenger transport by rail, water and coastal water; hotels and other accommodation and travel agencies – several other services activities included.

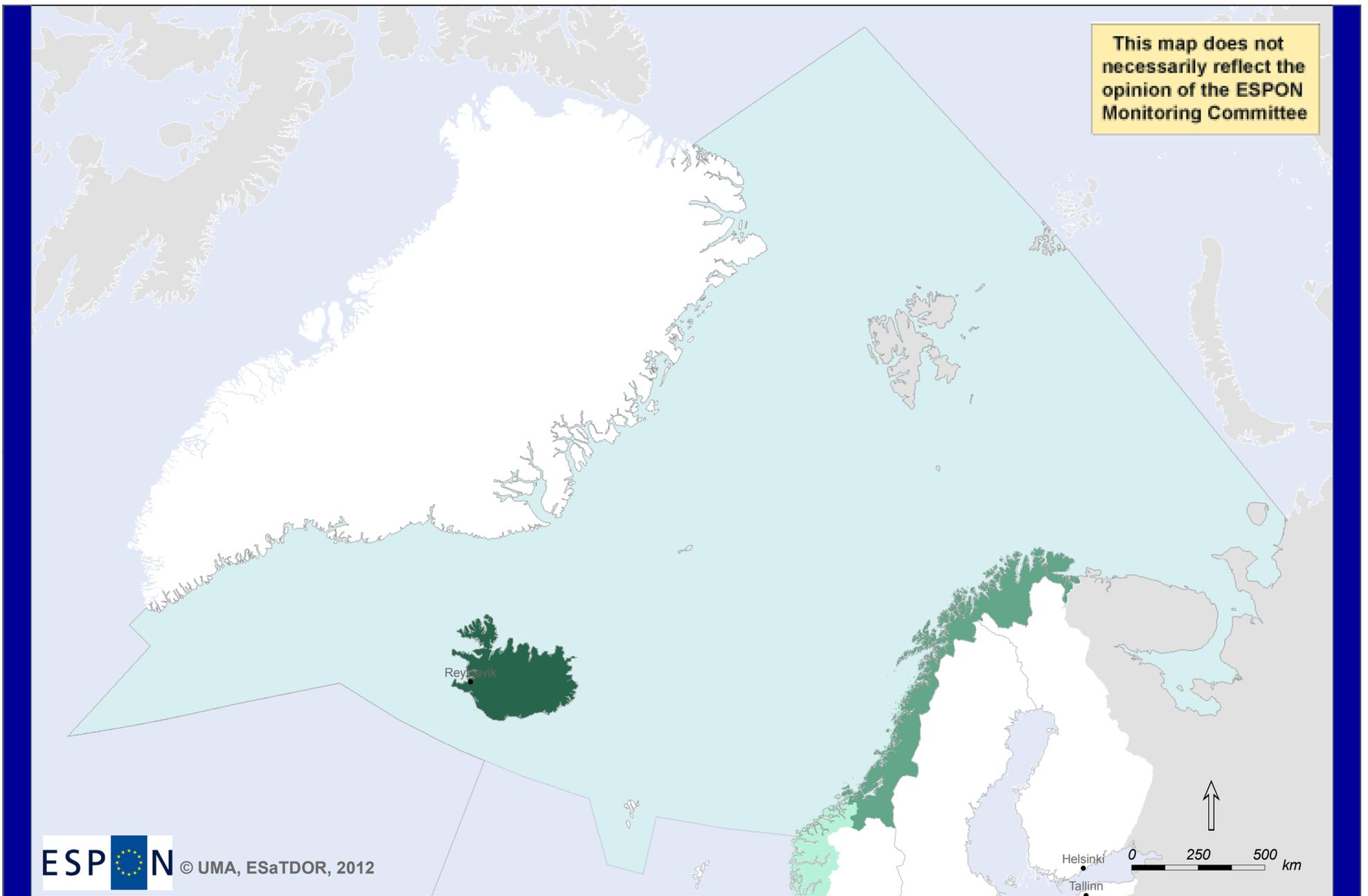



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Thematic data: Tourism Intensity, EUROSTAT, 2009
 Land boundaries: © EuroGeographics Association and ESRI. Regional level: NUTS3.
 Sea boundaries: OSPAR Convention, EU Integrated Maritime Policy and EEZ.

AR11. Tourism Intensity (establishments, bedrooms and bedplaces/km²), Arctic Ocean

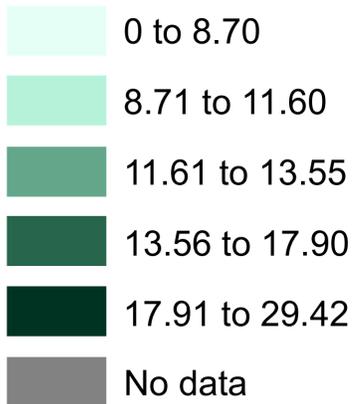





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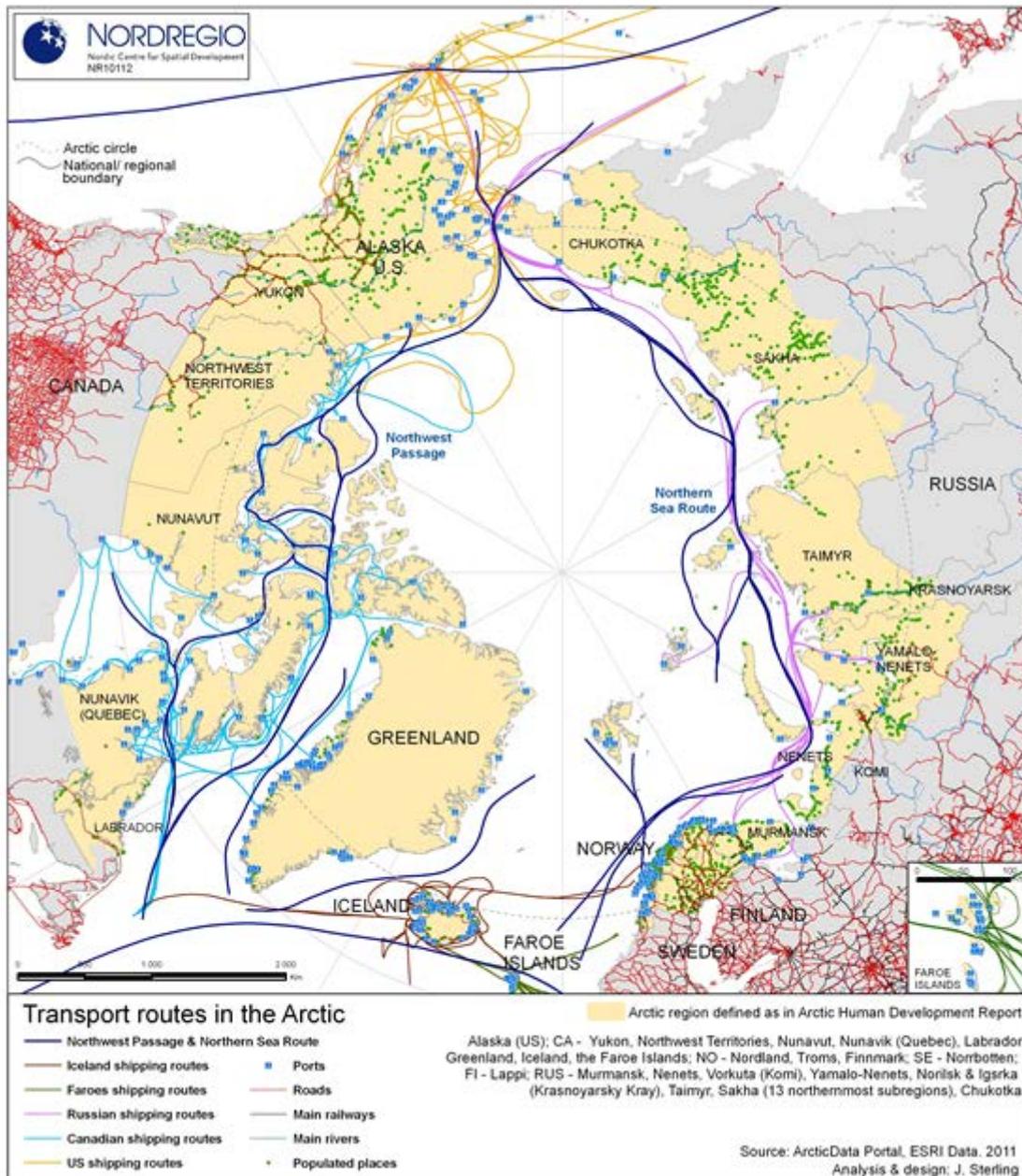
AR12b. Employment in Tourism 2009 (percentage of total employment), Arctic Ocean



Transport

Figure 1 is based on a newly published project by Nordregio and shows the transport routes in the larger Arctic region. According to this Nordregio report, in recent years the Arctic sea-ice has substantially reduced. Ice-thickness has for instance decreased by 10-15 per cent.

Figure 1 Overall characteristics of transport in the Arctic (except for connections by air).

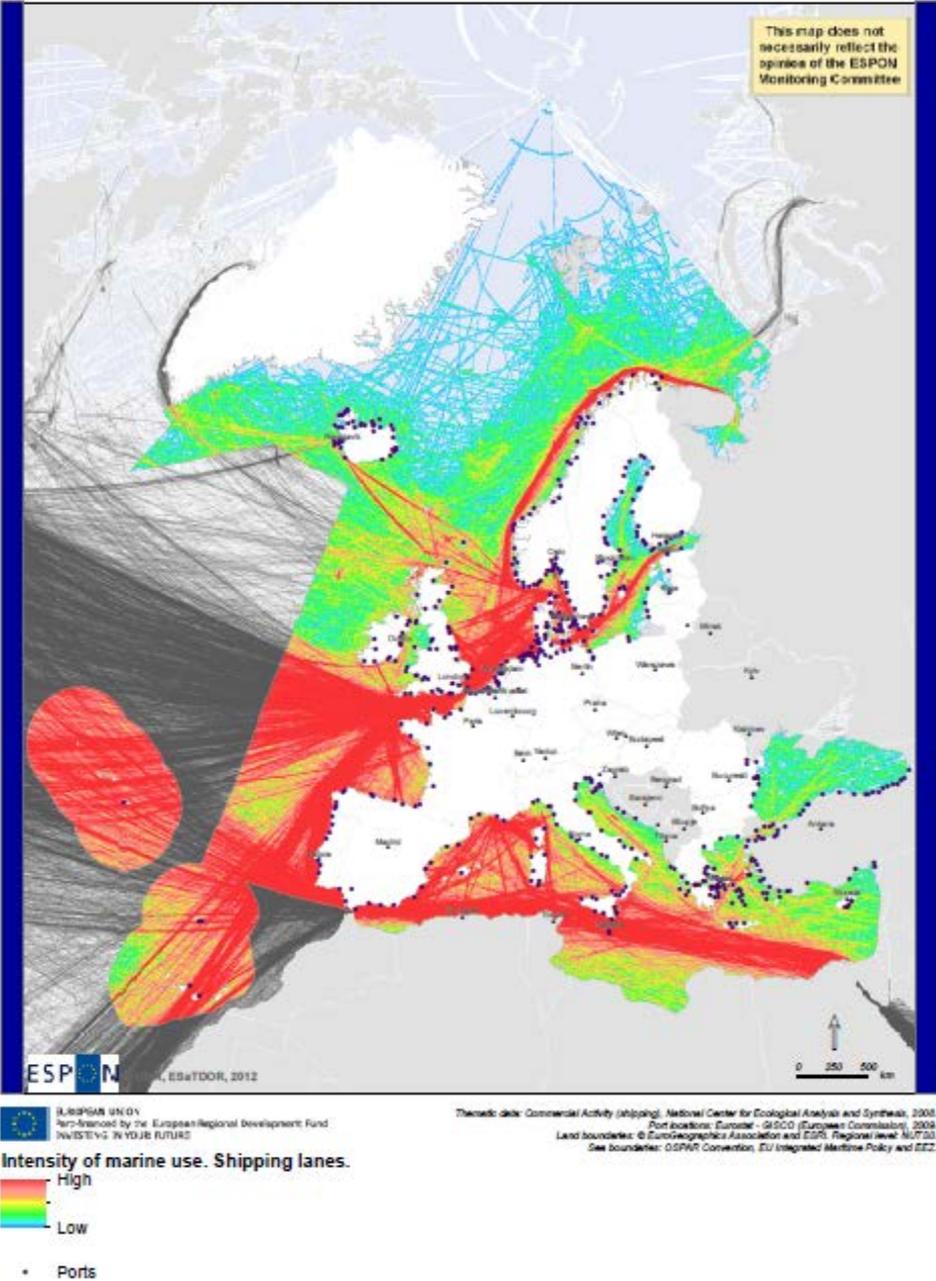


References: <http://www.nordregio.se/en/Maps--Graphs/06-Transport/Transports-routes-in-the-Arctic/>

In addition to the existing major shipping routes by country, Figure 1 pictures existing ports and inland transport (major roads and main railways as well as the rivers where transport is taking place)

as well as populated places and shows that except from Norway and Iceland, the populated areas relatively poorly connected.

Map AR13 Intensity of use. Shipping lanes



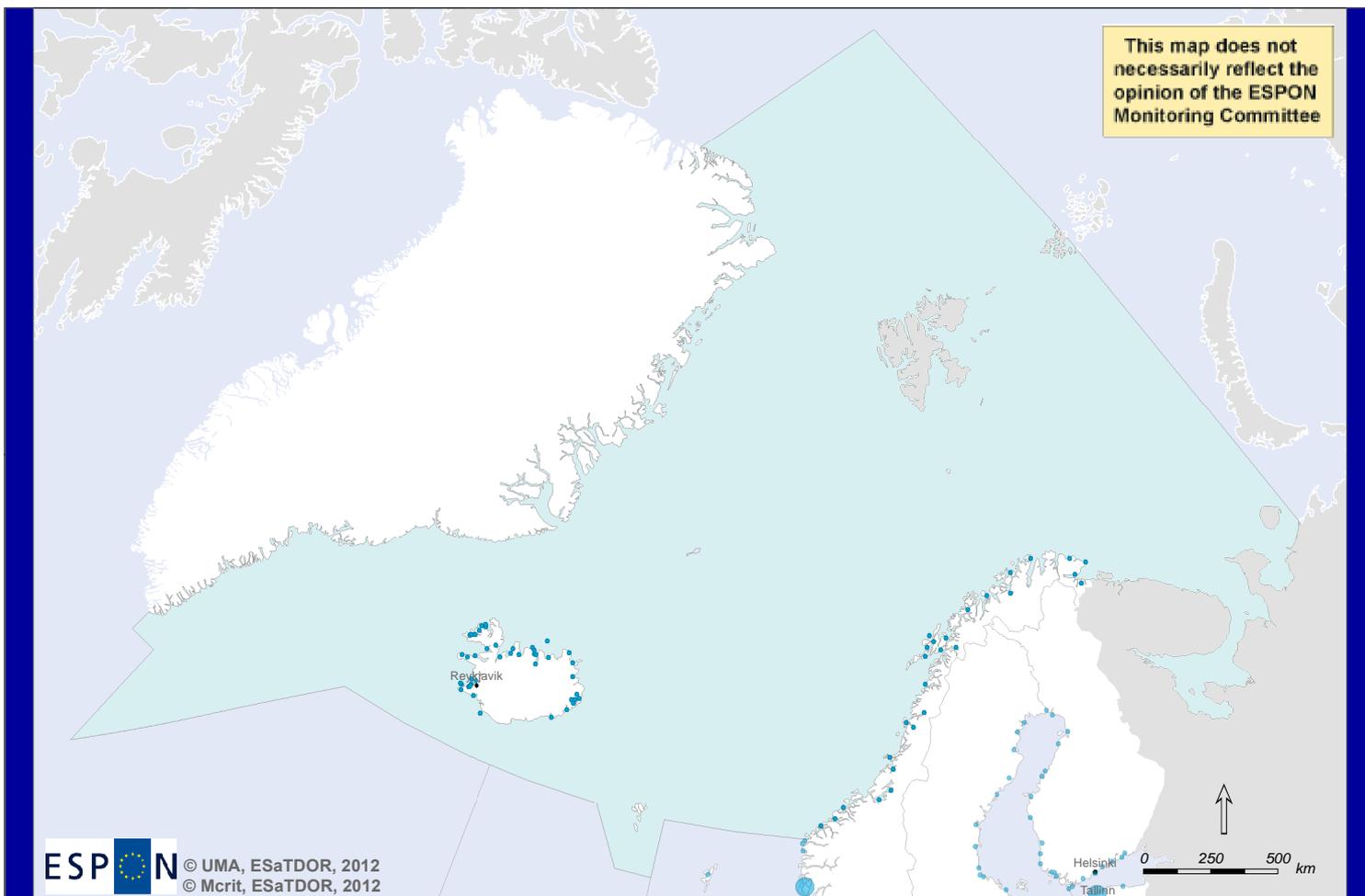
Map AR13 compares the intensity of use in form of shipping lanes in the European seas. In the Arctic this intensity on the map is still low to medium high, the exception being relatively heavy traffic along the Norwegian and Russian coastlines as well as between Reykjavik (Iceland) and the European continent. However, this may change rapidly if the ice melting will continue at the same pace as the last few years. Commercial passage through the Arctic has become easier since 2007, partly because of climate change. According to a newly published article by Bloomberg¹¹, there is extended traffic of cargoes of dry-bulk through Arctic waters this year to save travel time compared with Suez Canal shipment. An example is the transport of iron ore from Murmansk in Russia to China. Furthermore, dry-bulk cargoes to be sent to Asia from ports north of Rotterdam may be sent by the Arctic route once it is open. Russia has shipments of oil, gas and minerals to the Pacific Ocean. Arctic navigation may, however, be limited to the four summer months. There are challenges due to a shortage of specialized ships, uncertain hire costs for government-owned icebreaker escorts and more.

Figure 1 and Map AR13 show that there are several ports along the coast both in Iceland and Norway. Nevertheless, most of them are relatively small with total shipping in 2008 equal to less than 250 million tonnes, see Map AR14a.

Whereas most ports have a balance in inward and outward shipping, it is apparent from Map AR14b that the port in Narvik, Nord-Norge has higher outward - than inward shipping. This could have to do with exports of iron ore from Kiruna in Sweden.

Between 2004 and 2008, two ports in Nord-Norge had a decline in the annual traffic of 10 - 20 per cent whereas six ports had **an annual traffic increase of** below 10 per cent, see Map AR14c.

¹¹ Arctic Ship Cargoes Saving \$650,000 on Fuel Set for Record High. By Michelle Wiese Bockmann - Jun 13, 2012. <http://www.bloomberg.com/news/print/2012-06-13/arctic-ship-cargoes-saving-650-000-on-fuel-set-for-record-high.html>



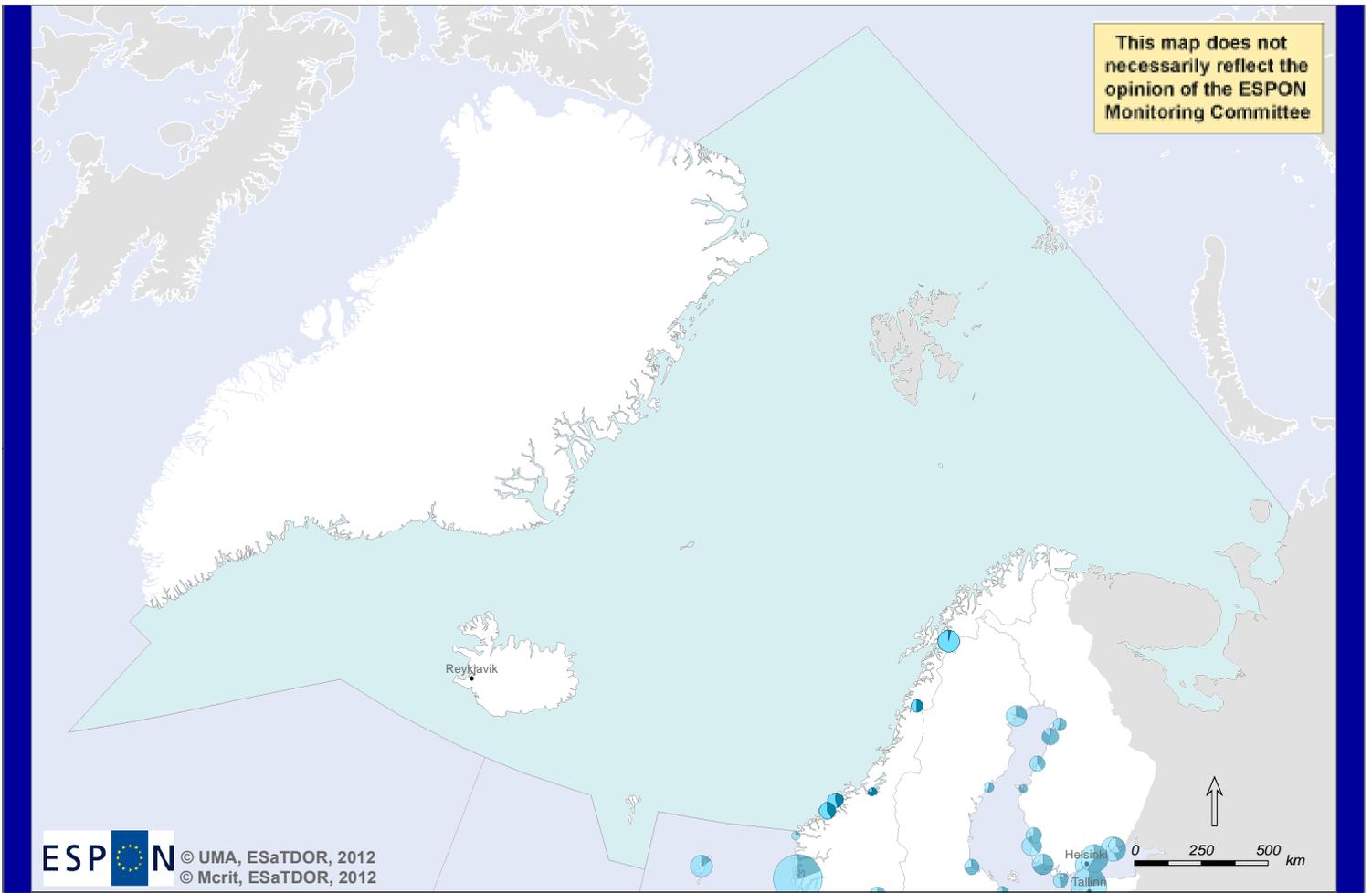

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Thematic data: Gross weight of goods handled in all ports, EUROSTAT, 2008.
 Iceland data: EUROSTAT, 2006.

