

Research Article

Cite this article: Olsen J. Adaptive capacity of Arctic communities in the context of climate change and shipping growth: A review of Russian and Western literature. *Polar Record* 56(e27): 1–11. doi: <https://doi.org/10.1017/S0032247420000297>

Received: 31 October 2019
Revised: 20 July 2020
Accepted: 23 July 2020


Keywords:

Adaptive capacity; Arctic; Russia; Shipping; Local communities

Author for correspondence:

Julia Olsen, Email: julia.olsen@nord.no

Adaptive capacity of Arctic communities in the context of climate change and shipping growth: A review of Russian and Western literature

Julia Olsen 

Faculty of Social Sciences, Nord University, PO Box 1490, 8049, Bodø, Norway

Abstract

Throughout the past two decades, the number of studies examining the adaptive capacity of Arctic communities in the context of climate change has been increasing; however, little is known about Arctic communities' ability to adapt to certain emerging changes, such as increased shipping activity. To address this knowledge gap, this study systematically analyses published scientific articles on community adaptive capacity in circumpolar Arctic, including articles published in Russian which may not be captured in English-only reviews. Throughout this review, the study focuses on three areas: the development of the adaptive capacity framework; the conditions that enable community adaptation abilities; and the extent to which shipping developments are addressed in the literature. This study demonstrates that the adaptive capacity framework has been significantly developed both theoretically and methodologically and is broadly used to address new types of climatic and non-climatic changes. Though the impacts from the shipping development are discussed in some studies, there is a clear need for further examination of coastal communities' ability to adapt to such changes. Additionally, the study reveals limitations in the application of the Western conceptual terminology when exploring community-based research by Russian scholars.

Introduction

Arctic communities face multiple cross-scale changes in socio-economic, political, environmental and cultural systems that have cascading impacts on local community viability. Throughout the past decades, Arctic scholars have been examining local responses and the local capacity to adapt to climatic and non-climatic changes occurring within and outside the Arctic region. At the same time, certain emerging changes, such as shipping development, have received less attention. In addition to the lack of knowledge on shipping impacts in Arctic communities, the Russian local communities and the Russian context are still understudied by Arctic scholars (Ford, McDowell, & Pearce, 2015) and less is known about their capacity to adapt to climate-induced changes. This disparity exists despite the fact that Russia represents nearly half the Arctic geographically and almost 40% of the Arctic demographically (Shestak, Shcheka, & Klochkov, 2019). Hence, in order to examine how the adaptive capacity of Arctic communities is understood in the Western and Russian literature, this study aims to (1) examine the status of adaptive capacity knowledge pertaining to local Arctic communities in the context of ongoing and emerging climatic and non-climatic change; (2) understand what conditions enable community adaptation and (3) examine whether and how the shipping development is addressed in those studies.

The existing scientific literature recognises that the historical adaptability and flexibility of Arctic community livelihoods is strained by the complexity and pace of climatic (Meier et al., 2014, p. 205) and non-climatic changes (see, for example, AMAP, 2017; Hovelsrud & Smit, 2010; Rasmussen, Hovelsrud, & Gearheard, 2014). According to a recent Intergovernmental Panel on Climate Change (IPCC) report (IPCC, 2018), the Arctic region is warming 2–3 times faster than the rest of the globe (AMAP, 2017b; Overland et al., 2018). Sea ice reduction is arguably one of the most noticeable changes in the Arctic (Meier et al., 2014) since it retreats and migrates northward with warming global temperatures. The number of days with sea ice cover has been declining by ten–twenty days per decade during the period 1979–2013 (AMAP, 2017b, p. viii).

