

# Scientific activities in and about Greenland

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An analysis of actors, activities, and collaboration in Greenlandic research  
for the Danish Agency for Science and Higher Education

By

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## Preface

This report presents the results of an investigation and analysis of opportunities, strengths and challenges of scientific activities involving Greenland as a research area or research object relative to other Arctic areas. The Danish Agency for Science and Higher Education has commissioned the Danish Centre for Research and Research Policy, Aarhus University, to carry out the survey.

A survey of recently active researchers from Greenland, the Faroe Islands and Denmark who had published academic papers about Greenland during the last five years, identified the relevant scientific actors from the Kingdom of Denmark and profiled the performed Greenlandic research activities based on the researchers' experiences of opportunities and challenges.

Another survey that targeted international research institutions whose researchers, in collaboration with researchers from Greenland, the Faroe Islands or Denmark, had published academic papers about a Greenlandic topic during the last five years, gathered knowledge about the experiences and views of foreign cooperating or collaborating research institutions.

The report contributes to the Agency's knowledge about Arctic research, education and innovation, and to the Ministry's Arctic Strategy (Ministry of Higher Education and Science 2016), as part of the realisation of the Kingdom of Denmark's Strategy for the Arctic 2011–2020 (Ministry of Foreign Affairs 2011).

It is our hope that the report informs policymakers and actors regarding the establishment of best possible facilities for future Arctic research, education and innovation in and around Greenland.

The Danish Centre for Research and Research Policy would like to thank the many researchers from Greenland, the Faroe Islands and Denmark as well as research organisations from the USA, Canada, the UK, Norway, Germany and Sweden that responded to the questionnaires.

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## Summary

The Danish Agency for Science and Higher Education seeks to investigate the size and types of scientific activities in or about Greenland. The investigation's main purpose is to create an overview of the scientific activities, opportunities and challenges involving Greenland as a research area or research object. In doing so, it contributes to the Agency's knowledge about Arctic research, education and innovation and to the Ministry's Arctic Strategy (Ministry of Higher Education and Science 2016), as part of the realisation of the Kingdom of Denmark's Strategy for the Arctic 2011–2020 (Ministry of Foreign Affairs 2011). In particular, it quantifies and qualifies the many initiatives already taking place in Greenland, e.g. the collaboration with Naalakkersuisut, the Government of Greenland, to establish the most efficient research facilities in Greenland.

This report presents the results of an investigation and analysis of opportunities, strengths and challenges of scientific activities involving Greenland as a research area or research object relative to other Arctic areas. The Danish Agency for Science and Higher Education has commissioned the Danish Centre for Research and Research Policy, Aarhus University, to carry out the survey.

A survey of recently active researchers from Greenland, the Faroe Islands and Denmark who had published academic papers related to Greenland during the last five years, identified the relevant scientific actors from the Kingdom of Denmark and profiled the performed Greenlandic research activities based on the researchers' experiences of opportunities and challenges.

Another survey to major international research institutions whose researchers, in collaboration with researchers from Greenland, the Faroe Islands or Denmark, had published academic papers about a Greenlandic topic during the last five years, gathered knowledge about the experiences and views of foreign cooperating or collaborating research institutions.

Analysis of the survey data reveals a population of dedicated researchers in an environment with unique research opportunities. A significant majority of the researchers wish to be situated in Greenland more often and for longer periods; however, economic constraints constitute a primary hindrance to this. Even though natural science researchers make up the majority, researchers from other fields are highly present as well.

Research institutions from the six collaborating countries outside the Kingdom of Denmark point at several specific, although thematically common opportunities and challenges for research related to Greenland. They point at opportunities like access to unique research material and other research data, and to infrastructural themes, such as accessibility and research stations. They mainly emphasise infrastructural challenges of various kinds (i.e. transport, costs, facilities) and language barriers in relation to the native languages spoken in the Kingdom of Denmark. Overall, this means that Greenland's research facilities and researchers, compared to other Arctic regions, are assessed as being quite unique and necessary for performing Arctic (including all kinds of Greenland-related) research, and that stronger research collaboration is highly valued and requested in the future. However, significant challenges for Greenland-related research activities still exist.

## 1. Introduction

The Danish Agency for Science and Higher Education seeks to investigate the size and types of scientific activities in or about Greenland. The present investigation creates an overview of the scientific activities, opportunities and challenges involving Greenland as a research area or research object. In doing so, it updates an earlier investigation by Aksnes, Larsen, Nielsen and Rørstad (2014) and contributes to the Agency's knowledge about Arctic research and innovation, and to the Ministry's Arctic Strategy (Ministry of Higher Education and Science 2016), as part of the realisation of the Kingdom of Denmark's Strategy for the Arctic 2011–2020 (Ministry of Foreign Affairs 2011). In particular, it quantifies and qualifies the many initiatives already taking place in Greenland, e.g. the collaboration with Naalakkersuisut, Government of Greenland, to establish efficient research facilities in Greenland.

The Danish Agency for Science and Higher Education has commissioned the Danish Centre for Research and Research Policy (CFA), Aarhus University, to document the scientific activities in or about Greenland and identify opportunities, strengths and challenges of scientific activities involving Greenland as a research area or research object relative to other Arctic areas.

The investigation relied on desk research together with two targeted surveys containing open-ended as well as close-ended questions: one to active researchers in Greenland, the Faroe Islands and Denmark, and another to major collaborating research institutions from the USA, Canada, the UK, Norway, Germany, and Sweden. These represent the empirical basis for identifying and profiling the performed Greenlandic research activities, their opportunities and challenges.

The present report summarises the results of an investigation and analysis of opportunities, strengths and challenges of scientific activities involving Greenland as a research area or research object relative to other Arctic areas. In doing so, it sheds light on the Kingdom of Denmark's contribution to international Arctic scientific cooperation, as agreed to and prioritised by the member countries of the Arctic Council (Arctic Council 2017a), also in the Fairbank Declaration (Arctic Council 2017b).

The investigation identifies researchers performing scientific work in or about Greenland, their belonging, activities, scientific characteristics and collaboration patterns in Section 2. This section also identifies the researchers' experienced opportunities and challenges in their scientific work in relation to Greenland.

The investigation continues in Section 3 with an analysis of experiences from research institutions that collaborate with researchers from Greenland, the Faroe Islands or Denmark on Greenlandic research. Here, the focus is on identification of scientific activity types, opportunities and challenges for Greenlandic research.

Lastly, the present report analyses the assessed size, importance and development of scientific activities in or about Greenland in Section 4.

## 2. Researchers in the Kingdom of Denmark

The number of researchers in the Kingdom of Denmark who perform Greenland-related research is difficult to quantify. A rough prediction estimates around 1340 researchers in total or 690 full-time equivalent (FTE) researchers in 2017 (see Box 1 in Appendix 1). However, there are no listings of these researchers and their affiliations. Therefore, the present analysis builds on answers from actively publishing researchers in Greenland, the Faroe Islands and Denmark in 2013–2017, identified through bibliometric sources and, as a last step, combined with the list of researchers in polar research from Aksnes et al. (2014). Removal of duplicates and contact information updates were made manually. A total of 1120 unique researchers was identified (see Appendix 3).

51% of this population answered the questionnaire, but since 74 persons claimed not to have performed Greenland-related research during the examined period, the final sample consisted of 472 persons who answered the questionnaire and had actively performed Greenland-related research in the Kingdom of Denmark.<sup>1</sup> The majority of respondents resided in Denmark, but the majority also performed Greenland-related research *in* Greenland during the period 2013–2017 (see Tables 3 and A.3.1).

A response rate of 51% and 472 individuals indicates representativeness of the analysis and results presented below in Section 2. Our impression, not knowing the real gross sample of researchers, is that the responding researchers may be among the very active ones, since 62% of them have been a principal investigator (PI) in at least one Greenland-related research project in the last five years, and 71% have performed research *in* Greenland in the last five years (see also Appendix 2). However, even with this in mind, the results presented in Section 2 reveal a very dedicated and research-active population in Greenlandic research in the Kingdom of Denmark.

The survey design process involved desk research (e.g. Aksnes et al. 2014) and expert consultations, e.g. with former Deputy Centre Director Tage Dalsgaard, Arctic Research Centre, Aarhus University, to form a high-quality questionnaire survey that contains relevant open-ended and close-ended questions as well as answer possibilities (see also Appendices 2–4). Together with the identified gross sample of researchers, questionnaire responses provide the empirical basis for the identification, characterisation and profiling of the performed Greenlandic research activities, their opportunities and challenges, as reported in this section.

### 2.1 Researchers' characteristics

Researchers from public research institutions reported thoroughly and exhaustively on the survey questionnaire (see Appendices 3 and 4). The majority are active scientific researchers in 2017, and two-thirds have acted as PIs in a Greenland-related research project during the last five years (see Table 1). The large fraction of PIs among the respondents reveals a high degree of research experience, meaning that they provided expert-based, important and meaningful answers. A small minority (7%) characterise themselves as technical or administrative staff in 2017, even though they have performed and published Greenland-related research and some have also been a PI during the last five years. Due to their apparent research experience, these respondents are also included in all the analyses.

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<sup>1</sup> A search of academic outputs of the persons that claimed not to have actively performed Greenland-related research during the last five years revealed that the vast majority did mention Greenland-related topics in their publications, but that it may not have been the central purpose of the publications. An example of a Greenland-related theme can be the use of Greenlandic material collected for other purposes or data from collaborating partners.

*Table 1. Distribution of personnel categories by Greenlandic PI experience during the last 5 years, 2013–2017*

Personnel category	Research project experience as		Total
	PI	Non-PI	
Research	63%	37%	100% (438)
Technical/administrative	47%	53%	100% (34)
Total	62% (294)	38% (178)	100% (472)

Note: Number of respondents in parentheses.

The majority of researchers belong to natural sciences (Table 2). 64% of the respondents perform research in natural sciences, 18% – in medicine and health, and 13% – in humanities. The smallest share of the researchers, 7%, perform research in engineering sciences. The distribution across fields corresponds well to the respective distribution of researchers from the Kingdom of Denmark for the broader field of polar research, as identified by Aksnes et al. (2014, Figure 2.4), and illustrates the focus in Greenland-related research on geosciences, climate/environment, biology and oceanography as opposed to, for example, oil exploration and extraction (see Table 2).

*Table 2. Shares of researchers by field of Greenland-related research activities, 2017*

Scientific field	% of total	Scientific discipline	% of total
Natural sciences	64%	Cosmic geophysics and space research	1%
		Atmosphere research and meteorology	9%
		Oceanography and geophysics	12%
		Cryospheric sciences	15%
		Other geosciences	22%
		Terrestrial biology	11%
		Marine biology and fisheries biology	16%
		Other biology	5%
Medicine & health	18%	Public health and social medicine	13%
		Psychology and psychiatry	2%
		Other medicine	7%
Engineering	7%	Civil engineering	2%
		Fisheries and aquaculture technology	1%
		Petroleum engineering	0%
		Marine transport	1%
		Environmental technology	4%
Social sciences	11%	Political sciences and administration	4%
		Sociology and anthropology	7%
		Economics	1%
		Law	3%
Humanities	13%	Archaeology and history	9%
		Linguistics and literature	1%
		Cultural studies and religion	5%
Other fields	4%		4%

Note: As the researchers could mark multiple scientific fields, the percentages total more than 100%. 'Other fields' contains scientific disciplines that are not obviously covered by the listed disciplines.

The researchers could mark more than one scientific discipline for their research activities. As Table 2 reveals, a significant share of researchers did that, especially for disciplines under natural sciences. As the shares in major scientific fields total 117%, the multiple marks illustrate that Greenland-related research is certainly interdisciplinary and even cross-disciplinary for at least some of the researchers.

## 2.2 Research activities in or about Greenland

The majority of respondents performed their Greenland-related research while being physically located in Greenland in the period 2013–2017. 71% of the researchers performed research *in* Greenland at least once during the five-year time span. The share does not fluctuate significantly across different periods, although the share of researchers who were based in Greenland is lowest among the small group of newcomers who conducted Greenland-related research only in 2017. These findings are in line with the observed large fraction of experienced PIs from Table 1 and suggest that young researchers may be underrepresented in the survey sample (see also Appendix 2).

The figures in Table 3 further show that more than half of the researchers, 55%, have performed Greenland-related research both recently and in the previous four-year period. The remaining 42% have conducted Greenland-related research in the period 2013–2016, but not during the last year. Overall, the figures reveal a continuity in visiting Greenland as part of Greenland-related research since the vast majority seems to carry out research activities over the span of several years and continues to revisit Greenland.

*Table 3. Distribution of researchers by period and location of research activities, 2013–2017*

Period for Greenland-related research	Research <b>about</b> Greenland, solely	Research located <b>in</b> Greenland at least once	Total
Only 2017	4%	3%	3%
2013–2016 and 2017	55%	55%	55%
Only 2013–2016	41%	42%	42%
Total	100% (135)	100% (337)	100% (472)

Note: ‘In Greenland’ means the respondent performed research while located in Greenland (either onshore or offshore) at least once during the last five years: 2013–2016 and/or 2017. ‘About Greenland’ means the respondent performed Greenland-related research during the last five years without being located in Greenland.