Port locations: Eurostat - GISCO (European Commission), 2009
 Land boundaries: © EuroGeographics Association and ESRI. Regional level: NUTS0.
 Sea boundaries: OSPAR Convention, EU Integrated Maritime Policy and EEZ.

AR14a. Total shipping at Arctic Ocean ports, 2008 (million tonnes). All ports.

- 1 - 250
- 250 - 500
- 500 - 1000
- 1000 - 2000
- > 2000

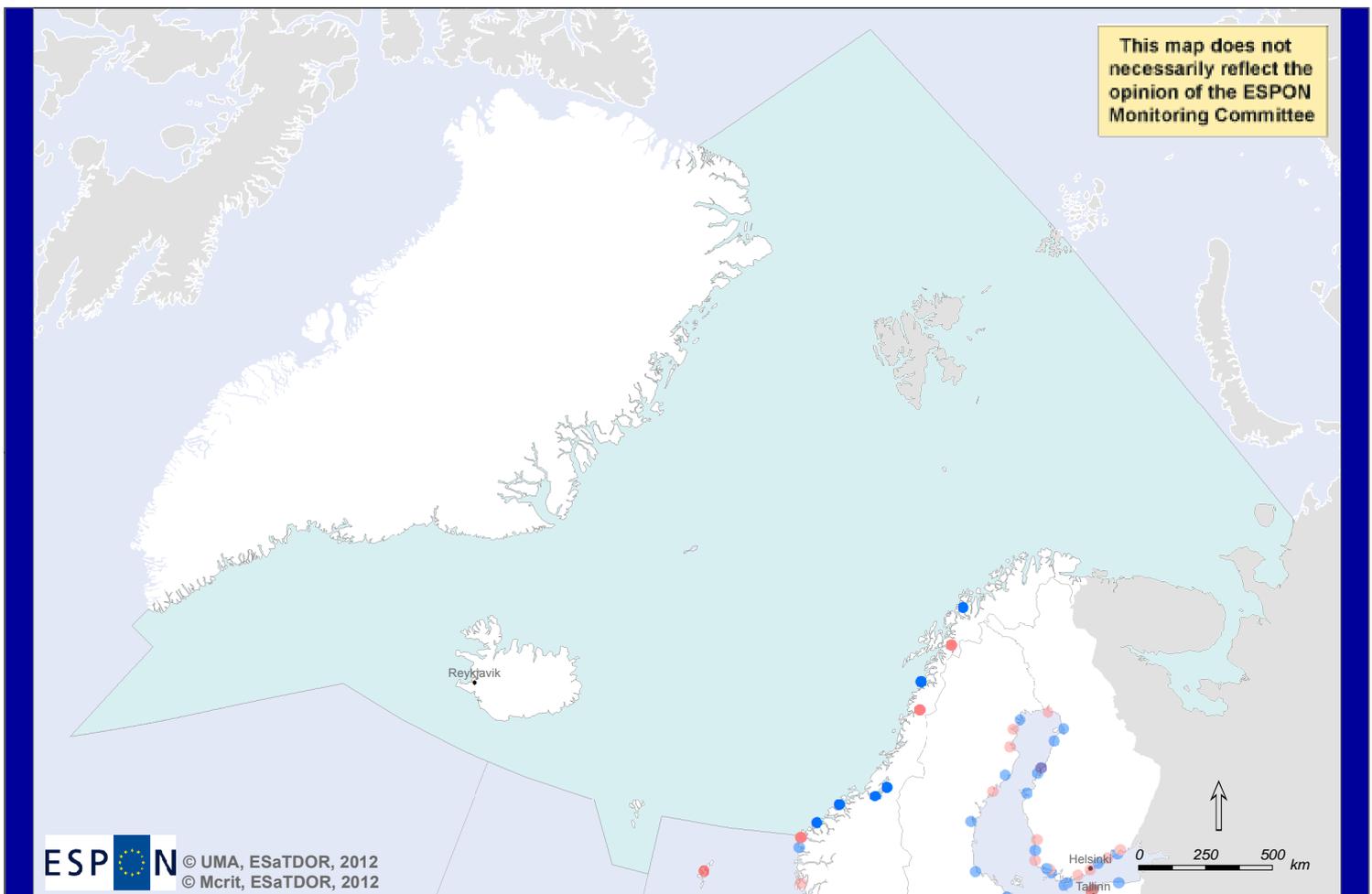



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Thematic data: Gross weight of goods handled in all ports by direction, EUROSTAT, 2008.
Port locations: Eurostat - GISCO (European Commission), 2009
Land boundaries: © EuroGeographics Association and ESRI. Regional level: NUTS0.
Sea boundaries: OSPAR Convention, EU Integrated Maritime Policy and EEZ.

AR14b. Total shipping at Arctic Ocean ports by direction, 2008.

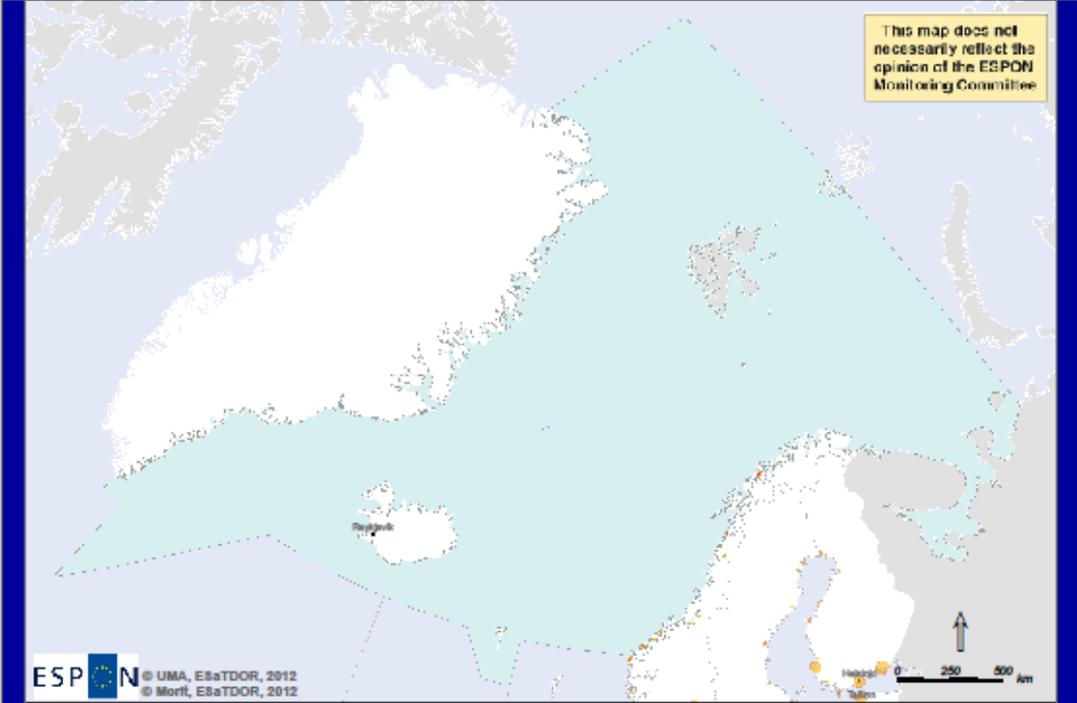
-  Inward direction
-  Outward direction



AR14c. Total shipping at Arctic Ocean ports. Average annual traffic increase, 2004 - 2008 (%).

- < -20%
- -20% to -10%
- -10% to 0%
- 0% to 10%
- > 10%

Container shipping at Norwegian ports in 2008 was below 0.15 million TEU (pro port) with inward higher than outward activities (see Map AR15a and AR15b). Furthermore, containershipping ports had an average annual traffic increase between 2004 and 2008, see Map AR15c.

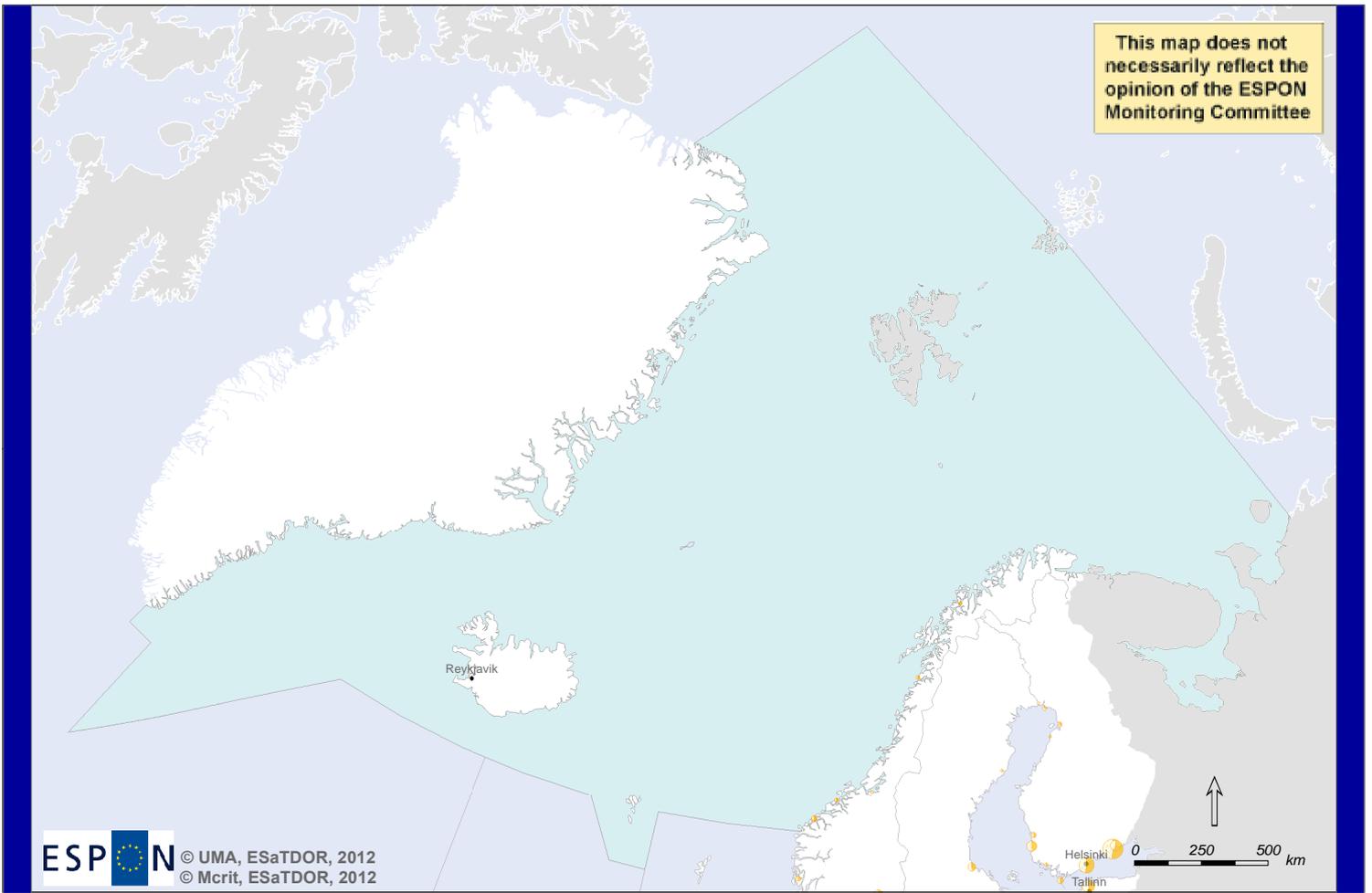


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Thematic data: Containers handled in all ports by direction, EUROSTAT, 2008.
Map data: Freeport Maps, 2008.
Port locations: Eurostat - GISCO (European Commission), 2009.
Land boundaries: © EuroGeographics Association and ESRI. Regional level: NUTS0.
See boundaries: OSPAR Convention, EU Integrated Maritime Policy and EEZ.

AR15a. Container shipping at Arctic Ocean ports, 2008 (million TEU). All ports.

- 0 - 0.15
- 0.15 - 0.70
- 0.70 - 1.6
- 1.6 - 5.5
- > 5.5




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Thematic data: Containers handled in all ports by direction, EUROSTAT, 2008.

*Marsaxlokk data: Freeport Malta, 2008

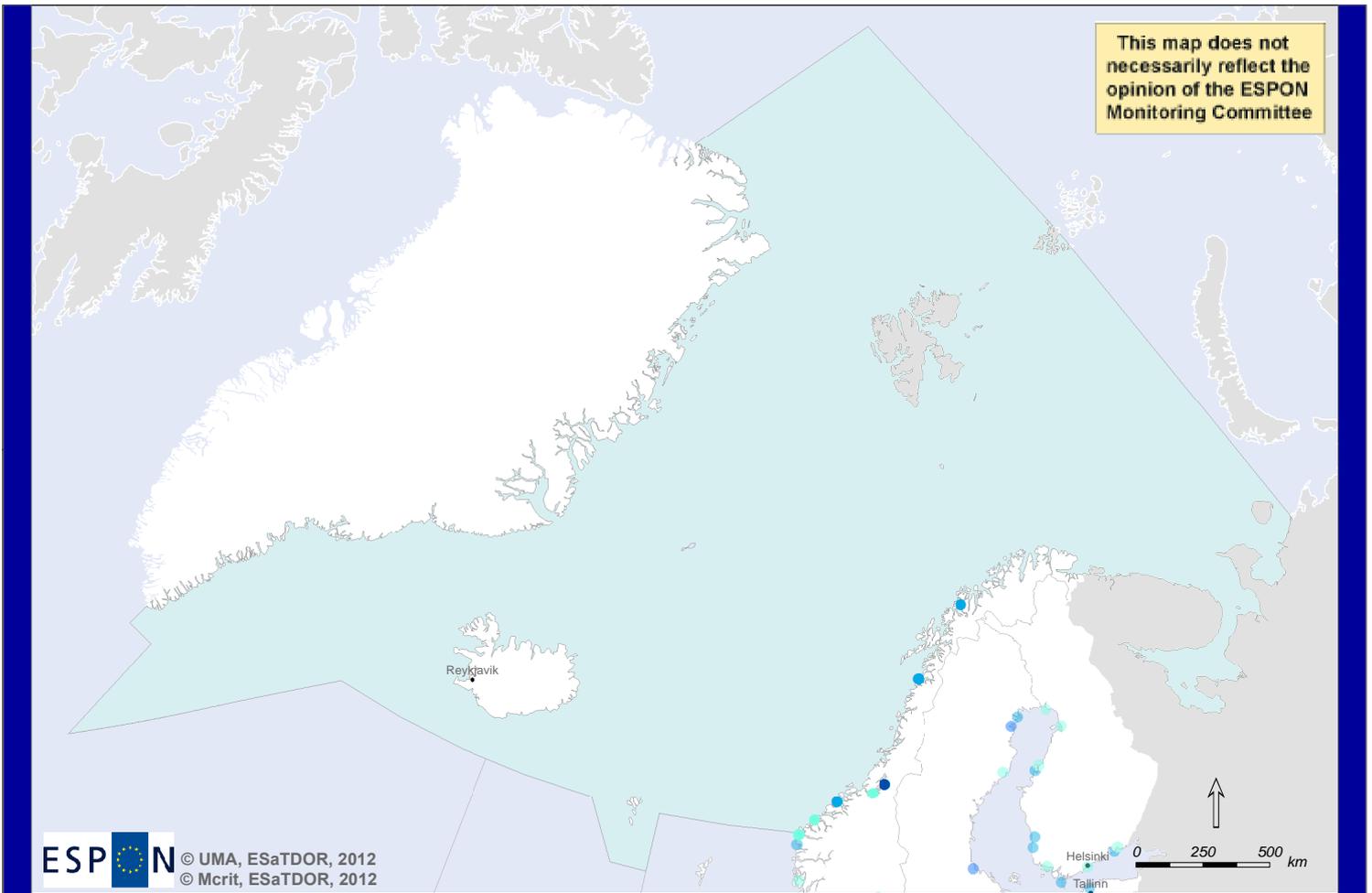
Port locations: Eurostat - GISCO (European Commission), 2009

Land boundaries: © EuroGeographics Association and ESRI. Regional level: NUTS0.

Sea boundaries: OSPAR Convention, EU Integrated Maritime Policy and EEZ.

AR15b. Container shipping at Arctic Ocean ports by direction, 2008.

-  Inward direction
-  Outward direction




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Thematic data: Containers handled in all ports by direction, EUROSTAT, 2008.
 *Marsaxlokk data: Freeport Malta, 2008.

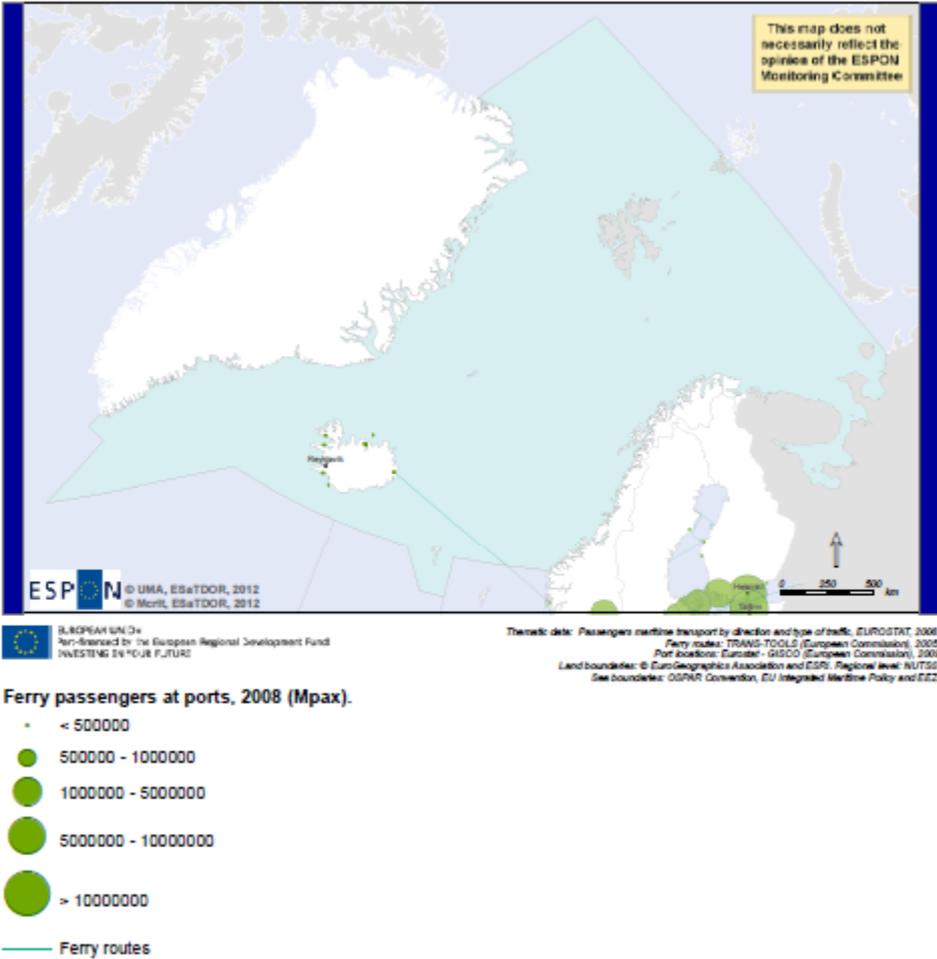
Port locations: Eurostat - GISCO (European Commission), 2009
 Land boundaries: © EuroGeographics Association and ESRI. Regional level: NUTS0.
 Sea boundaries: OSPAR Convention, EU Integrated Maritime Policy and EEZ.

