Grant 869580	ArcticHubs

Deliverable title and number:	D.1.4. Climate change impacts in different industries and Arctic hubs - project report, D4
Work Package:	WP1
Type of Deliverable[1]:	R **Dissemination Level[2]:** Public
Lead Beneficiary:	University of Lapland
Lead Author(s):	Pamela Lesser and Leena Suopajärvi
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Review(s): Reviewer(s):	[1°/25/09/22] [2°/date] [Pasi Rautio, Seija Tuulentie] [name(s)]
Delivery:	Due date: 30/09/2022 Submission Date: 30/09/2022

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Full reference: Lesser, P, Suopajärvi L, Bogadóttir R, Edvardsdóttir AG, Flick HM, Kyllönen KM, Nygaard V, Lidestav G, Ulatowski L (2022). *Climate change impacts in different industries and Arctic hubs project report.* ArcticHubs project, University of Lapland.

Reference: (Lesser, Suopajärvi et al. 2022).

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Executive Summary

The 'Climate Change Impacts in Different Industries and Arctic Hubs' project report (Deliverable 1.4) is a product of the EU-funded H2020 project *Global drivers, local consequences: Tools for global change adaptation and sustainable development of industrial and cultural Arctic "hubs".* It is the culmination of the task entitled 'Concluding Analyses of Climate Change Impacts in Different Industries and Arctic Hubs' (Task 1.3), the aim of which is to analyse the meaning of climate change as a global driver for different industries and hubs. The data comes from national climate change and climate change adaptation plans, national Arctic strategies, industry strategies as well as interviews of key informants.

The abundance of data on climate change's effects in the Arctic is overwhelming and this deliverable does not attempt to reinvent the wheel; rather, it explicates how impacts of climate change on relevant industries and hubs, as well as the tools for their management, are framed in relevant government strategies and in the perceptions of affected actors. The report also looks at challenges that are simply too complex and uncertain to concretize hence remain as suggestions. As developing co-knowledge is at the core of the ArcticHubs project, this deliverable is data-driven and not based on previous academic literature.

The popular image of the Arctic is a homogeneous region affected uniformly by climate change. In reality, the Arctic is an extremely heterogeneous area which experiences impacts in a myriad of ways, and as a result, industries also experience and perceive climate change differently. The fisheries and aquaculture sector, though concerned about warming seas and ocean acidification, does not view these as big threats to industry at least in the short-term. There are existing problems with sea lice, but to date the problems are controllable. In the long-term, increased biomass production in cold waters and pollution are the main concerns yet do not cause widespread apprehension. The economic outlook is generally very positive as there is a widely held view that demand for aquaculture's products will only increase with time. The forestry sector is primarily concerned with storm damage and new threats to the current populations of living organisms, namely the spread of new pests, but welcomes the likelihood that the growth of trees will improve. Whether the effects of climate change are negative or positive for the forestry industry ultimately depends on whether the activity itself is seen more as a solution or a problem. With respect to impacts on the mining industry, there are three main themes: the first relates to both the physical and socio-economic effects of climate change, examples of which include thawing permafrost causing the cracking of pipelines and the demand for raw materials from the European Arctic spurring job creation. The second theme is the mining-climate change nexus as both driver and supplier

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of the green transition. Battery technology and digital communication, in particular, are significant as products and drivers of demand. The third theme is the impact on raw materials awareness as one of the positive outcomes of climate change is that it makes the argument for the transition to renewable energy supplies, and in so doing, has raised awareness that raw materials form the base of our society. Impacts on tourism are both helped and hindered by climate change. The phenomenon of last chance tourism is both a boom and bust for the sector depending on whether one looks to the short-term or out further at the longer-term. Rapid climate change, which mainly refers to retreating sea ice is a large concern. In Svalbard, the worry is not only around the direct environmental impacts of retreating sea ice, but that this phenomenon will make more of Svalbard's coastal and marine areas accessible for much of the year, hence encouraging even more transiting along its coastlines. The general consensus for tourism is that while it is important for economies in the European Arctic, it should not come at the expense of the environment and should be limited. The negative effects of climate change on indigenous peoples are hard to overstate. The growing public interest in the Arctic, which is mostly caused by climate change (new sea routes, natural resources, tourism), is already causing enormous challenges for the Sámi and traditional livelihoods. In addition, there are external stressors related to the energy transition, such as mining projects and wind power projects, which aim to take over the living space from the Sámi and are realised at the expense of their communities and culture.

With respect to the management of climate change, the sources and materials that have been analyzed reflect the dominant perception in the industry and at governmental level, that issues of climate are being addressed, and that the fisheries and aquaculture sector have already implemented a number of approaches. For example, that the reduction of carbon has already been integrated into businesses practices, particularly around the production of salmon. The proposal for better governmental coordination in Norway when it comes to maritime spatial planning shows the proactiveness of government with respect to climate change management. Ocean businesses themselves in Norway have asked for a voluntary common code of conduct. In the Faroe Islands large investments have been made in land-based smolt farming and recirculating aquaculture systems. Seaweed farming and integrated multitrophic aquaculture is another new opportunity for aquaculture and seeks to be circular in its production process by producing at multiple trophic levels (fish, mussels, seaweed) rather than just one single trophic level (salmon). The forestry industry is the one sector where mitigation and adaptation will largely be addressed through policy mechanisms. The EU Taxonomy Regulation will become the overarching framework for both and will prioritise certain projects such as those that ensure forests' role as sinks in the carbon cycle are maintained or enhanced by providing bio-materials that can act as temporary carbon stores or as carbon substitutes, replacing carbon-intensive materials and fuels. The

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economic and social benefits of enhanced afforestation are stressed in the EU Forest Strategy as being one of the most effective climate change and disaster risk mitigation strategies in the forest sector. Direct references to climate change in the national mining strategies, which are mostly old and outdated, are minimal. There are also few references from the interviews as management of climate change is referred to as the management of sustainability. For instance, the continuous monitoring of water quality as well as the use of drones in the constant monitoring of tailing ponds is simply discussed in terms of supporting sustainability. Even in affected countries and those worried about increasing tourism, there is no desire to stop it; rather, the preferred alternative is to green tourism so tourists can still come but be carbon neutral. However, the carbon footprint is mainly from transportation and there is little political will to take the actions, such as placing restrictions on greenhouse gas emissions, to increase the cost of travel in order to reduce demand. As in mining, direct references to climate change are rare with the discourse centering on the sustainability concept instead. Arctic countries recognize that participation of indigenous and local communities in international climate change efforts is crucial; yet, the main vehicle for this has been the Arctic Council which has suspended activities in 2022. There are research projects, primarily focused on reindeer husbandry, to help with the management of climate change but most of these focus on the identification of vulnerabilities and prioritization of risks and not actual solutions. In terms of cultural traditions apart from reindeer herding, animal and natural materials necessary for upholding traditional practices and passing them on to future generations are diminishing thus negatively affecting traditional Sámi knowledge and language, posing uncomfortable questions as to whether adaptation is even possible in certain circumstances.

The last section of the report explores climate change challenges that are of a more existential nature, that are simply too complex and uncertain for solutions. These types of challenges are not mentioned in the national strategies reflecting the fact that official government strategies are intended to reassure and not to frighten. There is one common theme woven throughout the interviews, which is that people, their perceptions and their consequent behaviour are the biggest unknowns in the climate change equation. For example, in the fisheries and aquaculture sector, whether those who can afford to eat farmed salmon continue to do so, and whether sustainability is a factor in their choice of product, remains a question. The contemporary discourse in the mining sector centers on the tension between ramping up production of metals and minerals for the energy transition and the burdens and benefits placed on local communities. Whether this tension, which is growing in the European Arctic, can be alleviated is unknown. Managing climate change in the tourism sector seems to be almost solely dependent on people's behaviour, whether this is about last chance tourism and people deciding not to travel or about the tourist industry assuming responsibility for their clients eco-behaviour. Throughout the strategies and the interviews, the centrality of the human factor in managing climate change is unmistakable.

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1. INTRODUCTION

Whether in popular media, fiction or official government reports, the European Arctic (EA) is often portrayed as a homogeneous region, largely consisting of snow and ice. The effects of climate change in the EA, devoid of details such as physical geography, industry and people, are also suggested as being uniform. In truth, the region is far from being homogeneous but consists of various international economic, political, cultural, environmental and social forces that influence its development. So too are the effects of climate change, both real and perceived, and vary dramatically depending on one's perspective. This climate change report is a product of the EU-funded H2020 project *Global drivers, local consequences: Tools for global change adaptation and sustainable development of industrial and cultural Arctic "hubs"*. The chosen approach in the ArcticHubs project has been to analyse global drivers and their local consequences, and to strive to understand alternative pathways to the future for EA communities. WP1, for which this report is written, identifies and analyses global drivers affecting the development of the main industries in the Arctic. The subsequent WPs of the project (i.e., WP2 and WP3) study local impacts quantitatively and qualitatively from the natural and social science perspectives. At the end of the project, responses and solutions for local sustainable development will be defined and developed collaboratively (i.e., WP4 and WP5). Figure 1 below illustrates the workplan of the whole project.

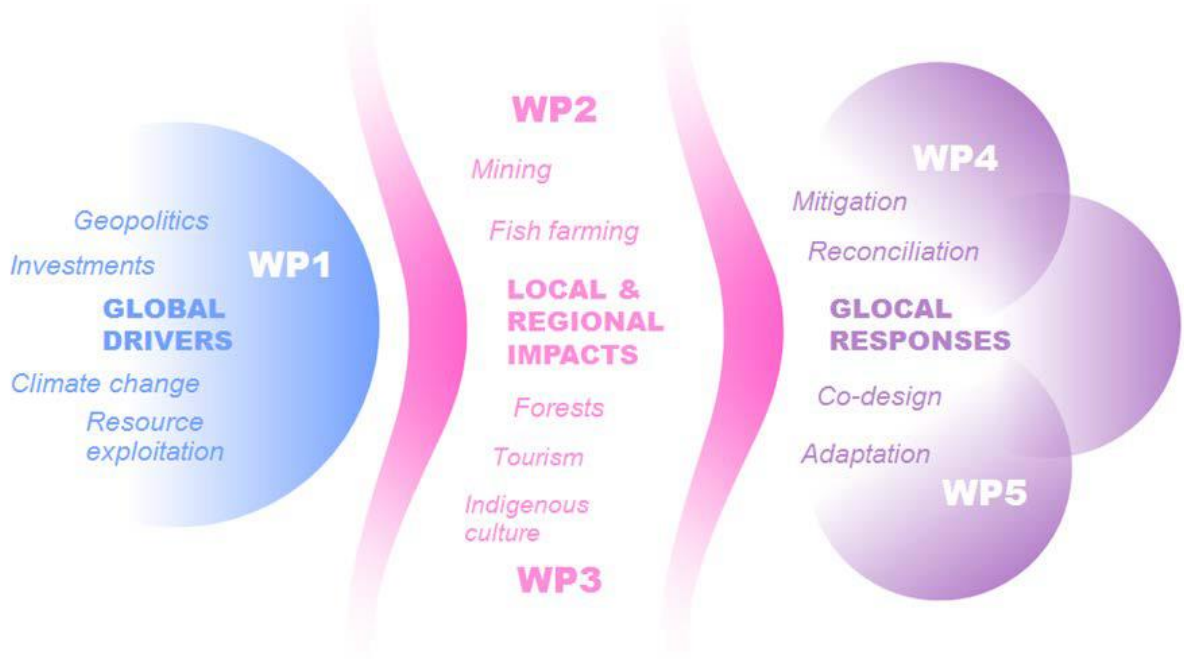

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Figure 1. ArcticHubs maps and analyses the main global drivers that cause local and regional impacts on various livelihoods and on local communities and cultures in the European Arctic. ArcticHubs aims to provide global and local – "glocal" – solutions for mitigating and adapting to the local impacts caused by global actors.[3]

This deliverable (D1.4) entitled 'Climate Change Impacts in Different Industries and Arctic Hubs' is the output of Task 1.3: 'Concluding Analyses of Climate Change Impacts in Different Industries and Arctic Hubs' from WP1 analyses the meaning of climate change as a global driver for different industries and hubs. Its completion is based on the analyses of policy documents, CSR analyses (D1.3) and interviews from Tasks 1.1 and 1.2. As there is extensive literature about climate change impacts on the Arctic and also about adaptation and mitigation strategies in the Arctic, the most referred research and policy programmes are included to the concluding analyses. Specifically the data comes from national climate change and climate change adaptation plans, national Arctic strategies, industry strategies as well as interviews of key informants. Two parallel reports have been submitted to the European Commission, one considering geopolitical tensions and drivers in January 2022 and the other assessing global drivers submitted in March 2022.