As mentioned in Section 2.1, the majority of research activities are in the field of natural sciences. Figure 1 shows the shares of researchers who have performed Greenland-related research in the period 2013–2017 by scientific field. It shows similar shares for researchers who were *in* Greenland at least once during the period and for those who carried out research *about* Greenland without being there. It is clearly visible that researchers in most fields seem to take advantage of being located in Greenland. However, the medicine and health field appears to be an exception, where research is equally likely to be conducted outside Greenland.

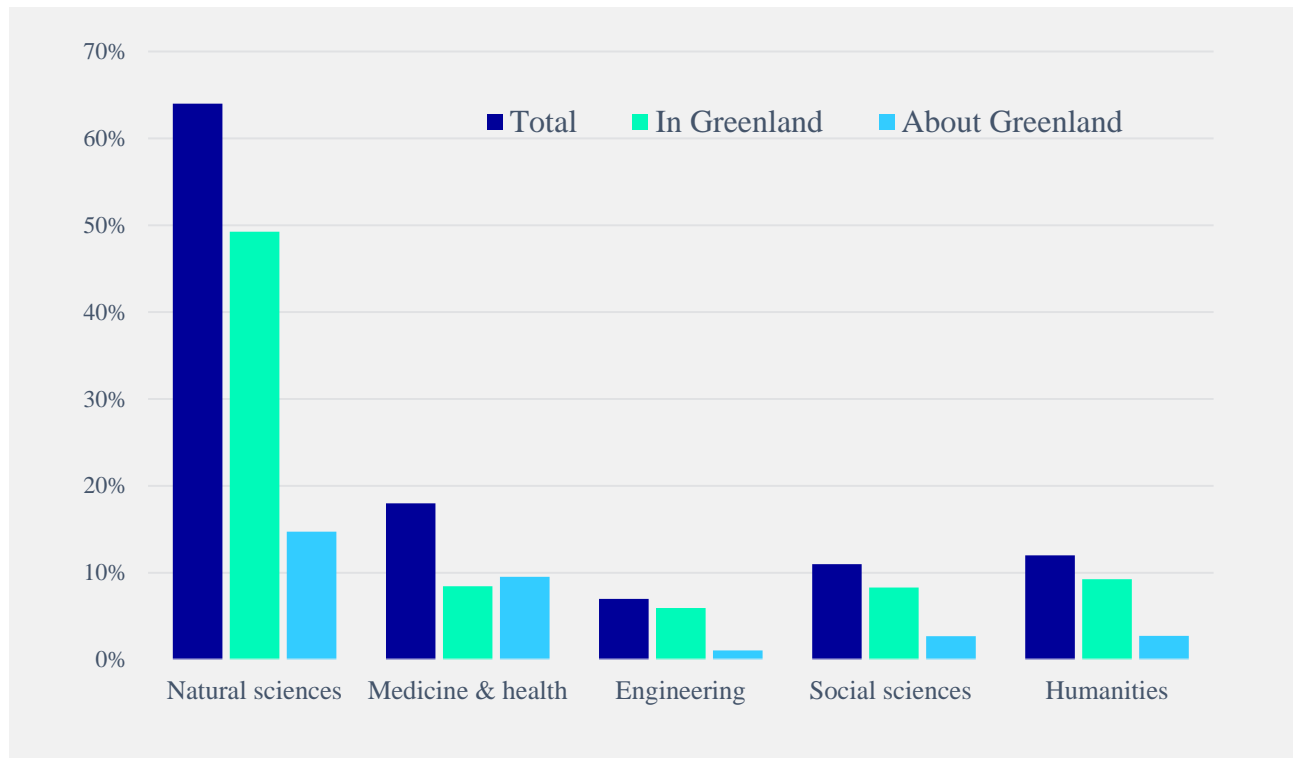


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*“Greenland is a unique natural laboratory to study a range of geological processes [...] through its unique exposure rate of geological formations” (Respondent 506)*

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**Figure 1. Greenland-related research activities during 2013-2017 by scientific field and those conducting research in or about Greenland**



Note: ‘In Greenland’ means the respondent performed research while located in Greenland (onshore or offshore) at least once during the last five years. ‘About Greenland’ means the respondent performed Greenland-related research during the last five years without being located in Greenland.

Having established that most researchers performing Greenland-related research reside in Denmark (see Table A.3.1), it is worth examining the average number of working days respondents spend in Greenland. Figure 2 shows the average number of working days, travel days and holidays among the researchers performing research in Greenland, conditional on them having been there in 2017.<sup>2, 3</sup> The chosen group intervals in Figure 2 correspond roughly to <1, 1–2, 2–5, and >5 regular months, i.e. 1–25 working days (group 1: 52%), 26–50 working days (group 2: 30%), 50–100 working days (group 3: 10%) and >100 working days (group 4: 8%), with the share of researchers noted in parentheses. This indicates that while groups 3 and 4 contain only a few researchers, they nevertheless spend a high number of days in Greenland (see Figure 2).

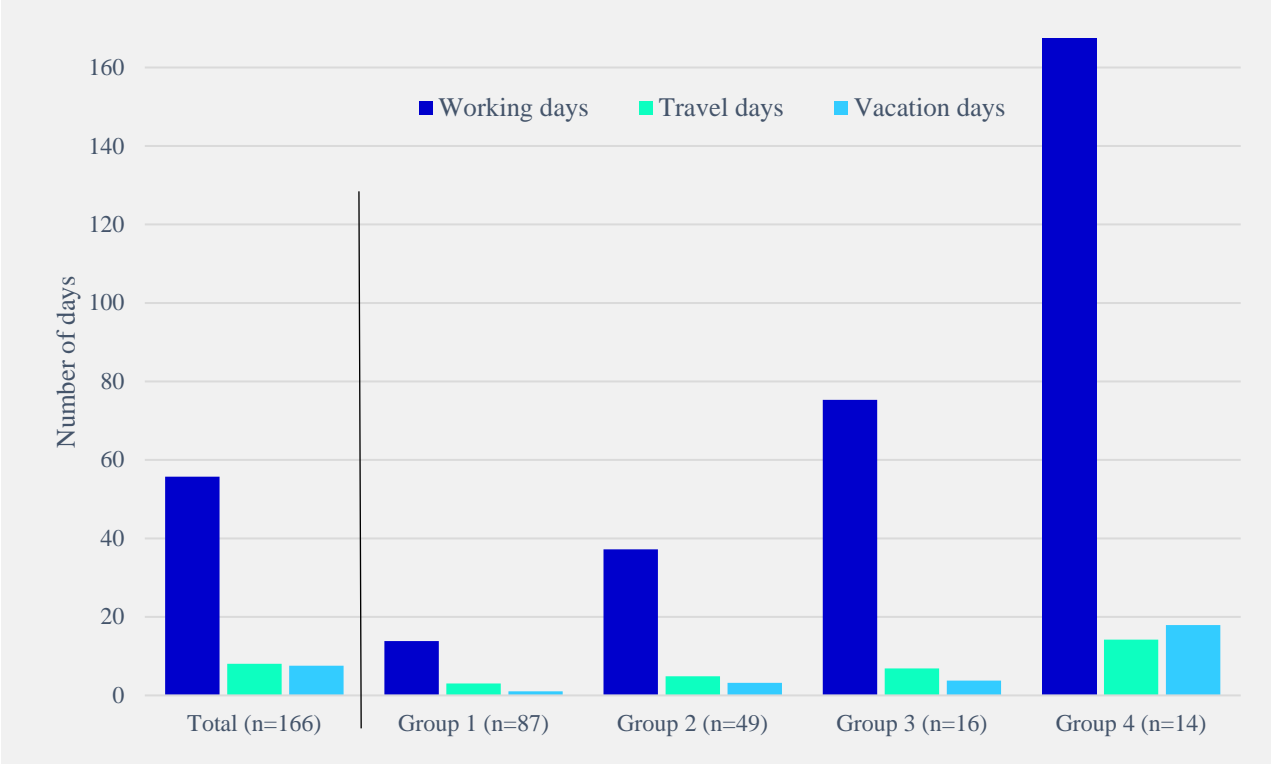
<sup>2</sup> In the survey construction phase, an expert indicated that researchers could provide valid answers for the last year, but not for the last five years. Hence, only respondents with research activity in Greenland during the last year were asked to note their working days, travel days and holidays. This resulted in fewer but also more valid responses.

<sup>3</sup> A few researchers claimed to simultaneously work 365 days, travel 365 days and have 365 holidays in 2017. Omitting the few outliers with more than 300 working days and grouping the intervals as shown in Figure 2 resulted in robust averages that did not deviate from the corresponding medians. Without groupings, there was a substantial skewness in the number of working days, i.e. low median and high average. A standard year contains approximately 220 work days.<sup>9</sup>

Conversely, the high number of researchers in group 1 and 2 only spend a rather limited number of days in Greenland.

Substantially, this indicates that the majority of researchers come from Denmark and are in Greenland for a limited number of days, i.e. group 1 and 2. Vice versa, a smaller share of researchers live in Greenland and therefore report many working days, i.e. group 4.

Figure 2. Number of working days among researchers in Greenland in the last 12 months (2017)



Note: 166 respondents grouped by working days. Only researchers doing research in Greenland during the last 12 months (n=195) that responded to the question (n=183), excluding respondents reporting <1 or >300 working days or >100 travel days or >100 days of holiday (n=17), yielded a final total of 166 respondents. The grouping in categories resulted in robust averages that did not deviate from the corresponding medians, see also Footnote 2. Categories are 1–25 working days (n=87), 26–50 working days (n=49), 51–100 working days (n=16), >100 working days (n=14).

## 2.3 Research locations in Greenland

The following section identifies locations of the researchers performing research in Greenland. Hence, only 319 respondents physically located in Greenland contributed to the analysis. Most activities are located at land (onshore), while a smaller group of researchers carried out their work at seas surrounding Greenland (offshore). Table 4 shows that the vast majority, 84%, perform research at land but also that one-third, 32%, perform research at sea. One-fifth of the first group – corresponding to half of the latter group – performed research both at land and at sea during the period.

*Table 4. Location of performed research among researchers IN Greenland, 2013–2017*

		Research activities at sea (offshore)		Total
		Yes	No	
Research activities	Yes	17%	68%	84%
on land (onshore)	No	15%	-----	16%
Total		32% (102)	68% (217)	100% (319)

Note: See land and sea locations in Figure 3 below. Number of respondents in parentheses. Three respondents answered ‘Yes’ to onshore but did not answer to offshore. They are set to ‘No’ to offshore in Table 4.

Detailing the picture of research locations provides more information, even though it also creates a more mixed and less interpretable picture. Figure 3 shows the share of all researchers who have performed research at or nearest to a certain marked location in Greenland or at seas surrounding Greenland. The most frequent location for research in Greenland is Nuuk, which is where the largest research institutions are located.

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*“The University of Greenland offers very good conditions for doing research”*  
*(Respondent 86)*

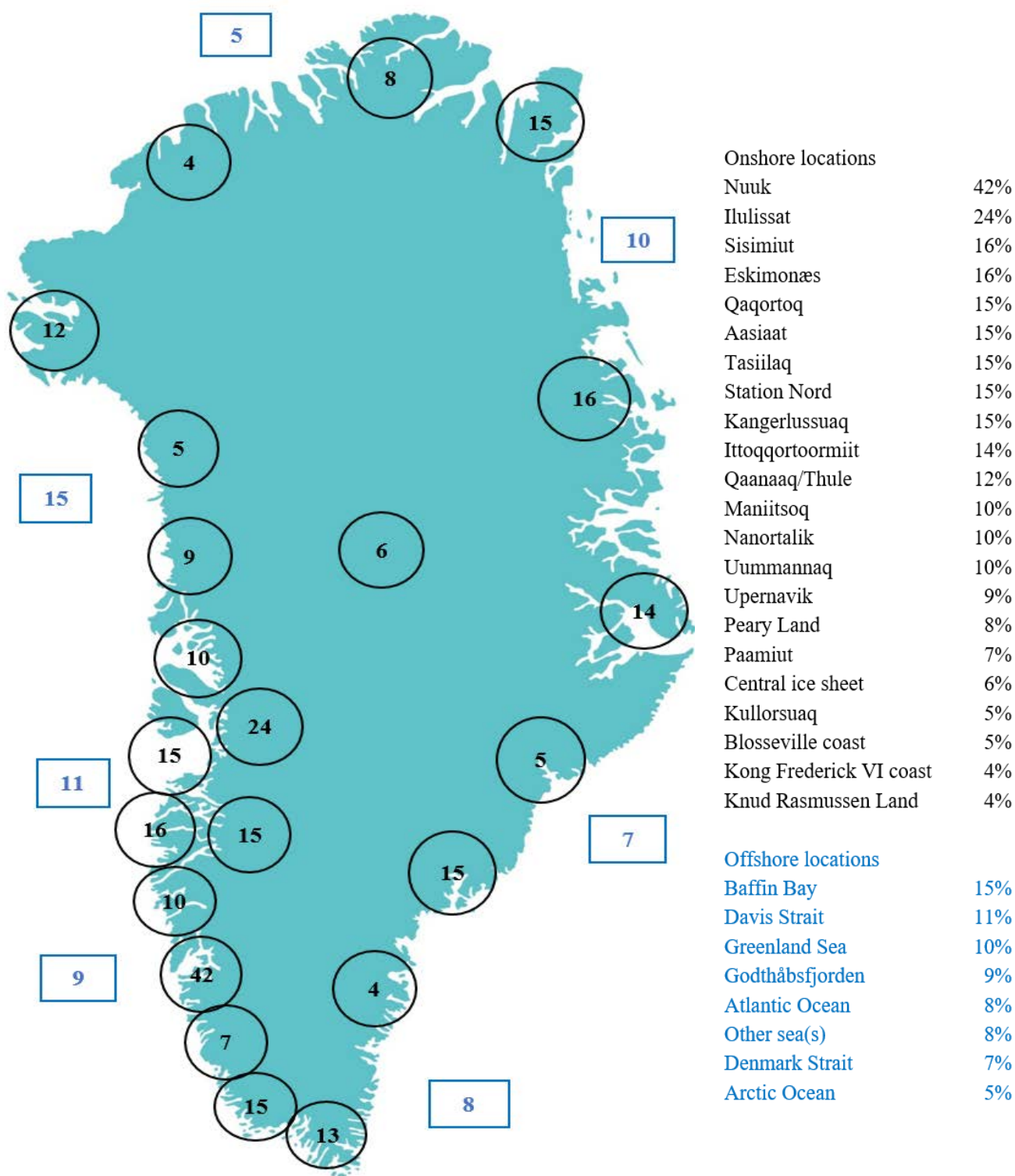
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The list of locations has been identified through Isaaffik<sup>4</sup> and checked in consultation with experts in the field for omitted or missing locations. In general, most researchers have performed research at the southwestern coastal area of Greenland. However, all regions of Greenland seem to be attractive, although this attractiveness varies across different fields for various reasons. The seas around Greenland are also attractive for a significant, although smaller number of researchers.