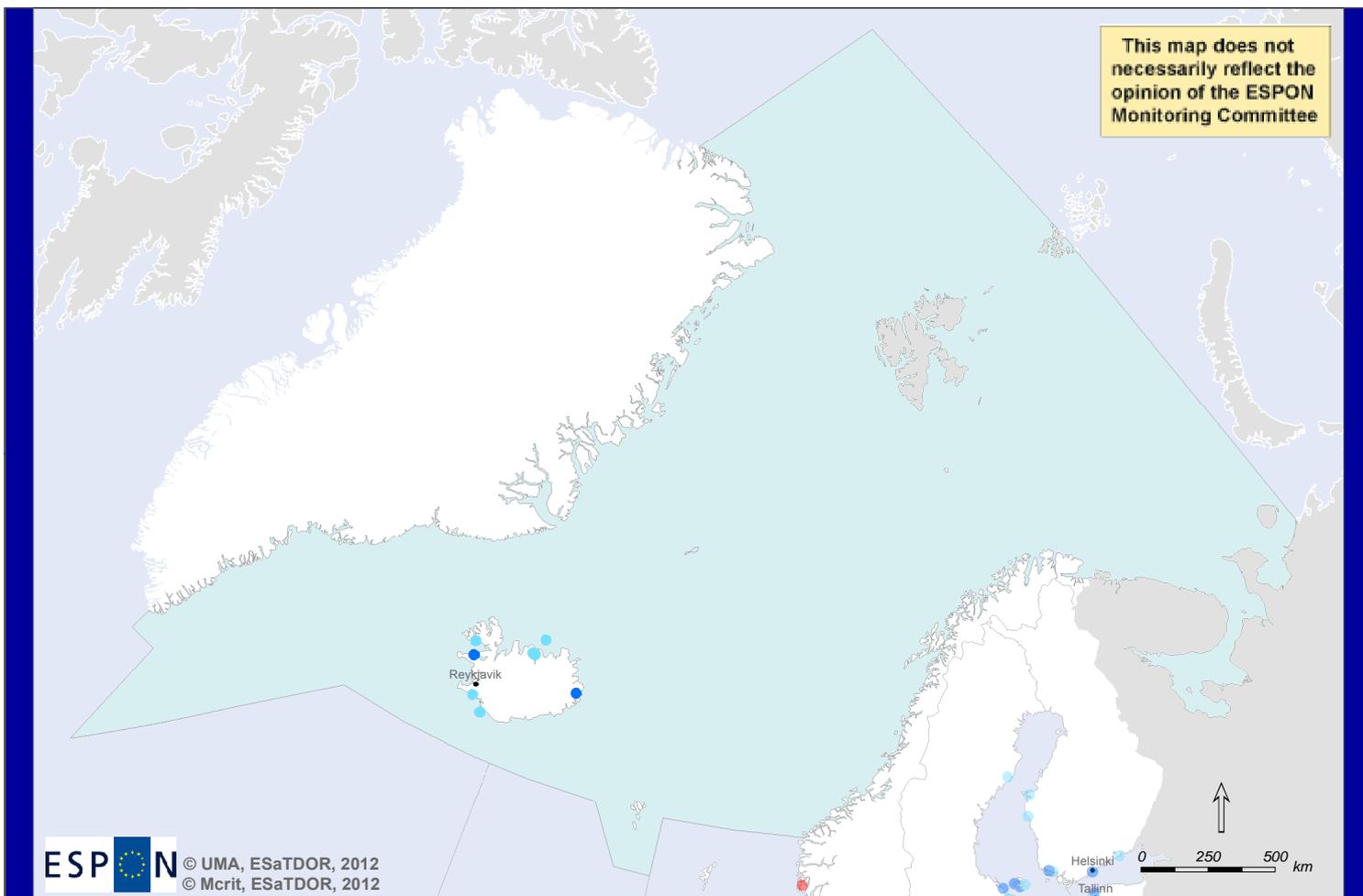
AR15c. Container shipping at Arctic Ocean ports. Average annual traffic increase 2004 - 2008 (%).

- 0% - 10%
- 10% - 20%
- 20% - 30%
- 30% - 50%
- > 50%

Iceland has six ports with number of ferry passengers between 50 and 100 thousand in 2008, see Map AR16a. There has been an average annual traffic increase of more than 15 per cent in two ports (east and west) and an annual reduction in five other ports, see Map AR16b.

Map AR16a Ferry passengers at ports, 2008






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Thematic data: Passengers maritime transport by direction and type of traffic, EUROSTAT, 2008.
 Port locations: Eurostat - GISCO (European Commission), 2009
 Land boundaries: © EuroGeographics Association and ESRI. Regional level: NUTS0.
 Sea boundaries: OSPAR Convention, EU Integrated Maritime Policy and EEZ.

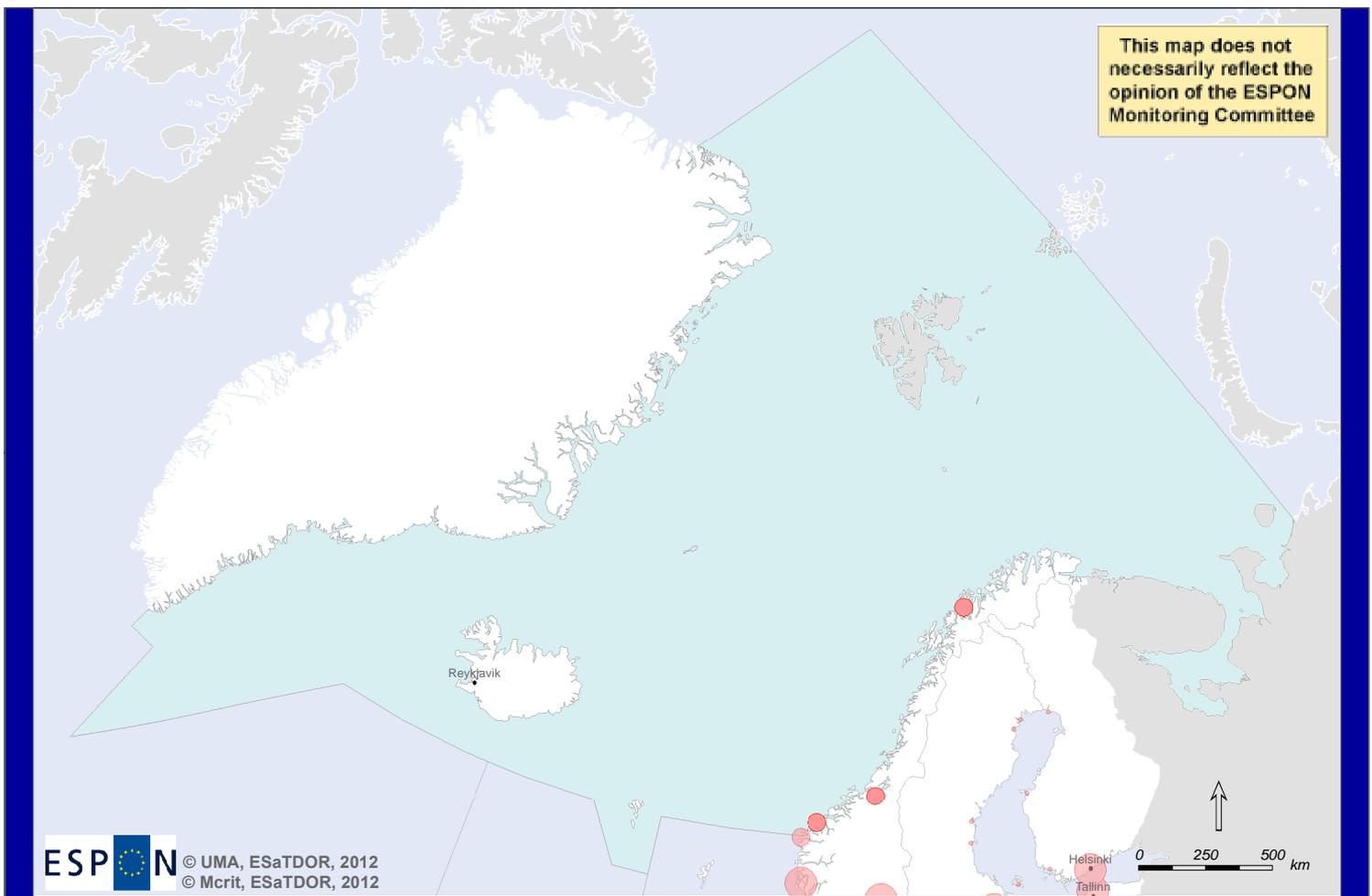
AR16b. Ferry passengers at Arctic Ocean ports.

Average annual traffic increase of ferry passengers 2004 - 2008 (%)

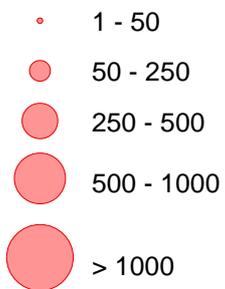
- > -35%
- -35% to -15%
- -15% to 0%
- 0% to 15%
- > 15%

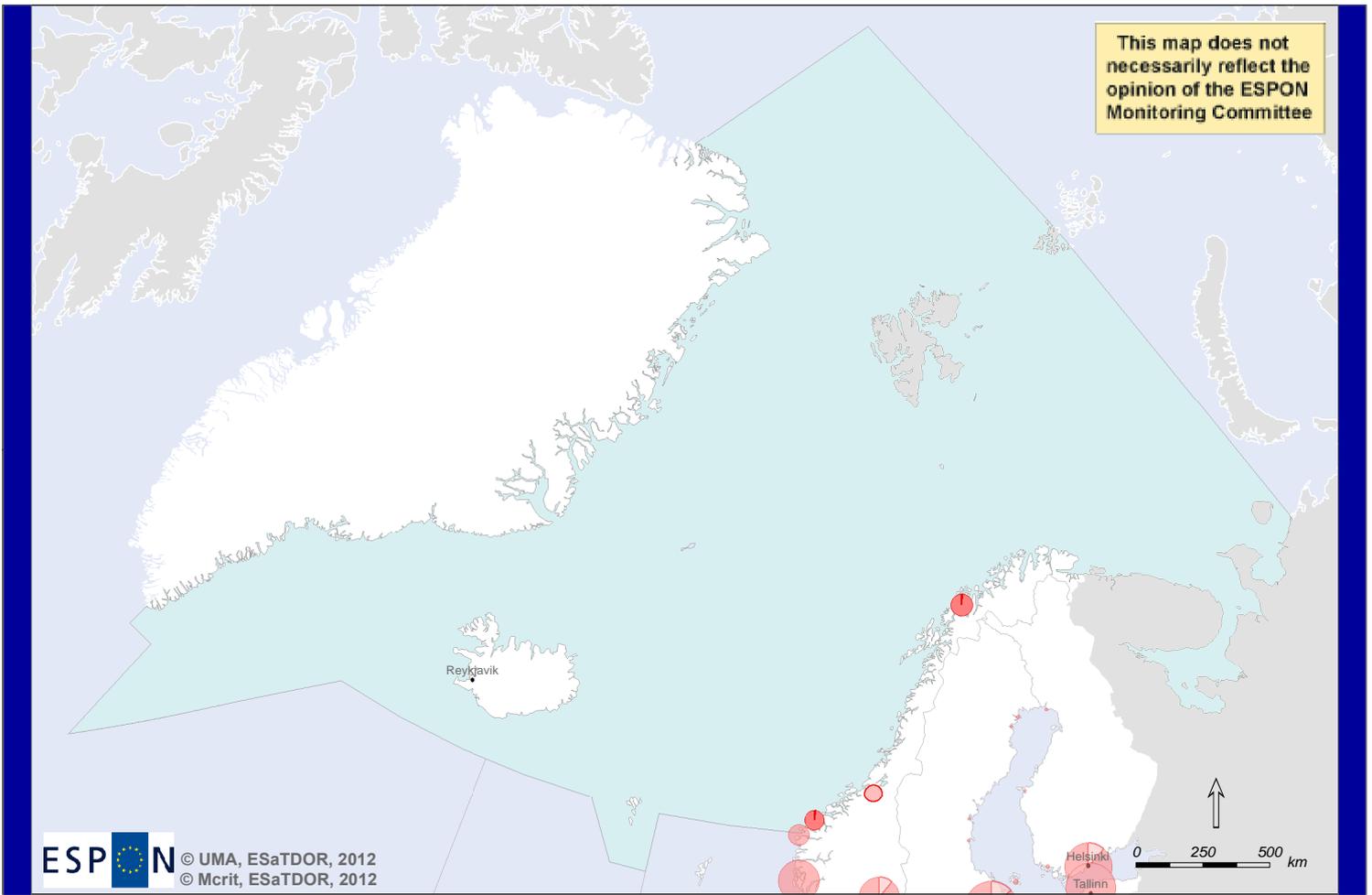
In 2008, between 50 and 250 thousand cruise passengers visited Norwegian ports (see Map AR17a). Trondheim seems to be a location for starting and ending a cruise whereas Tromsø appears to be a destination for passengers on excursions, see Map AR17b. There has been an average annual increase of cruise passengers between 2005 and 2008 (Map AR17c). There are no cruise traffic data for Iceland, Svalbard and Greenland, although more and more people lately travel to these regions to experience an Arctic environment and wild life.

According to Nordregio (2011:176), cruising may not be a form of tourism that benefits the Arctic region. On the contrary, the vulnerable ecosystem balance can easily be threatened. Residents may not be prepared for mass tourism and *“are still highly dependent on the environment for survival in both a physical and a cultural sense”*.



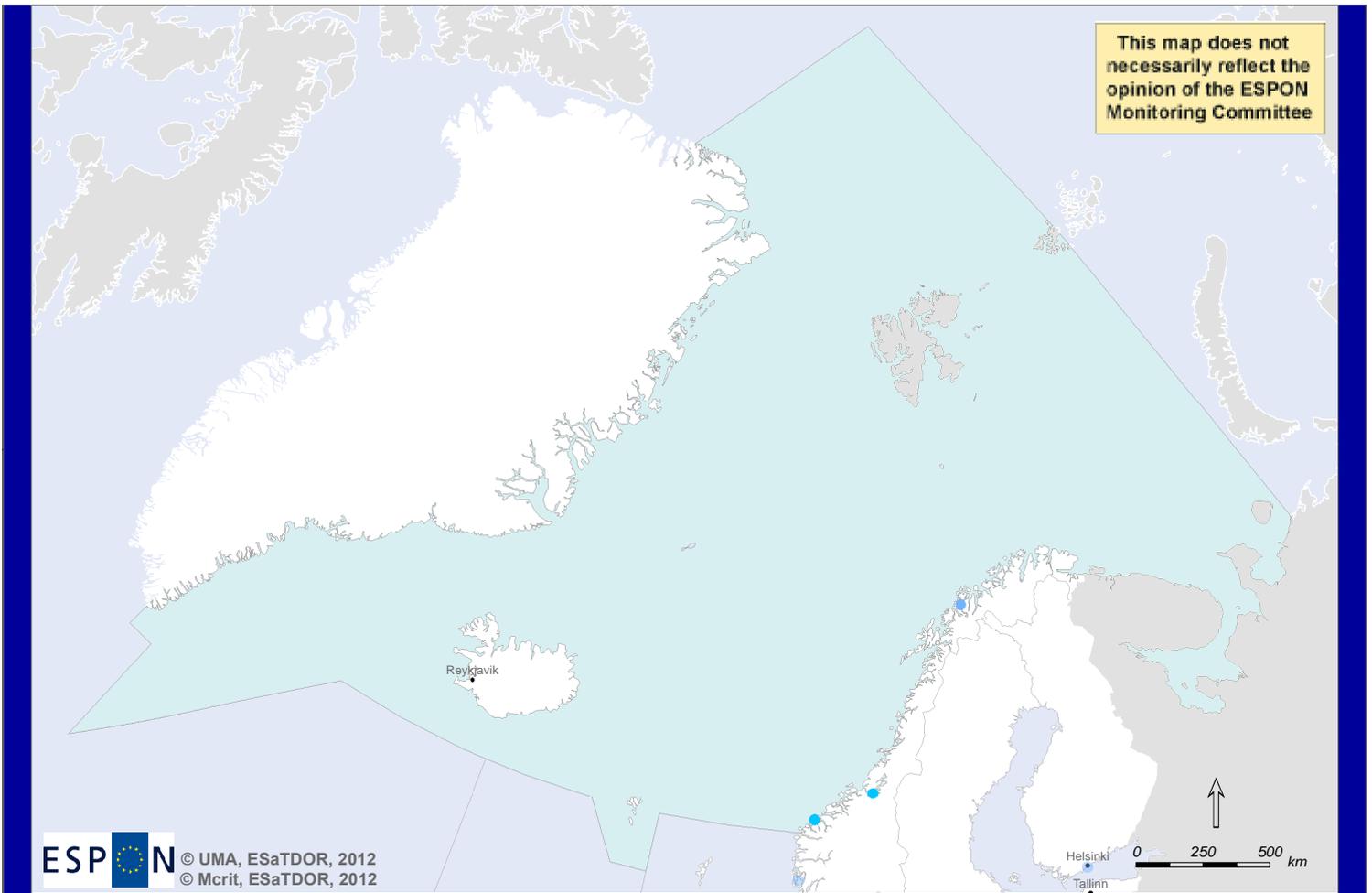
AR17a. Cruise activity at Arctic Ocean ports, 2008. (Thousand passengers). All ports.





AR 17b. Cruise activity at ports by passenger type, Arctic Ocean ports, 2008.

- Starting or ending a cruise
- On excursion




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Thematic data: Passengers maritime transport by direction and type of traffic, EUROSTAT, 2008.
Port locations: Eurostat - GISCO (European Commission), 2009
Land boundaries: © EuroGeographics Association and ESRI. Regional level: NUTS0.
Sea boundaries: OSPAR Convention, EU Integrated Maritime Policy and EEZ.

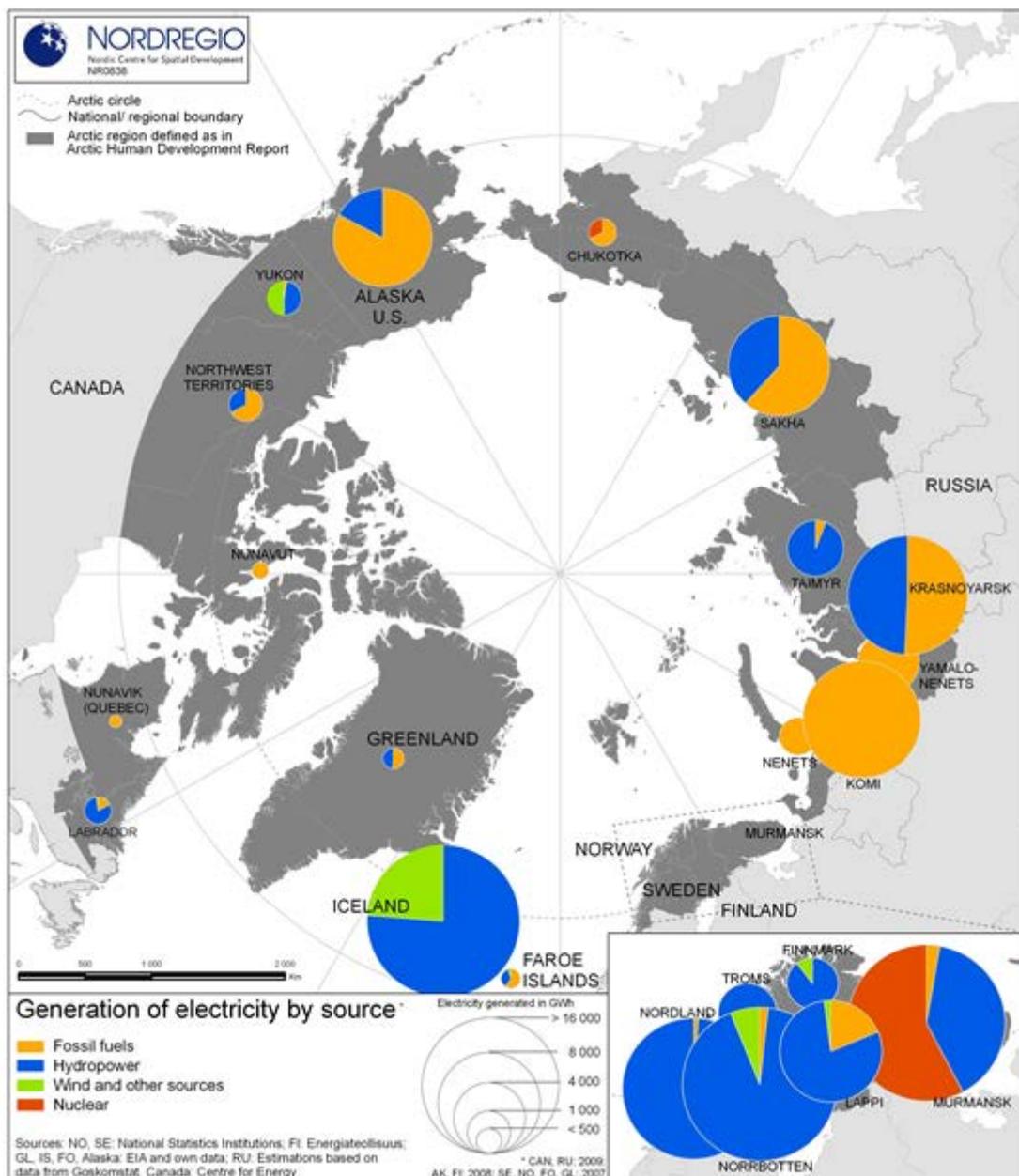
AR17c. Average annual passenger increase of cruise passengers, Arctic Ocean ports 2005 - 2008 (%)

- < 0%
- 0% - 10%
- 10% - 20%
- 20% - 30%
- > 30%

Energy and Undersea Infrastructure

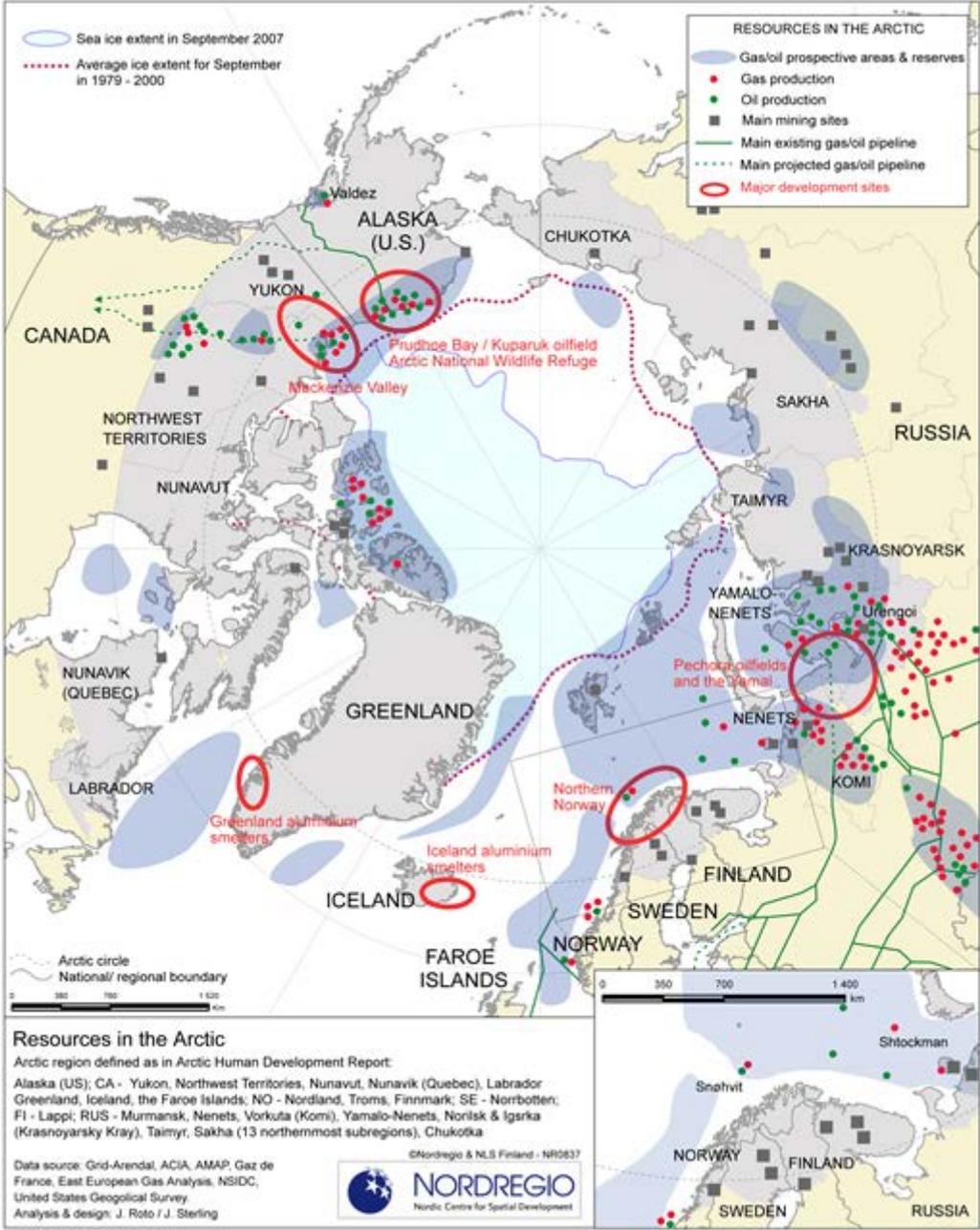
Figure 2 indicates the generation of electricity in GWh per region (size of the circles) subdivided into four classes: fossil fuels (orange), hydropower (blue), wind and other renewable sources (green), and nuclear energy (red). Hydropower is an important source of energy in Iceland and Norway. The Figure also shows that whereas wind and other sources (mainly thermal power) count for about one quarter of the generation of electricity in Iceland, it is of minor importance in Norway. Fossil fuels play an important role in production of electricity in other regions around the Arctic such as Alaska, Canada, Greenland and Russia. In the Murmansk region, the production of nuclear power is also significant.