There are five typologies of hubs including four related to industry – fish farming, forestry, tourism and mining – and one comprised of indigenous peoples, specifically the Sámi peoples. 'Hubs' in the project are defined as the growing concentration of Arctic communities in settlements that are interlinked by modern infrastructure such as air transport, new shipping routes and high-speed information technology. Hubs act as nodes that connect geographical sites in a network structure and are a driving force behind Arctic development.[4] The locations and types of different hubs are presented in Figure 2, below. The characteristics and challenges of the hub typologies are the following:[5]

- Sustainability of fish farming hubs – Aquaculture, already a big industry, is growing fast due to increase in global demand. Companies are multi-national and often establish themselves in rural locations where the fjords are suitable for cultivation and legislation allows fish farming in open sea cages. The scale of operations strains rural communities' resilience sometimes becoming the sole economic activity.
- Hubs of multiple use of forests – Ecosystem services is strongly determined by stand structure with vertical complexity being one of the most influential factors regulating the availability of habitats supporting biological diversity. Mature forests are highly sensitive to the management

[3] LUKE (2021).
[4] ArcticHubs Proposal B1-3, 2020.
[5] Ibid.

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of young stands meaning that current day decisions about young stand management will have important effects for a long time to come. The complexity of decision-making is exacerbated by the need to consider multiple future goals including carbon sequestration for climate change mitigation and maintenance of habitats for various species. A major challenge in evaluating the sustainability of new silvicultural methods as that traditional sustainability criteria cannot meaningfully describe and address spatial and temporal complexity.

- Sustainability of mining hubs – Mining is an industry with considerable effects on local communities. Mining activity exploits natural resources, changes landscapes and restricts the use of land often used by other industries and stakeholders. Mines also bring economic benefits through employment, taxes and increased population to rural local communities, often with limited alternative work opportunities, and are in some cases company forming towns. The dilemma with mining activities is that developed societies need minerals and metals to meet the requirements of the green shift and national governments support investments and development of new mining projects but extracting these resources also has negative impacts.
- Developing tourism hubs in a sustainable way – Tourism is a rapidly developing industry in the Arctic and has both positive and negative effects on Arctic communities. Positive effects through diversification of economic activities and creation of new workplaces; negative effects in that tourism exceeds in many places the ecological and social carrying capacity of an area. The balance between tourist activities and natural values has to be maintained so that nature-based tourism does not weaken natural values. Since most of the Arctic tourism is based on air transportation, climate change mitigation may have big impacts on the industry.
- Indigenous cultural hubs – The indigenous cultural hubs focus on locations with indigenous knowledge pertaining to reindeer husbandry, fishing, hunting and the traditional use of other resources from nature. Due to their interconnectedness with their territories, indigenous peoples many times bear the cumulative brunt of all other development, fracturing and chipping away from their lands and waters. Climate change has already forced changes in land use and traditional practices. Coupled with a prodigious interest in ramping up mining activities, national policies supporting new industrial development such as wind power, power lines, railroads, modern forestry and tourism, the possibilities for continued reindeer husbandry, hunting, fishing and both contemporary and traditional use of the land are at risk.

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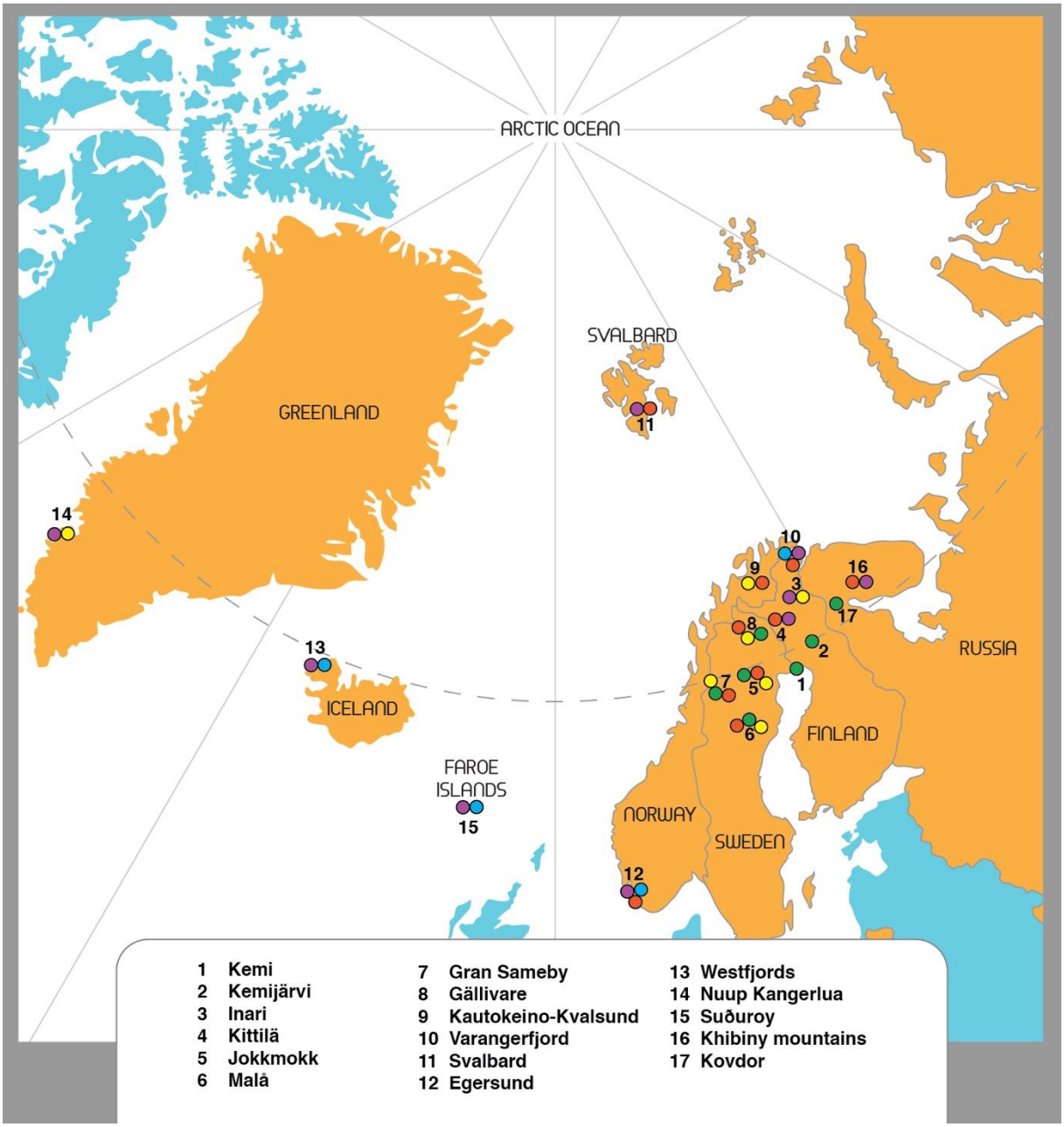

Figure 2. Locations of all hubs in the ArcticHubs project. The industry that a hub represents is indicated by colour. Blue: aquaculture hubs, violet: tourist hubs, red: mining hubs, green: forestry hubs, yellow: indigenous hubs.[6]

[6] Hubs in Russia (16 and 17) are not discussed in this report due to limited data.

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References to climate change from the strategies and interviews are analysed consistent with these typologies. To understand the effects of climate change on the industries and indigenous peoples, we specifically look at the strategies and interviews for existing and expected impacts, mitigation and adaptation tools and larger more existential challenges around climate change that are so complex and uncertain, no solutions appear to yet be in reach. As the co-creation of knowledge with stakeholders is at the core of the ArcticHubs project, this deliverable is data-driven and not based on previous academic literature.

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2. DATA AND METHOD

At the core of ArcticHubs is the concept of 'glocalisation', which is about linking what happens at the global level with on-the-ground impacts to people. Climate change epitomizes the idea of glocalization impacting economies, the natural environment and people. The approach of this deliverable emphasizes the latter viewing the impacts of climate change by reviewing policy documents that affect localities and emphasizing the perceptions of Arctic actors. This lends itself to a data-driven approach rather than using theoretical frameworks to make sense of the empirical. For this reason, academic references are not included in the report.

The material for this project report consists of three types of data: (1) future-oriented policy papers at the national or EU levels; (2) national industry-specific strategies and industry-relevant EU strategies; and (3) interviews conducted in 2021 with informants, such as political representatives and authorities, specialists in one of the four target industries (i.e., aquaculture, forestry, mining, and tourism), and stakeholders having a special interest in the Arctic at the national and international levels. References, policy papers and interviewed organizational representatives appear in Annexes 1, 2 and 3. In total, the data consist of 59 policy papers and 60 interviews, which have also previously been used for the preparation of D1.1. Geopolitical tensions and drivers of different industries in the European Arctic and D1.2 Global economic drivers in the development of different industrial hubs in the European Arctic.

National and EU level policy papers as well as industry-relevant EU strategies were screened with a qualitative data analysis tool, NVIVO, to map out which climate-related topics are discussed in future-oriented strategy documents. In NVIVO, references about a particular case or theme are grouped into nodes. For the climate change analysis, themes have been identified using the hubs as guidance as well as core concepts of climate change such as adaptation and mitigation. Keywords were then derived from the themes and used as nodes.

Table 1: Arctic Hubs themes and nodes used in the screening process

Themes – Arctic Hubs	**Nodes used in the screening process**
Mining	Mining, adaptation, climate change, megatrends, miscellaneous, mitigation, opportunities, sustainability, threats, trends, indigenous peoples
Forestry	Forestry, adaptation, climate change, megatrends, miscellaneous, mitigation, opportunities, sustainability, threats, trends, indigenous peoples

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Fisheries and aquaculture	Fisheries and aquaculture, adaptation, climate change, megatrends, miscellaneous, mitigation, opportunities, sustainability, threats, trends, indigenous peoples
Tourism	Tourism, adaptation, climate change, megatrends, miscellaneous, mitigation, opportunities, sustainability, threats, trends, indigenous peoples
Indigenous Peoples	Indigenous Peoples, mining, forestry, fisheries and aquaculture, tourism, adaptation, climate change, megatrends, miscellaneous, mitigation, opportunities, sustainability, threats, trends

The data were analysed using the search function to identify all text sections where the chosen keywords emerged. All identified references found in the policy documents were then extracted from NVIVO and listed in a Word document to provide a comprehensive report in a user-friendly and readable format. In the Word document, each keyword is followed by citations that explain why this specific section is relevant for screening and how these parts of the policy document match the search terms. The phrases around the keywords demonstrate the context within which each search term was used.