Discussion on adaptive capacity in the literature on global environmental change has burgeoned around the topic of climatic evaluation (Engle, 2011). This literature, among others, examines the necessity to develop adaptation measures to new climatic realities in the context of economic development (Lopulenko, 2009). In studies that apply an adaptation framework, adaptive capacity is embedded in the vulnerability paradigm; however, adaptive capacity is also connected to resilience research, where adaptability is described as “the capacity of actors in a system to influence resilience” (Walker, Holling, Carpenter, & Kinzig, 2004). Adaptive capacity in vulnerability research follows an actor-centred approach (Engle, 2011). It usually refers to the

© The Author(s), 2020. Published by Cambridge University Press. This is an Open Access article, distributed under the terms of the Creative Commons Attribution licence (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted re-use, distribution, and reproduction in any medium, provided the original work is properly cited.

conditions and abilities that enable people to adjust to changing conditions (e.g. Hovelsrud & Smit, 2010; Smit & Wandel, 2006) by minimising the consequences and/or take advantage of new opportunities (Cinner et al., 2018). Adaptive capacity is argued to be latent in its nature and needs to be activated to enable adaptation (Bay-Larsen & Hovelsrud, 2017; Brown & Westaway, 2011). However, despite a clear conceptualisation of adaptive capacity, there is still a debate on the contextual conditions that enhance and/or activate adaptive capacity. Hence, the understanding of the adaptive capacity framework as developed by Arctic scholars and its salient elements in responding to changing conditions represents the primary research interest of this study.

Arctic shipping represents one example of a changing condition to which local communities may respond to in varying ways (AMAP, 2017; Christensen, Lasserre, Dawson, Guy, & Pelletier, 2018). Arctic shipping refers here to all types of vessels operating in the Arctic (AMSA, 2009), destination, transition and local. The vessel types vary from small pleasure crafts to large overseas cruises, as well as fishing, research, cargo and government vessels (Dawson, Copland, et al., 2017). Though some of the vessels have an ice class, meaning they are enabled for year-around operation in ice-covered waters (IMO, 2010), much of the traffic takes place in open waters and summer navigation.

Growing trends in Arctic shipping for the past two decades are often connected to climatic and socio-economic changes. Declining sea ice opens new areas in the Arctic Ocean and results in the extension of the navigation season and increases the possibility for transiting along the Northeast and/or Northwest Passage. Additionally, fisheries and extractive industries are moving northward, and the area is becoming more attractive to marine tourism (e.g. Dawson, Pizzoloto, Howell, Copland, & Johnston, 2018).

Even though shipping activities have grown and will continue to increase in several Arctic regions, knowledge of how shipping growth affects local communities is rather fragmented. Sea ice decline presents opportunities for shipping development, yet we know little about these opportunities and how they should be managed (Ford et al., 2012, p. 296). A recent literature review on Arctic shipping underlined the deficit of studies that address social and environmental impacts from this growing sector (Ng, Andrews, Babb, Lin, & Becker, 2018). Existing studies that address the social and environmental impacts of Arctic shipping have mostly covered the Canadian Arctic (e.g. Christensen et al., 2018; Dawson, Johnston, & Stewart, 2017), while socio-economic and governance aspects of marine cruise development have also been explored for several other Arctic regions (e.g. Grushenko, 2014; Olsen, Nenasheva, et al., 2020; Pashkevich, Dawson, & Stewart, 2015; Stewart, Dawson, & Johnston, 2015; Van Bets, Lamers, & van Tatenhove, 2017).

This study aims to contribute to an increasing body of literature on community-based adaptation (Schipper, Ayers, Reid, Huq, & Rahman, 2014) that also corresponds with socially oriented observation transdisciplinary approach on sustainable knowledge coproduction (Vlasova & Volkov, 2016, pp. 429–430). Hence, this study (1) provides insight on the status of research on Arctic community's adaptive capacity and (2) expands knowledge on whether and how the Arctic shipping development is understood as a changing condition that local communities respond and/or adapt to. In doing so, this article began with a presentation of the significance of the topic, which will be followed by a detailed explanation of its methods – e.g. a description of the systematic literature review. The Results section conceptualises local adaptive capacity based on contributions from Arctic Western scholars, discusses the

ways this framework is addressed among Russian scholars, identifies elements that constrain local adaptive capacity and examines whether and how shipping is addressed in the literature on adaptive capacity. In the Discussion section, I synthesise the results of the literature review to illustrate the development of the adaptive capacity framework.

