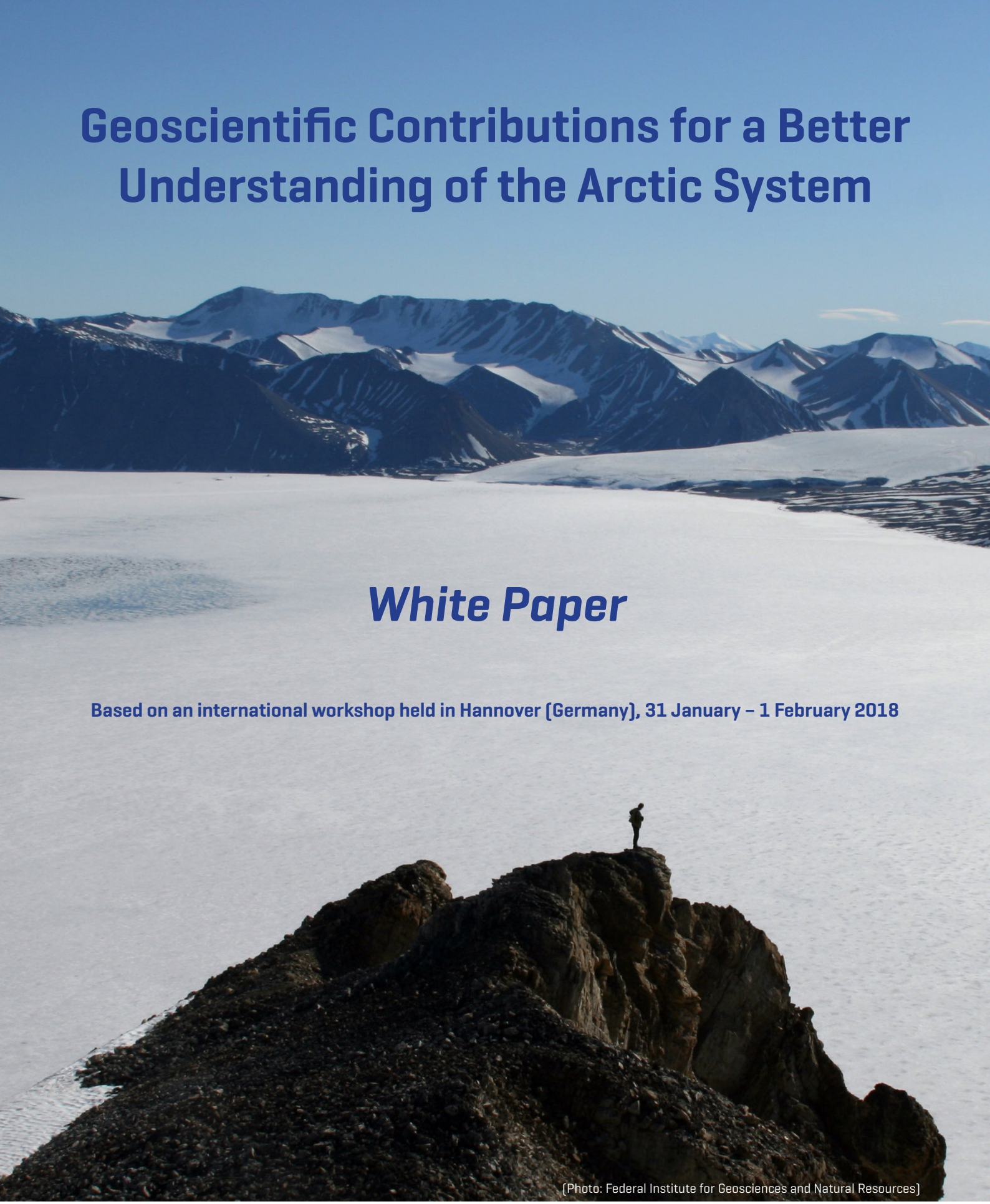
Geoscientific Contributions for a Better Understanding of the Arctic System



White Paper

Based on an international workshop held in Hannover (Germany), 31 January – 1 February 2018

(Photo: Federal Institute for Geosciences and Natural Resources)