Due to the large amount of coded NVIVO material from the relevant policy papers and information gathered from the interviews, a comprehensive overview was created. The data collected from NVIVO and the conducted interviews were added to an excel file to categorize all relevant information between the five hub typologies (i.e., fisheries and aquaculture, forestry, mining, tourism and indigenous peoples) and two columns added for mitigation and adaptation. The relevant information was then extracted for this climate change deliverable. With respect to the interviews, given the large number of interviews and their length, it was decided to summarize them rather than use the transcripts and these summaries have been used in all WP1 deliverables previously.

Interviews were conducted in all studied industries and within the indigenous peoples hub, in all partner countries, at the EU level, and, when possible, in the native languages. Policy makers (including NGOs) with a general interest in EA-relevant issues were included in the study. With respect to indigenous peoples, it should be noted this report refers only to the Sámi in Norway, Sweden and Finland. At the time of writing D1.4, interviews had not yet been conducted with the Inuit in Greenland. Due to the pandemic, most of the interviews were conducted online. Informants were first asked about COVID-19 and its impacts on the industry in question; they were then asked to identify megatrends, trends, weak

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signals, and wildcards affecting the industry or EA as such;[7] and, finally, sustainability and its meanings were also discussed.

The project report is organised as follows: Section 3 discusses realised and predicted climate change impacts to Arctic industries; Section 4 looks at how to manage climate change including adaptation and mitigation and Section 5 delves into the existential asking what challenges and risks are too large to manage.

[7] Suopajärvi, Nygaard et al. 2022.

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3. REALISED AND PREDICTED CLIMATE CHANGE IMPACTS TO ARCTIC INDUSTRIES

Realized and predicted climate change impacts on fisheries and aquaculture, forestry, mining, tourism and indigenous peoples vary dramatically depending on the perspective. The national strategies speak very little to the issue of impacts on industries or indigenous peoples tending to frame climate change more broadly and technically. This approach also allows for the proposal of solutions whether these are policy actions or something more tangible. The interviews of affected actors, both industry and non-industry related, tend to have more concrete views on realized and predicted impacts couched in the language of business opportunities and risks. Climate change is actually mentioned very little in either the strategies or interviews revealing its lesser role when talking about different industries in the Arctic. Particularly when it comes to mining, but also in general, climate change tends to be addressed under the umbrella of sustainability.

3.1. Fisheries and aquaculture

There are four fish farming hubs: Varangerfjord in the very north of Norway, Egersund in the south of Norway, Westfjords located at the northwest tip of Iceland and the island of Suðuroy in the Faroe Islands. Although fisheries and aquaculture are often considered together because fisheries and aquaculture are often intertwined, there are differences. Fish farming is usually seen as a subset of aquaculture focusing solely on raising fish commercially in pens, tanks or ponds, whereas aquaculture is commonly defined as the breeding, rearing and harvesting of animals and plants in all types of water environments. [8]

Warming seas and ocean acidification are the main climate related concerns of the aquaculture industry, all of which are indirect effects peripheral to actual aquaculture activities. Rising sea temperatures are not seen by all as a potentially significant risk, at least in the short term. A government official in the Faroe Islands noted that an increase in temperature of one or two degrees will not dramatically affect the fish farming industry and is to some extent beneficial as it allows the industry to slowly adapt to the changing environment.[9] Even if warming seas is not a serious concern, sea lice already pose a problem, although a manageable one, and the potential for future larger problems with sea lice and other parasites are acknowledged.[10] Conversely, the Arctic Climate Change Update (2021) report blames the loss of sea ice on detrimental outcomes for the marine food web, notably that marine algae bloom timing and

[8] European Commission (n.d.).
[9] Interview with Faroese government official (2021).
[10] Interview with Icelandic aquaculture industry representative (2021).

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intensity have shifted, affecting krill, fish, birds, and mammals. With respect to human impacts, the loss of sea ice, which serves as a platform for hunting and fishing, brings problems to coastal communities.[11] While ocean acidification is generally attributed to climate change, Iceland has a different interpretation of the data and believes it is likely happening due to natural conditions rather than human activities.[12] To emphasize the point in the Introduction, the Arctic is not a homogeneous area and the effects of climate change, both real and perceived, vary dramatically depending on one's perspective.

Although production may not be directly affected by climate change, climate change may cause changes in the oceans, such as agal blooms and changes in sea water quality that could affect how aquaculture is conducted today and what it will need to account for in the future if it is to continue its current growth trajectory.[13] Even if in the short- to medium-term climate change will not have such dire consequences for fisheries and aquaculture, the impact will be noticeable in the long-term. There will be many obstacles and challenges such as increased biomass production in cold waters and pollution, including plastic which can already be found in large amounts in oceans and rivers.[14] Projections for the aquaculture industry in the next 10-50 years are not uniform and vary from those who believe the Arctic will not offer significant commercial possibilities for fisheries to those who believe that as the ice melts and sunlight penetrates the sea, plankton populations will grow rapidly creating ideal conditions for new kinds of fish to thrive.[15] Perhaps to reconcile the dichotomy, the same document suggests that while there may be opportunities for demersal fisheries at depths where it is possible, pelagic fisheries in the Arctic will likely become the most important type of fishing.[16] Even with contradictory views, the prevailing belief is that demand for aquaculture's products will only increase over time and businesses will have to show they can deliver the products needed in a sustainable and environmentally friendly way.[17]

3.2. Forestry

There are five forest hubs including three in northern Sweden and two in northern Finland. In Sweden the hubs are Jokkmokk, Gran Sameby and Gällivare. In Finland they are located in Kemi and Kemijärvi.

[11] Arctic Climate Change Update (2021).
[12] Interview with Icelandic governmental official (2021).
[13] Interview with Faroese aquaculture research company (2021).
[14] Interview with Norwegian fisheries/aquaculture research organisation (2021).
[15] The Faroe Islands: A Nation in the Arctic (2013).
[16] Ibid.
[17] Interview with Norwegian fisheries/aquaculture research organisation (2021).

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Like the three other industries, the existing impacts of climate change also on forestry can either be negative or positive depending on one's point of view. From the negative point of view, Finland's National Climate Change Adaptation Plan (2022) mentions a changing climate may pose new threats to the current populations of living organisms as, for example, foreign harmful organisms may spread to new areas becoming increasingly abundant and damaging ecosystems, hence causing other problems. Finland's National Forest Strategy (2019) stresses the negative economic impacts, "An increase in forest damage resulting from climate change is also a threat to the different uses of forests, forest-based industry and business as well as the health and welfare benefits derived from forests".[18] Temporary disruptions in the demand and supply of wood are one manifestation of these potential threats.[19] Mirroring the tone and concerns, and also with a clear economic focus, Sweden's Climate Change Adaptation Strategy asserts "Climate change and a growing global market increase risks and problems with plant pests. To promote forest health and avoid export restrictions for Swedish forest products, there is a need for a long term and wide cooperation, adapted forest management, external monitoring, risk assessment, inventory, diagnosis, tree genetics and research and development".[20]

From the positive point of view, Finland's National Climate Change Adaptation Plan (2022) forecasts the biological productive capacity of forests and farming ecosystems to improve in the north, which may bring benefits and give rise to new business opportunities. Specifically, the changing climate is expected to improve the growth of trees especially in Northern Finland. Government's perception of the ambiguities around existing and potential future impacts is concerning, however, as stated forestry goals are too vague and attempt to address too much.[21]

The industry perspective tends to see the impacts of climate change from an economic vantage point subject to the whims of global events and phenomena. Changes in timber demand are very difficult to predict. Environmental shocks affecting the timber markets in different countries can affect the Finnish forestry sector by drastically reducing or increasing the demand for timber. For example, after the storms in Central and Eastern Europe, storm-damaged timber was brought and sold all the way to Finnish markets.[22] An industry representative from Finland noted that the demand for forestry products is increasing due to the growth of online shopping, which in turn has increased interest in packaging materials and therefore in forestry products, but also the desire for climate-friendly products. The latter is particularly important as this impacts on the forest sector in the north in general and on

[18] Finland's National Forest Strategy (2019).
[19] Ibid.
[20] Sweden's National Forest Program (2018).
[21] Interview with Finnish forest industry association (2021).
[22] Ibid.

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employment in northern Finland in particular.[23] The physical impacts of most concern to the timber market are storm damage, which can disturb large swaths of forest over a long period of time, and more potent and frequent forest fires.

For individual actors in the Arctic, the link between forestry and climate change is less direct, less clear. Climate change predictions and outcomes are open to debate. As one interviewee notes, "the effects of climate change depend on whether forestry is seen more as a solution or a problem"[24] an example of which was provided by a different interviewee who noted that in Finland, cuttings are typically equated with deforestation hence the view that forestry by definition negatively exacerbates climate change.[25]

3.3. Mining

Mining is one of the more dominant hubs, with there being a total of seven in the project, four in Norway, two in Sweden and one in Finland. The four in Norway include Svalbard, Egersund in southern Norway, Kautokeino-Kvalsund in northern Norway and Varangerfjord in the very north bordering on the border with Finland. In Sweden the hubs include Kristineberg and Gällivare, and in Finland, the single hub is in Kittilä.

There are three main themes around the impacts of climate change on mining activities in the north and the effects of climate change. The first theme relates to both the physical and socio-economic effects of climate change on the sector. In terms of the physical effects, issues such as thawing permafrost on mining infrastructure is cited as a problem for Russian companies due to pipelines cracking.[26] Svalbard was particularly highlighted in the interviews as there are serious concerns regarding climate change impacting its mining-related cultural heritage sites. The warmer climate and retreating sea ice have quickened the pace of coastal erosion causing a feedback loop where less sea ice leads to more wave activity, which in turn leads to more erosion of unprotected shorelines, where most of Svalbard's cultural heritage sites are situated. Other negative effects from climate change in Svalbard include more extensive damage from rust and rot, thawing permafrost, and landslides, all of which are expected to continue. The iconic cableways and pithead installations from mining operations in Longyearbyen and the surrounding vicinity are already exposed to rot and landslides.[27]

[23] Ibid.
[24] Ibid
[25] Ibid.
[26] Interview with environmental NGO (2021).
[27] Norwegian Ministry of Justice and Public Security (2016).

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Effects on industry are not contained to physical effects, but also encompass the robustness of the sector as a whole, particularly with respect to employment and innovation. The key role of using energy and raw material efficient technologies to achieve the climate goals have created demand that is viewed as an opportunity in Finland for mine and mineral ecosystem operators to offer new technologies, solutions and expertise,[28] as well as in Sweden, for companies to export their skills in smart mining to other countries furthering the global climate transition.[29] This growing demand for materials, especially battery technology-related materials, directly affects employment in the north given the current scarcity of raw materials and the potential untapped supply in the Arctic.[30] As northern regions are rich in green minerals (those needed to transition to a low carbon economy) demanded globally, there is expected to be a significant impact on the European Arctic in general. Supply security also enters the equation as one interviewee noted that Europe must be less dependent on China and other global actors,[31] and this is possible because the EU Raw Material Initiative and the European Green Deal support extraction of critical raw materials.