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<sup>4</sup> <https://www.isaaffik.org/>

Figure 3. Location of researchers in Greenland, 2013–2017. Percentage of all researchers in Greenland. Share of researchers who performed research at the marked land (onshore) or sea (offshore) areas. Multiple marks possible



Note: Figures on map mark percentages of all researchers who performed research onshore or offshore in Greenland (n=319), and correspond to the geographical locations and percentages in the right-hand side table. The shares only show presence and not necessarily importance of the different locations.

Table A.1 in Appendix 1 lists similar shares of researchers who performed research at the marked locations, but here calculated as the share of researchers at land and at sea respectively (column 1). Table A.1 also provides shares of researchers in natural sciences and all other fields separately (column 2 and 3). The figures in Table A.1 reveal the same overall pattern as Figure 3, but they also suggest that natural science researchers in particular are less present in the major city areas, i.e. Nuuk, Sisimiut and Ilulissat, or generally in the southwestern coastal area, than researchers from the remaining major scientific fields, e.g. social sciences or medicine and health. A reverse overrepresentation is the case for the outer northern and eastern coastal areas as well as the ice sheet centre of Greenland.

The survey asked all 319 researchers performing onshore or offshore research in Greenland about locations where they would like to perform (additional) research if possible. Table 5 below shows the ten most frequently requested land locations and the five most frequently requested sea locations among those presented in Figure 3.

Compared to the locations of the current research activity, there seems to be a rather extensive interest in performing research at other than the current locations - the only exception seems to be Nuuk. Between 25% and 34% wish to perform research at locations where less than 20% currently have research activities. In sum, there seems to be high demand for access to more research locations, especially outside the southwestern coastal areas.

*Table 5. Most frequently requested land and sea locations for additional research activities among researchers in Greenland, 2013–2017. Percentage of all researchers wishing to perform research at land (onshore) and at sea (offshore) and actually performing research at land (onshore) and at sea (offshore)*

	Location	Wished location (%)	Actual location (%)
Onshore	Nuuk	37%	50%
	Ittoqqortoormiit	34%	16%
	Ilulissat	34%	29%
	Qaanaaq/Thule	33%	14%
	Station Nord	32%	18%
	Qaqortoq	29%	17%
	Tasiilaq	28%	18%
	Sisimiut	25%	19%
	Nanortalik	25%	12%
	Peary Land	25%	9%
Offshore	Baffin Bay	62%	48%
	Greenland Sea	56%	31%
	Arctic Ocean	53%	17%
	Davis Strait	41%	35%
	Denmark Strait	38%	23%

Note: Multiple marks possible, and both onshore and offshore choices are possible simultaneously. Wishes – onshore: n=273; offshore: n=91. Actual – onshore: n=270; offshore: n=102.

Table A.1 in Appendix 1 gives a full list of the researchers' most frequently requested land and sea locations for additional research activities (column 4). Table A.1 also provides separate information on the shares of researchers in natural sciences and all other fields (column 5 and 6).

## 2.4 Opportunities for research in or about Greenland

The researchers' scientific activities involve Greenland either physically – being in Greenland (IN) – or topically – doing Greenland-related research without being in Greenland (ABOUT). For both the researchers IN Greenland and the researchers in Denmark or the Faroe Islands researching ABOUT Greenland, the unique opportunities that Greenland offers for their research are of high importance. The following section provides a description of those opportunities and their relative significance.

The gradation ranges from 'unique scientific opportunities' (not found easily elsewhere) to 'good scientific opportunities' (possible to substitute with alternatives) to 'no particular opportunities' (easily found elsewhere). Examples of unique characteristics are given in Table 8 and 9.

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*“The Greenlandic population has unique genetic characteristics that allow for unique medical genetics studies” (Respondent 241)*

*“South Greenland soils are unique in regard to geological, historical, and climate origin, organic matter quality and functions, and soil-gas transport behavior” (Respondent 661)*

*“Unique clinical samples from wildlife” (Respondent 860)*

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Table 6 shows the shares of researchers indicating that Greenland offers unique opportunities for their research activities. 78% of the researchers IN Greenland find *unique* opportunities, and 18% find *good* opportunities for their research. Similarly, 54% of the researchers ABOUT Greenland find *unique* opportunities, while 36% find *good* opportunities for their Greenland-related research activities. While Greenland offers equally unique opportunities for researchers IN Greenland across fields, natural science researchers ABOUT Greenland in particular find unique opportunities. Overall, Greenland offers unique scientific opportunities.

*Table 6. Uniqueness of research opportunities in Greenland-related research among researchers IN Greenland and among researchers ABOUT Greenland*

Scientific opportunities	Researchers IN Greenland			Researchers ABOUT Greenland		
	Natural sciences	Other fields	Total	Natural sciences	Other fields	Total
Unique	79%	72%	78%	66%	42%	54%
Good	17%	23%	18%	30%	43%	36%
No particular	4%	4%	5%	4%	15%	10%
Total	100% (231)	100% (134)	100% (329)	100% (70)	100% (72)	100% (134)

Note: As the researchers could mark multiple scientific fields, the number of respondents in natural sciences and other fields may amount to more than the total.

Asking the researchers ABOUT Greenland (i.e. those who did not physically perform research in Greenland), whether it would be advantageous for their research to have been or be located in Greenland, revealed that only a quarter, 26%, stated an unambiguous ‘yes’ (see Table 7). A third, 35%, was more ambiguous, while another quarter, 24%, answered with a definitive ‘no’. Hence, Table 7 shows that the majority find it advantageous or somewhat advantageous for their Greenland-related research activities to be located in Greenland.

Table 7 also shows the existence of a small group for whom it is not advantageous to be located in Greenland even though Greenland offers unique or good research opportunities. They might for instance have samples or data brought home by other researchers, as some write in their comments.

*Table 7: Share of researchers ABOUT Greenland stating the advantageousness for their research to be physically in Greenland*

Advantageous to be in Greenland	Scientific opportunities in Greenland			Total
	Unique	Good	None in particular	
Yes	32%	17%	23%	26%
Maybe	35%	41%	15%	35%
No	15%	28%	54%	24%
Do not know	17%	13%	8%	15%
Total	100% (71)	100% (46)	100% (13)	100% (130)

All researchers were given the possibility to give free text comments on the uniqueness of Greenland as a research topic, and a large fraction of the respondents did so. In Table 8, researchers both IN and ABOUT Greenland commented on similar aspects of uniqueness, while Table 9 presents three aspects relevant for experiences of researchers IN Greenland.

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*“Greenland covers 23 latitudes and low arctic as well as high arctic ecosystems can be studied” (Respondent 73)*

*“As a marine biologist, Greenland is highly relevant due to the great biodiversity in invertebrates compared to other areas, e.g. Svalbard” (Respondent 58)*

*“Ice cores drilled in Greenland enable to retrieve unique information about the past evolution of the climate and environment back to the past” (Respondent 149)*

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The comments are naturally distributed and grouped across major scientific fields as shown in Table 8, where the first identified theme on nature and wildlife is dominated by natural science researchers. More than 120 comments referred to this theme. The second theme on native population is dominated by researchers from medicine and health science (42 references), while the third theme on society and history is dominated by social science and humanities researchers (24 references). The number of references is more or less proportional to the number of researchers in the major scientific fields, so an overall conclusion is that the researchers find and list numerous unique characteristics for Greenland-related research.

*Table 8. Researchers' comments on unique characteristics for Greenland-related research*

	Unique characteristics	
Nature and wildlife	<ul style="list-style-type: none"> <li>• Ice sheet/ice cores and glaciers</li> <li>• Highly exposed to climate change</li> <li>• Unique geological and paleontological objects</li> <li>• Exposed outcrops and rocks</li> <li>• Ecosystem variety</li> <li>• Sensitive species and ecosystems</li> <li>• Simple food chains</li> </ul>	<ul style="list-style-type: none"> <li>• Exceptional minerals</li> <li>• Special meteorological conditions</li> <li>• Unique types of soil</li> <li>• Absence of pollutants</li> <li>• Undisturbed ecosystem and landscape</li> <li>• Coverage of many latitudes (high/low Arctic)</li> <li>• Unique flora and fauna</li> </ul>
Native population	<ul style="list-style-type: none"> <li>• Unique genetic characteristics of the Inuit population</li> <li>• Specific public health issues related to lifestyle and nutrition (e.g. diabetes disorders)</li> </ul>	<ul style="list-style-type: none"> <li>• Health issues related to marine food contaminants</li> <li>• Homogenous and small population isolated from civilisation</li> <li>• Exceptional longitudinal data</li> </ul>
Society and history	<ul style="list-style-type: none"> <li>• Clash of societal development and Inuit culture</li> <li>• History of Inuit population</li> <li>• Old historic settlements</li> </ul>	<ul style="list-style-type: none"> <li>• Case of (de)colonisation and postcolonial identity</li> <li>• Case of Danish foreign policy and diplomacy (in the Arctic)</li> </ul>

Note: Number of recorded thematic comments – nature and wildlife: 124; native population: 42; society and history: 24.

In Table 9, only researchers IN Greenland came up with comments on these experience-based unique characteristics. Some of them are absolute, but others seem to be relative to other comparable research topics or areas. The number of comments is lower than the numbers in Table 8, but equally interesting, encompassing such topics as logistics and infrastructure (56 references), collaboration (26 references) and science in society (19 references).



*Table 9. Researchers' comments on unique characteristics for Greenland-related research. Solely researchers performing research in Greenland*

	Unique characteristics	
Logistics	<ul style="list-style-type: none"> <li>• Relatively easy and cheap access from Denmark <i>compared to other Arctic regions</i></li> <li>• Good infrastructure to field research locations</li> </ul>	<ul style="list-style-type: none"> <li>• Good conditions for research (e.g. University of Greenland and the Arctic Station in Qeqertarsuaq)</li> </ul>
Collaboration	<ul style="list-style-type: none"> <li>• External partners in public and private sector (e.g. Greenland Institute for Natural Resources)</li> <li>• Collaboration opportunities with authorities and local researchers</li> </ul>	<ul style="list-style-type: none"> <li>• Multiple different fields working closely provides basis for multidisciplinary research</li> <li>• Established collaborations with Danish institutions</li> </ul>
Society and research	<ul style="list-style-type: none"> <li>• Call for more local interest in research and participation in research</li> <li>• Foreign researchers encouraged to gain stronger connection to the Greenlandic society</li> <li>• Unique knowledge in the local research community compared to their limited numbers</li> </ul>	<ul style="list-style-type: none"> <li>• More focus on research that is NOT detached from the Greenlandic society</li> <li>• More consideration for Greenlandic educational needs and economic development</li> <li>• Importance of "Research about Greenland, for Greenland and connected to Greenland"</li> </ul>

Note: Number of recorded thematic comments – logistics: 56; collaboration: 26; society and research: 19.