Methods

The study adopts a systematic literature review of peer-reviewed journal articles in order to examine the status of knowledge – developed by the Western and Russian scholars – regarding local adaptive capacity in the Arctic, and whether, and how, shipping development is addressed in those studies. The systematic review process was developed based on the guidelines for conducting literature reviews (e.g. Biesbroek et al., 2018; Easterby-Smith, Thorpe, & Jackson, 2012; Ford et al., 2012). According to Ford et al. (2011, p. 328), the systematic literature review presents an assessment of the state of knowledge on a specific topic. Such reviews consist of three main components: data collection (clearly formulated questions and syntaxes), full reporting on criteria for inclusion and exclusion of articles and the possibility of using quantitative and qualitative analysis (ibid).

During the data collection process, the question for literature review was defined as follows: *What characterises the local adaptive capacity of Arctic communities?* To respond to this question, the following sections discuss literature on adaptive capacity from all Arctic nations, including Russia. The inclusion of which adds novelty to this study. The ability to combine results published in both English and Russian provides a more robust and comprehensive overview of published Arctic research.

In order to incorporate peer-reviewed scientific articles from several Arctic regions, two main electronic databases were chosen as follows: Scopus in English and eLIBRARY.ru in Russian (that was supplemented with Google Scholar) to search for Russian language articles. Though the search and selection options of the selected databases are similar, it is important to note that Scopus includes studies on the Russian Arctic only if they are published in English, whereas eLIBRARY.ru is a useful database to search for studies that are published in Russian. However, due to a small number of relevant articles and accessibility issues with some of the selected articles in eLIBRARY.ru, a secondary Boolean search and a search for specific Russian language articles were run in Google Scholar.

The following Boolean search – a keyword-searching syntax – was applied in Scopus: ((adapt* AND capacity AND commun* OR local) AND arctic OR “high north” OR northern AND Alaska OR Canada OR Russia OR Norway OR Sweden OR Finland OR Iceland OR Greenland) AND (EXCLUDE (PUBYEAR, 2019) AND (LIMIT-TO (DOCTYPE, “ar”))). The search protocol in eLIBRARY.ru was similar; however, three main adjustments were necessary. First, since the search in the Russian database aimed to assess only Russian literature about adaptive capacity in the Russian Arctic, and other Arctic countries were excluded. The second adjustment was necessary due to differences in translation and the concepts used in the Russian language. To be more specific, the translation of the core concepts like “adaptive capacity” and “local communities”. The word “capacity” can be translated in various ways, such as “sposobnost” (*ability or capacity*), “potencial” (potential) and “vozmozhnost” (*ability*). Hence, in the search syntaxes, I chose to use only “adapt*” instead of “adapt* AND capacity”. The use of another relevant concept, local

Table 1. Criteria for literature inclusion and exclusion (modified from Ford et al., 2012).

Inclusion	Exclusion
Written in English and Russian	Written in languages other than English and Russian
Published between 1 January 2000 and 31 December 2018	Published outside the selected date range
Peer reviewed	Not peer reviewed
Reviews and scientific articles	Book reviews, conference proceedings and reports
Studies on adaptive capacity and its determinants	Mitigation, transformation and explicit focus on biophysical changes
Adaptive capacity of local communities/indigenous population small social groups	Adaptive capacity as a biophysical attribute; health studies
Studies the local levels (partly regional level for Russian studies)	Studies the regional, national and international levels
Arctic countries (Arctic area in AHDR)	No reference to the Arctic

community (in Russian “*mestnye soobshchestva*”), retrieves the results from natural sciences that describe communities of flora and fauna. Hence, I found it valuable to add a concept of populace (in Russian “*naselenie*” or “*narody*”).