Not all interviewees, however, view the future of mining to be one of continuous growth. The energy transition notwithstanding, a slow-down due to global economic stagnation, especially around the year 2050, was predicted by an industry expert. The rationale given is this is likely simply because the pace of economic growth over the last 20-30 years is unsustainable.[32] Limits to mining are also tied directly to climate change with its negative impacts on the fragile ecosystem of the Arctic. From a long-term perspective, the acquisition of financing for mine sites may become more difficult since investors tend to invest in more sustainable and environmentally friendly initiatives despite the counter argument of having positive benefits for civilization.[33]

The second theme is the mining-climate change nexus as both driver and supplier of the green transition. Climate change is a driver of new environmentally friendly and more energy-efficient products for the mining industry, but its key role in furthering the green shift is as a supplier of industrial minerals and metals for downstream industries and consumers.[34] Goods and services that can impact the green shift, reduce CO2 emissions, and contribute to slowing down global warming will be of interest. Battery technology and digital communication, for instance, will be significant as products and drivers of

[28] Finland's Strategy for Arctic Policy (2021).
[29] Sweden's Strategy for the Arctic Region (2020).
[30] Interview with Finnish government official (2021).
[31] Interview with Norwegian mineral industry representative (2021).
[32] Ibid.
[33] Interview with international mining related NGO (2021).
[34] Strategy for the Mineral Industry (2013).

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demand.[35] Platinum is used in catalysers for vehicles and rare earth elements such as neodymium are used in super-magnets in windmills and in hybrid vehicles.[36] Although the primary materials for the energy transition are produced throughout the European Arctic, it was the interviewees from Norway who particularly emphasized the importance of production versus climate change, specifically extracting energy critical metals including rare earth elements, cobalt, lithium, vanadium, and graphite.[37]

The third theme is the impact on raw materials awareness. The nexus between climate change and mining is not only physical but based on perceptions too. One of the positive outcomes of climate change is that it makes the argument for the transition to renewable energy supplies, and in so doing, has raised awareness that raw materials are the foundation of our society. As one interviewee noted, "climate change, as such, is not of course a good thing, but it has raised awareness about raw materials and about the need for raw materials as a base for our society."[38] Average citizens are now more aware and discuss the use of raw materials whether this is extraction itself or less tangible topics such as the role of raw materials in value chains. This awareness in turn has led to a challenging of the demand and use of raw materials. How to reconcile this argument with the growing need for industrial minerals and metals in daily life, future societies and for the energy transition in particular, is a tension that industry and authorities both must do a better job addressing.[39]

3.4. Tourism

Tourism is the only hub that is present in all the partner countries of ArcticHubs except Sweden. There are a total of seven tourism hubs: Nuup Kangerlua in the southwest of Greenland, Westfjords in the northwest of Iceland, Suðuroy in the Faroe Islands, Egersund in southern Norway, Varangerfjord in northern Norway, Kittilä in Finnish Lapland and Inari in northern Finnish Lapland.

Arctic tourism is a prime example of an industry that touches on many types of economic activities, including recreational fishing, cruising and sailing, skiing and other winter activities. As such, it also exemplifies how the impacts of climate change vary a great deal within the same region; yet, impacts are discussed to a greater degree in the climate change strategies than the interviews. In some interviews, climate change did not even arise as a topic.[40]

[35] Interview with Norwegian minerals research organisation (2021).
[36] Strategy for the Mineral Industry (2013).
[37] Norwegian industry representative (2021).
[38] Interview with Finnish government official (2021).
[39] Ibid.
[40] Interview with Icelandic government official (2021).

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Impacts in the national strategies, while sometimes portrayed positively, are in fact a measure of relative deprivation. For example, although northern Finland will most probably have less snow in the future leading to a shorter ski season, countries such as Switzerland, Austria and Italy will have even less snow. In the long run, northern Finland could emerge as the ski destination not only of choice but of necessity.[41] Whether climate change is actually beneficial for Lapland therefore becomes more of an ethical question than an environmental and economic one.

Impacts identified in the interviews tend to be mixed, divided between those that exist and those that may happen in the future. One of the more jarring of the existing impacts has to do with what is termed, last chance tourism. The visual identity of what tourists are coming to look at is changing. For example, in Iceland and the Arctic as a whole, glaciers are melting, affecting the appearance of individual countries and the region alike. Yet it is precisely their disappearance which draws more and more people in the hopes of viewing these natural wonders before they cease to exist. Throughout the European Arctic, people are paradoxically coming to experience climate change, while simultaneously contributing to it. They want to see the polar bear before it is gone and winter landscapes before they vanish.[42] This trend will surely continue and begs the question in what ways should the tourism industry deliver on sustainability issues in the future?[43]

Rapid climate change, which mainly refers to retreating sea ice and its ramifications, is another prevalent theme in the interviews. Svalbard exemplifies the issue because it is an area where climate models predict the temperature will continue to rise particularly fast; although, problems related to retreating sea ice pertain to all parts of the EA. Concerns about Svalbard revolve not only around the direct environmental impacts of retreating sea ice, but that this phenomenon will make more and more of Svalbard's coastal and marine areas accessible for much of the year. This in turn presents opportunities for a continued rise in maritime traffic related to cruise tourism around Svalbard and in the northern Barents Sea, exacerbating sea ice retreat and other environmental impacts and risks. [44]

Although most interviewees stressed the importance of the tourism industry to Arctic economies, there is also a palpable concern that it is coming at the expense of the environment and should perhaps be limited. The concerns revolve around the potential for large-scale changes in travelling patterns over the long term because of increasing tourism in general and the desire for much of the rapidly urbanizing global population to experience the pristine nature of the Arctic.[45] While industry hopes this can be

[41] Finland's National Climate Change Adaptation Plan (2022).
[42] Interview with Norwegian tourism representative (2021).
[43] Ibid.
[44] Norwegian Ministry of Justice and Public Security (2016).
[45] Interview with Faroese environmental official (2021).

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avoided simply by raising the awareness of eco-conscious tourists as to the impacts their travel is having, thus they would of their own accord act responsibly, there is also wide-spread skepticism around at least the sole-use of this strategy to limit tourism. [46]

3.5. Reindeer herding and Indigenous livelihoods

There are six indigenous hubs: Egersund on the southwest coast of Norway, Gran Semeby, Jokkmokk and Gällivare in northern Sweden, Kautokeino-Kvalsund in northern Norway and Inari in Finland.

Climate change and the increasingly urgent discourse around the energy transition cause enormous challenges for the traditional livelihoods of the Sámi peoples as they are forced to adapt to extreme natural phenomena and changing conditions.[47] National strategies frame these effects as objective rather than personal and community phenomena. For example, there is language that discusses the rapid warming endangers Arctic species and ecosystems which are dependent on the ice platform, the snow and permafrost.[48] Changing weather patterns such as more rain and the covering of moss and lichen in ice rather than snow negatively influence food accessibility for reindeers, which has implications on both individual and herd health as well as the disposable income of the Sámi.[49]

As indigenous communities are directly, and mostly negatively, impacted by climate change, they want to have a seat at the table about issues previously mentioned, but also when it comes to larger economic issues such as the opening of new sea routes or extractive projects.[50] What may be beneficial for industries and countries can be devastating for the indigenous way of life. Arctic countries are recognizing that participation of indigenous and local communities in international climate change efforts is vital[51] and explicitly state their active participation in decision-making is crucial to be able to meet future climate challenges.[52] This demonstrates that local knowledge can also influence global drivers illustrating the local-global connection runs in both directions.

The interviews, however, have a very different tenor. The Sámi talk about how climate change has a strong negative impact on their livelihoods and culture as they are often the first to suffer from climate change, even if they are perhaps the least to blame for it. There are natural resources in the Arctic, and various parties are increasingly interested in exploiting them. The growing public interest

[46] Interview with Icelandic government official (2021).
[47] Interview with Finnish Sámi representative (2021).
[48] Norwegian Government's Arctic policy white paper: abstract 20 (2020).
[49] Finland's National Climate Change Adaptation Plan (2022).
[50] Interview with Finnish Sámi representative (2021).
[51] Norwegian Government's Arctic policy white paper: abstract 20 (2020).
[52] Sweden's Strategy for the Arctic region (2011).

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in the Arctic, which is mostly caused by climate change (new sea routes, Arctic natural resources, growth of tourism), is already causing enormous challenges for the Sámi and traditional livelihoods, as practitioners have to adapt to the extreme natural phenomena and changing conditions caused by climate change. In addition, there are external stressors related to the energy transition, such as mining projects and wind power projects, which aim to take over the living space and pastures from the Sámi and are realised at the expense of their communities and culture. While some of these projects appear beneficial on the surface, they are not seen as providing benefits to the local communities. Wind turbines exemplify this as they are described as crucial to fight climate change, but the produced energy is used elsewhere and does not benefit the surrounding region. Some Sámi representatives question why they should sacrifice their way of life to help fight climate change while the rest of the world can continue as is without making sacrifices and changes. People think that the Sámi culture and livelihoods are flexible, but they cannot adapt endlessly. One interviewee asks, "Why are we taking from those who are already in a disadvantaged position?"[53]

As weather and landscape patterns change, so also does the behavior of the reindeer, leading to poorer productivity and profitability in reindeer husbandry.[54] In addition to reindeer husbandry, Sámi culture is also adversely affected by climate change due to impacts on traditional handcrafts, hunting and fishing. As a result, animal and natural materials necessary for upholding these practices and passing them on to future generations are diminishing negatively affecting traditional Sámi knowledge and the Sámi language, posing uncomfortable questions as to whether adaptation is even possible in certain circumstances.[55]

An interviewee in Sweden captured the very personal aspects of the Sámi in the extractives context when asked how a sustainable society can be reached, and answering that, first, it has to be acknowledged the Swedish view of the extractive industry has come at the expense of reindeer husbandry for decades. In Sweden there is no awareness of this. Reindeer husbandry and the Sámi people are, in general, overlooked in Sweden and therefore also in Europe. The question is non-existent and therefore not on the table for discussion, which is the real problem. As long as Sweden can push these questions aside, they will not have to consider reindeer husbandry and Sámi rights, the outcome being that reindeer husbandry is sacrificed and silenced in the process as there are no economic incentives. Building on the first question, the interviewee continues by asking on whose terms and at whose expense is this sustainable society developed? Where is the discussion on climate justice? And if there is a discussion, who frames it? How words are used, words like 'sustainability' in the contexts

[53] Interview with Finnish Sámi representative (2021).
[54] OHCHR (2020).
[55] OHCHR (2020).

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of ‘sustainable mining’ and ‘sustainable forestry’ matter and need to be debated in the open. It seems like the whole discussion is green washed. [56]

[56] Interview with Swedish Sámi representative (2021).

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4. HOW TO MANAGE CLIMATE CHANGE

Managing climate change is typically addressed either by mitigation or adaptation measures; however, national strategies, even explicit climate change strategies, have very little to offer in the way of actual measures. Most of the plans describe the impacts or expected impacts of climate change and policy conundrums but proposed solutions are relatively few.

More recently, at least in the European context, approaches to mitigation and adaptation are converging via the EU Taxonomy Regulation[57], which is essentially the world's first green list of sustainable business activities and practices. The classification system provides a set of sustainability metrics enabling direct comparisons between companies, and also informs investment decisions, on the social and environmental impacts of the business.[58] The regulation is primarily aimed at the financial sector to accelerate sustainable investment, but other sectors will have to comply with the new regulation and disclose the sustainability impacts of their activities. It entered into force on 1 January 2022.

With respect to the relevant industries and hubs in the ArcticHubs project, it is the EU Taxonomy that will be the main instrument for implementing both mitigation and adaptation, the two of which are the initial focus of the Taxonomy. Of all the hubs, only forestry is explicitly listed as an included practice; although, activities related to extractive projects, fisheries and aquaculture will likely be affected as well. The Taxonomy's potential to influence if and how land and business owners conduct business in the future inevitably will provoke concerns and questions of power. This is already seen in the European Arctic with forestry owners expressing concerns over their future ability to develop forests.