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*"The exposed geology and subsurface geology in Greenland is unique for energy resource studies and associated analogue studies" (Respondent 95)*

*"Many different arctic ecosystem components are co-located within limited distance from each other i.e. icesheet, glaciers, terrestrial, limnic and near-coastal" (Respondent 168)*

*"The Arctic is warming faster than elsewhere, the cryosphere is a sensitive indicator of climate, and Greenland has one of the two ice sheets and thousands of independent glaciers" (Respondent 176)*

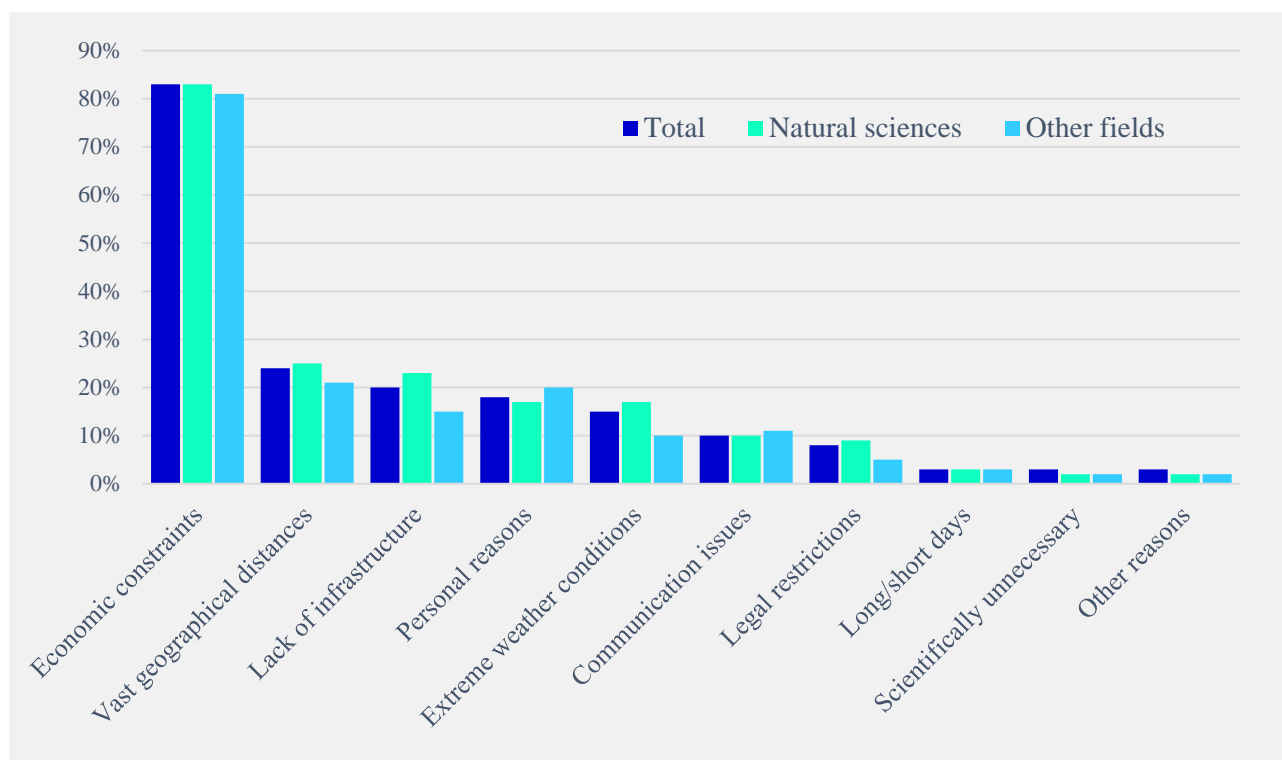
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## 2.5 Challenges for more research in Greenland

Similar to opportunities, there may be challenges for Greenland-related research among researchers IN Greenland as well as ABOUT Greenland. 79% of the researchers IN Greenland wish they could visit Greenland more often, and 59% of the researchers IN Greenland wish they could visit Greenland for longer periods. However, they seem to face challenges doing so. Following the literature on research challenges in general and consulting a few experts in the field, we compiled a short list of the most frequent challenges for more research in Greenland. Figure 4 and 5 shows the shares experiencing the challenges for more research (IN Greenland) and starting research in Greenland (ABOUT Greenland), respectively. Most researchers found answers in the provided list, and only a few added comments with other kinds of challenges.<sup>5</sup>

As expected, economic constraints are by far the most frequent challenge for conducting more research among the researchers in Greenland. Above 83% experience *economic constraints* for additional research in Greenland (see Figure 4). *Structural* and *personal reasons* account for about 20% each, while *scientific unnecessary* received the lowest share of responses. The shares of researchers from natural sciences and other fields are almost equal across all types of challenges. A few exceptions where researchers from natural sciences experience challenges slightly more often are in regard to fieldwork, i.e. *infrastructure* and *extreme weather*, and to legalisms or admittance, i.e. *legal restrictions*.

Figure 4. Share of researchers IN Greenland experiencing challenges for more research in Greenland

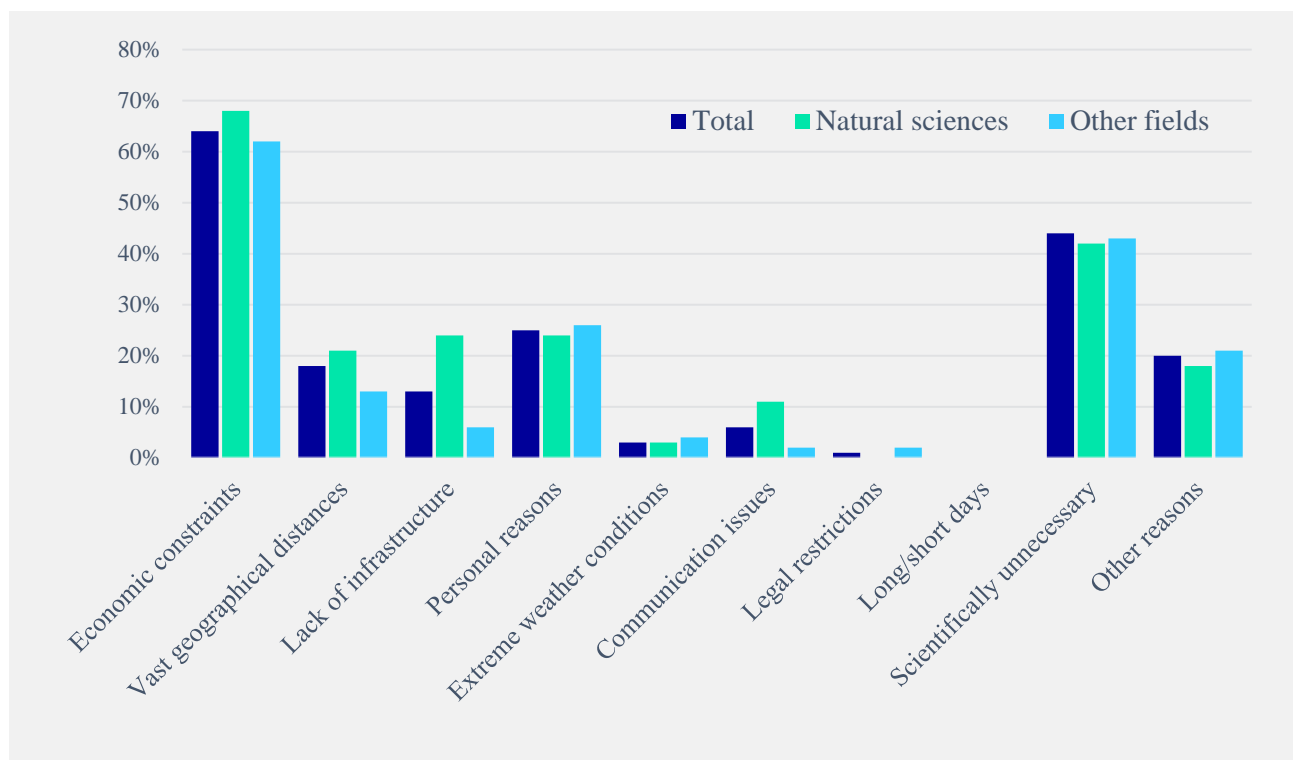


Note: As the researchers could mark multiple scientific fields, the respondents in natural sciences (n=229) and in other fields (n=122) amount to more than the total (n=315).

<sup>5</sup> Some of the comments were explanatory and replaced with closed categories.

Turning towards the challenges of performing research in Greenland among the researchers ABOUT Greenland gives a more diverse picture (see Figure 5). The shares are calculated from the part of the researchers that found unique or good scientific opportunities in Greenland (see Table 6). While 64% of the researchers also point towards *economic constraints* as a significant challenge for research in Greenland, 44% admit that their presence is *scientifically unnecessary* for their Greenland-related research. The first share indicates an uncovered need, while the latter share reveals that Greenland-related research does not necessarily require a physical Greenlandic location. Personal and structural challenges again account for around 20%. The *other* category is also large and covers mostly a mix of different kinds of challenges. Lastly, researchers in the natural sciences seem to find *lack of infrastructure* as a more common challenge compared to researchers in the remaining fields. As they generally perform fieldwork outside populated areas (e.g. southwest Greenland), this pattern is not surprising.

Figure 5. Share of researchers ABOUT Greenland experiencing challenges of performing research in Greenland. Only researchers finding unique or good scientific opportunities (see Table 6)



Note: As the researchers could mark multiple scientific fields, the respondents in natural sciences (n=38) and in other fields (n=47) amount to more than the total (n=80).

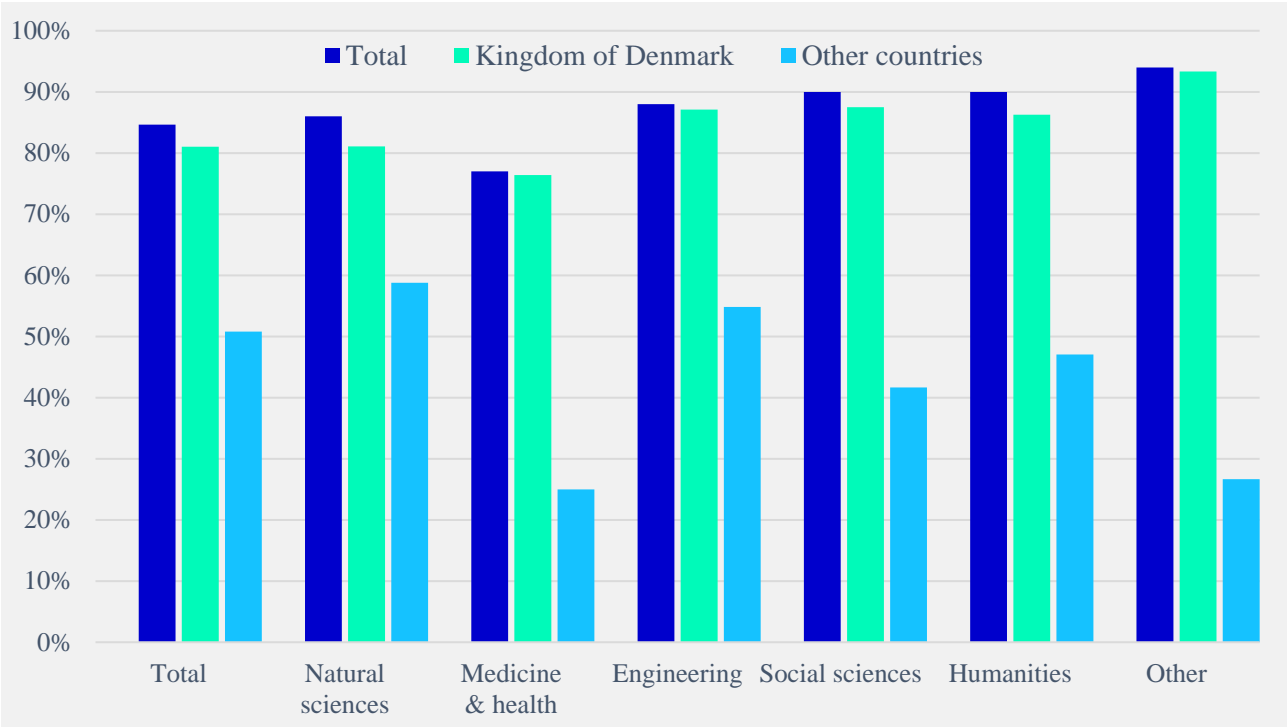
## 2.6 Scientific collaboration

As stated in the Fairbank Declaration and in the Agreement on Enhancing International Arctic Scientific Cooperation (Arctic Council 2017a; 2017b), scientific collaboration is highly profiled and requested by the governments in the Arctic region. Collaboration has already been widely used among researchers in the Kingdom of Denmark within polar research as shown by Aksnes et al. (2014), and the present survey finds similar patterns among researchers in Greenland-related research (see Figures 6 and 7).

Nearly 85%, or 375 of the 443 researchers answering this part of the survey, collaborate with other institutions, such as research institutions, government authorities, NGOs, private firms or other partners (see Figure 6). The shares are fairly equally distributed across scientific fields, with 90% of researchers in social sciences and humanities and 76% of researchers in medicine and health. Overall, scientific collaboration seems to be common and widely used among researchers in all scientific disciplines; see also Glob (forthcoming).