Finally, the Arctic as a geographical region in Russian studies is usually associated with the high Arctic, mostly the territory above the Arctic circle (The President of the Russian Federation, 2014). The Russian geographical border of the Arctic differs from and is smaller (especially in the eastern part) compared to the one defined by the Arctic Human Development Report (AHDR, 2004) and broadly used by the Western scholars. A precise definition of the Russian Arctic area (that is defined by the Russian government) was presented in the Arctic Council’s agreement (2017) on Enhancing International Arctic Scientific Cooperation. Moreover, the published studies by the Russian authors do not necessarily include the term Arctic to describe the geographical area of their research. The most common words to describe the region is “high north” and/or just “north”, e.g. Russian north and northwest Russia (see, for example, Lazhentsev, 2016).

In order to address those challenges in addition to narrowing the search focus, I applied an adjusted syntaxis and had to run several search tests with a combination of different translation opportunities. These adjustments were necessary; however, they led to a large number of search results that were not necessarily relevant as most were focused on natural science research or human health-related research. Additionally, as mentioned, not all results of interest in this study were accessible via eLIBRARY.ru, thus, a supplementary search in Google Scholar was used.

Those exclusion and inclusion criteria are listed in Table 1. The systematic literature review includes scientific articles published between 2000 and 2018. This period was chosen to reflect the IPCC’s Third Assessment Report, Working Group II, which highlighted adaptive capacity within studies on global environmental change (IPCC, 2001).

The Boolean search, which involves a search for both keywords and abstracts (Biesbroek et al., 2018), was conducted in 2019. The search resulted in 118 relevant articles on Scopus and 39 in eLIBRARY.ru. An abstract screening was conducted to examine whether articles addressed adaptive capacity and/or comparable concepts within adaptation studies. This process limited the total number of articles to 54 in Scopus. To evaluate the relevance of the Russian articles, during the screening process, I also had to include articles’ introductions, as some abstracts were of limited length or absent, making it difficult to assess the theoretical choices.

In total, 12 articles in eLIBRARY.ru and Google Scholars were selected that are connected to local context and adaptability to climate-induced changes in the Arctic. Those selected Russian articles present the conceptual application of the adaptation framework and the differences from Western studies, rather than an assessment of adaptive capacity.

I coded these selected articles in qualitative data analysis software, NVivo, using predefined coding categories, such as the conceptualisation of adaptive capacity, connection to other social attributes within the adaptation framework (e.g. vulnerability, resilience and adaptive responses), adaptive capacity aspects and/or dimensions and limitations. Some emerging categories (e.g. the type of change, region and study methods) were added during the analysis process. The results of literature review are presented in the Results section.

Results

This section presents the results from the systematic literature review. It begins with the conceptualisation of adaptive capacity by Western scholars and follows with a presentation of how Russian scholars have interpreted and used this framework. It also examines aspects of adaptive capacity as well as shipping development and its treatment in selected studies.

Adaptive capacity in Western studies

Within the literature on global environmental change, the concept of adaptive capacity (earlier described as “adaptability”) has its origin in the vulnerability approach highlighted in the Third AR IPCC report (Smit & Pilifosova, 2001 in Ford & Smit, 2004). The reviewed studies that examine adaptive capacity employ vulnerability as a central concept. *Vulnerability* is defined as a susceptibility to changing conditions (Keskitalo & Kulyasova, 2009) and is a function of both exposure sensitivity to impacts of a changing condition and the adaptive capacity to deal with those impacts (Ford & Smit, 2004).