With the exception of the fisheries and aquaculture sector, industry interviews, like the national strategies, also offer little in the way of either concrete mitigation or adaptation strategies suggesting that industry may not know how to manage climate change. For the Sámi peoples, while there may be short-term measures that can help with reindeer husbandry adaptation, in the longer term and around the larger issue of continuing cultural existence, the outlook is not positive.

4.1. Fisheries and aquaculture

The Icelandic Association of Companies in Aquaculture (2021) asserts the tolerance limit on land has been reached and therefore the focus should shift to the oceans. Indeed this shift has already begun occurring and is clearly manifested in discussions on the Blue Economy, whose role encompasses both

[57] Regulation (EU) 2020/852
[58] Financing a Sustainable European Economy (2020).

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mitigation and adaptation for the aquaculture industry. For example, the reduction of carbon is already integrated into the business practices around salmon production. Salmon products are expensive, and it is primarily the fast-growing middle class, especially in China, that both looks for food with a low carbon footprint and can also afford to buy salmon products. Downstream along the value chain is the issue of feed for the salmon manufactured by the large feed companies. Traditionally, they have relied on fishmeal and fish oil, and while these are still main ingredients, the fish farming industries are looking ahead to other sources such as insect production to minimize their carbon footprint. This, however, is still a way off and in the meantime fish farming industries rely heavily on feed components, such as soy, imported from distant ecosystems.

If there is consensus on anything, it is that management of the fisheries and aquaculture sector has to be forward-looking using the most contemporary and accurate projections for climate change based on climate models. Norway illustrates this via their maritime spatial planning and intergovernmental coordination.[59] In Norway, there is one uniform management plan for all ocean areas, and a different management regime for the coastal areas where the municipalities are in charge. Since ecosystems and climate change do not recognise administrative borders, it is argued the improved coordination of what is now a fragmented, largely municipality-driven way of managing could be an interesting track to investigate. It is also important to be very clear that local interest and local know-how are extremely important and should not be left out in such cross-local area coordination. Tailor-made solutions are an important part of this.

Marine industrial parks where activities (offshore wind, aquaculture, oil and gas, fisheries and blue forests) are physically concentrated is another concept on the Norwegian agenda. One possible future marine industrial park could be used to stimulate growth of seaweed and algae to capture CO2, but also to produce biomass for food usable both for fish and humans.[60]

Ocean businesses themselves in Norway have asked for a voluntary common code of conduct even though there are already laws and regulations furthering sustainability. Transparency and knowing the rules of the game provide a common language and framework for defining a sustainable ocean business. One interviewee noted that many businesses are struggling with taking the UN Sustainable Development Goals down to their own company level and implementing actions that are sustainable. [61]

Climate change also brings new opportunities for re-thinking how fish farming is conducted. The Faroe Islands have expertise in land-based smolt farming and in RAS (recirculating aquaculture systems) used

[59] Interview with Norwegian fisheries/aquaculture research organization (2021).
[60] Ibid.
[61] Ibid.

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to reduce the time salmon are kept in pens in the fjords, where the lice are the big problem. The difficult irony of the situation is that if the technology works well, then it would be more profitable to move production closer to the markets. This in turn would mean that the advantageous situation for Faroese salmon producers today resulting from the good natural conditions for salmon farming, would no longer be relevant in the production process, thus wreaking havoc on the domestic economy. As it is now, land-based smolt farming is very expensive and requires a lot of energy. Even so, there are already very large land-based smolt-plants in the Faroes and they are expanding. [62]

In addition to land-based farming, offshore fish farming is seen as a way to increase production, and possibly to eliminate the sea lice problem. It can also be a way to reduce environmental pressures from organic waste in the fjords. Offshore fish farming in the Faroes is potentially problematic though because currents form a front that protects shelf waters, and production activities transgressing these zones would potentially increase the risk of pathogens and more in the coastal areas. Also it would likely conflict with other activities, fisheries especially.

Seaweed farming and "integrated multitrophic aquaculture" is another new opportunity. This is aquaculture that seeks to be circular in its production process and producing at multiple trophic levels (fish, mussels, seaweed) rather than just one single trophic level (salmon). Mussels can be used to filtrate waste from fish farming and thus nourish seaweed. The issue of spatial conflicts arises again as an interviewee notes there are already difficulties referring to the extant conflicts over space between different forms of aquaculture (salmon and seaweed).

Increased production in fish farming should be expected in the EA as there is an increased need for protein in the world, while at the same time an ongoing expectation (at least in the EU) these proteins are produced with a low footprint, which is already the case. More production should not come at the expense of biodiversity, however. There should be a stronger focus on quality protection measures and these should work as intended; for example, they must be dynamic and adjusted according to changes in climate. There is a need for smart combinations of use and protection again reiterating the belief that too large protection areas are not suitable measures for the current challenges. [63]

Many interviews mention the nexus between technology and climate change with respect to mitigation for the fisheries and aquaculture industry.[64] Transitioning away from air freight by plane can be achieved first by using new freezing technology to reduce the quality between fresh and frozen fish which in turn

[62] Interview with Faroese aquaculture research company (2021).
[63] Ibid.
[64] Ibid.

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allows the use of a boat instead of a plane. There has been rapid technological advancement in working offshore in ever-deeper waters. Robotics, video surveillance, and submersible technology are now routinely packaged into machinery for operations that were not previously possible. While all of these examples are more about making production more cost effective, they also have the effect of making the fisheries and aquaculture industry more environmentally friendly.

Although the link between vessel emissions related to fisheries and aquaculture with climate change is not direct, it has been a driving force for countries in the EA to promote the development of low- and even zero emission solutions for relevant vessel categories. The location of fish stocks in the Arctic has changed, in part due to climate change, [65] which in turn directly affects carbon emissions as fisherman need to go further into the sea to find new fish stocks and therefore need larger vessels that use more fossil fuels. For instance, heavy fossil fuel is responsible for up to five per cent of Iceland's emissions, and while the relationship between climate change and the fisheries and aquaculture sector is not the only contributor to its widespread use, this nexus is still the rationale for the Icelandic government aiming to rapidly decarbonize the fisheries sector. This has resulted in both financial support and concrete measures to eventually replace heavy fuel oil with clean electricity using hydro energy and by harnessing geothermal steam.[66] In the past several years, Iceland has begun the switch to clean electricity and aims to finalize the transition to electricity before 2030.[67] Norway has a similar ambition, aiming to halve emissions from fisheries and domestic shipping by 2030 by promoting the development of low- and zero emission solutions for all vessel categories.[68]

4.2. Forestry

In the context of climate change, the forestry industry is the one where mitigation and adaptation will largely be addressed through policy mechanisms. As noted in the introduction to Section 4, the EU Taxonomy Regulation will become the overarching framework for mitigation and adaption in the forestry sector. At the time of analysing the relevant strategies and conducting interviews in 2021, the EU Taxonomy was not yet official. Hence for the purposes of looking at how climate change in the forestry sector is managed from a policy perspective, the renewed EU Forest Strategy (2021), which not only affects the EU level but national levels as well, is the point of departure. For mitigation, commitments and actions in the forestry sector will help achieve the EU's greenhouse gas emission

[65] Interview with Norwegian regional government representative (2021).
[66] Iceland's new Climate Action Plan for 2018-2030 (2018).
[67] Ibid.
[68] Norway's National Plan (2019).

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reduction target of at least 55% in 2030, set out in the European Climate Law and implemented by the measures in the Fit for 55 package. The revised Regulation on Land Use, Land Use Change and Forestry cites a more specific net removal target for the EU of 310 million tons of carbon dioxide- equivalents through the removal of greenhouse gas emissions by forests and forest products.[69] One way this is accomplished is through forest management and ensuring forests' role as sinks in the carbon cycle is maintained or enhanced and by providing bio-materials that can act as temporary carbon stores or as 'carbon substitutes', replacing carbon-intensive materials and fuels.[70]

The economic and social benefits of enhanced afforestation are stressed in the EU Forest Strategy as being one of the most effective climate change and disaster risk mitigation strategies in the forest sector. Afforestation can create substantial job opportunities, especially in relation to the collecting and cultivating of seeds, planting seedlings, and ensuring their development, as well as providing socio-economic benefits to local communities. Exposure to green and forested areas can greatly benefit people's physical and mental health.

Reference is specifically made to the important role that private forest owners play. Forest owners and managers need drivers and financial incentives to be able to provide, in addition to wood and non-wood materials and products, ecosystem services through forest protection and restoration. They also must increase the resilience of their forests through the adoption of most climate and biodiversity friendly forest management practices. This is particularly important in parts of Europe that have been hit by climate change earlier and harder than anticipated and where rural areas have suffered from the loss of income and livelihoods.[71]

The issues of private forest owners are emerging on the political stage in the context of the EU Taxonomy debate. Prior to Russia's invasion of Ukraine, the Taxonomy was problematic for Finnish and Swedish forest owners as they believed it would stop them from developing their forests. In light of the sanctions on Russia and there no longer being timber exports, this issue has quieted down in Spring 2022.

Forestry mitigation is also included in the EU Biodiversity Strategy for 2030, which sets outs a pledge to plant at least three billion additional trees by 2030 to combat the ongoing trend of declining forest area. Over time, it will contribute to increasing the EU forest cover and, correspondingly, the EU land carbon sink and stock. It is also expected to help raise societal awareness and commitment. This Strategy

[69] European Parliament (2021).
[70] Ibid.
[71] Ibid.

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includes a roadmap for the implementation of the pledge based on the overall principle of planting and growing the right tree in the right place and for the right purpose.[72]

In the EU Forest Strategy, adaptation is defined as both adapting forests to climate change and restoring forests following climate damages. Climate adaptation requires investing in disaster prevention, preparedness, response and post-disaster forest recovery and spending should include, as a minimum, to 'restore and reforest better' conditions in line with management practices that increase forest resilience. The use of genetic resources, meaning forest reproductive material to climate-proof forestry, is one proactive approach in this category. The strategy gives a more active role for the Commission as it evokes a co-partnership role between the Commission and Member States to monitor the situation of tree health in the EU, including the impact of invasive alien species, diseases and pests such as bark beetles, and encourage the necessary preventive actions for early detection and eradication. Finally it stresses the need for more collaborative research between EU countries to assist forest species migration.[73]

There is no mention of either mitigation or adaptation to climate change in the Finnish Forest Strategy. Finnish politicians have raised a question about compensation in case Finland should increase its protected areas, but there are no guidelines regarding compensation measures yet. In Sweden's National Forest Program (2018), there is only one mention of climate change which simply states that sustainable forest management provides climate benefits, such as sustainable forest growth. This ensures security of supply and access to domestic biomass resources from Swedish forests. [74]

There is little mention of mitigation and adaption in the interviews. Only two of the interviewees had comments on this topic, the first of whom noted that forest owners are preparing more regularly for storms and extreme weather events as they are becoming more common. The popularity of forest insurances is on the increase, as currently half of the forests are covered by forest insurances. Legislation and recommendations for good forest management already acknowledge the need to adapt to climate change including the maintenance of mixed wood forests and diversity in species as these make forests more resilient to extreme weather events. Although the forest industry has been preparing for these events for a long time, the need to prepare is growing.[75] The other interviewee noted that due to the shortening of winters, forest roads need more maintenance and the extent of the road network needs to be considered when making felling plans and budgets.[76] The same interviewee also made the link

[72] Ibid.
[73] Ibid.
[74] Interview with Finnish forestry government representative (2018).
[75] Interview with Finnish forest industry association (2021).
[76] Ibid.