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Climate change in the Arctic has wide-ranging impacts on the region's people and ecosystems, not least because of the increasing accessibility of a more and more open Arctic Ocean. This concerns specifically the wide Arctic continental shelves that are expected to contain thus far undiscovered oil and natural gas resources. Against this background, geosciences can provide policy makers and stakeholders with essential knowledge to better understand and consequently respond to the uncertainties inherent in Arctic change processes. This requires increasing efforts to fill current knowledge gaps in geoscientific research on the Arctic as well as to realize synergies with other scientific disciplines such as law, economics, political science, and anthropology. Such efforts provide the basis for societal services that geosciences could provide. Not least, this opens possibilities for geosciences to engage with societal stakeholders about geoscientific knowledge generation and transfer, which will ultimately enhance the societal relevance and legitimacy of geoscientific research efforts.

To highlight current and potential geoscientific contributions for a better understanding of the Arctic systems, the Federal Institute for Geosciences and Natural Resources (BGR), the German Arctic Office at the Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, GEOMAR Helmholtz Centre for Ocean Research Kiel, and the Institute for Advanced Sustainability Studies (IASS) Potsdam organized a workshop at the BGR in Hannover on 31 January and 1 February 2018, funded by the German Science Foundation (DFG). Leading experts from various backgrounds provided keynote talks on the changing environment in the Arctic, geological and climatic history, natural resources and exploration activities, impacts of hydrocarbon exploration and exploitation, and governance and the legal regime of the Arctic.

On day two of the workshop the participants, including senior and early career researchers from geosciences, environmental assessment, economics, political science, law, and humanities from Germany and abroad, formed three breakout groups to develop input for geoscientific contributions for a better understanding of Arctic systems. The groups focused on "Past, Present and Future of the Arctic", "Natural Resources: exploration and exploitation", and "Economic, legal and social risks and impacts". The results of the breakout groups summarized in the present document outline concrete ideas how geosciences in interdisciplinary cooperation with other disciplines can contribute to cutting edge Arctic research efforts and science-policy-society interactions.

Geoscientific knowledge and research interest in relation to the Arctic

Participants compiled a number of scientific topics that outline the current knowledge gaps in geoscientific research on the Arctic. Tackling these issues will significantly improve our understanding of the Arctic we see today and will see in the future. Among the identified topics are improved efforts to understand the full dimensions of climate variability from geological records as the current instrumental record is too short and anthropogenic influences and natural variability need to be separated. Further efforts are needed to enhance our process understanding through climate reconstructions and paleo-modelling, for example to enable models to reproduce and predict modern and future sea ice decrease. Participants further highlighted the need to delve deeper into the geodynamic evolution of the Arctic in deep time, i.e. linking paleoenvironmental history and resources and reconstruct past climates in different ocean-continent configurations. The past is a key to the present as to the future. In the past, the Arctic has experienced drastic changes in the environment and climate. Only the understanding of processes leading to these changes will allow reliable predictions for the future.

Achieving knowledge enhancements on these topics requires Arctic wide coverage of data and studies, for example through wide-range drilling initiatives as well as observing systems that monitor ice and coastal zone dynamics. Also, new environmentally friendly low-impact remote sensing methods have to be applied to study mineral resources and its distributions.

With solid knowledge about resource characteristics, geosciences can further contribute to resource management and the related regulatory framework through controlled resource assessment, identification of usage conflicts, design of effective monitoring systems, and research on full cycle management. This, in turn, can feed into decision-making and information processes on various scales, ranging from northern communities to regional and national policy-makers as well as industry and the general public as illustrated in Figure 1.