Figure 2 Energy production by source



Reference: Nordregio (2011:153)

Figure 3 Main sites and areas for gas & oil production including infrastructure, main mining sites and sea ice extent in the Arctic



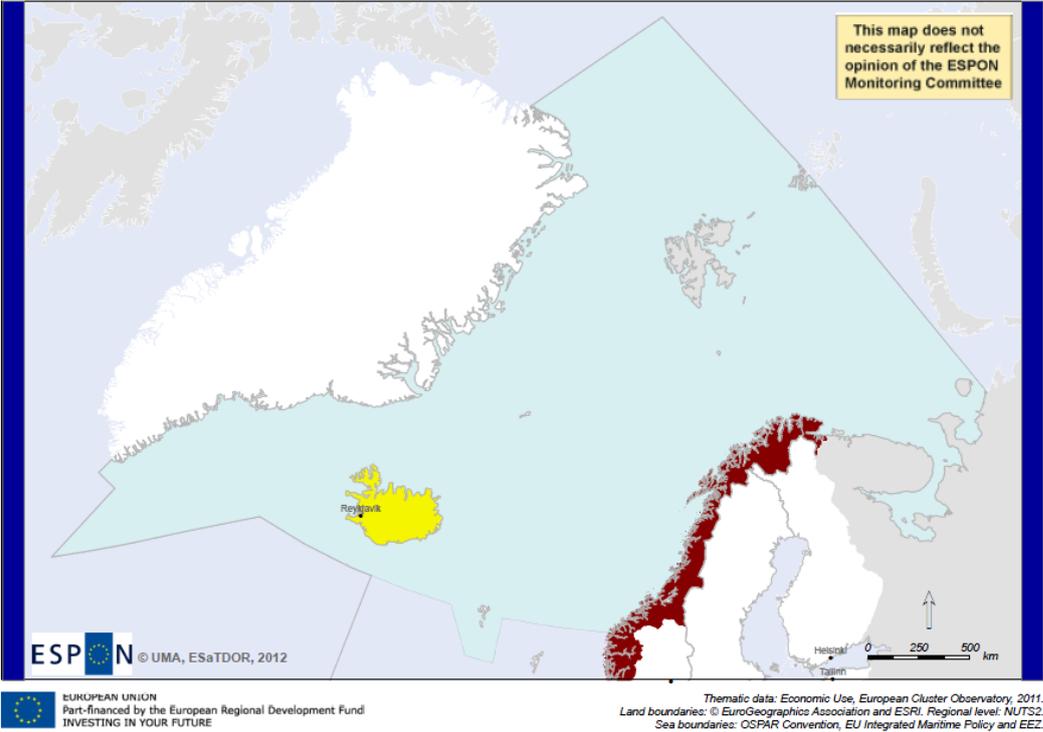
Reference: <http://www.nordregio.se/en/Maps--Graphs/05-Environment-and-energy/Resources-in-the-Arctic/>

Figure 3 shows the potential and existing sites of mineral and energy resources in the Arctic region. As is apparent from the map, there are relatively large areas of potential gas and oil reserves in the European part of the Arctic Ocean.

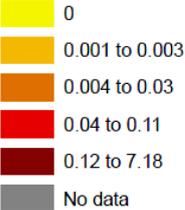
There are several potential oil and gas fields at the coast of Nord-Norge, in the Barents Sea as well as on the continental shelf of north-eastern Greenland, see Map AR18a. The Norwegian regions have relatively high employment within the oil and gas sector compared to the median of all European coastal regions, but still it counts for less than 1 per cent of total employment (Map AR18c). This can be explained by the very high capital intensity in this sector.

According to a newly published article by Reuters¹², Norway plans to license 72 blocks of petroleum in the Barents Sea for exploration next year. In 2011 two large oil fields (Skrugard and Havis) were discovered in the Arctic.

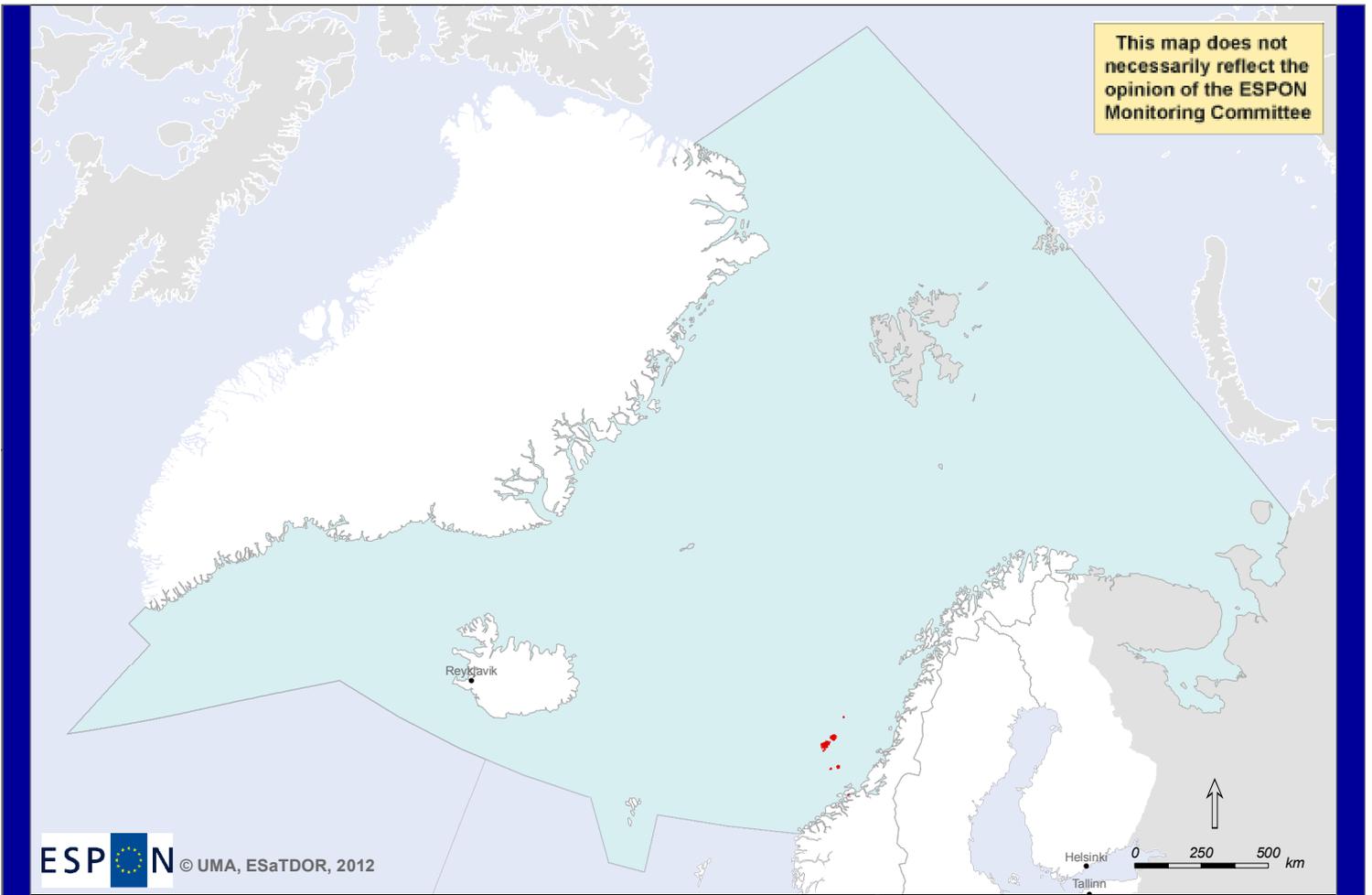
Map AR18c Employment in oil and gas as percentage of total employment.



AR18c. Employment in Oil and gas 2009 (percentage of total employment), Arctic Ocean



¹² UPDATE 2-Norway offers exploration licences in Arctic waters. Tue, Jun 26 2012 by Victoria Klesty.
<http://www.reuters.com/article/2012/06/26/norway-licences-idUSL6E8HQ3FW20120626>




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*Thematic data: National Center for Ecological Analysis and Synthesis based on data from NOAA's National Geophysical Data Center, 2008; HELCOM and LOTOS Petrobaltic S.A., 2011.
 Land boundaries: © EuroGeographics Association and ESRI. Regional level: NUTS0.
 Sea boundaries: OSPAR Convention, EU Integrated Maritime Policy and EEZ.*

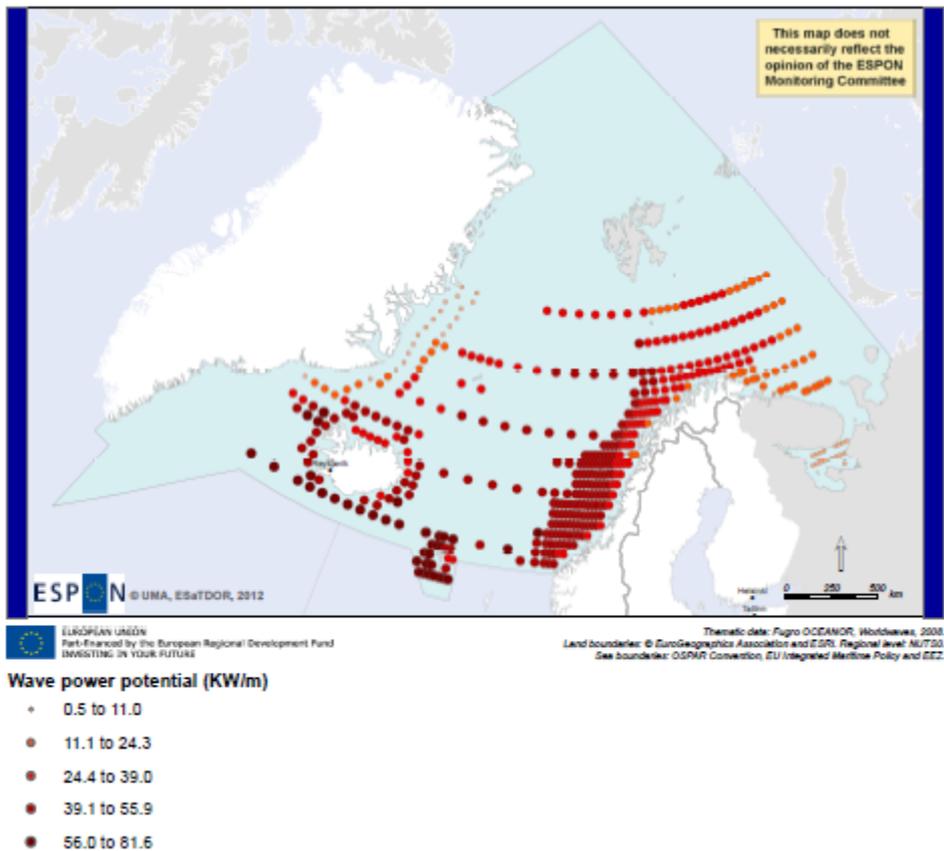
AR18a. Oil and gas rigs, Arctic Ocean, 2008

 Oil and gas rigs

The Scandinavian countries have high national development goals for wind power, and the spatial potential is large. However, cold climate has shown to cause several problems in regions of the north and at high elevations. The major problems occur when turbine blades are iced-up.¹³

Map AR20 also shows that there also is a high wave power potential. According to Nordregio (2011:159), usage of tidal current energy is increasing in Nord-Norge.

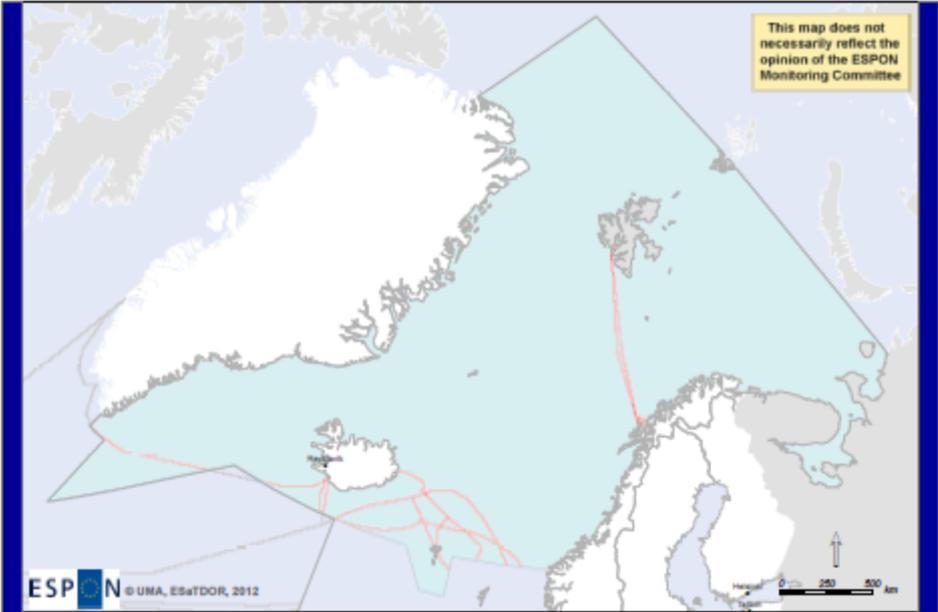
Map AR20 Wave power potential (KW/m)



¹³ <http://www.nordicenergy.org/publications/>

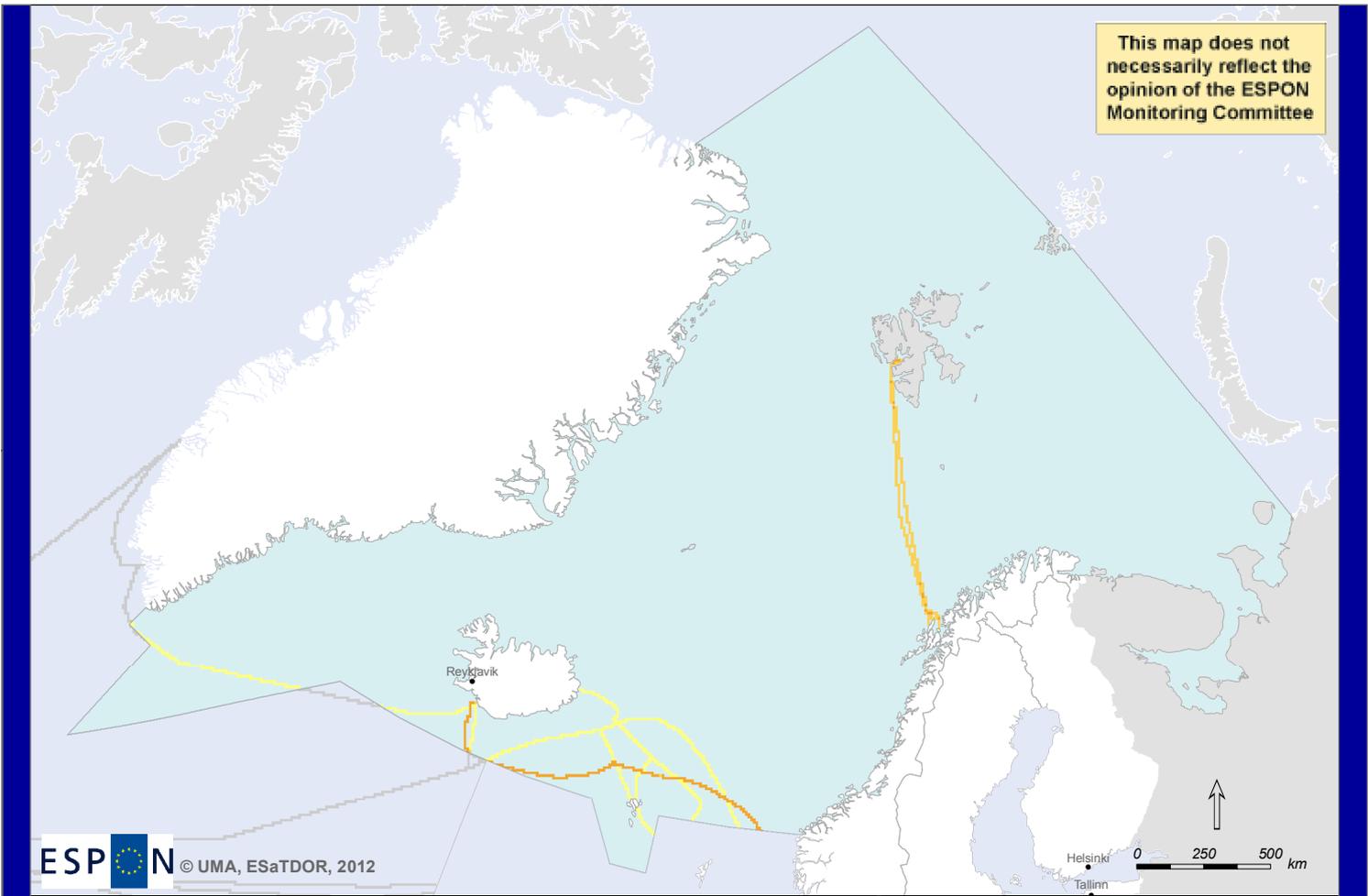
Undersea cable length (measured as kilometers per 10km grid square) is relatively low compared with the other oceans, see Map AR21a. Undersea cable capacity (measured as gigabytes/s per 10km grid square) is, however, in the medium range for cables between Norway and Svalbard and between Iceland and Germany, see Map AR21b.

Map AR21a Undersea cable length



Cable length (Kilometers per 10km grid square)

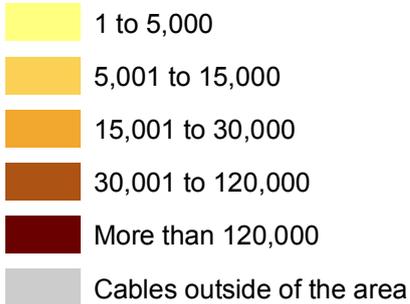
- 0 to 15
- 16 to 30
- 31 to 40
- 41 to 50
- 51 to 53




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Thematic data: Greg Mahlknecht, www.cablemap.info, updated 22-02-12
 Land boundaries: © EuroGeographics Association and ESRI. Regional level: NUTS0.
 Sea boundaries: OSPAR Convention, EU Integrated Maritime Policy and EEZ.