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between forestry and the energy transition by suggesting that forestry products could be used for the energy transition by providing raw materials to replace fossil products.

Although not directly related to climate change, a critical perspective on forestry practices emerged with one interviewee stating that forestry companies are driven by timber prices. They are re-active and focus only on what they know instead of looking at changes and innovations. More effort should be put into developing techniques instead of defending the practices of today. [77]

4.3. Mining

The regulation of mining is a national competence; yet, extant national mining strategies tend to be old and outdated as most were published around 2010. They are, however, increasingly viewed as a necessary and separate mechanism to secure resources and promote the minerals sector. In the EA they are not, however, utilized to promote either climate mitigation or adaptation. In Finland, the National Minerals Strategy (2010) makes no reference to climate change.[78] In 2013, an action plan entitled Making Finland a Leader in the Sustainable Extractive Industry was published by the Ministry of Employment and Economy. The plan contains only a few references to climate change and all at a very general level, such as the link between the minerals industry and low carbon energy solutions, the need to address climate policy and energy conservation and the importance that investments support low-emission production.[79] More recently in Finland, a National Battery Strategy (2021) also published by the Ministry of Employment and Economy promotes battery minerals as useful for reaching climate targets. This connection, however, is only mentioned briefly at the beginning and end of the document.[80] Sweden's Minerals Strategy (2013) discusses climate change only indirectly and mentions two basic points, the first is that industry should make the production of metals and minerals even more resource-efficient, and the second is that the mining industry needs to further reduce its emissions of greenhouse gases.[81] To date there has been no revision of the Swedish Minerals Strategy. The Norwegian Strategy of the Minerals Industry (2013) does not mention climate change at all. The only reference to climate is the Climate and Pollution Agency, responsible for issuing discharge permits to mines, which works with the Directorate of Mining in many areas including the preparation of guidelines on planning for the

[77] Interview with Swedish forestry NGO (2021).
[78] Finland's Minerals Strategy (2010).
[79] Finland's Sustainable Extractive Industry Action Plan (2013).
[80] National Battery Strategy 2025 (2021).
[81] Sweden's Minerals Strategy (2013).

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subsequent use or restoration of areas after mineral extraction ends, but not explicitly on climate change.[82]

The angle of the mining industry in relation to climate change is that of being a supplier of raw materials for green technologies.[83] One suggestion for industry is to consider what the sea can provide. The exploitation and mining of minerals from the sea, other than sand and gravel, have just started and most current activity is in shallow water. Early estimates are that by 2030, 10 percent of the world's minerals, including cobalt, copper and zinc, could come from the ocean floors. Global annual turnover of marine mineral mining can be expected to grow from virtually nothing to up to €10 billion by 2030.[84] Rather than climate change, it is the more generic term of sustainability most often invoked. For instance, one interviewee talked about digitalization and technological development in environmental monitoring not being fully utilized. Continuous monitoring of water quality as well as the use of drones, for example, in constant monitoring tailing ponds are supporting sustainability.[85]

4.4. Tourism

Even in affected countries and those worried about increasing tourism, there is no desire to stop tourism; rather, the preferred alternative is to green tourism so tourists can still come but be carbon neutral. In Scandinavia, Iceland, the Faroe Islands and Greenland, tourism's carbon footprint is primarily a result of transportation, predominantly from the need to get to and from tourist destinations and the fossil fuels used to support that transportation. For example, in the Finnish tourism sector, emissions mainly originate from transport (75%) and accommodation (20%).[86]

Not all countries in the European Arctic view tourism as needing to be a low-carbon sector. Finland envisions tourism this way and advocates an approach where political decisions and international agreements reinforce the sector's own decisions to support changes in the consumption behaviour of tourists.[87] In Iceland, there is little political will to reduce travel and there is concern that restrictions on greenhouse gas emissions, emissions trading and potential increases in jet fuel and other fuel prices will increase the cost of travel and reduce demand for destinations that require air travel.[88] One interviewee expressed the concern that if airlines are taxed separately, it could lead to a rise in air fares to such an

[82] Norwegian Strategy for the Mineral Industry (2013).
[83] Interview with international mining related NGO (2021).
[84] Blue Growth Strategy (2017).
[85] Interview with Finnish government representative (2021).
[86] Finnish Tourism Strategy 2019-2023: Achieving More Together (2020).
[87] Ibid.
[88] Ibid.

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extent that Iceland, Greenland and the Faroe Islands will be knocked out of the competition.[89] The degree to which a country's tourism industry is developed also tends to define the sector's most pressing issues. It is therefore not surprising that Finland's well-developed tourism industry would have different concerns than those of the newly burgeoning sector in Iceland, Greenland and the Faroe Islands.[90]

'Flight shame', or the reluctance to travel by air because of the awareness of one's contribution to greenhouse emissions, is in real terms both mitigation and adaptation but is perceived to be neither. Instead, at least in Iceland and the Faroe Islands, it is viewed more as a threat to the tourism industry and national economies.[91]

As in mining, there is very little discussion around climate change directly; rather, the preferred angle is discussing sustainability aspects.

4.5. Reindeer herding and indigenous livelihoods

As indigenous communities are directly, and mostly negatively, impacted by climate change, they want to have a seat at the table when it comes to larger economic issues such as the development of new sea routes or extractive projects.[92] Multilateral governance institutions, such as the Arctic Council, as well as national Arctic strategies, are the primary mechanisms to make visible and incorporate the voices of indigenous peoples into policies and activities intended to mitigate and adapt to climate change. Studying the impacts of climate both in terms of science and social effects, particularly with regard to indigenous peoples, is one of the main tasks of the Arctic Council.[93] Two recent notable outputs are the Arctic Resilience Forum 2020[94] and the Impacts of Short-Lived Climate Forcers on Arctic Climate, Air Quality and Human Health (2021).[95] Unfortunately, due to the Russian invasion of Ukraine, the Arctic Council in 2022 has paused all official meetings for the foreseeable future closing off one very significant pathway of empowerment for indigenous peoples.

Arctic countries are recognizing that participation of indigenous and local communities in international climate change efforts is crucial. At the national level, Sweden's strategy for the Arctic asserts the Sámi population shall be able to continue to pursue reindeer husbandry and other traditional activities to continue to survive and earn a livelihood in the Arctic. As the reindeer husbandry industry is facing

[89] Interview with Icelandic tourism industry association (2021).
[90] Ibid.
[91] Interview with Icelandic tourism industry association (2021).
[92] Ibid.
[93] Sweden's Strategy for the Arctic region (2011).
[94] Arctic Council (2021).
[95] Ibid.

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multiple challenges including access to suitable calving grounds, Sweden's strategy recommends the provision of migration routes with resting pastures and centrally connected seasonal grazing areas for long term sustainability.[96]

For example, in Sweden the Sámi Parliament, a separate indigenous parliament, has proactively addressed the subject of climate change adaptation through the creation of an action plan which addresses ongoing and planned projects.[97] Projects specific to reindeer husbandry include research on how climate change affects conditions for reindeer herding, providing alternative adaptation measures for reindeer husbandry, and an analysis of agreements related to winter grazing. In 2017, the Parliament announced funding to develop a climate and vulnerability analysis and an action plan for climate adaptation in Sámi villages. Again, mostly focused on reindeer husbandry, the goal is to produce an overall picture of how climate change affects the conditions for reindeer husbandry, to identify the threats and opportunities and to analyze possible proposals for action. During its annual reporting to the government, the Swedish Sámi Parliament report on work specifically related to climate change adaption including identification of vulnerabilities and prioritization of risks. To ensure continuous implementation, the national adaptation work is followed up in a five-year evaluation cycle by the National Expert Council on Adaption.[98]

Whether there are even adaptation measures that will help the Sámi remains unclear. For example, as mentioned previously, traditional Sámi knowledge of which the language is the important means to communicate traditions to the next generation, is negatively affected by climate change suggesting adaptation may not always be possible. [99]

[96] Sweden's Strategy for the Arctic region (2011).
[97] Swedish Climate Change Adaptation Strategy (2018).
[98] OHCHR (2020).
[99] Ibid.

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5. WHAT IF? UNMANAGEABLE CHALLENGES AND RISKS

This section is intended to explore climate change challenges in the national strategies and interviews of a more existential nature, that are simply too complex and uncertain for solutions. Insofar as strategies are concerned, these types of challenges are not mentioned, which reflects the fact that official government strategies are intended to reassure and not to frighten. The problems and solutions posed in these documents are of a manageable nature to catalyse the development of policy instruments and prod on-the-ground actions. However, as impacts become more severe over time in the European Arctic and calls to action from citizens presumably grow louder, debates around environmental justice and the sharing of burdens and benefits will come to the fore. Governments will have to take a stronger role not only to manage climate change, but to manage society.

Building on the idea of managing society, if there is one common theme that winds throughout discussions around complex, large-scale uncertainties, it is that people, their perceptions and their consequent behaviour, are the biggest unknowns in the climate change equation. For example, in the fisheries and aquaculture sector, the market for farmed salmon depends on the richer people in the world, not the poor, and they often change their eating habits.[100] Whether sustainability is a factor in the salmon they choose to eat, or if they even continue their interest in eating fish, is a large unknown.

The contemporary discourse in the mining sector centers on the tension inherent in the rising production of minerals and metals, largely due to the energy transition, and the burdens and benefits on local communities and indigenous peoples. Using the energy transition as the rationale for ramping up mining also shifts the discourse from one concentrated on local communities to one that pertains to society at large. The issue of who assumes the burdens and the benefits, communities or society, and for what reason, should the common good prevail over the lives of those most affected, is likely to grow more heated in the future and lead to more conflicts. While this tension has always been part of the debate, using the energy transition as justification for projects that might not otherwise be approved, poses a moral and ethical dilemma not so much for companies but for government. When it comes to indigenous peoples, more complex issues around human rights, sovereignty and even the possibility for devolution similar to what the northern territories in Canada have experienced makes the reconciliation of interests appear that much further away.[101]

With respect to tourism, the ramifications from peoples' behaviour touch on several areas. First, the growing middle class in India and China who have disposable income to spend on touristic activities at

[100] Interview with Icelandic fisheries/aquaculture government official (2021).
[101] Interview with Finnish Sami representative (2021).

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least so far appear to prefer more natural and peaceful areas that are quiet and sparsely populated. [102] If this trend continues, it is difficult to imagine that tourist destinations throughout the European Arctic will not become more crowded. This leads to the second ramification which is the growth in 'last chance' tourism. More tourists will aggravate the climatic impacts on the environment creating a vicious circle. In the strategies as well as the interviews, the only approach to stopping this cycle also is dependent on human behaviour, which is known as flight shame. Whether tourists to the Arctic really are eco-conscious remains to be seen. Even if they are eco-conscious, whether their awareness will be enough to stop them from visiting places that are vanishing also remains to be seen. In a very different way the issue of burdens and benefits also plays out in the flight shame concept. Those who are environmentally conscientious and voluntarily decide to stop traveling bear the burden of not seeing earth's disappearing natural wonders while people who continue to travel will be able to see them, at least for a while. The third ramification has to do with making the tourist industry responsible for peoples' behaviour, namely their clients; although, 'responsible' here means forcing them to buy carbon offsets, which has not been proven to be a very effective mitigation effort. This also implies the tourism industry recognises that they profit from the beautiful nature in the Arctic and therefore have a responsibility to preserve it. Given that it is human behaviour causing climate change, and that emissions continue to rise while knowing the dire consequences, relying on human behaviour on a mass scale to 'fix' the problem is rather worrisome.