Figure 6 also shows the shares of researchers who collaborate with institutions from the Kingdom of Denmark and from other countries, respectively. While almost all collaborating researchers are working with a colleague from the Kingdom of Denmark, the shares collaboration with institutions outside the Kingdom of Denmark fluctuate across scientific fields. As many as 59% of natural science researchers collaborate with a foreign (outside the Kingdom of Denmark) institution, followed by engineering with 55%, humanities with 47%, social sciences with 42%, and lastly medicine and health with 25%. Hence, these collaboration rates with foreign institutions indicates the extent of internationalisation across the various scientific fields.

*Figure 6. Share of all researchers who collaborate with other institutions on Greenland-related research by collaborator country group and scientific field*



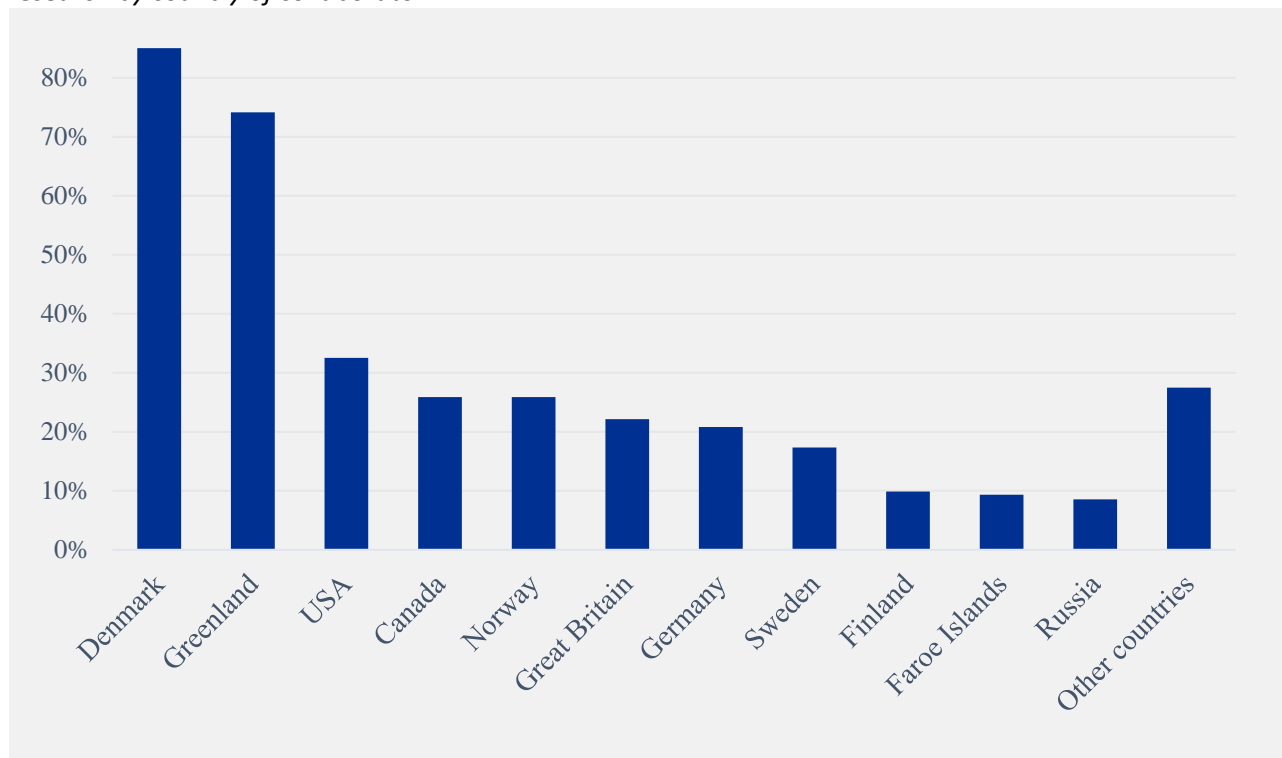
Note: In total, 443 researchers answered this question; natural sciences (n=296), medicine & health (n=72), humanities (n=51), social sciences (n=48), engineering (n=31), and other (n=18). As the researchers could mark multiple scientific fields, the number of respondents amounts to more than the total.

It is of an even higher interest to identify the nationality and affiliation of those with whom the researchers collaborate. While opportunities and challenges for specific collaborating research institutions are analysed in Section 3, the collaborators' country and institutional affiliations are gathered and shown in Figure 7 and 8. In Figure 7, the three constituent countries – Greenland, Denmark and the Faroe Islands – are listed together with the six countries identified by Aksnes et al. (2014) as the most frequently collaborating

countries. In addition, Finland and Russia are included after a consultation with experts in polar research. Although present, the latter two countries do not dominate among the collaborators.

A large fraction of all collaborating researchers on Greenland-related research in the Kingdom of Denmark, above 87%, collaborate with an institution from Denmark (see Figure 7). 74% and 9% collaborate with institutions from Greenland and the Faroe Islands, respectively. Of countries outside the Kingdom, researchers from US institutions are most common, as approximately one-third collaborate with these institutions. One-quarter collaborate with institutions from Canada and Norway each, and around one-fifth with institutions from the UK, Germany and Sweden each. Interestingly, more than one-quarter of the researchers collaborate with institutions from other countries than the eleven mentioned in Figure 7. Overall, the figures show high internationalisation of Greenland-related research due to the high collaboration rates both internally within the Kingdom of Denmark as well as externally with institutions from other countries. It could be added, that all these countries are located in or nearby the Arctic region.

*Figure 7. Share of collaborating researchers who collaborate with research institutions on Greenland-related research by country of collaborator*

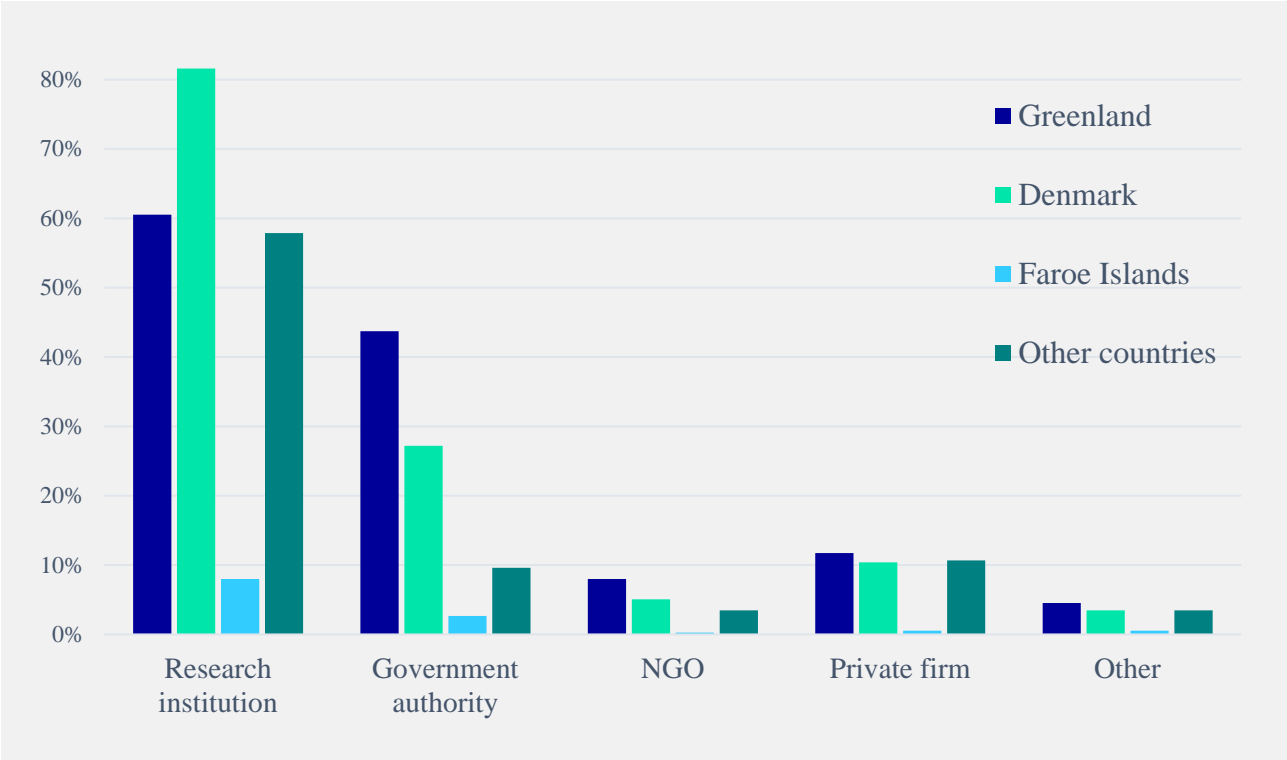


Note: In total, 375 researchers answered this question in the survey, i.e. 85% of 443. The shares are out of 375.

The most frequent type of collaborator institution is research institutions (see Figure 8). 82% of the collaborating researchers in the present survey work with Danish research institutions. It is 61% and 8% for Greenlandic and Faroese research institutions, respectively. A lower share collaborate with government institutions or authorities; the highest share, 44% – with Greenlandic government authorities. Collaboration with NGOs and private firms is not very common, with a much lower level (around 10%).

60% of the collaborating researchers (224 out of 375) mentioned partners from outside the Kingdom of Denmark. Research institutions in particular are present among these collaborators, as Table 10 below shows. Even though the 58% mentioning research institutions from other countries in Figure 8 seems high, their distribution across these other countries in Table 10 shows a variant of the same pattern as in Figure 7 above. The total column in Table 10 is identical to the figures shown in Figure 7.

Figure 8. Share of collaborating researchers by institutional type of collaborator and country of affiliation



Note: Share of researchers with the specific type of collaborator affiliation out of all collaborating researchers (n=375).

Furthermore, table 10 and Figure 9 explores the data on collaborating institutions from countries outside the Kingdom of Denmark in two distinct ways<sup>6</sup>. However, the results illustrates similar same patterns found in Figure 7 and 8. When the researchers marked collaborators from outside the Kingdom of Denmark, the survey also asked the researchers to mark the collaborators’ institutional type and country (see Table 10). Table 10 clearly shows that the majority of the international collaborators are research institutions.

<sup>6</sup> Note: The numbers in Figure 7 corresponds with the “Total” column presented in Table 10

Table 10. Share of collaborating researchers by institutional type of collaborator and country of affiliation. Countries outside the Kingdom of Denmark

	Total	Research institution	Government authority	NGO	Private firm	Other
USA	33%	30%	4%	1%	3%	0%
Canada	26%	25%	4%	1%	2%	1%
Norway	26%	24%	3%	1%	1%	1%
Great Britain	22%	20%	1%	1%	3%	0%
Germany	21%	18%	1%	1%	3%	0%
Sweden	17%	16%	2%	1%	1%	0%
Finland	10%	9%	2%	1%	1%	0%
Russia	9%	8%	1%	0%	0%	0%
Other countries	27%	24%	2%	2%	5%	1%
Total	60%	58%	10%	3%	11%	3%

Note: Share of collaborators' affiliations out of all collaborating researchers (n=375). Each institutional type and country could only be marked once by each respondent. 224 mentioned at least one type of foreign collaborators' affiliation type, i.e. 60%.

When the researchers marked a collaborator from outside the Kingdom of Denmark in the survey, they were subsequently asked to provide name and country of the five most important collaborating partners. 197 out of the 224 did so. Figure 9 shows the distribution of their answers in two ways.

First, all – up to five – marks on each country are summed (to 583), and their share of 197 is calculated and labelled as 'Total' in Figure 9. The share could be as high as 295%, i.e.  $583/197=2,95$ . It is, however, much smaller, see Figure 9.<sup>7</sup> Second, the share of researchers that marked a country as their first choice (most important collaborator) is summed and their share of 197 is calculated and labelled as 'Most important collaborator' in Figure 9. Here, each of the 197 researchers could only give one answer and the share would sum to 100% if they all selected the same country.

For example, a collaborator from the US is mentioned 105 times, giving it a share of 53% in 'Total'. Furthermore, 52 of the 197 researchers mentioned a collaborator from the US as the most important (first choice collaborator), resulting in a share of 26% under 'most important collaborator' in Figure 9. The importance of a country regarding research collaboration is then calculated as the ratio of the two indicators, i.e. 26% divided by 53% for the US.