AR21b. Cable capacity (Gigabytes/s per 10km grid square), Arctic Ocean



Environment

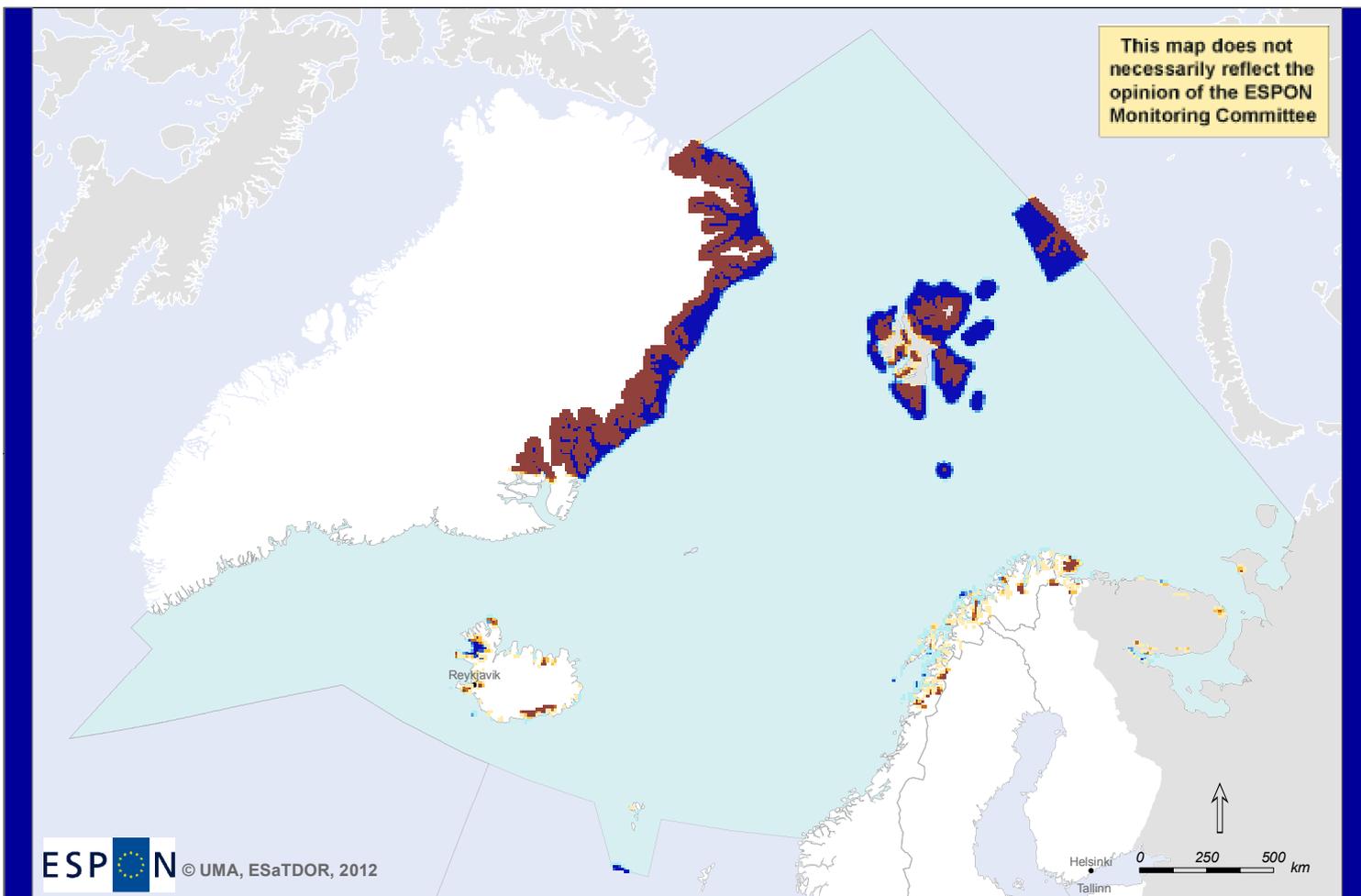
Enhanced openness of the Arctic also means enhanced accessibility to the ocean's resources. However, there are several challenges connected with this development. According to Nordregio (2011:175): *"Increased access raises several questions such as sovereignty over shipping routes and seabed resources, security and safety both for the new activities and their impact on the activities already there, for instance commercial fishing, the hunting of marine wildlife by indigenous people, tourism and existing shipping. In addition, increased access to shipping routes and resources entails a higher risk of environmental degradation, significantly impacting the environment, such as marine mammal migration and the introduction of alien invasive species in the region."*

Furthermore, *"several studies conclude that oil spills and other industrial accidents could have serious, long-lasting effects in the high-latitude, cold ocean environment. Despite preventive measures such as improved boat-building standards, 'spill response operations' are more complex and demanding in ice-covered waters and effective response strategies have yet to be developed while better port facilities and operating procedures in relation to oil spills are also required."*¹⁴

Protected areas

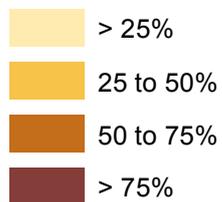
Relatively large parts of North-Eastern Greenland, Svalbard, Frans Josef's Land and their adjacent waters are protected areas, see Map AR22. The Convention on Biological Diversity (CBD) expressed in 1992 serious concerns regarding the ongoing decrease in biodiversity, and the members of the Convention pledged themselves to a number of (legally binding) commitments regarding the sustenance of biodiversity values within their borders. Amongst others, this included the creation of an extensive system of protected areas that could protect valuable species, habitats and ecosystems. This prompted EU regulations regarding NATURA 2000, via Birds and Habitats Directives, in which member states were required to propose a system of interconnected nature reserves. In the Arctic, the Arctic council designed nature reserves through their Conservation of Arctic Flora and Fauna (CAFF) working group. Although the CBD expressed explicit concerns regarding the protection of the biodiversity of the high seas, marine protected areas (MPAs) in the North East Atlantic have only recently been designated by OSPAR. The implementation of these MPAs is not yet finished, and these MPAs are therefore not yet fully in place. The dataset shows therefore the NATURA2000 and CAFF sites.

¹⁴ Nordregio (2011:176).

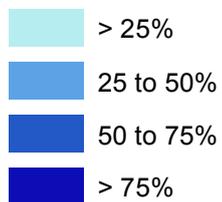


AR22. Protected Areas (Natura 2000 and CAFF sites), Arctic Ocean

Percentage of grid size (Land)

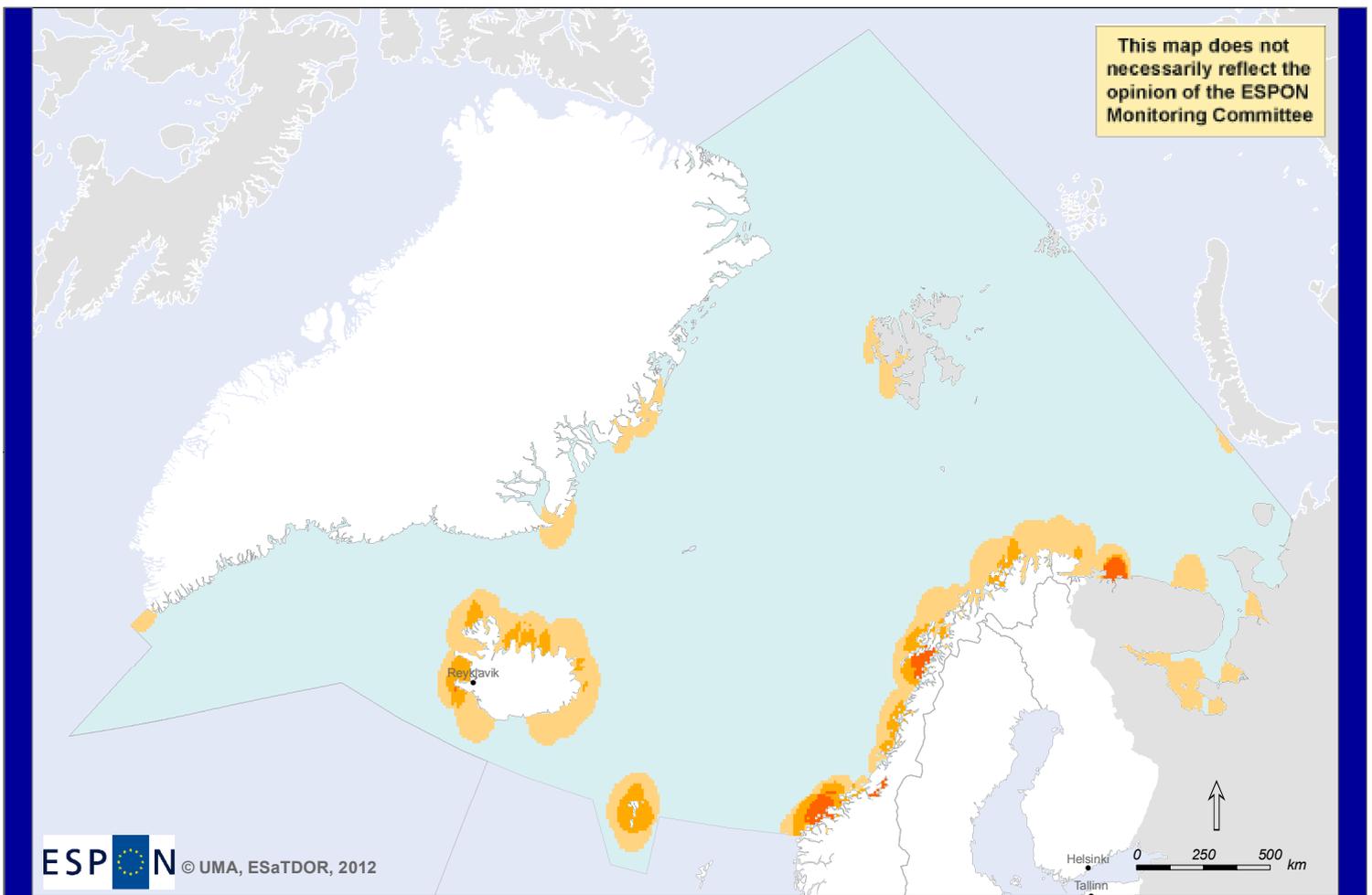


Percentage of grid size (Sea)



Invasive species

In 2004-2005 the number of invasive species was relatively low compared to other seas, but still there were between 101 and 300 invasive species per grid in some areas, as for instance in Lofoten and in the waters around the city Trondheim in Norway as well as in the waters around the city of Murmansk in Russia, see Map AR23. Invasive species can be a problem because their populations can increase enormously and outcompete local species. The result can be an important decline of these more vulnerable, local species but also a disruption of the entire ecosystem if ecosystem-engineer species or ecosystem services disappear due to the excessive abundance of the new (pest) species. Shipping is one of, if not the, major source of invasive species in coastal zones, and regional seas in general. Ships use ballast water, and with the inlet of ballast water unwanted species can be taken on board and unwillingly transported to new areas. The Ballast Water Convention set-up by the International Maritime Organization (IMO) is addressing this issue, but it will take time before the measures described in this convention will take effect. This dataset has modelled the incidence of invasive species along the European coastline with a limit of <60m depth (i.e. most invasive species transported through ballast water are intertidal or shallow subtidal species). The incidence of invasive species was modeled as a function of the amount of shipping cargo transported through European ports, with a diffusion model to mimic the expansion of invasive species around these ports.



AR23. Total number of invasive species per grid square (October 2004 - October 2005), Arctic Ocean

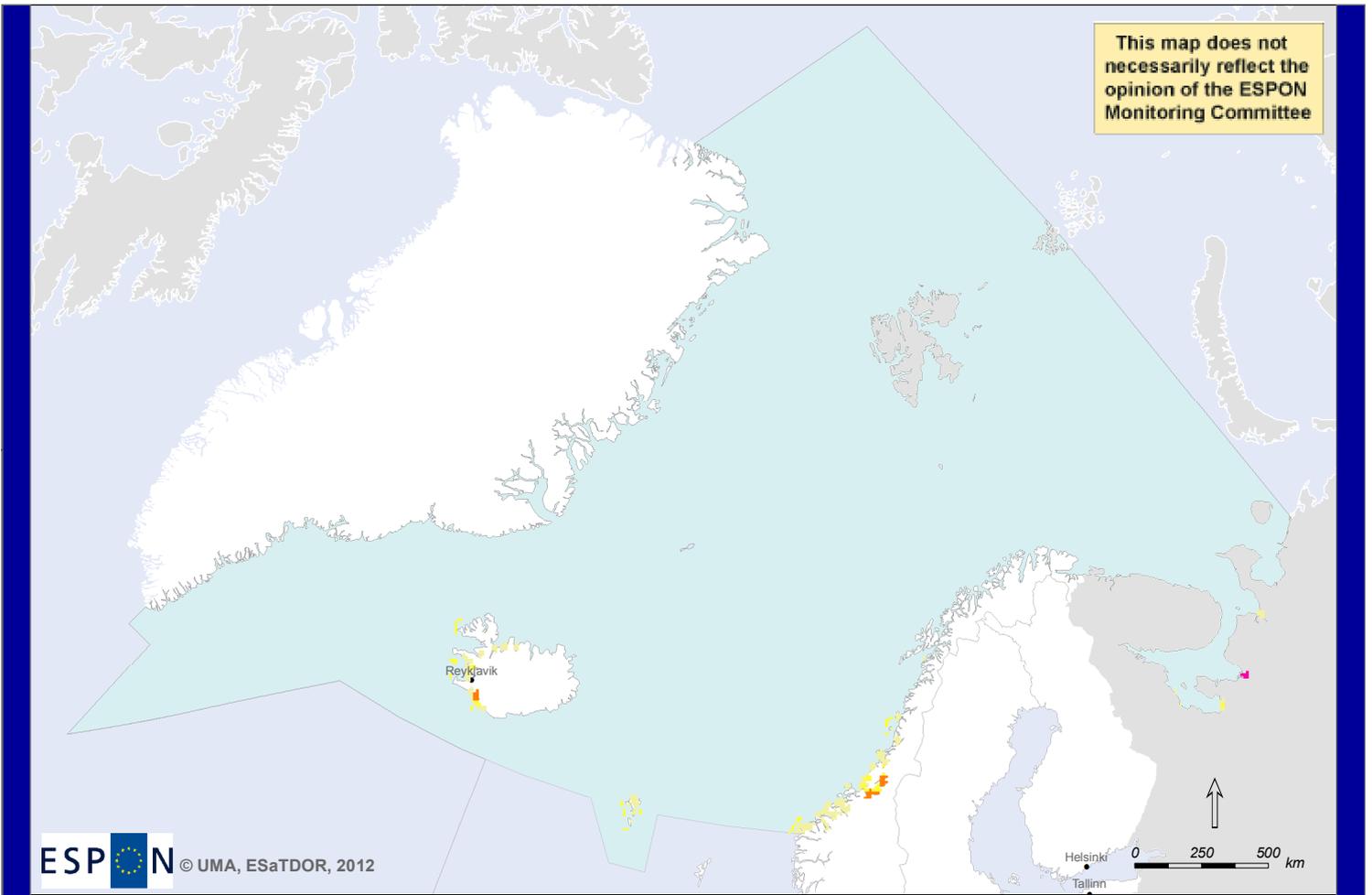


Marine contaminants: Organic pollution

Map AR24 shows the impacts on coastal areas of loads of nutrients from pesticides (used in agriculture). The load from pesticides (organic contaminants) is based on FAO national statistics for the period 1992-2001. These national statistics have been downscaled over the land area, and then transport of these contaminants through the hydrological network towards sea was modeled. The result is thus the load of these contaminants through inflowing rivers. Because the dataset is derived from FAO statistics, the dataset indicates agricultural activity within catchments. Consequently, the size of a catchment and the level of agricultural intensity will have a big influence on the results. Point sources have not been accounted for in this dataset. Pesticides can build up in individual organisms (bioaccumulation) and then become over-time poisonous. But they can also accumulate in the foodweb. The result of this biomagnifications in the food webs is that top predators become especially vulnerable due to their longevity and diet.

Climate Change: Sea Surface Temperature

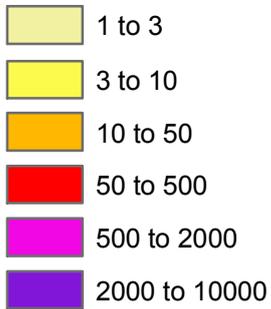
Changes in sea surface temperature are important because many marine ecological processes are profoundly influenced by temperature, and important differences are found between ecosystems at different latitudes differing in temperature. The data shown in Map AR25 represents the average change in SST over a 30 year period, showing that for most of the Arctic SST is increasing, and in particular the areas to the north of Iceland and in the White Sea (north east Russia) have experienced significant increases. Along the eastern coast of Greenland and extending to Svalbard, SST decreases may be associated with movements of the thermohaline circulation, the large-scale ocean current which brings cooler waters from the Arctic southwards through the Greenland Sea.



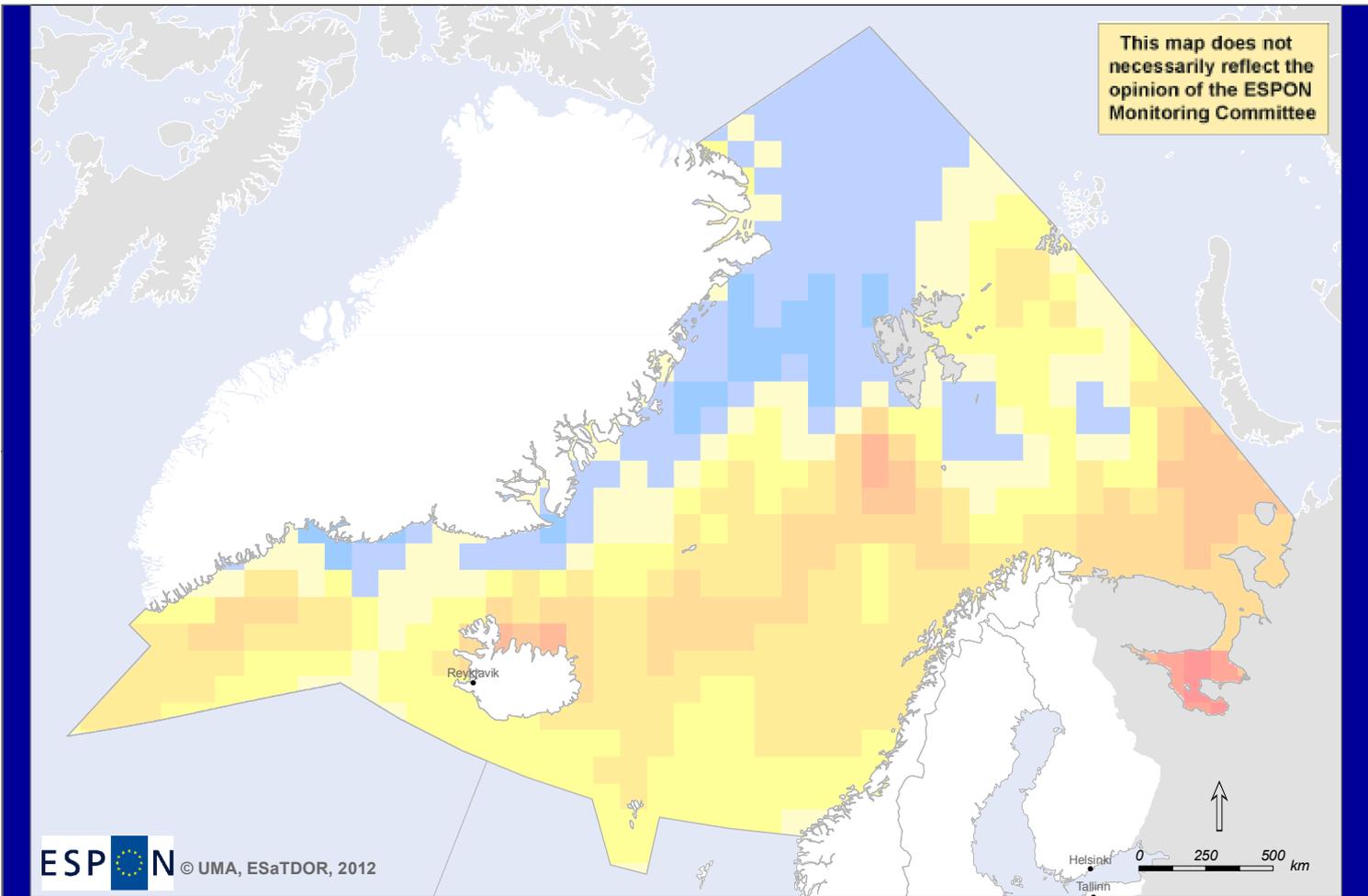

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Thematic data: National Center for Ecological Analysis and Synthesis, Organic Pollution, 2008.
 Land boundaries: © EuroGeographics Association and ESRI. Regional level: NUTS0.
 Sea boundaries: OSPAR Convention, EU Integrated Maritime Policy and EEZ.

AR24. Organic pollution (total kg of pesticides per year), Arctic Ocean



This map does not necessarily reflect the opinion of the ESPON Monitoring Committee

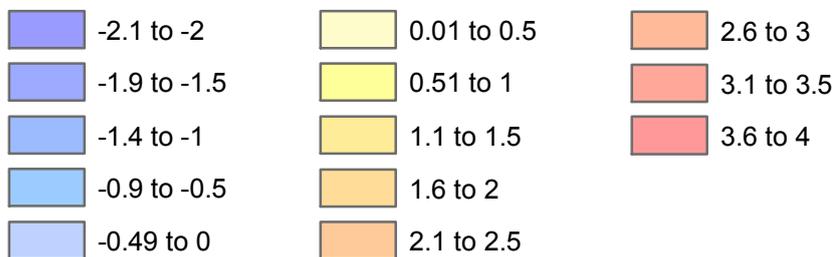


ESPON © UMA, ESaTDOR, 2012

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Thematic data: National Oceanic & Atmospheric Administration (NOAA), Optimum Interpolation (OI) Sea Surface Temperature (SST) V2, 2012
Land boundaries: © EuroGeographics Association and ESRI. Regional level: NUTS0.
Sea boundaries: OSPAR Convention, EU Integrated Maritime Policy and EEZ.AR26.