In addition to human behaviour and its direct affects on climate change, there is the reverse situation where the effects on the environment will directly impact people and these environmental effects are still largely unknown. The Arctic is now considered to be warming three times faster than the rest of the world where it previously was two times faster. The rapidity of changes is more likely to be exponential as time goes on rather than linear and what the cascading effects will be really is unknown. Governments and people seem unable to cope with the current situation let alone be able to concretely plan how to cope with a world in 2100.

The role of government, and the tensions between different levels of government, is another large unknown. For example, there is already tension between the EU, with its newly adopted Taxonomy Regulation, and Finland, as forest owners believe the taxonomy may stop them from developing their property. This would ultimately affect not only individual citizens but Finland's economy as a whole resulting in EU policy conflicting with a Member States' economic interest. This said, much of the discussion in this report points directly to the need of government assuming a much stronger role in every facet of climate change. While the European Arctic is tackling the situation head-on, the largest

[102] Interview with Icelandic tourism industry association (2021).

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emitters continue to evade legal or even conceptual entanglements preferring to still favour the economic argument. Political cycles are short; it is not the politicians who should lead the effort but the civil servants who provide the consistency and stability in government needed for confronting long-term challenges. This implies that who has power to make decisions has to change, not in terms of horizontal governance, but in government itself.

The last large unknown is an ideological one, specifically whether the whole debate around greening everything from energy to the blue economy will gain traction in a way that will help manage climate change or simply further economic growth and exacerbate the situation. If, as is argued, changing human behaviour is the key, then certainly changing human values and our entire model of being has also to change. This is a long, difficult process, however, and someone must bear the mantle of responsibility for galvanising those currently in power who have the ability to change things. Leadership is the problem and the solution, and again, comes down to human beings proving the point that the centrality of the human factor in managing climate change is the single biggest unknown in the equation.

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6. CONCLUSIONS

Impacts and expected impacts in the Arctic vary by industry. Short- to medium-term climate change effects, such as rising sea temperatures, will not have such dire consequences for fisheries and aquaculture, and while the impacts will be noticeable in the long-term, they are still not considered an urgent problem. Given the limited concern of the industry, it is not surprising that adaptation revolves around the development of new types of equipment, or technological fixes, to take advantage of changing fishing opportunities.

Forestry impacts are concerned primarily with the spread of harmful organisms spreading to new areas and multiplying. There are positive impacts as well which have to do with the growth of trees expecting to improve in the north. Management of climate impacts in this industry are largely envisioned to be addressed through policy mechanisms, at least in the EU Forest Strategy. To date in the national forest strategies, there is almost no mention of either mitigation or adaptation.

Mining impacts are related to the physical and socio-economic effects of climate change, climate change as both driver and supplier of the green transition and the impact on raw materials awareness. Yet, there is almost no information about mitigation and adaptation measures likely because national mineral strategy documents are outdated, but this is also true from the interviews. Other than the mining industry being the supplier of raw materials for green technologies, there is not much talk of industry needing to manage climate change directly and practically as such, but the industry is developing its operations toward ecological sustainability. This theme, however, is disputed among local rights holders and stakeholders due to the adverse impacts of mining on the environment.

The national strategies only address the projected future impacts on tourism, such as the reduction of snow in the north. For existing impacts, we turn to the interviews, which reveal a common discourse around the changing visual identity of what tourists are coming to see, referred to as last chance tourism. In addition, there is a palpable tension between the importance of tourism to Arctic economies and the adverse impacts on the environment, around which tourism is largely based. Managing climate change involves only adaptation, specifically greening tourism so tourists can still travel but be carbon neutral. Flight shame in practice can be both mitigation and adaptation but the perception of those interviews is that it is purely a threat to tourism and not a solution.

For indigenous peoples, the devastating effects of climate change now and in the foreseeable future are all too real. The one avenue where their voices were always heard, the Arctic Council, is now suspended

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and the resumption of future activities is unclear. The disproportionate negative effects on indigenous peoples force government and society to also confront the larger moral and ethical questions, such as human rights and territorial sovereignty, which so far have not been answerable. If adaptation is indeed impossible, these questions will be even more important to answer.

The large, unmanageable challenges of climate change are tied to long term affects such as ocean acidification and warming affecting the fisheries and aquaculture industry, invasive pests in the forestry sector, tensions between ramping up the production of minerals and metals and the need for greater protection of the natural environment, how the environmental management authorities will possibly regulate tourism activities which to date are not regulated, and the identity and sovereignty of the Sámi peoples. At present there are no solutions to these questions but there should be a public dialogue around them as they will, sooner rather than later, become all of our realities.

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

ANNEX 1: References in D1.4

Achieving More Together - Sustainable Growth and Renewal in Finnish Tourism. Finland's Tourism Strategy 2019–2028 and Action Plan 2019–2023 (2020). Ministry of Economic Affairs and Employment. https://tem.fi/en/finland-tourism-strategy (Accessed 4.4.2022)

Arctic Council website's link to the Arctic Resilience Forum 2020 report https://oaarchive.arctic-council.org/handle/11374/2614 (Accessed 16.06.2022)

Arctic Council website's link to the Impacts of Short-lived Climate Forcers on Arctic Climate, Air Quality and Human Health. Summary for Policy Makers https://oaarchive.arctic-council.org/handle/11374/2609 (Accessed 16.06.2022)

Arctic Monitoring and assessment (2021). *Arctic Climate Change Update 2021. Key Trends and Impacts. Summary for Policy-makers.* https://www.amap.no/documents/doc/arctic-climate-change-update-2021-key-trends-and-impacts.-summary-for-policy-makers/3508 (Accessed 25.3.2022)

ArcticHubs Proposal (2019). *Global drivers, local consequences: Tools for global change adaptation and sustainable development of industrial and cultural Arctic "hubs" (ArcticHubs).*

European Commission (2021a). *New EU Forest Strategy for 2030.* https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021DC0572 (Accessed 28.3.2022)

European Commission (2021b). *A European Green Deal. Striving to be the first climate-neutral continent.* https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en (Accessed 28.3.2022)

European Commission (2021c). *EU taxonomy for sustainable activities.* https://ec.europa.eu/info/business-economy-euro/banking-and-finance/sustainable-finance/eu-taxonomy-sustainable-activities_en (Accessed 29.3.2022)

European Commission (n.d.) *Overview of EU aquaculture (fish farming).* https://ec.europa.eu/oceans-and-fisheries/ocean/blue-economy/aquaculture/overview-eu-aquaculture-fish-farming_en (accessed 10.5.2022)

EU Technical Expert Group on Sustainable Finance (2020). *Taxonomy: Final report of the Technical Expert Group on Sustainable Finance.* Financing a Sustainable European Economy Technical Report. https://ec.europa.eu/info/sites/default/files/business_economy_euro/banking_and_finance/documents/200309-sustainable-finance-teg-final-report-taxonomy_en.pdf (Accessed 5.4.2022)

Faroe Islands: *A nation in the Arctic* (2013). PMO – The Foreign Service. https://lms.cdn.fo/media/10243/f%C3%B8royar-eitt-land-%C3%AD-arktis-uk-web.pdf?s=jggeB2qre-4xB5sMlrqpjQdbTrg (Accessed 16.6.2022)

Finnish Government. *Finland's Strategy for Arctic Policy (2021).* Working group of public servants responsible for Arctic issues, Steering group for the Strategy for Arctic Policy https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/163247/VN_2021_55.pdf?sequence=1&isAllowed=y (Accessed 29.3.2022)

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

Flick, H., Leppaiho, T., Nygaard V., and Suopajärvi, L (2022). *Analyses of the corporate social responsibility reporting of the main international companies operating in different Arctic hubs: Sustainable development in focus*. ArcticHubs Project D.1.2. Subtask 1.1.3.

Geological Survey of Finland (2010) *Finland's Minerals Strategy.* The Ministry of Employment and the Economy and Geological Survey of Finland. http://projects.gtk.fi/export/sites/projects/minerals_strategy/documents/FinlandsMineralsStrategy_2.pdf (Accessed 22.06.2022)

Government Offices of Sweden (2018). *Strategi för Sveriges nationella skogsprogram* [Sweden's National Forest Program, in Swedish]. Regeringskansliet.

Ministry of Agriculture and Forestry (2014). *Finland's National Climate Change Adaptation Plan 2022*. Government Resolution 20 November 2014. https://mmm.fi/documents/1410837/0/Finland_s_National_climate_Change_Adaptation_Plan_2022+%281%29.pdf (Accessed 29.3.2022)

Ministry of Agriculture and Forestry of Finland (2019). *National Forest Strategy of Finland 2025: aims for growth of overall welfare* (updated version). https://mmm.fi/documents/1410837/2000444/Brochure_National_Forest_Strategy_2025_updated_version.pdf/9e32e0b9-ee2a-b906-8222-8c3a7df5f7d0/Brochure_National_Forest_Strategy_2025_updated_version.pdf (Accessed 31.3.2022)

Ministry of Economic Affairs and Employment of Finland (2021). *National Battery Strategy 2025.* Publications of the Ministry of Economic Affairs and Employment Enterprises 2021:6. National Battery Strategy 2025 (valtioneuvosto.fi) (Accessed 22.6.2022)

Ministry of Employment and the Economy of Finland (2013). *Making Finland a leader in the sustainable extractive industry – action plan.* Publications of the Ministry of Employment and the Economy, Concern 22/2013. Making+Finland+a+leader+in+the+sustainable+extractive+industry+04072013.pdf (tem.fi) (Accessed 22.6.2022)

Ministry for the Environment and Natural Resources. Iceland's 2020 Climate Action Plan. https://www.government.is/library/01-Ministries/Ministry-for-The-Environment/201004%20Umhverfisraduneytid%20Adgerdaaaetlun%20EN%20V2.pdf (Accessed 23.6.2022)

Ministry of Enterprise, Energy and Communications (2013). *Sweden's Mineral Strategy: For sustainable use of Sweden's mineral resources that creates growth throughout the country.* Government Offices of Sweden (Regeringskansliet) https://www.government.se/contentassets/78bb6c6324bf43158d7c153ebf2a4611/swedens-minerals-strategy.-for-sustainable-use-of-swedens-mineral-resources-that-creates-growth-throughout-the-country-complete-version (Accessed 17.6.2022)

Ministry for Foreign Affairs (2011). *Sweden's Strategy for the Arctic Region*. Regeringskansliet. https://www.government.se/information-material/2020/11/swedens-strategy-for-the-arctic-region-2020/ (Accessed 23.6.2022)

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

Ministry for Foreign Affairs (2020). *Sweden's response to questionnaire on cultural rights and climate change – Negative impacts of climate change in culture and cultural rights*. Government Offices of Sweden.

Norwegian Ministry of Climate and Environment (2019). *Norway's National Plan* related to the Decision of the EEA Joint Committee No. 269/2019 of 25 October 2019. https://www.regjeringen.no/contentassets/4e0b25a4c30140cfb14a40f54e7622c8/national-plan-2030_version19_desember.pdf (Accessed 23.6.2022)

Norwegian Ministry of Foreign Affairs (2020). *Norwegian Government's Arctic Policy: People, opportunities and Norwegian interests in the Arctic.* Norwegian Ministries. https://www.regjeringen.no/en/dokumenter/arctic_policy/id2830120/ (Accessed 23.6.2022)

Norwegian Ministry of Justice and Public Security (2016). *Svalbard - Meld. St. 32 (2015-2016) Report to the Storting (white paper)*. Recommendation of 11 May 2016 from the Ministry of Justice and Public Security, approved in the Council of State the same day. https://www.regjeringen.no/en/dokumenter/meld.-st.-32-20152016/id2499962/ (Accessed 21.6.2022)

Norwegian Ministry of Trade and Industry (2013). *Strategy for the Mineral Industry.* mineralstrategi-for-nord-norge.pdf (tffk.no) (Accessed 23.6.2022)

Suopajärvi, L et al. (2022). *Global economic drivers in the development of different industrial hubs in the European Arctic.* ArcticHubs Project D1.2.