Exposure sensitivity relates to one’s susceptibility to impacts of changing conditions in a particular place over time (e.g. Risvoll & Hovelsrud, 2016), while *adaptive capacity refers to one’s (in this study community) ability to address, plan for, or adapt to these impacts* (Ford et al., 2009; Ford, Smit, & Wandel, 2006; Ford, Smit, Wandel, & MacDonald, 2006) and *take advantage of new opportunities* (Debortoli, Sayles, Clark, & Ford, 2018). This or a

similar definition of adaptive capacity is commonly used in the reviewed literature.

The reviewed studies suggest that the relationship between adaptive capacity and exposure sensitivity is context dependent and varies over time and scale (Debortoli et al., 2018), while an increase in a communities' adaptive capacity and/or resilience leads to a decrease in vulnerability (e.g. Kvalvik et al., 2011). Hence, some scholars argue that in adaptation studies, adaptive capacity was described as a synonym to resilience (Turner et al., 2003 in Risvoll and Hovelsrud, 2016). In adaptation research, resilience is described as another attribute of socio-ecological systems associated with coping mechanisms, where the term "adaptive" refers to the evolutionary/ecological description of responses that increase the probability of survival (Berkes and Jolly, 2002).

Adaptive capacity, in the vulnerability approach, is socially constructed. Adaptive capacity is approached as a dynamic attribute that varies across communities (Ford, Smit, & Wandel, 2006; O'Brien, Eriksen, Sygna, & Naess, 2006). Assessments of adaptive capacity tend to place emphasis on the local level (e.g. Keskitalo, 2008; Risvoll & Hovelsrud, 2016), as it is dependent on political and economic settings, scientific and traditional knowledge, as well as resource distribution, involved stakeholders (Adger, Brown, & Tompkins, 2005 in Keskitalo and Kulyasova, 2009) and communities' ability to act collectively, also described as human agency (e.g. Hovelsrud et al. 2018). Additionally, it should be noted that due to uneven distribution of resources and power across scales, the enhancement of adaptive capacity for one group of stakeholders (those who gain access to the resources) may reduce the adaptive capacity of another (those who lose the access to resources) (Keskitalo & Kulyasova, 2009).

In line with Debotoli et al. (2018), this review indicates that there is a long tradition of vulnerability and adaptation research in Canada. From a geographical perspective, Canadian–Arctic communities are represented most prominently in the captured studies, followed by Alaskan communities and communities in Scandinavian countries. Less knowledge has been accumulated on Russian communities. While the majority of these studies use single case study research designs, a few establish multiple cases within and outside the Arctic region. One of these comparatively analyses local adaptive capacity in Nordic countries and Russia, illustrating the contextual differences between those communities.

Russian studies

As the previous section illustrates, only a few studies published in English explore the Arctic Russian context as it pertains to adaptive capacity. Simultaneously, only a few Russian studies reflect on local communities and their abilities to adapt to changing conditions.

Here, it is also important to mention that the Western-developed vocabulary of adaptation studies is not always used in studies published by Russian scholars that describe the impacts of changes taking place in northern communities. Moreover, Riabova and Klyuchnikova (2018, p.101) recognise that, despite an increasing attention among the Western Arctic scholars to the research on social impacts of climate-induced changes, fewer studies are dedicated to Russian communities also by Russian scholars.

A decade ago, Lopulenko (2009, p. 142) argued that even though there is a certain understanding of climate change impacts, little research investigates these impacts' role in the social aspects of

Arctic life. During the past decade, the topic has received more attention, especially after adopting a Climate Doctrine of the Russian Federation in 2009 (Riabova & Klyuchnikova, 2018). However, most of the focus has been given to sectoral and adaptation to climatic changes or to adaptation of Russian regions (e.g. Murmansk oblast). Those units of analysis are not considered in this review – that is, local level communities. The literature search results indicate that in contrast to Arctic studies where an understanding of adaptive capacity among others derives from local levels such as communities, municipalities and local economic sectors (e.g. Ford, Couture, Bell, & Clark, 2018; C. Keskitalo, H. Dannevig, G. Hovelsrud, J. J. West, & A. Swartling, 2011), studies covering the Russian Arctic use either an individual or diverse sectoral and regional levels as units of analysis and fewer community-level cases.