AR26. Increase in sea surface temperature between 1981-2011 (degrees Celsius), Arctic Ocean



4. Governance case studies

This section presents a summary of the three Arctic Ocean case studies included key messages. First the regional sea case study is presented and then the two sub-sea case studies.

Regional Sea case study: the Northern Dimension and Arctic Council

The 1982 Law of the Sea Convention (UNCLOS) is the primary international legal instrument governing maritime jurisdiction and boundary delimitation of the Arctic Ocean (see Figure 4). There are several global and seas level governance arrangements for the Ocean. The two most important circum-polar governance bodies at the regional sea level are *The Northern dimension* (ND) with actors from EU-level and, the *Arctic Council* with actors from national and regional level. The main objective of the Northern Dimension is to promote dialogue and cooperation in order to achieve a sustainable development in Northern Europe. The Arctic Council has a common goal in promoting cooperation among the Arctic States. Likewise important is involvement of the Arctic Indigenous communities here with a particular focus of sustainable development and environmental protection in the Arctic.

The Northern dimension addresses the specific challenges and opportunities arising in those regions and aims to strengthen dialogue and co-operation between the EU and its member states, the northern countries associated with the EU under the European Economic Area (Norway and Iceland) and Russia. The agreement emphasises active participation of all stakeholders in the North, including regional organisations, local and regional authorities, the academic and business communities, and civil society (indigenous peoples' organisations). Main policy challenges of the new Northern Dimension are how to achieve real equality between partners, particularly in relation to Russia; how to coordinate the ND policies with other northern European regional cooperation; how to achieve institutional coordination and how to develop existing partnership and launch new partnership (Aalto et al 2008).

The Arctic Council's main focus has been on environmental issues and involvement of indigenous people in the governance of the Arctic. The Council's most important contributions have been the generating of policy-relevant knowledge and scientific assessments on environmental issues and lately particularly on climate change impacts. AC is primarily a forum for *soft law* and has no binding or regulatory authority and, it is dealing with *low politics* issues such as environment and living conditions in the Arctic. It is also a project-driven and not an operational body which can execute policies.

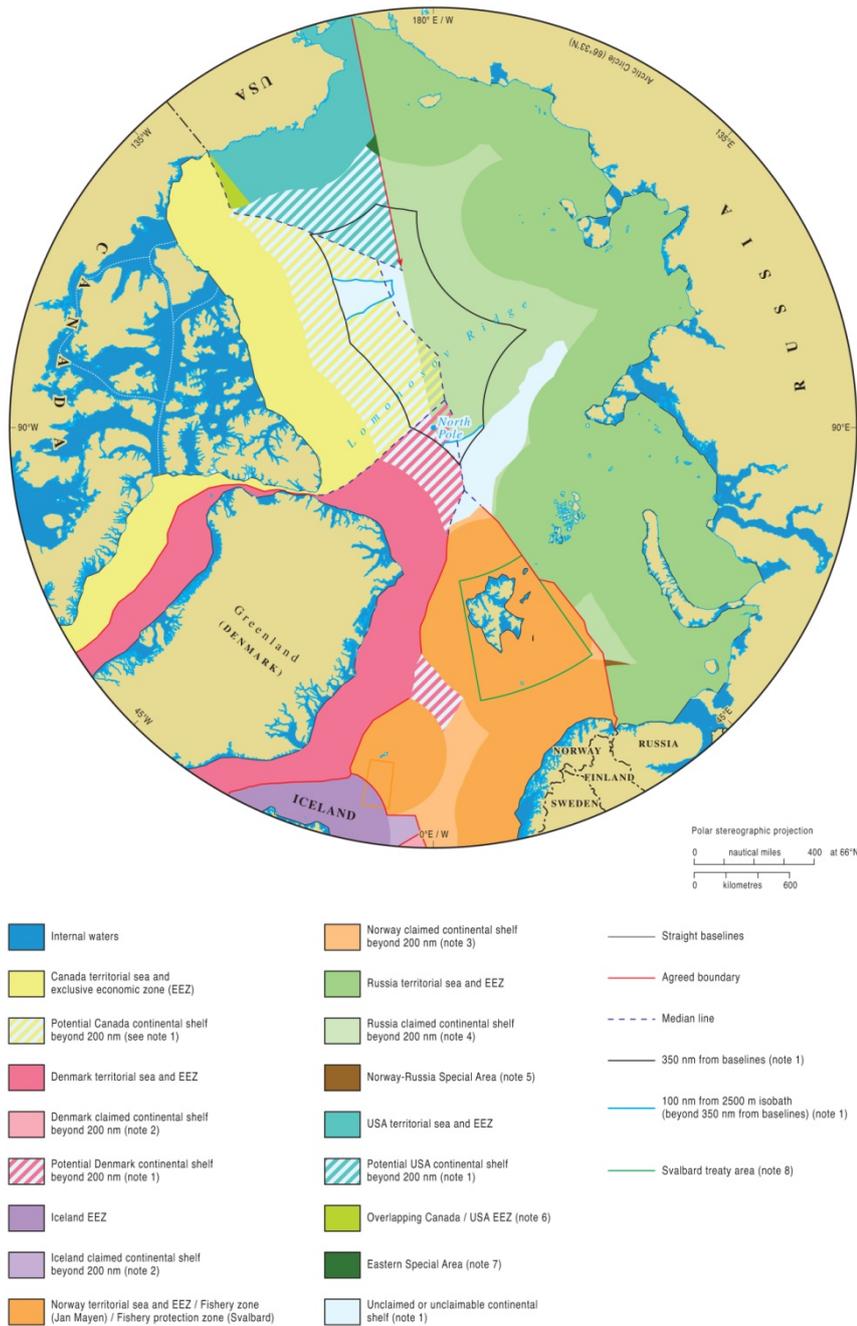
Neither the Northern Dimension nor the Arctic Council have binding or regulatory authority and accordingly have to rest on consensus-based policy recommendation and work through partnerships arrangement and networking. This kind of collaboration provides confidence between the different partners but has the disadvantage that coordination may be fragmented and important issues may not come to the fore. However, both The Arctic Council and The Northern Dimension have become more important as governance bodies the past years. AC plays an increasingly important role in contributing to a solid basis for a science-based policy in the Arctic and, the Northern Dimension has promoted the development of important areas such as health and environment. Regional cooperation in the Arctic seems to function well when it is based on common interests and mutual confidence between the parties. To obtain a sustainable future governance of the Arctic Ocean it is

important that coordination is flexible enough to adapt to changes but also that the governance arrangements have the necessary authority to solve conflicts of interests.

Fig 4: Maritime jurisdictions and boundaries of nations in the Arctic region



Maritime jurisdiction and boundaries in the Arctic region



Sub-sea case study: The Maritime Delimitation Treaty between Norway and Russia (Barents Treaty)

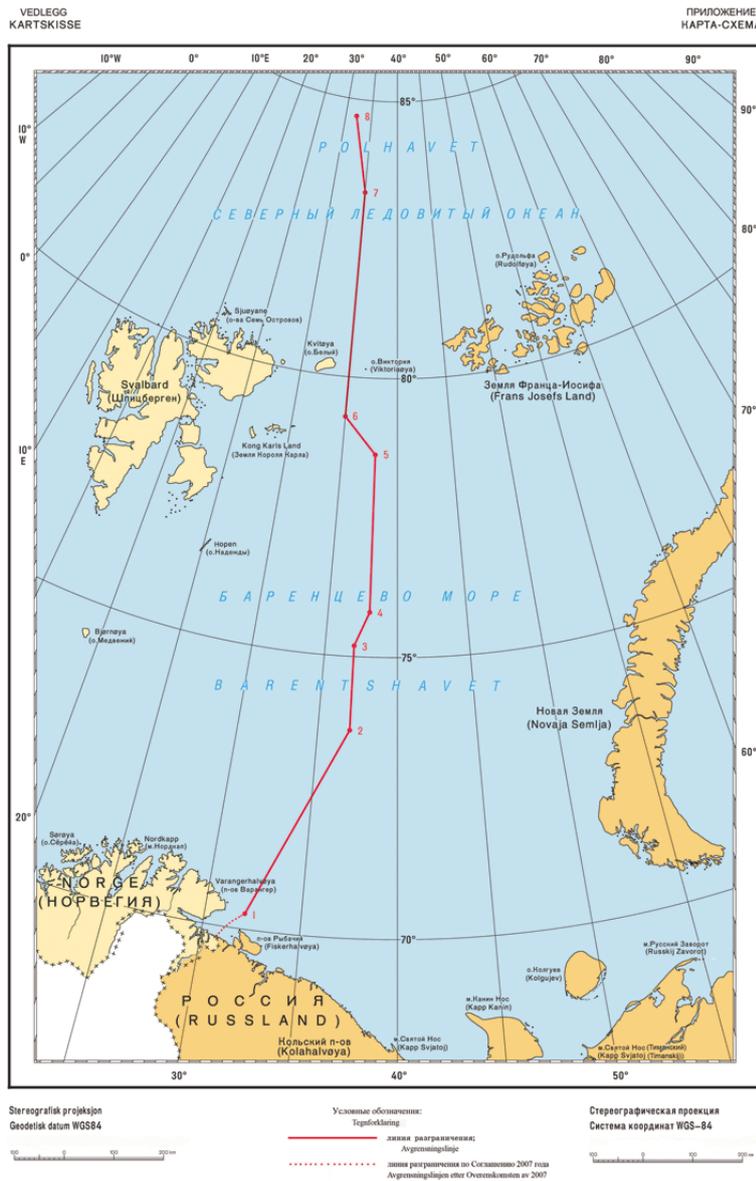
The Law of the Sea Convention (UNCLOS) make up the legal basis for the Barents Treaty. The treaty entered into force in 2011 and it marked an end to an almost forty year long border disputes in the Barents Sea and the Arctic sea between Norway and Russia. The Barents Treaty applies to Norway's and Russia's respective exclusive economic zones (in addition to the Fisheries Protection Zone around Svalbard) and the continental shelf within and beyond 200 nautical miles (see Figure 5). The treaty will ensure the continuation of the Norwegian-Russian fisheries cooperation, and governs cooperation on the exploitation of any petroleum deposits that extend across the delimitation line. This will add to the orderly governance in the Barents Sea by bringing about predictability and legal certainty which is important for enacting and enforcing environmental rules, extracting of oil and gas resources and fisheries regulations.

Governance issues are particularly important since the Barents Sea is an area of high economic interest due to valuable natural resources. The fisheries resources in the area are amongst the richest in the world and the Barents Sea is also expected to hold vast hydrocarbon resources. With an increasing global energy demand and high oil prices, and thinning of the pack-ice due to climate change, the Barents Sea may increasingly become a main centre of attention of the oil industry. This may lead to an increasing maritime transport along the coast of Russia and Norway and this may again endanger the Barents Sea eco-system. These issues are focused upon in the different governance bodies at the sub-regional sea level, such as The Arctic Council (AC), Council of the Baltic Sea States (CBSS), The Barents Euro-Arctic Council and the Nordic Council of Ministers and, The Norwegian-Russian Joint Fisheries Commission.

There are several reasons behind the Barents Sea Treaty. The Law of the Sea provides important principles for informing the delimitation solution and the delimitation line is justified with reference to recent international case law. Economic reasons related to large petroleum resources are also important. When maritime boundaries are settled the states can enact domestic legislation when planning the development of oil and gas industry in the former disputed area. Political reasons such as changes in foreign policy after the cold war period also created a better climate for negotiation and an increased willingness to compromise for both Norway and Russia.

The governance effectiveness in the Barents Sea may be reduced by the fact that neither the Arctic Council nor the other regional councils have binding or regulatory authority. Governance bodies produce consensus-based policy recommendation and cooperate through partnerships and networks. However, The Arctic Council may develop into a more important governance body due to its role as a provider of knowledge for a more science-based policy and, also as a result of more states represented in the council. As a circum-polar governance body, AC has become gradually more important the past years due to climate change and new options and risks in the Arctic.

Figure 5: The delimitation line between Norway and Russia



Source: Ministry of Foreign Affairs

Sub-sea case study: The Maritime Delimitation Treaty between Norway and Denmark/Greenland.

In 2006, Denmark and Norway agreed on the delimitation of the opposite maritime zones of Greenland and Svalbard. The two countries have earlier used international courts to sort out their differences in the Arctic Ocean but in 2006 they came to an agreement on a bilateral basis. The boundary line between Greenland and Svalbard is concurrent with the exclusive economic zone of Greenland and the Fisheries Protection Zone (FPZ) around Svalbard. The agreement also regulates how the parties should deal with the possible existence of a mineral deposit on the continental shelf (shelves) (see Figure 6).

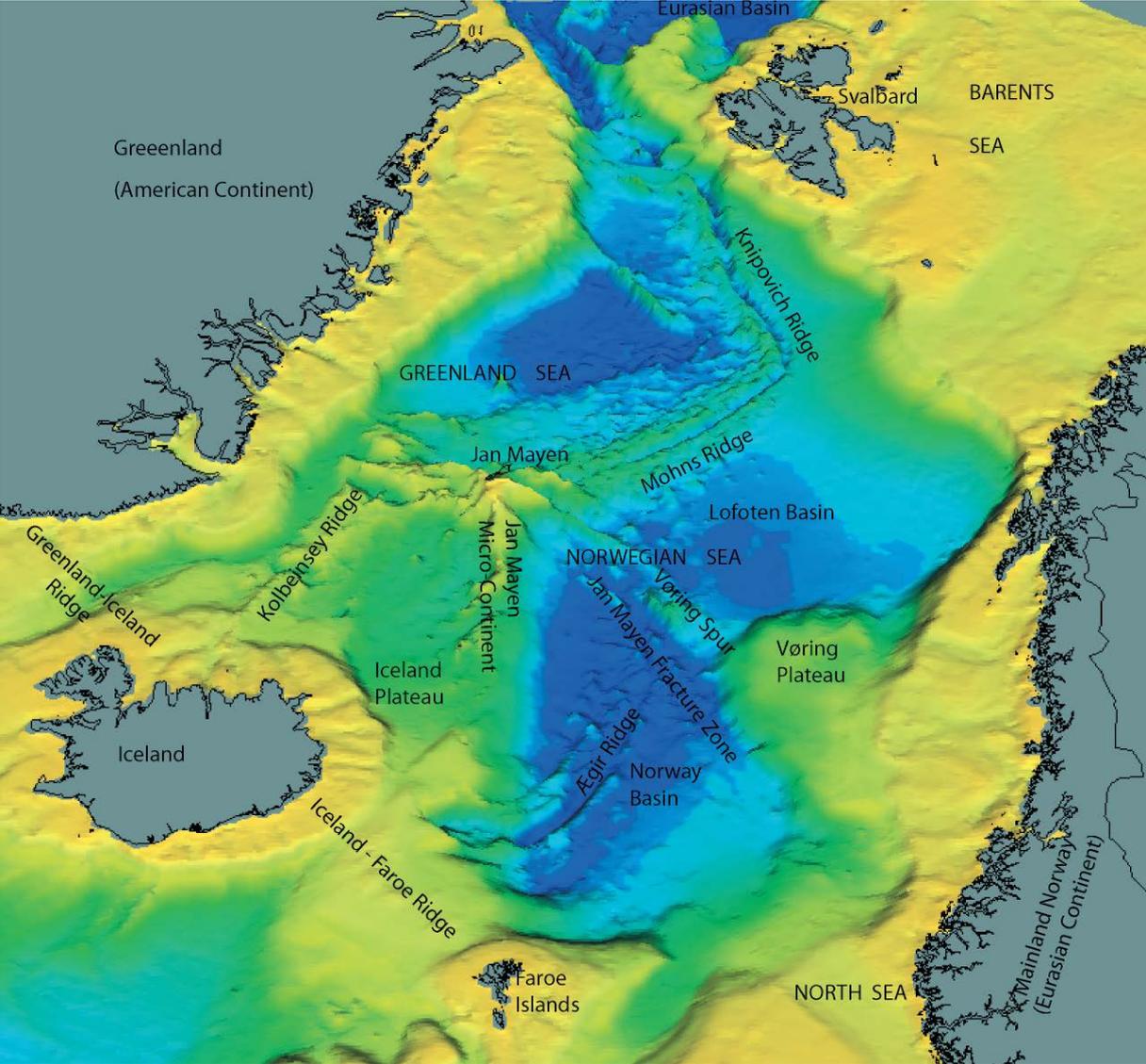
Since 2006, then, all sovereignty issues and maritime boundaries involving 200-nautical-mile claims between the Danish and Norwegian territories in the Arctic area have been settled (Pedersen 2009). However, one sovereignty issue remains unresolved and continues to trouble the relationship

between the two countries. Norway asserts that it has a coastal state's exclusive rights to the resources adjacent to Svalbard; Denmark has increasingly come to challenge this assertion. Denmark, and its dependencies Greenland and the Faroe Islands, have repeatedly claimed extensive rights to the resources of the 200-nautical-mile zone around Svalbard.

The Svalbard issue is an international issue which involve several countries and which is regulated through the Svalbard Treaty. The treaty entered into force in 1925 and it states that the Arctic islands Spitsbergen should become a part of Norway given the name Svalbard. The treaty gives Norway sovereignty over the islands but other parties to treaty have equal rights to carry out economic activities on the islands as well as in their territorial waters. In 1977, in order to ensure a sustainable management of the marine ecosystem and the rich fish stocks in the area, Norway implemented a non-discriminatory Fisheries Protection Zone (FPZ) around Svalbard. Although not generally accepted the FPZ has been implicitly acknowledged by involved countries such as Iceland, Russia and Spain. This is probably due to the soft enforcement of the fisheries regulation in the zone.

The Norwegian view that Svalbard has no continental shelf itself but is an extension of the Norwegian continental shelf and, that Norway has exclusive rights to natural resources in the 200-nautical-mile zone around Svalbard, is disputed. Other contracting partners to the Svalbard Treaty claim that they should have the possibilities to extract resources on equal footing with Norway. It is uncertain whether any of the other contracting partners will take this dispute to an international court and if so – what might be the consequences for the Maritime Delimitation Treaty between Norway and Denmark/ Greenland. The maritime areas around Svalbard are home to key marine ecosystems and valuable natural resources and, the more partners involved in an area, the more challenging the resource management might be. The Spitsbergen Treaty may serve as inspiration for an Arctic multilateral regime in such topics as of peaceful management of resources, environmental protection or scientific cooperation. The Arctic Council may also play an increasingly important role as a governance body in the years to come as more states become represented in the body and, if more vital issues are brought to the fore.

Figure 6: Continental shelves



Source: The Royal Ministry of Foreign Affairs
(<http://www.regjeringen.no/upload/kilde/ud/prm/2006/0375/ddd/pdfv/299461-sokkel.pdf>)

Table 2: Summary of case studies

	Case Study 1: Arctic Ocean	Case Study 2: Barents Treaty	Case Study 3: Greenland/Svalbard
Drivers	Climate change, natural resources	Climate change, natural resources	Climate change, natural resources
Challenges	Overharvesting of natural resources, pollution	Overharvesting of natural resources, pollution	Overharvesting of natural resources, pollution
Legal Status	Not legally binding	Partly legally binding	Partly legally binding
Effectiveness	Low/medium	Medium/high	Medium/high
Stakeholder involvement	Medium/high	Low	Low

5. Characterisation of the Sea

As can be seen from the discussion above the Arctic is a large sea, where there is a close relationship between a very small local population and their economic and social wellbeing linked to the exploitation of maritime resources. It is also a sea that environmentally sensitive and whilst there is growing interest in further exploiting the natural resources, there are growing concerns what the impacts might be from each activity, individually or collectively. This section presents some basic characteristics of current position the seas and illustrates relations between sea and land. Land-based information (economic significance) is combined with sea-based information (environmental pressure and flows/transport) in order to get a more general picture of sea-land relations for the oceans. The combined findings are summarised in a typology map and a map showing the different kind of regions derived from the typology.

Economic Use

Map 27a and 27b illustrate the land-sea relation of economic use. Map 27a shows the total marine cluster employment within NUTS2 regions in coastal areas. This is an indicator of the impact on sea from land-based marine activities. As can be seen for the Arctic region the total employment is very low both in Iceland and most of Norway which should indicate a low impact on the sea from these countries. Southern Norway has a low score on this indicator.

Map 27b shows total marine employment as percentage of total employment within NUTS2 coastal regions. This is an indicator of the significance of sea-related industrial activities in the regions. Not surprisingly such activities are particularly important for Iceland as a small resource-based and sea-related economy. Since Iceland is only one NUTS2 region it is not possible to see if the pattern of maritime employment varies in the country. For Norway the picture is somewhat more varied. The importance of sea-related industrial activities is high on the West-coast but only medium in Northern Norway although fisheries and sea-related activities are important in this part of the country. However, the main industrial marine activities are located at the West-coast of Norway.