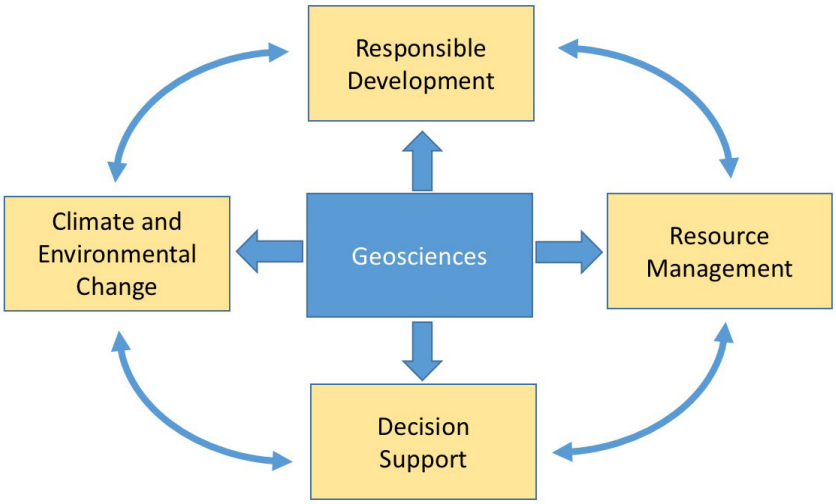

Figure 1: Geoscientific contributions to decision-making and information processes.

All these are important pieces in the overall task of responsible resource development (see below) to which geosciences can provide a significant contribution, including adaptation strategies to geo-hazards with impacts on health and infrastructure, damage control, and improvement of living conditions in the north. This, in turn, feeds back into resource characterization in the sense of assigning resources and their (non) development a role for societal development and/or protection.

Recommendations:

* Maintain Arctic wide geoscience studies to enhance our circumpolar understanding of climate variability, including:
  - sampling for climate proxy calibration/improvement;
  - studying the deep time record to understand Arctic climate through geologic time
  - revitalizing drilling initiatives in the Arctic Ocean using mission specific platforms;
  - utilizing seismic data to date key marker horizons and to reconstruct the tectonic history, oceanic gateways and thus the interaction between oceanic circulation and climate change.
* Monitor parameters of present geological change, such as:
  - geodetic measurements to monitor uplift and ice dynamics;
  - seismic activity;
  - carbon and sediment dynamics.
* Develop proxies for climate change, such as salinity indicators.
* Provide precise ages as a backbone of all paleoclimatic interpretations.
* Enhance traditional methods of resource assessment:
  - employment of new low-footprint concepts of mapping, including remote sensing on various scales;
  - feasibility studies and exploration models.
* Manage natural geo-resources involving
  - controlled resource assessment;
  - design of effective monitoring systems;
  - water management;

* Research on full cycle management from exploration to environmental and societal impact of exploitation and land recultivation.
* Provide open access to all relevant data and baseline studies.
* Investigate and assess the complete chain of natural resources usage from exploration to production and mining in order to mitigate pressure on environment and social systems.
* Foster the engagement of early career researchers in disciplinary as well as interdisciplinary research efforts on the Arctic.

Geoscientific Services and Self-Reflexive Exercise

Building on existing and future research efforts as outlined above, geoscientists should more strongly highlight the societal services that geosciences could provide and that are relevant for legal, political, and economic processes and decision-making alike. These range from services in relation to resource characterization, including mapping, resource assessment, feasibility studies, to exploration models of mineral and energy resources as well as water, soil, and aggregates. For this to be successful, the motivation, goals, modes, risks, and impact of knowledge generation and transfer in relation to geoscientific services have to be discussed with and require the engagement of decision-makers and Arctic communities in order to ensure the legitimacy of geoscientific research and related services. Such interactions further need to provide a platform to allow for the engagement of scientific methods and knowledge on a par with traditional and local knowledge, and for the option to adapt research plans and methods accordingly.

Taking the role as societal service provider seriously as well as the ambition to contribute to responsible resource development requires a self-reflexive exercise of geosciences in the sense of defining its role in resource development including respective normative implications. Geoscientists need to engage with questions like: What is sustainable and responsible resource development? How can (and should!) geoscientists contribute to sustainable and responsible resource development? As a striking example, the dilemma of (some activities of) geosciences contributing to the development of fossil fuels while also being committed to mitigating climate change, needs to be addressed. This is especially crucial in an Arctic context where the tension between economic opportunities from resource development stand in stark contrast to the North experiencing double the rate of warming than the global average.

This will have to lead to questions about how geoscientific research efforts should be initiated and conducted, taking into account the possible consequences of such research in relation to politics, economics, and society at large. This would not only ensure the societal legitimacy of geoscientific knowledge generation and transfer into society but also counteract possible unwanted perceptions of geoscientific efforts, such as being seen as a mere “helping hand” of the resource industry.