However, it is important to mention that adaptation studies of the Russian Arctic population have a long history extending back to the 1930s, a period marked by intensive development in Arctic territories and by the opening of the Northern Sea Route (Maximov & Maximova, 2007). The first generation of studies was dedicated to health and/or the physical human ability to survive in harsh climates, which later led to the establishment of a new scientific subdiscipline of ecological physiology in the 1990s (ibid.). This research area is still emerging and, similar to Western studies, the concept of adaptive capacity is mainstreamed in biophysical, physiological and psychological studies. Searching results indicate that adaptive capacity has been studied at the individual level and at the group level when studying health challenges.

The recent literature review on the social consequences of a changing climate in the Arctic (Riabova & Klyuchnikova, 2018, pp. 91–92) indicates that foreign literature (that is outside of Russia) is more advanced in addressing social impacts, while Russian studies are dominated by biological and ecological impact assessments. The same review states that research on climate impacts and adaptation in local and indigenous communities at local and regional levels is covered less frequently but is gaining prevalence among Russian scholars (ibid). Developing the adaptive capacity framework is also increasingly important, as it helps to identify the adaptation options and strategies of local communities (Nechiporenko, 2015).

The existing studies also indicate that though Arctic residents are exposed to impacts of climatic and climate-induced changes (Boyakova, Vinokurova, Ignatjeva, & Filippova, 2010; Filippova, 2011; Oparin, Kulikova, & Shchigreva, 2011; Vinokurova, Filippova, Suleymanov, & Grigorev, 2016), several changes require adaptation measures. The literature describes the changes that followed the collapse of the Soviet Union and a transition towards the market economy that, taken together, negatively affected the traditional livelihoods of several Arctic indigenous and local communities (Perevalova, 2015). Other changes that are discussed in the reviewed literature are changes in ecosystem services (Leksin & Porfiryev, 2017), industrial expansion to the north (Perevalova, 2015) and, as a result, demographical changes of the Arctic population (Tomaska, 2015). Less attention is given to direct impacts of climate change. Referring to AMAP (2017), Riabova and Klyuchnikova (2018) argue that this complexity of change will require adaptation at a variety of levels – local, regional, national and global. Leksin and Porfiryev (2017) suggest that in the context of the climate change impacts, indigenous communities might need to adjust their methods for maintaining traditional lifestyles such as reindeer herding, fishing and hunting, but also their mobility options.

The elements of adaptive capacity

The development of the adaptive capacity framework reveals that several aspects and contextual factors influence a community's ability to adapt to climatic and non-climatic changes. The literature recognises that local adaptive capacity depends on a set of available and interdependent aspects: different forms of capital, distribution and access to resources, as well as the structure of institutions (e.g. Bay-Larsen, Risvoll, Vestrum, & Bjørkhaug, 2018; Pearce et al., 2010; Smit & Pilifosova, 2001 cited in Keskitalo et al., 2011). These aspects are also described in the literature as determinants, indicators and/or capitals of adaptive capacity. They can be grouped in objective and subjective dimensions or, as described by Armitage (2005), as fast-moving and slow-moving attributes, respectively (Armitage, 2005, p. 707).

While objective aspects, such as infrastructure, technology and economic assets, were already identified in the Third Assessment IPCC report (Smit & Pilifosova, 2001 in Keskitalo et al., 2011), the role of subjective and/or socio-cognitive ones in shaping adaptive capacity received greater attention in more recent years (Bay-Larsen et al., 2018; Blennow & Persson, 2009; Goldhar, Bell, & Wolf, 2014). Local adaptive capacity can now be “*conceptualised as the sum of objective and subjective dimensions, where the adaptive capacity is latent under the former and activated under the latter*,” (Berman, Kofinas, & BurnSilver, 2017 in Tiller and Richards, 2018).