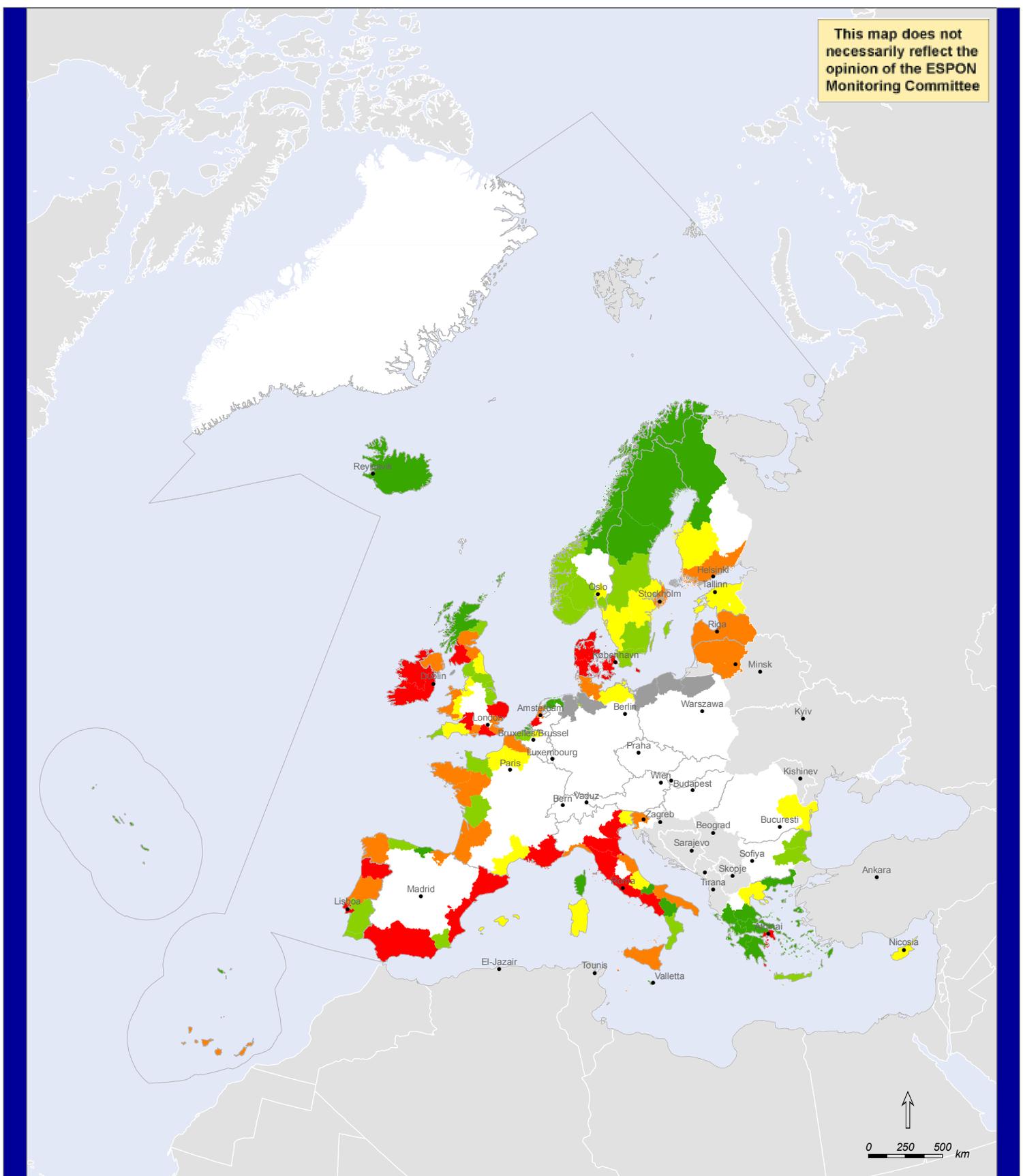
Environment

Map 28 illustrates the environmental pressure on the sea as combination of the effects of river discharges (organic and inorganic contaminants) and from ports (invasive species). For the Arctic Ocean the environmental pressure in general is low. Only the Southern and Western coastal parts of Norway are somewhat exposed whereas the Northern part and Iceland experienced very low environmental pressure.

Flows and Links

Map 29 provides a summary of flows (of goods, people and information). In this case flows around the Arctic are very low, with a slightly higher degree of activity around western Norway associated with larger ports at Bergen and Stavanger, which have a high degree of freight transport and cruise traffic respectively.

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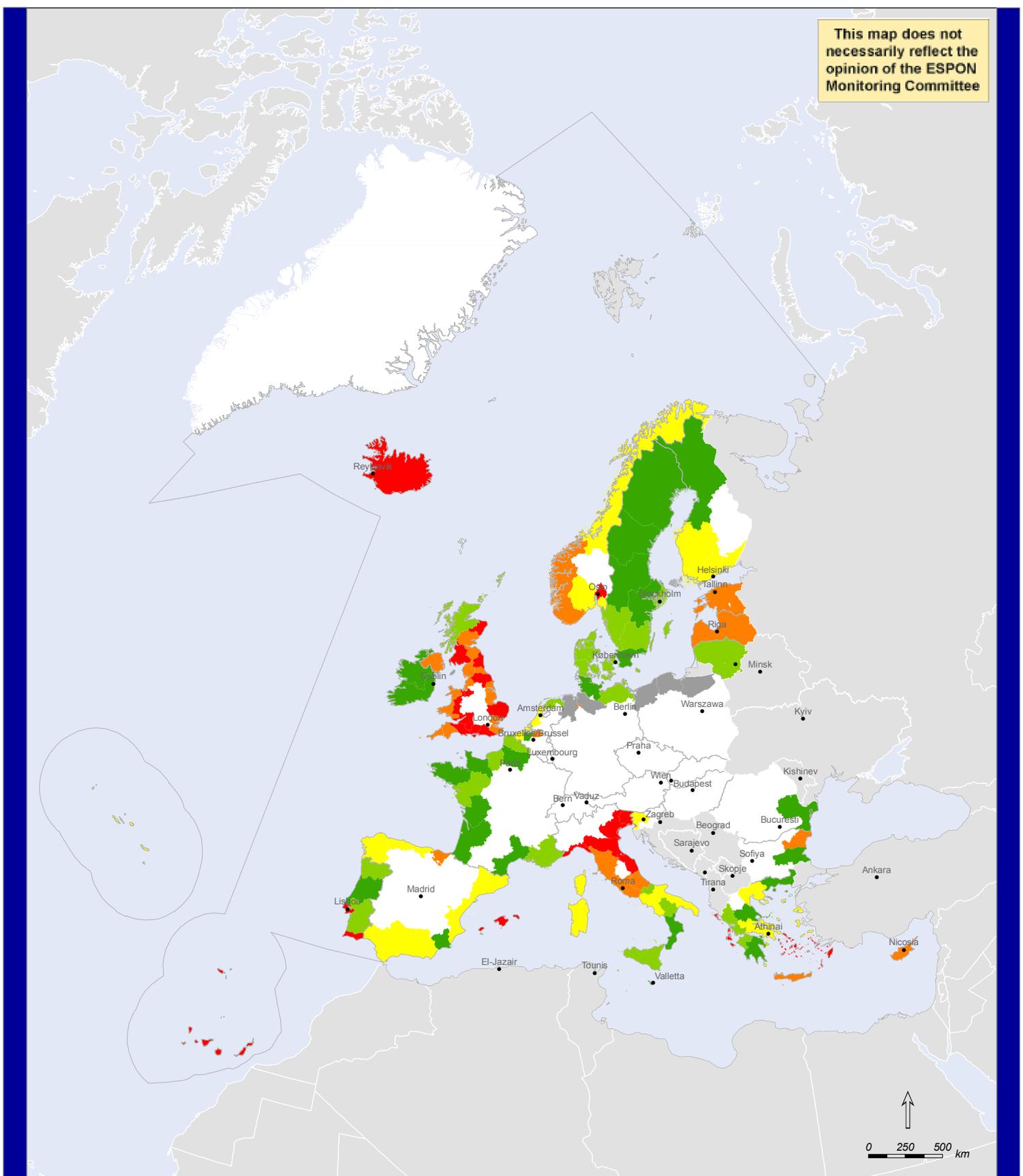
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Thematic data: Economic Significance Composite Map.
Land boundaries: © EuroGeographics Association and ESRI. Regional level: NUTS2.
Sea boundaries: OSPAR Convention, EU Integrated Maritime Policy and EEZ.

EU27a. Economic Use Composite Map (total maritime cluster employees within each NUTS2 region).

- Very Low
- Low
- Medium
- High
- Very High
- No data

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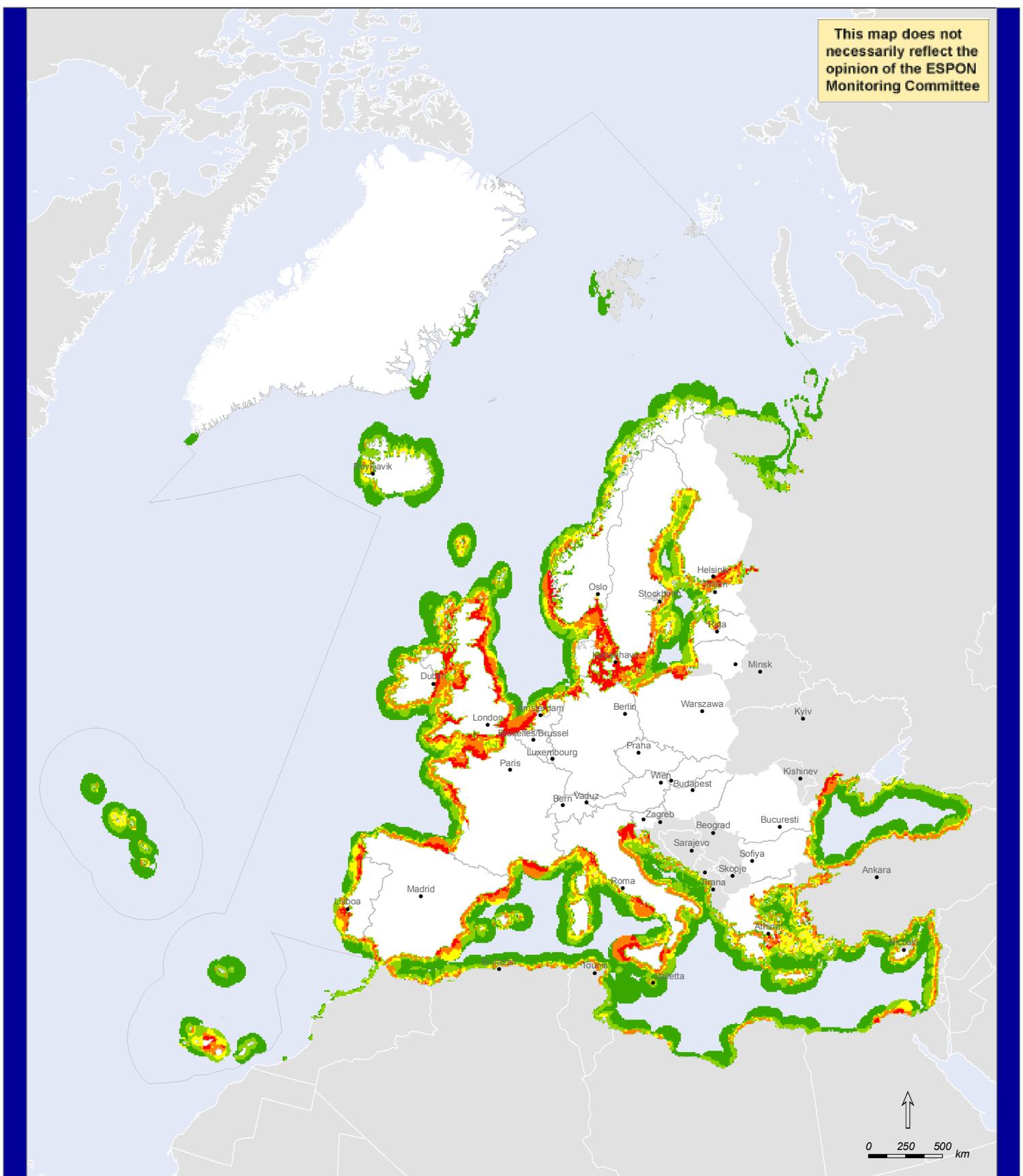
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Thematic data: Economic Significance Composite Map.
Land boundaries: © EuroGeographics Association and ESRI. Regional level: NUTS2.
Sea boundaries: OSPAR Convention, EU Integrated Maritime Policy and EEZ.MEU27

EU27b. Maritime Employment Composite Map (percentage of total employment within each NUTS2 region)

- Very Low
- Low
- Medium
- High
- Very High
- No data

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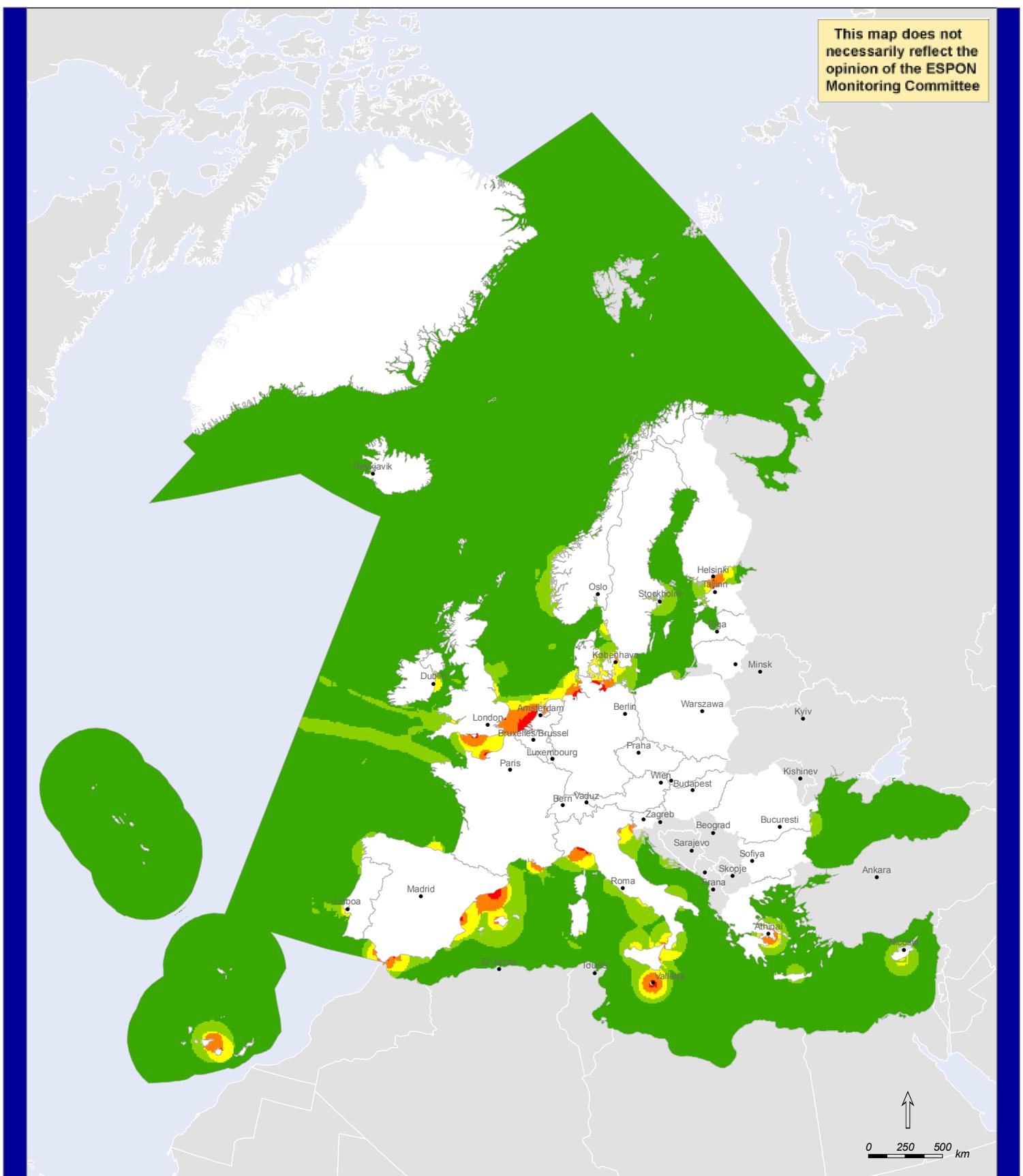
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Thematic data: Environmental Pressures Composite Map.
Land boundaries: © EuroGeographics Association and ESRI. Regional level: NUTS2.
Sea boundaries: OSPAR Convention, EU Integrated Maritime Policy and EEZ.

EU28. Environmental Pressures Composite Map

- Very Low
- Low
- Medium
- High
- Very High

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Thematic data: Flows Composite Map.
Land boundaries: © EuroGeographics Association and ESRI. Regional level: NUTS2.
Sea boundaries: OSPAR Convention, EU Integrated Maritime Policy and EEZ.

EU29. Flows Composite Map

- Very Low
- Low
- Medium
- High
- Very High

5.1 Towards a Regional Sea Typology

Combining the composite pictures of economic use, transport flows and environmental pressures shown above has enabled maps showing coldspots (Map EU30a) and hotspots (EU30b) for maritime related activity within Europe's regional sea areas to be produced. This sets the background for the final step towards a maritime typology shown in figure (Map EU31) which categorises maritime regions into a five-way typology: European Core, Regional Hub, Transition, Rural and Wilderness. The typology map is a simplified graphic presentation of the pattern of broad divisions evident from the data. The zones identified cover both land and sea and have deliberately 'fuzzy' boundaries reflecting data quality and availability issues which are discussed in more detail in the Data and Mapping project report.

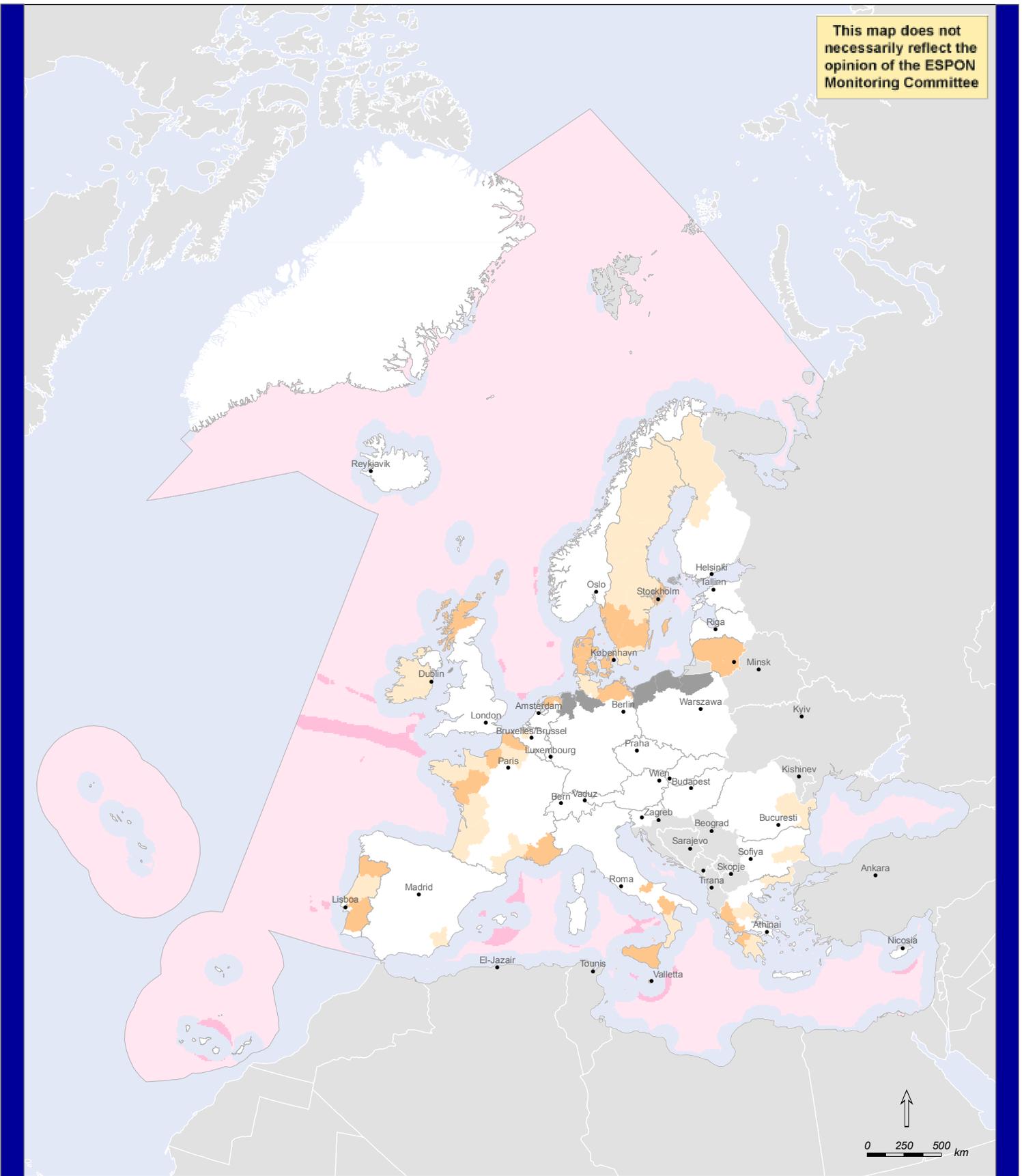
One of the premises for these maps was the selection of European data sets to ensure Europe wide comparability of maritime characteristics. For many sectors (such as fisheries) and issues (such as underwater noise, dredging and eutrophication) adequate information was not available on a European level although very good data exists in relation to some regional seas. For example data collected for OSPAR purposes provides a very good basis for understanding many aspects of the Arctic, Atlantic and North Sea marine environments, but compatible data is not available for other European seas. The picture presented is therefore less than ideal and the following maps (EU30a, 30b, 30c and 31) should be understood as a first iteration of a European maritime typology demonstrating how this concept could be developed over time as data improves.