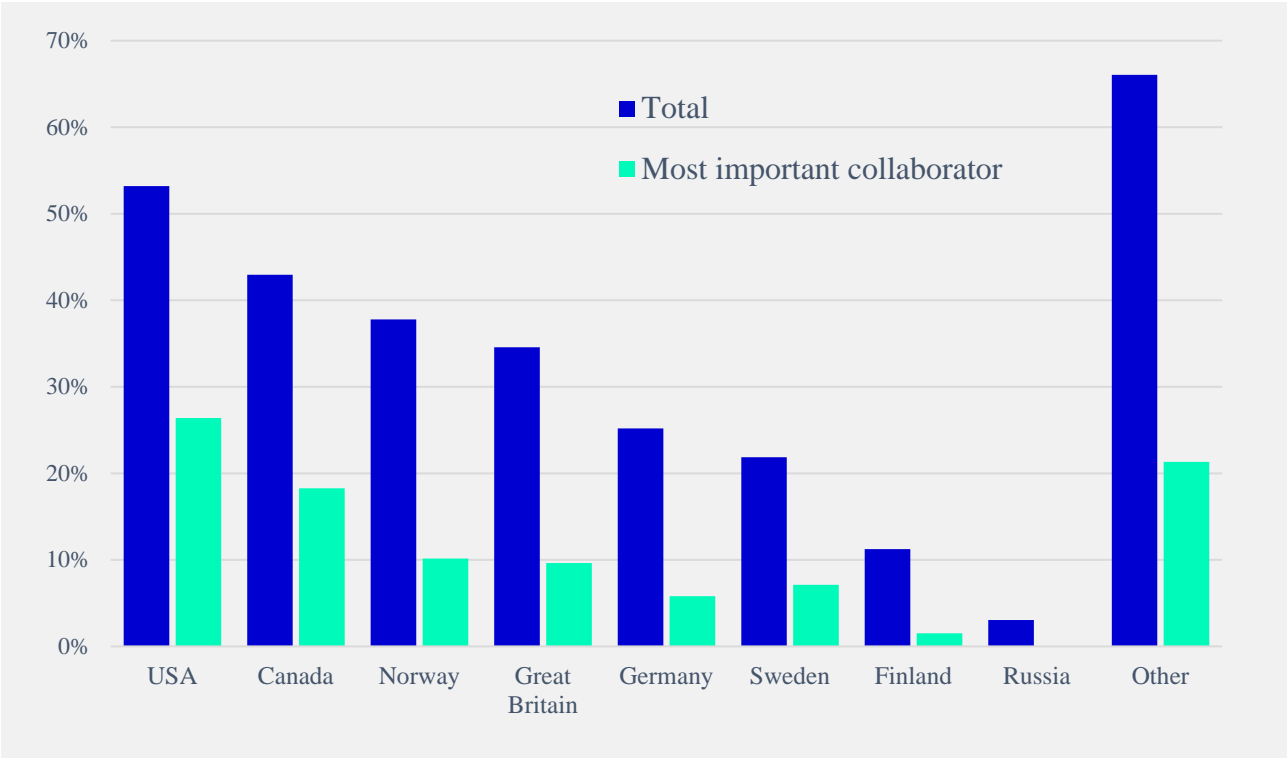
Hence, Figure 9 shows that approximately one out of two (26%/53%) researchers that mentions USA as a collaborating country *also mentions USA as the most important collaborating country*. This ratio is a little lower for Canada which indicates, that collaboration with Canadian institutions is both less frequent compared to collaboration with US institutions and also deemed less important compared to the collaboration with US institutions.

The ratio between collaboration and importance of collaboration is even lower for Sweden, the UK and Norway with one out of three, and Germany with one out of four. Interestingly, the most important collaborating country share for 'Other countries' is as high as one out of three. This indicates that collaboration on Greenland-related research includes a diverse range of other countries than those six found

<sup>7</sup> The division is done to make it scalable with the second indicator.

as most important by Aksnes et al. (2014). On the other hand, the two added countries, Finland and Russia, are seldom mentioned as first choice most important collaborating countries.

Figure 9. Distribution of researchers by collaborator country. Researchers mentioning up to five most important collaborating countries and the most import first choice collaborator country respectively



Note: All – up to five – marks for each country are summed (to 583) and their share of 197 defines ‘total’ (and could be as high as 295%, i.e. =583/197). The ‘most important collaborator’ share is the share of researchers that marked a country as their first choice most important collaborator (and could be as high as 100%, i.e. =197/197).



### 3. Research institutions from six collaborating countries

Aksnes et al. (2014, Table 3.5) identified six countries additional to the three countries in the Kingdom of Denmark, that have the highest rate of co-authorships in the period 2008–2012 with researchers from the Kingdom of Denmark on Arctic-related research. Therefore, a part of the commission by the Danish Agency for Science and Higher Education was to collect experiences on opportunities and challenges for Greenland-related research from research institutions in these countries.

Hence, the gross sample of respondents in the present survey includes research institutions from these six countries (USA, Canada, UK, Norway, Germany and Sweden); these institutions have affiliated authors who co-published with researchers from institutions from Greenland, the Faroe Islands and Denmark during the previous five years, 2013–2017, as identified through the database Web of Science.

A total of 99 institutions with a significant number of co-publications were identified and 23 institutions responded to the survey (see Table A3.2). Although the responding institutions are relatively few and scarcely represent the entire population of research institutions in the countries, they delivered important and extensive responses providing comprehensive and exhaustive insights. Hence, the collected data is usable to answer the specific questions raised by the Danish Agency for Science and Higher Education, i.e. to gather knowledge about the experiences and views of foreign cooperating or collaborating research institutions; however, it is not representative across either countries or scientific fields.

#### 3.1 Scientific field and research activities in Greenland

The 23 institutions that answered the survey are mainly institutions with researchers from the natural sciences (see Table 11).<sup>8</sup> Oceanography, cryospherics and other geosciences are particularly present among them. As the institutions could mark multiple scientific disciplines, they also reveal the presence of interdisciplinary research, especially internally in the natural science field with 57 and 43 marks among the 21 institutions performing research in and about Greenland, respectively. Only institutions performing Greenland-related research in the humanities field are not present among the included institutions.

The recent data collection did not reveal whether such institutions exist or whether the 23 included institutions could be treated as representative of research institutions in Greenland-related research among the six countries. However, the corresponding figures for researchers' collaboration in Figure 6 indicates that natural sciences, to some extent, have a higher probability of collaboration with institutions outside the Kingdom of Denmark. Combined with the large share of researchers from natural sciences among the population of researchers performing Greenland-related research, the many marks in natural sciences in Table 11 are not surprising.

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<sup>8</sup> One institution did not indicate any research fields.

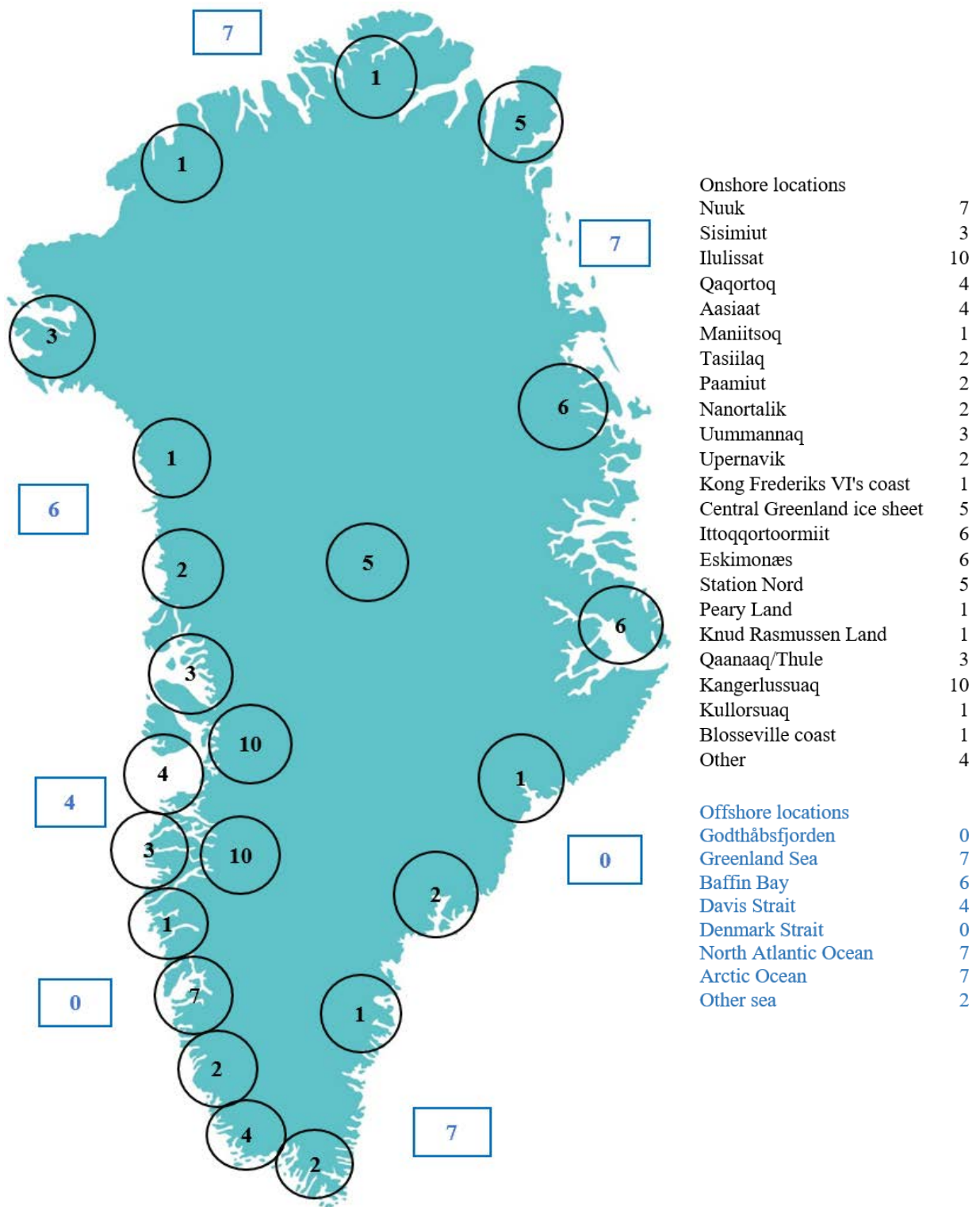
*Table 11. Number of research institutions performing research IN Greenland, performing research ABOUT Greenland and number of unique institutions by scientific field of Greenland-related research activities, 2013-2017*

Field	Number of marks IN	Number of marks ABOUT	Total number of marks	Unique institutions
Natural science total	57	43	100	21
Cosmic geophysics and space research	1	1	2	
Atmosphere research and meteorology	6	5	11	
Oceanography and geophysics	13	10	23	
Cryospheric sciences	12	11	23	
Other geosciences	12	7	19	
Terrestrial biology	4	5	9	
Marine and fisheries biology	8	4	12	
Other biology	1	0	1	
Medicine & health	2	1	3	2
Engineering	2	2	4	3
Social sciences	4	4	8	3
Humanities	0	0	0	0
Other	2	1	3	0
Total	67	51	118	

Note: One institution did not indicate research fields. As the remaining 22 research institutions could mark multiple scientific fields, the numbers total more than 22. 'Other' contains scientific disciplines that are not covered by the listed disciplines; see all disciplines in Table 2.

A mapping of locations where the included research institutions perform research is shown in Figure 10. Keeping in mind that natural sciences dominate among the research institutions, the mapping shows an expectable high number of locations away from the southwest coast. In fact, the institutions carry out their activities at almost all locations in Greenland. However, the highest number of institutions is present onshore in Illulissat, Kangerlussuaq and Nuuk, and offshore in the northern and south-eastern waters. However, the number of institutions is so low that a ranking of locations is somewhat dubious to be used to support conclusions.

Figure 10. Location of research institutions performing Greenland-related research. Numbers out of 23 at each location at land (onshore) or sea (offshore)



Note: Figures on map mark percentages of all institutions in the survey that performed research onshore or offshore in Greenland, and correspond to the geographical locations and percentages in the right-hand side table. The shares only show presence and not necessarily importance of the different locations.

### 3.2 Opportunities for Greenland-related research compared to other Arctic regions

When the institutions were asked to specify what made Greenland-related research opportunities unique as a topic (if they researched *about* Greenland) or as a location (if they researched *in* Greenland), they had a lot in mind. They were asked to contribute, in free text, with experiences indicating uniqueness of Greenlandic research opportunities and to suggest potential improvements.

The comments were analysed and condensed into the most frequent common themes, see Table 12 and the citations in Table 13. The opportunities in Table 12 are a mix of access to unique research material and other research data, and infrastructural themes such as accessibility and research stations.

Comparing comments from institutions that researched *about* Greenland or *in* Greenland or both, revealed no systematic differences. Hence, Table 12 compiled themes from all institutions disregarding whether their researchers were located in Greenland.

*Table 12. Research institutions' comments on opportunities and unique characteristics for Greenland-related research*

- 
- Easy access (relative to Antarctica, regular flights, logistic support from Denmark)
  - Helpful research stations (Arctic Station, Villum research station/Station Nord, Zackenberg Research Station)
  - Unique ice sheet for studying global warming (ecosystem impact, human pollution, effects of past and recent (de)glaciations, contributor to sea-level rise)
  - Studies are easier to conduct in Antarctica (ice evolution, biochemistry, microbiology)
  - Well-preserved terrestrial and cryosphere systems
  - Unique natural resources (rocks from widely different ages, fossils)
  - Unique high Arctic fjord environments
  - Unique collection of specimens
  - Unique conditions for studying conditions and processes in space physics at high latitudes\*
  - Pristine study sites\*
  - Opportunities for international collaboration\*
  - Maintenance of settlements while developing welfare state services (combination of social, infrastructural and environmental questions)\*
- 

Note: \* comment only mentioned once or a few times.

The research institutions provided quite exhaustive comments on opportunities and uniqueness of Greenland-related research. A selected representative number of these are cited in Table 13.