Those aspects or determinants of adaptive capacity vary over time and location. Table 2 presents those determinants that were identified in the literature, describes their meanings and presents references to the reviewed literature. Following the presentation of those determinants, they were grouped under 10 categories such as social capital, flexibility, worldviews, institutions, natural capital, human capital, technology, infrastructure, equity and economic resources.

It is important to note the complexity of the relationships between adaptive capacity and adaptation (e.g. O'Brien et al., 2006), as the presence of any particular determinant does not necessarily strengthen local adaptive capacity and/or lead to adaptation (e.g. Ford & King, 2015). For example, Keskitalo et al. (2011) suggest that economic resources, infrastructure and technology may be made inaccessible by high-maintenance costs. In fact, determinants can even weaken adaptation. For example, some scholars have argued that while financial resource and/or technology can enhance the adaptive capacity, they may simultaneously not be available for some households (Ford & Pearce, 2010) and can increase the dependency on those determinants (Keskitalo et al. 2011).

The question of enhancing adaptive capacity, and more specifically its translation into adaptive actions, was further developed by Ford and King (2015) and Ford et al. (2018) who examine and identify the necessity of governance factors that enable adaptation to take place. They present interdependent institutional factors that lead to adaptation: political leadership on adaptation, institutional organisation, decision-making and stakeholder engagement, availability of usable science, funding and public support (Ford & King, 2015). Yet, even with this knowledge, policy mechanisms, dilemmas and trade-offs in the implementation stages can weaken local adaptive capacity (Risvoll, Fedreheim, & Galafassi, 2016).

In addition to determinants and adaptation readiness, literature identifies several contextual factors and cross-scale processes that are not strictly a part of adaptive capacity, but can complicate the

effectiveness of community's ability to adapt to changing conditions (C. T. West, 2011) and may also affect local exposure to changing conditions (Ford, Smit, & Wandel, 2006). The following factors are identified as follows: demographic trends like gender and its societal roles (Buchanan, Reed, & Lidestav, 2016; Bunce, Ford, Harper, Edge, & Team, 2016; Goldhar et al., 2014; Tomaska, 2015), population structure (Lundmark, Pashkevich, Jansson, & Wiberg, 2008), youth participation and engagement (MacDonald, Ford, Willox, Mitchell, & Productions, 2015), the type of community (Armitage, 2005) and the area's political and socio-economic situation (Keskitalo, 2009; Kvalvik et al., 2011), including market conditions and globalisation (Keskitalo & Kulyasova, 2009). Wesche and Chan (2010) underline that food security also influences local adaptive capacity (see also Fillion et al., 2014).

Several scholars stress the scale and/or variables of adaptive capacity, stating, “*adaptive capacity is nested ... in cross-scale societal processes that may hinder or enable action*,” (AMAP, 2017 in Hovelsrud et al., 2018). Here, O'Brien et al. (2006) argue that local adaptive capacity may differ from national adaptive capacity due to the diversity between these scales. The scale of change itself and the scale of decision-making can influence the scope of adaptation (Armitage, 2005; J. J. West & Hovelsrud, 2010), while Tiller and Richards (2018) argue that stakeholders and stakeholder groups will have to adapt to different levels of change.

Shipping as an emerging change

This literature review indicates that many selected studies examine adaptive capacity in the context of climatic and non-climatic change. It is also acknowledged that communities do not adapt to climate change in isolation from other changes (e.g. J. J. West & Hovelsrud, 2010). Thus, in describing adaptive capacity, the focus is given to the interplay of multiple cross-scale changes (e.g. Rattenbury, Kielland, Finstad, & Schneider, 2009). Prno et al. (2011, p. 17) describe climate change as an additional factor in societal changes already occurring and argue that the impacts of climate change present “*a minor concern, outweighed by [other] social issues ...*”.