Maps 30a, 30b and 30c combine sea-based information (environmental pressure + flows/transport) and land-based information, i.e. economic significance (percentage of total employment within NUTS2 regions) in order to get a comprehensive picture of sea-land relations for the oceans. As can be seen Iceland has a relatively high score on economic significance (land-based) and a medium score on environmental pressure and flows (sea-based), with particular "hot" spots to the west of Iceland around Reykjavik (Map 30b). The picture is somewhat different for Norway which has a high score on economic significance for the capital region (Oslo & Akershus), a high score for the Western part of the country and a medium score for Northern part. The sea-based information shows a very high score on the combined indicator of environmental pressure and flows for the central part of western Norway, a high score for the Southern part and the North-West part and, a medium score for the Northern part. In the marine (offshore) areas and the eastern coast of Greenland, virtually all of the Arctic shows very low levels of activity or environmental pressure, with the exception of a small area to the west of Bergen. However these "cold" spots may be somewhat misleading, as the relatively unspoilt nature of the Arctic makes it more sensitive to environmental pressures resulting, for example, from pollution accidents.

The regions derived from the typology vary on a scale from European core to Wilderness and the Arctic Ocean in general belongs to the wilderness sea, where the intensity of use is low, the environment is relatively pristine, but potentially vulnerable and not very resilient to change. This is partly a function of the region being sparsely populated; there are no larger cities and long distances between the settlements and local employment based on natural resources is limited. However, there is some variation in this picture. Iceland is partly defined as wilderness and partly as rural in the area where the capital Reykjavik is situated. The Southern and Western parts of Norway in which all the larger cities are located are classified as regional hubs with the potential connectivities linking

through to part of a regional hub located within the North Sea region. This tends to highlight the importance of some of the connections being just as strong across regional seas as well as with the regional sea itself. Central parts of Northern Norway are transition regions whereas Mid-Norway and most Northern part (Finnmark) are defined as wilderness.

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Thematic data: Typology Map.
Land boundaries: © EuroGeographics Association and ESRI. Regional level: NUTS2.
Sea boundaries: OSPAR Convention, EU Integrated Maritime Policy and EEZ.

EU30a. Typology Map (coldspots)

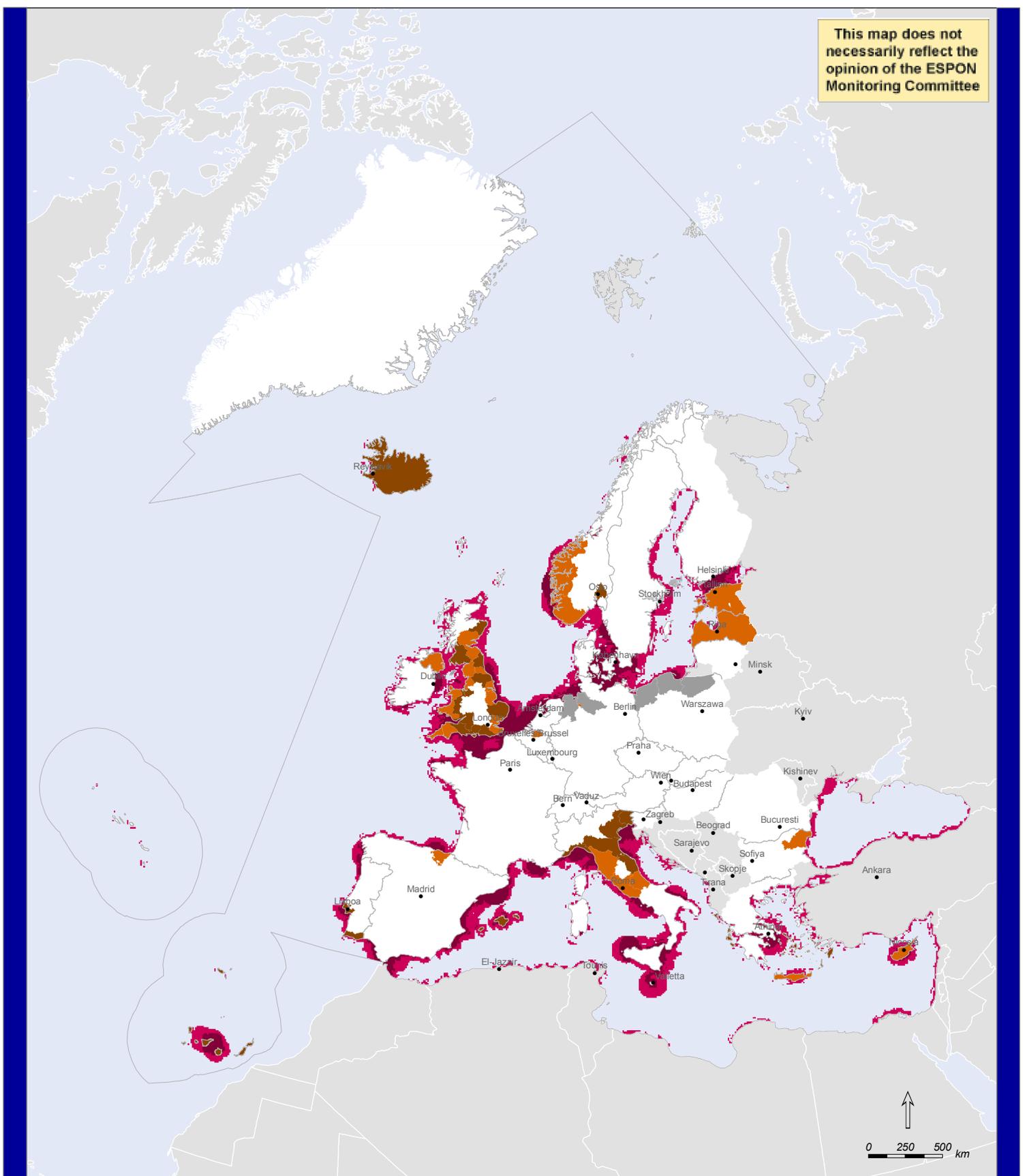
Sea (Environmental Pressures and Flows)

- Very low intensity
- Low intensity

Land (Economic Significance)

- Very low intensity
- Low intensity
- No Data

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Thematic data: Typology Map.
Land boundaries: © EuroGeographics Association and ESRI. Regional level: NUTS2.
Sea boundaries: OSPAR Convention, EU Integrated Maritime Policy and EEZ.

EU30b. Typology Map (hotspots)

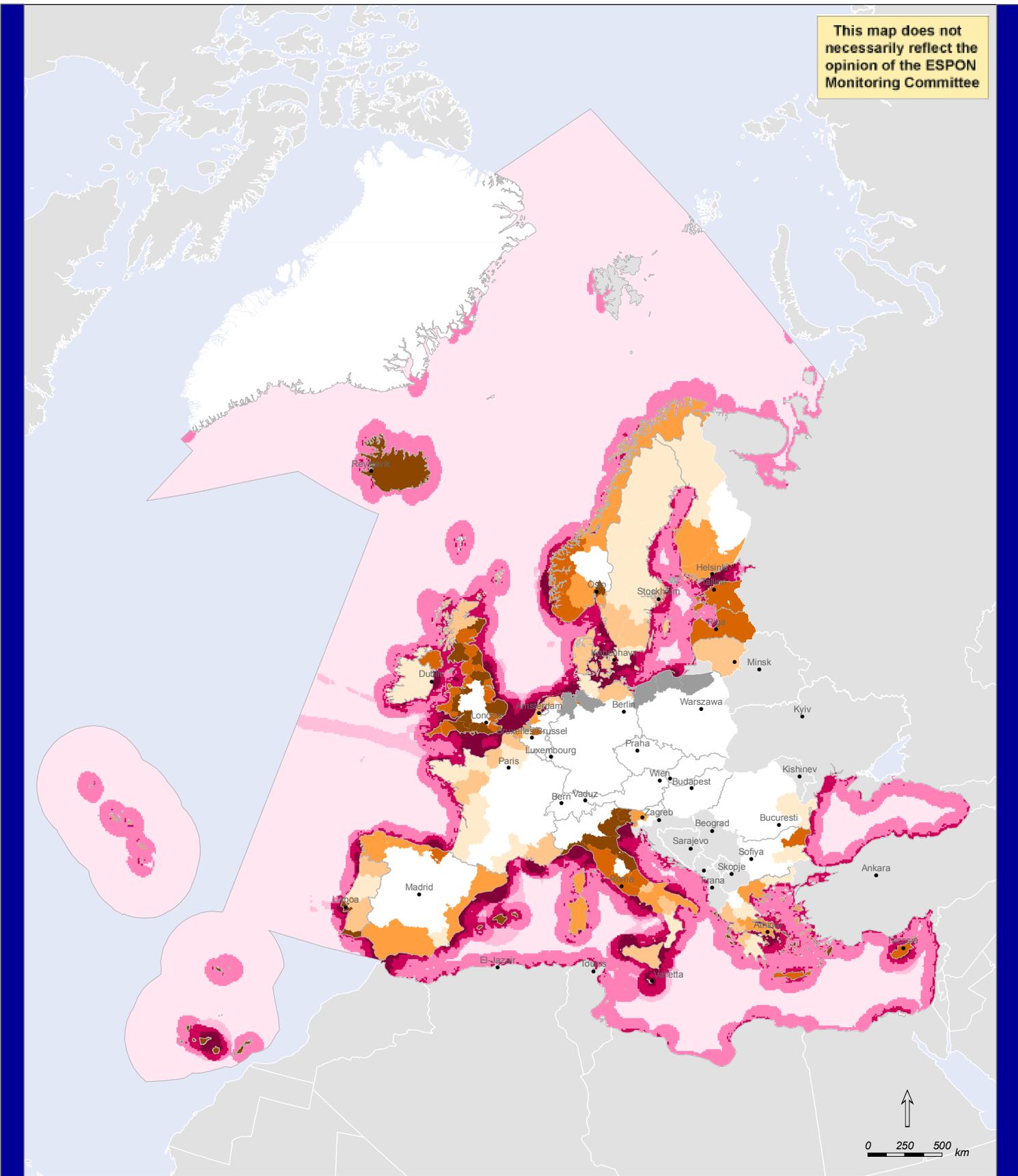
Sea (Environmental Pressures and Flows)

- High intensity
- Very high intensity

Land (Economic Significance)

- High intensity
- Very high intensity
- No Data

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Thematic data: Typology Map.
Land boundaries: © EuroGeographics Association and ESRI. Regional level: NUTS2.
Sea boundaries: OSPAR Convention, EU Integrated Maritime Policy and EEZ.

EU30c. Typology Map

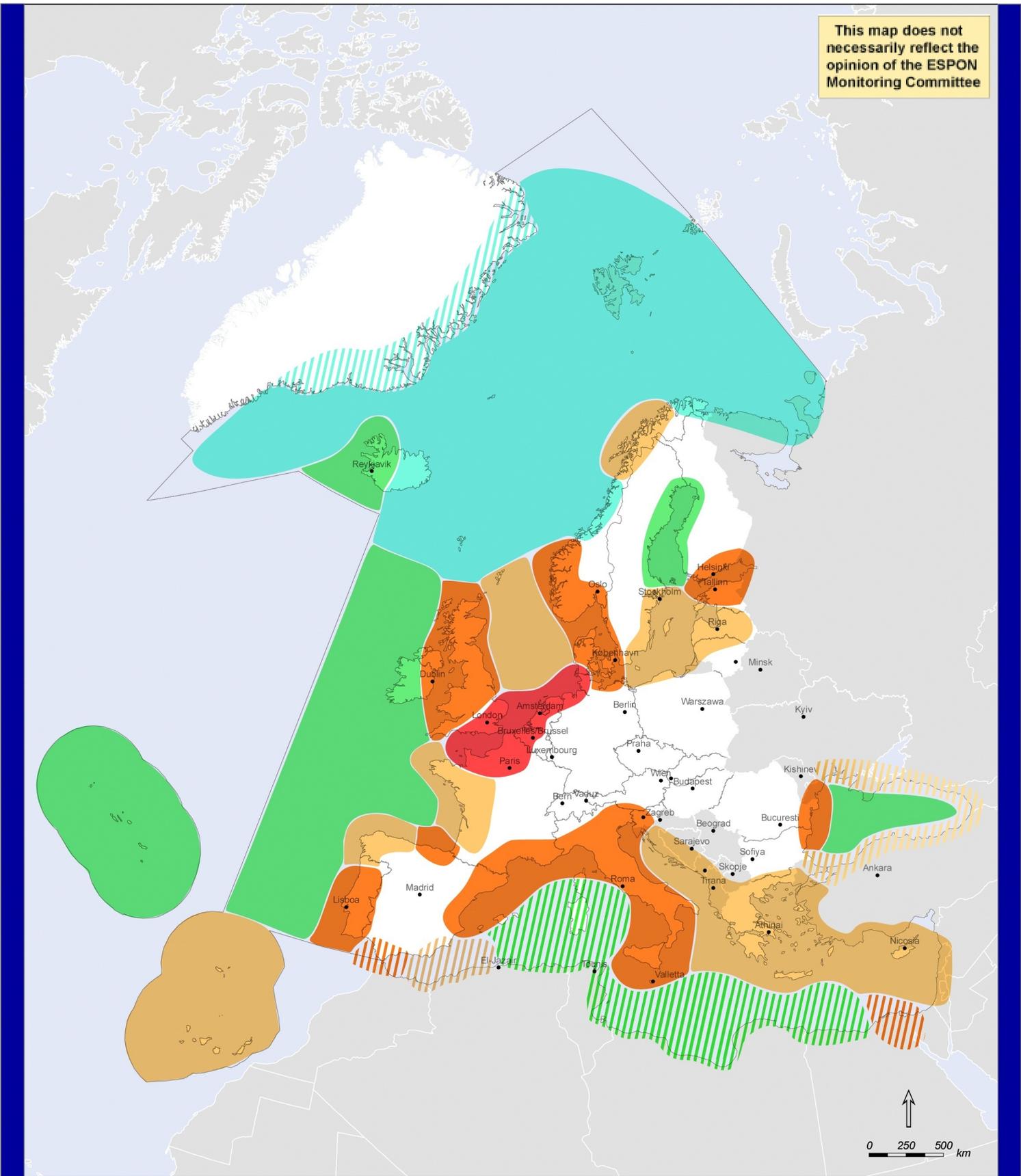
Sea (Environmental Pressures and Flows)

- Very low intensity
- Low intensity
- Medium intensity
- High intensity
- Very high intensity

Land (Economic Significance)

- Very low intensity
- Low intensity
- Medium intensity
- High intensity
- Very high intensity
- No Data

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Thematic data: Typology Map Regions: Broad.
 Land boundaries: © EuroGeographics Association and ESRI. Regional level: NUTS2.
 Sea boundaries: OSPAR Convention, EU Integrated Maritime Policy and EEZ.

EU31. Regions derived from typology map (schematic)

-  European Core
-  Regional Hub
-  Transition
-  Rural
-  Wilderness
-  Typology influenced by lack of data

PART 2

6. Key territorial Development Opportunities and Risks

There are several challenges – opportunities as well as risks - for the Arctic in the years to come. Increasing global temperature and reduction of the pack-ice represents climate and environmental challenges. Sustainable management of living marine resources and petroleum resources and shipping is another major challenge in the future. To develop efficient governance arrangements and implement internationally binding agreements is probably the main challenge for obtaining a sustainable management of the Arctic region. This is also necessary for handling security policy challenges and to ensure that possible conflicts of interests in the Arctic area can be solved in accordance with international laws and agreements.

Climate change and environmental challenges:

Climate change is probably the biggest challenge in the Arctic region and it implies both risks and opportunities. Global warming may endanger not only the local Arctic ecosystems but also the global ecosystem. “Nowhere is climate change more visible than in the Arctic, which is a vital and vulnerable component of the Earth's environment and climate system” (Join (2012) 19 final. According to AMAP (2011) the years 2005-2010 has been the warmest period ever recorded in the Arctic, Arctic glaciers, ice caps and the Greenland Ice Sheet has contributed over 40% of the global sea level rise observed between 2003 and 2008 and, The Arctic Ocean is projected to become nearly ice-free summer within the next 30 to 40 years. Since these changes probably not can be reversed in a short to medium term, the largest challenge is to find acceptable ways of adaptation. Since the problems are global they require global solutions, i.e. the Arctic states must cooperate with non-Arctic states in this effort. As the primary international forum the Arctic Council must play a central role in ensuring a sustainable development and environmental protection in the Arctic.

Challenges related to natural resources and industrial development

The rapidly retreating sea-ice alongside technological progress also opens up new economic opportunities in the Arctic region such as shipping, mining, energy extraction and fishing. For the present there are no marine resources of commercial significance in the Arctic high sea but this may change with climate change. However, The Bering Sea, The Barents Sea and the sea areas outside Canada, Greenland and Iceland are among the most important fishing grounds in the world. The main challenges here are to ensure a sustainable management of the marine resources (Larsen et al 2001). Moving fish stocks may also be a challenge as a warmer climate may extend the areas for some fish stocks. For the Arctic high sea it is a challenge to implement an international conservation and management system ((SWD (2012) 182 final). Large environmental challenges are also related to increased exploitation of petroleum resources in the Arctic. Neither the technology nor a sufficient international set of rules are in place yet for oil and gas extraction in many parts the Arctic (Forsgren et al 2009). A warmer climate will also increase the shipping and transport opportunities in the Arctic region. Both the Northwest and the Northeast Passage will be more open and, perhaps also the Arctic high sea during the summer (see Figure 3 in this paper). With increasing knowledge of marine transportation in this region it may be profitable. The journey from Murmansk to China takes 23 days using the northern route (<http://www.bloomberg.com/news/2012-06-13>), compared with 43 for the Suez Canal. Also with transport – the environment is the biggest challenge.

Institutional and international law challenges

International cooperation in the Arctic has increased the past decades. However, although there are legally binding agreements on a bilateral and trilateral level, the circumpolar collaboration is still based on consensus-based partnerships arrangements dealing with “low politics”. Environmental organisations have advocated more binding regulations and WWF has suggested implementing a specific Arctic Treaty in order to achieve sustainable management of the region. According to Hønneland (2012), this proposal is unrealistic because it is not in the interest of superpowers like USA and Russia. They would not submit “hard politics” issues to a common circumpolar governance body like the Arctic Council. A more striking case on the Arctic agenda now, therefore, is the question of how to involve non-Arctic states in Arctic collaboration. Both EU and China has in the past years showed strong interests in the Arctic and has applied to obtain a permanent observatory status in the Arctic Council. This may well come true; the question is if and how this may change the Arctic governance regime. The main legal international instrument for the Arctic, the Law of the Sea Convention, also needs supplementary regulations in order to deal with increased activities in the area, particularly related to petroleum activities and shipping. These activities represent significant environmental challenges which must be solved in order to accomplish sustainable management. With increased economic activity common rules is needed for the Arctic, as stated in a new report on risks and opportunities from Lloyds and Chatham House (2012): “The mosaic of regulations and governments in the Arctic creates a multi-jurisdictional challenge for investment and operations in the Arctic. Working through the Arctic Council to promote high and common regulations for Arctic economic activity is key. “

Security policies challenges

The main security policy challenge is to ensure that possible conflicts of interests in the Arctic area is solved in accordance with international law and governance arrangements, particularly the Law of the Sea Convention and the Arctic Council. All the Arctic states, and China, have agreed to accept the Law of the Sea Convention which contain procedures for how to determine the continental shelf. Although one does not know how the different states will react if decisions disfavour them, the probability for a military confrontation in the Arctic is small. The involved states agree on how to solve sovereignty issues and they are connected through good neighbourhood relations, alliances and binding international collaboration (Hønneland 2012).

7. Initial Policy recommendations

The Arctic Ocean represents a unique marine ecosystem and contains valuable natural resources, particularly fisheries and petroleum. Climate change and overharvesting are among the main threats to the biodiversity in the area. Robust governance systems based on international laws and common agreements between the involved parties are needed in order to achieve a sustainable management of the region. Following the analysis of the previous chapter on opportunities and risks the policy recommendation can be divided into three groups – climate and environment, management of industrial activities and cooperation and governance. This is also in line with the report to the Norwegian Parliament (Meld.St.7 2001) and new Arctic policy from the EU which is based on the following three building blocks – knowledge, responsibility and engagement (Join 2012 19 Final).

Knowledge focuses on the need of a proper scientific understanding of causes and effects of climate change in the Arctic and how this may affect the rest of the world. The EU will invest more in Arctic climate research through its flagship initiatives “innovation Union”¹⁵ and “Horizon 2020”¹⁶. Climate change, energy and resource scarcity are among the important topics in these programmes. This aim is also in accordance with the policy of the Arctic Council which has one of its main focuses on environment and particularly on climate change impacts and, on the generating of policy-relevant knowledge and scientific assessments for these issues.

Responsibility refers to a sustainable management of economic activities and use of natural resources both on land and sea in the Arctic. Fisheries must be protected against over-harvesting, extraction of oil and gas must be based on environmentally friendly, low-risk technologies and, shipping and tourism must also be based on sustainable principles.

Engagement relates to governance and cooperation. International cooperation is already well-developed in the Arctic through partnerships and agreements. The Arctic Council will play a main role in the further development of Arctic international cooperation. In its statement “The EU considers the Arctic Council to be the primary forum for international cooperation in the region”¹⁷. One important question to be discussed is how to decide “who” should be partners in the Arctic Council in addition the Arctic states. Several non-Arctic states have permanent observatory status and EU and China have applied for it. Indigenous people and non-governmental organisations are already represented but does it work well and are there additional stakeholders? Another question is “what” issues should be dealt with in the Arctic Council. Today the focus is on “soft” politics; should also “hard” politic issues be included or would that threatens the cooperation? A third question is “how” cooperation should take place. Should it mainly be based on network and partnership as today or should it be legally based? All these governance issues must be dealt with in the years to come. There is no simple answer to these questions which should be solved in a dialogue between all involved partners in the Arctic.

¹⁵ COM (2010) 546 of 6 October 2010.

¹⁶ COM(2011) 808 and accompanying proposals COM(2011) 809, COM(2011) 810, COM(2011) 811 and COM (2011) 812 of 30 October 2011.

¹⁷ JOIN (2012) 19 of 26 June 2012

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