*Table 13. Citations from research institutions' comments on opportunities and unique characteristics for Greenland-related research. Country in parentheses*

- 
- *Just a few days of field work resulted in discovery of at least two species of beetles that were new to Greenland list. (UK)*
  - *Greenland is unique in so many ways and there is an unlimited amount of data available for further studies. Despite the remoteness of the areas of interest, the historical attendance of Danish military and other governmental bodies in the area provide an unique opportunity of accessibility that would otherwise be impossible. (S)*
  - *In Geological research Greenland offers unique exposures of Archean geology that are essential for the study of the development of the Early Earth. (S)*
  - *Politically, socially, culturally and geographically, it offers an interesting comparison to the Canadian Arctic context. There are many innovative social policy developments taking place in Greenland, developments that are interesting to investigate in their own right but also a way to share knowledge and experience across circumpolar contexts. (C)*
  - *Most of our work (all our Greenland work) is based on fieldwork, so research about Greenland and research in Greenland is the same thing. This also implies that the work we do on Greenland must be done on Greenland, and not somewhere else. (N)*
  - *For a botanist the flora of Greenland is unique, and studies on the Greenland flora cannot be done elsewhere in the Arctic. (N)*
  - *Greenland provides an opportunity to study some biological phenomena that do not exist or not as pronounced in other Arctic regions. (N)*
  - *The geographical position of Greenland is unique for studying the conditions and processes in space physics at high latitudes. (N)*
  - *From a geologist's perspective, Greenland is an attractive research target because in many places rocks of widely different ages, ranging from the Archean (>2500 Million years) to Cenozoic (<66 Million years), are juxtaposed with perfect exposures, and these locations are generally more easily accessible than those in other Arctic regions (e.g. High Canadian Arctic or far Russian North). (N)*
  - *Our researchers use the research facilities in Greenland every year and have a very positive opinion of the research stations and their facilities. (N)*
  - *Our researchers use the Sermilik Station, the Arctic Station and KISS on an almost annual basis. These stations are very important for our research and reduce any problems with local logistics significantly. (N)*
- 

Note: UK (Great Britain), S (Sweden), C (Canada), N (Norway), US (USA), G (Germany)

Asking for potential improvements, the most prevalent comment was suggestions on how to minimise the most important challenges. Section 3.3 below addresses these suggestions.

### 3.3 Challenges for Greenland-related research compared to other Arctic regions

Asking about challenges in Greenland-related research resulted in even more similarity in identified topics (see Table 14). It essentially boils down to infrastructural challenges of different kinds (i.e. transport, costs, facilities) and language barriers, namely due to the native languages in the Kingdom of Denmark. An important difference in the comments relates to infrastructural challenges where the institutions point at logistical challenges travelling around *in* Greenland as well as transporting themselves *and* equipment to Greenland.

*Table 14. Research institutions' comments on challenges for Greenland-related research*

- 
- Logistics (in Greenland during fieldwork): mobilisation of equipment without logistic hubs, shipping equipment to/from Greenland, limited accessibility to remote areas, dependence on Air Greenland (for helicopters)
  - Logistics (getting to Greenland): flights via Denmark or Iceland increase travel costs and time, low and expensive accessibility to ships
  - Funding (very high costs especially due to poor logistics)
  - Absence of research base in the far north
  - Restricted internet access
  - Communication issues (difficulties without language skills in Danish or Inuit)
- 

The research institutions provided numerous comments on challenges for their Greenland-related research. A selected representative number of these are cited in Table 15.

*Table 15. Citations from research institutions' comments on challenges for Greenland-related research. Country in parentheses*

- 
- *Accessibility is a major problem once research is supposed to be conducted far inland or on remote glaciers – which are typically the locations of highest interest. (G)*
  - *Complete dependence on Air Greenland for helicopter support. This is the single greatest impediment to field research on the Greenland Ice sheet. (UK)*
  - *Absence of a research base such as (Norway's) Ny-Alesund base on Svalbard. There is useful accommodation at KISS in Kangerlussuaq but nothing of significance farther north – severely restricting access for science teams. (UK)*
  - *The Air Greenland monopoly on helicopters has been a major difficulty in the past for many research teams in terms of trying to access a helicopter in certain research areas but especially around Kangerlussuaq. As a result, it hasn't always been possible to get access to a helicopter when wanted or a helicopter has had to be transferred from Ilulissat or Nuuk with an enormous charter re-positioning cost. These issues mean that a considerable amount of money is needed to support any research, not least because a large contingency fund is needed to cover any associated weather or last minute helicopter availability delays. I can certainly say without doubt, that after carrying out a decade of field based research in Greenland, the logistics, costs and difficulties associated with chartering Air Greenland helicopters are by far and away the most difficult challenge of all in undertaking the research (once research money has been secured which itself is of course is hard). (UK)*

- *The barrier to entry to do research and field teaching in Greenland is the very high logistical cost, including travel to Greenland. (N)*
- *The overriding challenge remains funding. Opportunities to carry out research in Greenland are dependant on external research grants, in a very competitive funding climate. (UK)*
- *One of the main problems with Greenland sites like Zackenberg Research Station, the Arctic station, and Station Nord is the limited accessibility and the large costs connected to fieldwork. So even if there are still large areas that urgently need to be investigated before the environmental parameters changes too much, there is no way that single scientists can afford to go there. (S)*
- *The system for obtaining permits to work in Greenlandic waters is not conducive to the planning of research expeditions. Although applications can be submitted well in advance, permits are typically issued only a few days before requested expedition start dates. A lot of research tasks require planning further in advance. It is difficult to make work in Greenland the main focus of an expedition visiting several regions when permission is not granted until the last minute. (N)*
- *The major challenges for us involves the remoteness of the area we are working in. Also weather conditions and nature restrictions (rightly so), make the work slight complicated. This will have the effect that the costs for fieldwork is high. The whole logistics with transport of material, staff and collected samples is complicated and very costly. Fieldwork of the type conducted by our research groups are difficult to get funding for and is often not enough to be efficient enough. (S)*
- *There are no commercial flights from Mainland US to Greenland. We therefore have to rely on the 109th which has a fixed rotation schedule that is sometimes difficult to work around. (US)*
- *Of course, travel to and from Greenland is one of the most difficult challenges, particularly from North America. (C)*

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Note: UK (Great Britain), S (Sweden), C (Canada), N (Norway), US (USA), G (Germany)

However, suggestions on how to reduce the challenges point solely towards the infrastructural topics, see Table 16. They focus on transport, facilities and costs but also on the administrative speed or burden and extended international collaboration.

*Table 16. Research institutions' suggestions on how to reduce the most prevalent challenges for Greenland-related research*

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- Science helicopter support
  - Research centre/logistic hubs
  - Better logistical support for research (Air Greenland should not have monopoly)
  - Faster processing of expedition permits/lower administrative burden (applications are designed for mining companies and not research trips)
  - Stronger international collaboration (e.g. expanding Isaafiq platform; Denmark should take active part in multilateral Arctic research cooperation; University in Nuuk could serve as a coordinating centre)
  - Better funding opportunities
-



The research institutions gave a number of suggestions on how to reduce challenges for their Greenland-related research. A selected representative number of these are cited in Table 17.

*Table 17. Citations from research institutions' suggestions on how to reduce the most prevalent challenges for Greenland-related research. Country in parentheses*

- 
- *In terms of accessibility, more logistic hubs, e.g. like research stations as in Antarctica or on Svalbard, would be very useful, in particular also skiways/runways of length suitable research aircrafts of medium size. (D)*
  - *To further conduct research onshore Greenland, I could imagine that some kind of logistical/infrastructure support from Danish/Greenland partners/institutions could help, e.g., accessibility to helicopters to reach remote areas. (G)*
  - *A suggestion would be to expand the Isafiq platform and to arrange annual logistic meetings in which international and local partners could join efforts, e.g. for sharing cargo charter flights, mobilization of aircraft. (G)*
  - *In order to give outside scholars and students better access to Greenland, it is advisable that Denmark takes very active part in multilateral Arctic research cooperation and embeds Greenland research in such multilateral frameworks, such as the International Arctic Science Committee, the International Arctic Social Sciences Association, the China Nordic Arctic Research Center, Norden, Nordforsk, etc. (N)*
  - *Improved logistical support (e.g. equivalent to US NSF operations, but available to all) would help, as would science support contacts within local communities who can facilitate access to sites and services. (UK)*
  - *Things would have been improved considerably if Air Greenland charter didn't have such a monopoly or at least make it very very hard for any other operator. (UK)*
  - *One possible way to improve "the possibilities and facilities" would be to make better research facilities/equipment available to other research communities (in addition to the Danes?) to encourage research activities. (UK)*
  - *Suggestions for improvement include more assistance in connecting with research assistants, graduate students and interpreters. It is difficult to do social research in Greenland without knowledge of Danish as well as Greenlandic. (C)*
  - *Everything is so expensive. More funding opportunities for those who do (or wish to do) research in Greenland (and use the research facilities) would be welcome. Also, some kind of hub providing overview of research facilities across Greenland would be useful. (N)*
  - *Applications and subsequent reporting over fieldwork is tedious and designed for mining companies and not research trips. Improved and simpler requirements by the MLSA would be helpful, as well as MLSA actually responding to enquiries would also help. (N)*
  - *If it is possible to reduce the cost for helicopter transport for researchers, then it would be easier to examine the scientifically most relevant field sites rather than selecting field sites based on low travel costs. (N)*
- 

Note: UK (Great Britain), S (Sweden), C (Canada), N (Norway), US (USA), G (Germany)



## 4. Concluding remarks

This report has analysed and presented results on Greenland-related research activity with opportunities and challenges for conducting research in or about Greenland. The following section summarises the main findings.

### 4.1 Recent trends and developments in Greenlandic research

Natural sciences clearly dominate Greenlandic research followed by medicine and health. The remaining fields, i.e. engineering, humanities and social sciences, are all present in Greenlandic research, but not to the same extent. There is, however, a strong tendency for research to be carried out *in* Greenland across all scientific fields, except for medicine and health where half of the research activity is located outside Greenland.

In addition to this result, the analysis also shows that there is a consistently high level of research activity in Greenland, since the majority of researchers active during 2013–2016 also conducted research in 2017. Most researchers located in Greenland work there for no more than 50 days per year, with almost half of the respondents working less than 26 days or so. The scarce number of researchers working for more than 50 days is due to the few researchers that are permanent residents in Greenland.

Onshore activity is higher than offshore activity, but there is quite a substantial number of researchers located at the seas west of Greenland and in the northeast. The southwest coast is the most frequently visited onshore region across all fields, with Nuuk accounting for the highest research activity. In general, researchers from the natural sciences are more broadly represented in the different regions, especially in the northern and northeastern part of Greenland.

### 4.2 Uniqueness and opportunities

Most researchers, but especially those conducting their research *in* Greenland, consider Greenland as rather scientifically unique. The ice sheet, geological variety and special characteristics of the Inuit population are highlighted by the researchers as the most unique research objects among a number of other relevant characteristics. For researchers in Greenland, there is a widespread recognition of the relatively good logistic opportunities compared to other Arctic regions.

### 4.3 Challenges and future development

The researchers consider economic constraints (i.e. lack of funding) as the most important challenge for carrying out research both in and about Greenland and across all fields. Additional but less important challenges include vast geographical distances, lack of infrastructure, personal reasons and extreme weather conditions.

The researchers *about* Greenland also mention economic constraints as the most challenging factor for conducting research in Greenland, but almost half of the respondents also indicate that it is actually scientifically unnecessary to conduct their research *in* Greenland. Furthermore, natural scientists are particularly likely to mention challenges related to the lack of infrastructure and vast geographical distances compared to researchers from other fields.

#### 4.4 National and international collaboration

Collaboration with other institutions is very common across all fields, but collaboration is primarily with research institutions and government authorities from Greenland and Denmark. When it comes to collaboration between researchers from the Kingdom of Denmark and international institutions, there is a somewhat higher degree of collaboration in natural sciences and engineering compared to other fields. These international collaboration partners are typically research institutions, as was the case for the national institutions. The US and Canada constitutes the most frequent and important institutions with whom collaboration is engaged, but relative to size, Norway is to be regarded as an important collaborator as well.

#### 4.5 International institutions

A less comprehensive survey distributed to a number of international institutions provided perspective from partners outside the Kingdom of Denmark. These results have mainly contributed to an in-depth understanding of the opportunities and challenges for research in and about Greenland. In line with the results from the national survey, the natural sciences dominate Greenland-related research. Furthermore, international institutions also consider Greenland as scientifically unique with a number of different unique objects for carrying out research. Regarding challenges, the logistics of travelling to and within Greenland seem to be the main issue of carrying out research, which also implies economic and funding issues.