The European Files (2017) *Blue Growth Strategy*

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

ANNEX 2: Policy Papers Gathered for WP1

AQUACULTURE

Centre for the Ocean and the Arctic (2019) *Sustainable Blue Economy in the Norwegian Arctic. Part 2: Foresight for 2030 and 2050*.

Ministry of Environment, Industry and Trade (2020) *Report to the Parliament on the aquaculture industry* (in Faroese). Tórshavn, Faroe Islands.

Ministry of Industries and Innovation (2017) A *strategic report about aquaculture done by a workgroup appointed by the minister of fisheries and agriculture. Part I - suggestions* (in Icelandic).

Ministry of Industries and Innovation (2017) *A strategic report about aquaculture done by a workgroup appointed by the minister of fisheries and agriculture. Part II - appendixes* (in Icelandic).

Norden (2012) Conference on Competitive and Sustainable Aquaculture Dimensions and Tools of Competitive and Sustainable Aquaculture in Northern Europe. Editors Heinimaa S & Rahkonen R. *TemaNord 2012:518.*

Nordic Council of Ministers (2017) *Co-operation Programme 2017-2020 – Nordic Council of Ministers for Fisheries and Aquaculture, Agriculture, Food and Forestry*.

Nordregio (2020) Strengthening regional resilience through adaptive collaboration – A case study on the fisheries co-management: Northern Bohuslän. *POLICY BRIEF 2020:5*.

Norwegian Ministries (2019*) Blue Opportunities – The Norwegian Government's updated ocean strategy*.

Norwegian Ministry of Climate and Environment (2021) *Norway's integrated ocean management plans – Barents Sea–Lofoten area; the Norwegian Sea; and the North Sea and Skagerrak*.

Norwegian Ministry of Trade, Industry and Fisheries & Norwegian Ministry of Petroleum and Energy (2017) *New Growth, Proud History – The Norwegian Government's Ocean Strategy*.

Rosten TW, Poulsen H, Alanära A, Eskelinen U, Bergsson AB & Olafsen T (2013) *Perspectives for sustainable development of Nordic aquaculture. The Paban-Report.* Nordic Council of Ministers.

Scholaert F (2019) *Ocean governance and blue growth – Challenges, opportunities and policy* responses. European Parliamentary Research Service.

WWF (2018) *Getting It Right in a New Ocean: Bringing Sustainable Blue Economy Principles to the Arctic*. WWF Arctic Programme.

FORESTRY

Council Directive 2009/147/EC. *Conservation of wild birds*. European Parliament, Council of the European Union.

Council Regulation 2173/2005/EC. *Establishment of a FLEGT licensing scheme for imports of timber into the European Community*. European Parliament, Council of the European Union.

Council Directive 92/43/EC. *Conservation of natural habitats and of wild fauna and flora*. European Parliament, Council of the European Union.

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

European Commission (2020) *EU Biodiversity Strategy for 2030 – Bringing nature back into our lives*. Brussels.

European Commission (2019) *Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions. The European Green Deal*. Brussels.

European Commission (2018) *Communication from the Commission to the European Parliament, the Council, The European Economic and Social Committee and the Comitteee of the Regions. A sustainable Bioeconomy for Europe: Strengthening the connection between economy, society and the environment*. Brussels.

European Commission (2015) *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions Closing the loop-An EU Action plan for the Circular Economy*. Brussels.

European Commission (2015) *Commission Staff Working Document: Multi-annual Implementation Plan of the new EU Forest Strategy*. Brussels.

European Commission (2014) *General Union Environment Action Programme to 2020 – Living well, within the limits of our planet*. Brussels.

European Commission (2013a) *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee of the Regions: A new EU Forest Strategy: for forests and the forest-based sector*. Brussels.

European Commission (2013b) *Commission Staff Working Document: A Blueprint for the EU Forest-Based Industries (woodworking, furniture, pulp & paper manufacturing and converting, printing).* Accompanying the document Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee of the Regions. A new EU forest Strategy: for forests and the forest-based sector. Brussels. SWD (2013) 343 final.

European Commission (2010) *Green Paper on Forest Protection and Information in the EU: Preparing forest for climate change*.

Ministry for the Environment (2019) *Revised National forestry accounting plan for Sweden. Government Offices of Sweden*.

Ministry of Agriculture and Forestry of Finland (2019) *National Forest Strategy 2025 - updated version*. Government Resolution 21 February 2019. Publications of the Ministry of Agriculture and Forestry 2019:17.

Ministry of Agriculture and Forestry of Finland (2015) *National Forest Strategy of Finland Aims for Growth of 2025 Overall Welfare.*

Norwegian Ministry of Climate and Environment (2019) *National forestry accounting plan for Norway for the first commitment period 2021-2025*.

Regeringskansliet, Government Offices of Sweden (2018) *Strategi för Sveriges nationella skogsprogram* (in Swedish).

Regulation 995/2010. *Laying down the obligations of operators who place timber and timber products on the market*. European Parliament, Council of the European Union.

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

Geological Survey of Finland (2010) *Finland's Minerals Strategy*. The Ministry of Employment and the Economy and Geological Survey of Finland.

Government of Greenland (2014) *Greenland's oil and mineral strategy 2014-2018*. FM 2014/133.

Nordland Fylkeskommune, Finnmark Fylkeskommune & Troms fylkeskommune (2019) *Mineralstrategi for Nord-Norge* (in Norwegian).

Norwegian Ministry of Trade and Industry (2013) *Strategy for the Mineral Industry*.

Swedish Ministry of Enterprise, Energy and Communications (2013) *Sweden's Minerals Strategy – For sustainable use of Sweden's mineral resources that creates growth throughout the country*. Regeringskansliet.

The Ministry of Mineral Resources (2020) *Greenland's Mineral Strategy 2020 – 2024.*

TOURISM

Innovation Norway (2021) *National Tourism Strategy 2030: Big impact, small footprint*.

Ministry of Economic Affairs and Employment of Finland (2020) *Achieving more together – Sustainable growth and renewal in Finnish tourism. Finland´s tourism strategy 2019-2028 and action plan 2019-2023*. Publications of the Ministry of Economic Affairs and Employment, Regions, Enterprises 2020:18.

Ministry of Industries and Innovation (2015) *Road map for tourism in Iceland.*

Ministry of Trade, Industry and Fisheries (2017) *Experiencing Norway – a unique adventure Introduction, summary and policy measures*.

Øian H & Kaltenborn B (2020) *Turisme på Svalbard og i Arktis. Effekter på naturmiljø, kulturminner og samfunn med hovedvekt på cruiseturisme.* NINA Rapport 1745. Norsk institutt for naturforskning.

PKF Accountants & Business Adviser (2013) *Long-term strategy for the Icelandic tourism industry*. Extract from the Master Mapping Report.

Sverige Utredningen Sveriges besöksnäring (2017) *Ett land att besöka. En samlad politik för hållbar turism och växande besöksnäring* (in Swedish). Statens Offentliga Utredningar, SOU 2017:95.

Visit Faroe Islands (2019) *Join the preservolution! Sustainable tourism development strategy for the Faroe Islands towards 2025*.

Visit Greenland (2021) *Towards more tourism – A joint effort for growth, innovation and responsible tourism. Visit Greenland´s marketing and market development strategy 2021-2024.*

NATIONAL STRATEGIES

China: *China's Arctic Policy* (2018) SCIO.

Finland: *Finland's Strategy for the Arctic Policy* (2021) PMO.

Finland: *Government Policy Regarding the Priorities in the Updated Arctic Strategy* (2016) PMO.

Finland: *Finland's Strategy for the Arctic Region* 2013 (2013) PMO.

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

Faroe Islands: *Faroe Islands – A nation in the Arctic* (2013) PMO – The Foreign Service.

Iceland: *A Parliamentary Resolution on Iceland's Arctic Policy* (2011) Althingi.

Norway: *Norwegian Government's Arctic Policy* (2020) Norwegian Ministries.

Norway: *Norway's Arctic Strategy* (2017) Norwegian Ministries.

Norway: *Svalbard* (2016) Norwegian Ministry of Foreign Affairs.

Sweden: *Sweden's Strategy for the Arctic Region* (2020) Regeringskansliet.

Sweden: *New Swedish Environmental Policy for the Arctic* (2016) Regeringskansliet.

Sweden: *Sweden's Strategy for the Arctic Region* (2011) Regeringskansliet.

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

ANNEX 3: List of Interviewed Organizations

Aquaculture
Aquaculture Company in Norway – 1
Aquaculture Company in Norway – 2
Aquaculture company owner in Iceland
Fiskaaling, Aquaculture Research Station in the Faroe Islands
ISFA, the Icelandic Aquaculture Association
Minister of Fisheries and Aquaculture in Iceland
Ministry of Environment, Industry and Trade in the Faroe Islands
Senter for hav og Arktis, Centre for the Ocean and the Arctic, Norway
Troms and Finnmark County Administration, Norway
Forestry
Barents Forest Sector Network (BEAC working group)
Finnish Forest Industries
Maa- ja metsätaloustuottajain Keskusliitto, The Central Union of Agricultural Producers and Forest Owners, Finland
Metsähallitus (State owned forests, Finland)
Metsäkeskus, Finnish Forest Centre
World Forest Forum
Mining
DG Mining, European Commission
ICMM, International Council of Mining and Metals
Industry expert in the committee evaluating the Norwegian Mineral Act
IRMA, The Initiative for Responsible Mining Assurance
Kaivosvastuu, Finnish Network for Sustainable Mining
LO, Norwegian National Labour Union
Ministry of Economic Affairs and Employment, Finland
NGU, Geological Survey of Norway
Norsk Bergindustri, The Association of Norwegian Mineral Industry
Regional geologist, Norway
RMF, Responsible Mining Foundation
WWF Minerals and Metals
Tourism

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

Business Iceland/Visit Iceland
Greenlandic tourism sector, municipal level representative
Icelandic Tourist Board
Icelandic Travel Industry Association
Joint Working Group on Tourism (BEAC working group)
Ministry for the Environment and Natural Resources, Iceland
Ministry of Environment, Industry and Trade, Faroe Islands
Ministry of Industries and Innovation, Iceland
Tourism companies and authorities in Svalbard
VFI, Visit Faroe Islands
Indigenous
Sáminuorra, Sami youth organization
Suoma Sámi Nuorat, Finnish Sámi Youth Organization
Svenska samernas riksförbund, Swedish Sámi Organization
General
Barents Press
BEAC, Barents Euro-Arctic Council
East and North Finland EU office/Northern Sparsely Populated areas
Economic Cooperation (BEAC working group)
EEAS, European External Action Service
Finnish Arctic Association
Ministry for Foreign Affairs, Finland
NATO, North Atlantic Treaty Organization
Nordic Council of Ministers
North Norway EU Office
North Sweden EU Office
POP – Bank Sector, Finland
Regional State Administration Agency in Finland
SITRA, The Finnish Innovation Fund
WWF Arctic Programme

Total: 60 interviews. In some organizations more than one informant was interviewed.

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