To explore societal services that geosciences could provide and to answer the abovementioned questions, interdisciplinary research efforts with researchers from social sciences, law, economics, and anthropology should be fostered. This involves an array of tasks, ranging from setting up appropriate communication and collaboration formats, sufficient funding, new measurements of scientific output in the sense of acknowledgement of interdisciplinary and policy-relevant contributions, and the identification of joint research topics. Examples for the latter are the clarification of legal concepts that are based on geological understandings, as implemented by the United Nations Convention on the Law of the Sea. Other options include review work as to the feasibility of data acquisition in different Arctic regions, i.e. to map where and why it is (im)possible to gather certain types of required data. Other studies could look into the possible political interpretations and consequences of geoscientific data acquisition and analysis, especially in relation to resource characterization, including mapping, resource assessment, feasibility studies, and exploration models of mineral and energy resources, as well as water, soil, and aggregates.

Recommendations:

* Identify **societal services** that geosciences can and should provide, for example in form of reviewing existing mission statements of geoscientific institutes and a possible workshop discussing possible updates thereof with stakeholders from policy, local communities, ethical committees, industry etc.
* Initiative a **self-reflexive exercise** to define geosciences' role in resource development including respective normative implications. For example, revisit existing ethical codes for geoscientific research and discuss these with ethical committees, funding agencies, and local communities affected by geoscientific research.
* Initiate **inter- and transdisciplinary research** efforts to explore geoscientific services and the meaning of sustainable and responsible resource development and draw conclusions for the initiation and conduct of geoscientific research.
    - Set up communication and collaboration formats for interdisciplinary work, e.g. nationally establish regular working group meetings, such as via online tools, cutting across different German Arctic research institutes, organized by the German Arctic Office
    - Internationally, embed interdisciplinary research efforts within the International Arctic Science Committee (IASC), e.g. consider setting up an interdisciplinary steering board in cooperation with IASC with researchers from various disciplines to help bring interdisciplinary Arctic research teams together.
    - Highlight the (inter)disciplinary contribution of geosciences during international Arctic research planning efforts, such as ICARP (International Conference for Arctic Research Planning)
    - Brainstorm interdisciplinary cooperation formats with the International Arctic Social Sciences Association (IASSA)
    - Identify joint research projects/questions
    - Secure the necessary funding for inter- and transdisciplinary collaborations
    - Initiate efforts for a new measurement of scientific output in the sense of acknowledgement of interdisciplinary and policy-relevant contributions, possibly in cooperation with IASC and funding organizations.
    - Set up communication and collaboration formats for transdisciplinary work (engage on par with traditional and local knowledge and allow real input thereof in the form of possible adaptations to geoscientific research plans and methods)

Annex: List of participants.

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Diekmann	Bernhard	AWI	Germany	-
Franke	Dieter	BGR Hannover	Germany	1
Frei	Michaela	BGR Hannover	Germany	2
Fugmann	Gerlis	APECS	Germany	3
Gaedicke	Christoph	BGR Hannover	Germany	3
Geissler	Wolfram	AWI	Germany	2
Gohl	Karsten	AWI	Germany	1
Grasby	Steve	Geological Survey of Canada	Canada	2
Humrich	Christoph	University of Groningen	The Netherlands	3
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Koglin	Nicola	BGR Hannover	Germany	1
Krüger	Martin	BGR Hannover	Germany	-
Krylov	Alexey	VNIIOkeangeologie	Russia	1
Läufer	Andreas	BGR Hannover	Germany	3
Melles	Martin	Cologne University	Germany	1
Mikkelsen	Naja	GEUS	Denmark	2
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Reinhardt	Lutz	BGR Hannover	Germany	3
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Ruppel	Antonia	BGR Hannover	Germany	1
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Weigelt	Estelle	AWI	Germany	3

40 scientists from Canada, Denmark, Germany, Norway, Russia, The Netherlands, and USA participated in the workshop “Geoscientific Contributions for a better understanding of the Arctic System” funded by the DFG. (Photo: Federal Institute for Geosciences and Natural Resources)

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