## References

- Aksnes, D. W., Larsen, K. S., Nielsen, L., and Rørstad, K. (2014). [\*Polar research in the Kingdom of Denmark 2013. A mapping survey. NIFU report 18/2014\*](#). Oslo: Nordic Institute for Studies in Innovation, Research and Education.
- Arctic Council. (2017a). [\*Agreement on Enhancing International Arctic Scientific Cooperation\*](#).
- Arctic Council. (2017b). [\*Fairbank Declaration 2017\*](#).
- Danish Agency for Science, Technology and Innovation (2016). [\*The Kingdom of Denmark: Cutting Edge Research in the Arctic – a presentation of Danish polar research\*](#). Copenhagen: Ministry of Higher Education and Science.
- Glob, A. (forthcoming). *Kortlægning af polarforskning i Kongeriget Danmark*. Copenhagen: Ministry of Higher Education and Science.
- Ministry of Foreign Affairs. (2011). [\*Denmark, Greenland and the Faroe Islands: Kingdom of Denmark Strategy for the Arctic 2011–2020\*](#). Governments of Denmark, Faroe Islands, and Greenland.
- Ministry of Higher Education and Science. (2016). [\*Strategy for research and education concerning the Arctic\*](#). Copenhagen: Ministry of Higher Education and Science.
- Ministry of Higher Education and Science. (2017). *Polar Secretariat*. Retrieved from <https://ufm.dk/en/research-and-innovation/international-cooperation/the-polar-secretariat> and <https://ufm.dk/forskning-og-innovation/internationalt-samarbejde/polarsamarbejder>
- Mortensen, P. S. (2006). [\*Grønlandsrelateret forskning og udvikling – Forskningsstatistik 2003-04. Tabelsamling\*](#). Aarhus: Danish Centre for Studies in Research and Research Policy, Aarhus Universitet.

## Appendix 1. Additional data

*Table A.1. Location of research IN Greenland, 2013–2017. Share of researchers onshore and offshore who performed (current) or want to perform (future) research at the locations*

Location		Current activity (2013–2017)			Future activity requested by researchers		
		Total	Natural sciences	Other fields	Total	Natural sciences	Other fields
Onshore locations*	Nuuk	50%	36%	72%	37%	31%	47%
	Sisimiut	19%	12%	31%	25%	17%	41%
	Ilulissat	29%	27%	37%	34%	26%	50%
	Qaqortoq	17%	18%	15%	29%	19%	44%
	Aasiaat	17%	17%	22%	15%	12%	18%
	Maniitsoq	11%	10%	13%	16%	12%	20%
	Tasiilaq	18%	19%	17%	28%	23%	41%
	Paamiut	8%	8%	7%	14%	11%	18%
	Nanortalik	12%	11%	13%	25%	21%	33%
	Uummannaq	12%	13%	10%	19%	17%	23%
	Upernavik	11%	12%	7%	19%	17%	22%
	Kong Frederick VI coast	5%	6%	2%	12%	14%	9%
	Central Greenland ice sheet	7%	10%	2%	11%	13%	6%
	Ittoqqortoormiit	16%	22%	9%	34%	34%	35%
	Eskimonæs	19%	27%	2%	24%	29%	11%
	Station Nord	18%	26%	4%	32%	39%	16%
	Peary Land	9%	13%	2%	25%	30%	12%
	Knud Rasmussen Land	4%	6%	1%	13%	16%	7%
	Qaanaaq/Thule	14%	16%	12%	33%	32%	39%
	Kangerlussuaq	18%	24%	12%	15%	17%	15%
	Kullorsuaq	6%	7%	5%	13%	13%	14%
	Blosseville coast	6%	8%	2%	13%	16%	6%
		<b>Total onshore</b>	<b>270</b>	<b>182</b>	<b>121</b>	<b>273</b>	<b>206</b>
Offshore locations*	Godthåbsfjorden	29%	29%	32%	30%	28%	33%
	Greenland Sea	31%	32%	18%	56%	55%	50%
	Baffin Bay	48%	49%	39%	62%	60%	75%
	Davis Strait	35%	34%	32%	41%	39%	38%
	Denmark Strait	23%	24%	7%	38%	38%	29%
	North Atlantic	26%	28%	21%	33%	33%	25%
	Arctic Ocean	17%	18%	11%	53%	54%	33%
	Other sea	25%	26%	32%	20%	20%	17%
		<b>Total offshore</b>	<b>102</b>	<b>96</b>	<b>28</b>	<b>91</b>	<b>87</b>

Note: As the researchers IN Greenland could mark multiple scientific fields, the respondents from natural sciences and other disciplines may amount to more than the total. \* Share of researchers at land and sea respectively, and not of total as in Figure 3.

*Box 1. Predicted number of researchers in Greenland-related research residing in the Kingdom of Denmark in 2017*

The estimations presented below build on the work of Mortensen (2006) and Aksnes et al. (2014), two works that are theoretically comparable even though they are based on different sources. The predicted number of researchers in Greenlandic research in 2017 may not be an entirely accurate figure. However, these calculations, based on trends and growth rates, are, to the best of our knowledge, illustrative of the number of personnel performing Greenland-related research in the Kingdom of Denmark.

In 2004, the public-sector research and development (R&D) personnel performing Greenland-related research in Denmark and Greenland equalled 316 people, including 163 full time equivalent (FTE) researchers (Mortensen 2006). In 2013 (Aksnes et al. 2014, table 2.3), the public-sector FTE R&D personnel performing Greenland-related research amounted to 466 in total for the three countries (Denmark, Greenland and the Faroe Islands). Natural sciences account for the largest fraction of R&D personnel, 67%. Using the figures from 2004 and 2013, we found an average annual growth rate in FTE R&D personnel slightly above 10%.

Using the FTE/headcounts in Mortensen (2006) and the identified growth rate of 10.25%, the total number of R&D personnel situated in the Kingdom of Denmark and performing some kind of Greenland-related research is predicted to be approximately 1 340 in 2017. This corresponds to 690 FTE researchers.

However, 1 340 may be a slight overestimate since bibliometric search for researchers, who are situated in the Kingdom of Denmark by the end of 2017 and have published Greenland-related research in the last five years (2013–2017), was found to be approximately 1 120 (see Section 2.1 and Appendix 2). However, the bibliometric search lacks (mostly young) researchers who have not (yet) published work that includes the search words in the period, as well as native researchers living outside the Kingdom of Denmark in 2017.

In addition to the researchers in the Kingdom of Denmark, a high number of researchers in collaborating countries also perform Greenland-related research, see Section 2.6 and Glob (forthcoming).

## Appendix 2. Empirical and methodological data collection strategy

### *Identification of respondents*

The number of researchers in the Kingdom of Denmark who perform Greenland-related research is difficult to quantify, see Box 1 in Appendix 1. There exist no listings of these researchers and their affiliations. Therefore, the potential respondents for the present survey were identified in two steps. First, all actively publishing researchers in Greenland, the Faroe Islands and Denmark in 2013–2017 were identified through bibliometric sources.<sup>9</sup> Second, the list of researchers in polar research from Aksnes et al. (2014) was extracted. Merging these two samples and deleting duplicates resulted in a list of 1 120 unique researchers affiliated with institutions in the Kingdom of Denmark, who potentially had performed Greenland-related research.

Of the 1 120 researchers, 1 079 were traceable with up-to-date contact information at public research institutions in 2017. 51% of these answered the survey questionnaire; since 74 persons claimed not to have performed Greenland-related research in the period, a total of 472 responses were collected from people who said they had actively performed Greenland-related research while residing in the Kingdom of Denmark.<sup>10</sup> The majority resided in Denmark, but most had also performed Greenland-related research in Greenland at least once during the last five years. See also the distributions and response rates in Appendix 3.

Using the pool of 1 120 researchers identified above, a list of co-authors was sampled. The co-authors' affiliated institutions and country were then identified, and institutions from the USA, Canada, the UK, Norway, Germany and Sweden were isolated and manually checked for differences in spelling and language references of the institution names. Finally, the institutions with a significant number of co-authorships were selected for the survey, see Table A.3.2. Of 99 institutions, 23 answered the questionnaire survey.

### *Construction of questionnaires*

Initially, the survey was informed by and built on a comprehensive desk study of past and recent investigations, information and developments in scientific activities in Greenland and the Arctic, e.g. Aksnes et al. (2014) and the Ministry of Higher Educations' Polar Secretariat (2017), among others.

The questionnaire was constructed to answer the specific questions raised in the commission by the Danish Agency for Science and Higher Education. The quality of the researcher survey questionnaire was improved through consultations with the Agency and with former Deputy Centre Director Tage Dalsgaard, Arctic Research Centre, Aarhus University. As a next step, another survey questionnaire was developed and distributed to scientific institutions in the USA, Canada, the UK, Norway, Germany and Sweden that had researchers co-publishing Greenland-related research together with colleagues from the Kingdom of Denmark. See also explanations in Appendix 4.

### *Data collection*

Empirical data has been collected on a voluntary basis from potential respondents with knowledge of or experience in Greenland-related research. Both researchers and research institutions are therefore potential informants for the present survey. Without knowledge of their representativeness, it is important to note

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<sup>9</sup> A search in the database Web of Science identified researchers from Greenland, the Faroe Islands and Denmark who have published Greenland-related research in the period 2013–2017.

<sup>10</sup> A search of academic outputs of the persons that claimed not to have actively performed Greenland-related research during the last five years revealed that the vast majority did mention Greenland-related topics in their publications, but that it may not have been the central purpose of the publications. An example of a Greenland-related theme can be the use of Greenlandic material collected for other purposes or data from collaborating partners.

that opinions are potentially biased towards active and dedicated experts in the field. A short overview revealed that answering researchers are well experienced in the field and that the complying research institutions are significantly represented in Greenland-related research. Hence, there may be a tendency that less active researchers and institutions are overrepresented among the non-respondents.

A potential overrepresentation of experienced expert respondents may make the survey results even more relevant for identifying the present needs and experiences in Greenland-related research. The identified opportunities and barriers, opinions on uniqueness and importance of Greenland as a research field may therefore be even more comprehensive and reflective of an accurate picture. We do believe that the present survey reveals reliable results usable for policymakers and other interest organisations in relation to infrastructure, funding and accessibility to Greenland and Greenland-related research.

#### *Analytical strategies*

Without knowing the total population of researchers or research institutions, the survey is structured as a contribution analysis where statistical figures and qualitative statements are used to illustrate patterns and answer the commissioned questions. The validity of the results is high and documentable and represents a large volume of expert-based knowledge and evidence on scientific fields, geographical locations, uniqueness, opportunities and challenges for Greenland-related research.

Quantitative and qualitative analyses have been used to extract important results, synthesise the responses and summarise the findings in a step-by-step approach, i.e. mixed methods approach.

## Appendix 3. Researchers and collaborative research organisations

### *Participating researchers from the Kingdom of Denmark*

The population of researchers affiliated with research institutions in Greenland, the Faroe Islands and Denmark are identified in the present survey as researchers who published scientific articles and other publications during the previous five years, 2013–2017, with variations of the word ‘Greenland’ included in the title or abstract.

*Table A3.1 Numbers of researchers in population and among the survey respondents by country*

Country	Responding	Not responding	Total	Response rate
Greenland	39	25	64	61%
Denmark	494	496	989	50%
Faroe Islands	13	5	18	72%
Total	546	533*	1079*	51%

Note: 1 120 unique researchers were identified through Web of Science, but only 1 079 were identifiable at research institutions. \* Seven non-responding researchers could not be assigned to one of the three countries.

### *Participating research organisations from US, Canada, UK, Norway, Germany, and Sweden*

The institutions are identified in the present survey as research institutions in the six countries (USA, Canada, UK, Norway, Germany and Sweden), having affiliated researchers who co-published with researchers affiliated with institutions from Greenland, the Faroe Islands and Denmark during the previous five years, 2013–2017. A list of institutions with an identified significant number of co-publications constitutes the potential contributors for this part of the survey (see Table A3.1). Twenty-three institutions responded to the survey. Aksnes et al (2014) identified the six main collaborating countries with researchers from Greenland, the Faroe Islands and Denmark on Greenlandic scientific activities in the period 2008–2012.

*Table A3.2 Numbers of research institutions in population, and answering the survey by country*

Country	Responding	Not responding	Total
US	2	24	26
Canada	4	11	15
UK	6	17	23
Norway	7	8	15
Germany	1	12	13
Sweden	3	4	7
Total	23	76	99



## Appendix 4. Questionnaire surveys

Initially, the survey was informed by and built on a comprehensive desk study of past and recent investigations, information and developments in scientific activities in Greenland and the Arctic, e.g. Aksnes et al (2014) and the Ministry of Higher Educations' Polar Secretariat (2017), among others.

### *Questionnaire survey to researchers in the Kingdom of Denmark*

As part of the survey of scientific activities in and about Greenland, a questionnaire was developed to gather information from researchers in Greenland, the Faroe Islands and Denmark. The questionnaire was constructed to answer the specific questions raised in the commission by the Danish Agency for Science and Higher Education. During the design phase, the quality of the survey questionnaire had been improved through consultations with the Agency and with former Deputy Centre Director Tage Dalsgaard, Arctic Research Centre, Aarhus University.

The survey can be requested from the authors.

### *Questionnaire survey to research organisations in US, Canada, UK, Norway, Germany, and Sweden*

As another part of the survey of scientific activities in and about Greenland, a questionnaire was developed to gather information from significant research institutions in six countries, namely the USA, Canada, the UK, Norway, Germany and Sweden. The survey questionnaire was constructed to answer the specific questions raised in the commission by the Danish Agency for Science and Higher Education.

The survey can be requested from the authors.

## Research stations in Greenland



Source: [Danish Agency for Science, Technology and Innovation. 2016, p. 2.](#)