In relation to this study, shipping growth is also considered to be a kind of changing condition in the reviewed literature. However, the examination of this emerging development with application of the adaptation and adaptive capacity framework is rather deficient.

About 15% of selected articles for this literature review refer to shipping a developing industry in the Arctic. The majority of these studies were published during the past decade and connect shipping development to changing ice conditions (e.g. Andrachuk & Smit, 2012; Christie, Hollmen, Huntington, & Lovvorn, 2018; Ford et al., 2012; Ford & Goldhar, 2012) as well as industrial activities, including tourism (e.g. Andrachuk & Smit, 2012; Olsen & Nenasheva, 2018). In reference to assessment reports (ACIA, 2005; AMAP, 2011), Riabova and Klyuchnikova (2018) explain that rapid changes in the cryosphere enable better navigation in previously sea-bounded areas.

Shipping in this context is described as an “economic opportunity” of climate change (Ford et al., 2018; Ford & Goldhar, 2012) with the potential to influence local economies of northern settlements (Christie et al., 2018), contribute to local value creation (Olsen & Nenasheva, 2018) and provide employment opportunities (Angell & Stokke, 2014). However, few studies have examined

Table 2. Categories of the determinants of adaptive capacity, their definitions and references to the literature.

Determinants	Definition	References from the literature review
Social capital (including networks, social norms, trust, place attachment and perception of risk or change)	Refers to cooperation and ability to act collectively in order to achieve mutual social and spiritual benefits (Armitage, 2005), but also to practices that evolve shared perception of change (Bay-Larsen et al., 2018).	(Armitage, 2005; Bay-Larsen et al., 2018; Biesbroek et al., 2018; Blennow & Persson, 2009; Crate, 2007; Ford et al., 2009; Ford et al., 2008; Ford, Smit, Wandel, et al., 2006; Hovelsrud, Karlsson, & Olsen, 2018; Tiller & Richards, 2018; J. J. West & Hovelsrud, 2010)
Flexibility	Refers to communities' ability to adjust their (subsistence) practices and "is based on environmental knowledge and land skills" (Ford & Goldhar, 2012).	(Ford & Goldhar, 2012; Ford et al., 2009; Ford & Pearce, 2010; Ford, Smit, & Wandel, 2006; Ford et al., 2008; Ford, Smit, Wandel, et al., 2006; Goldhar et al., 2014; Hovelsrud et al., 2018; Rattenbury et al., 2009; Risvoll & Hovelsrud, 2016; Tyler et al., 2007)
Values, beliefs and worldviews	Psychological and cognitive aspects of community viability. Also refers to beliefs in climate change and adaptive capacity.	(Bay-Larsen et al., 2018; Blennow & Persson, 2009; Goldhar et al., 2014)
Institutional capital and governance system	Refers to a decision-making system that facilitates or hinders local participation in decision-making process, community engagement, flexibility and adaptation strategies within or outside a given community. Also refers to regulation and market mechanisms (Keskitalo & Kulyasova, 2009).	(Angell & Stokke, 2014; Brattland, Eythórsson, Weines, & Sunnanå, 2018; Buchanan et al., 2016; Budreau & McBean, 2007; Ford & Goldhar, 2012; Keskitalo & Kulyasova, 2009; E. C. H. Keskitalo, H. Dannevig, G. K. Hovelsrud, J. J. West, & A. G. Swartling, 2011; Tiller & Richards, 2018)
Natural capital	Usually refers to biophysical conditions and natural resources that support local communities and their subsistence. The natural environment that is modified by human cultures.	(Bay-Larsen et al., 2018; Olsen & Nenasheva, 2018; Risvoll et al., 2016; Risvoll & Hovelsrud, 2016)
Human capital information, knowledge and education	Refers to various types of knowledge that help to better understand impacts, that is traditional, local and/or ecological knowledge that is "the cumulative body of knowledge, practice, and belief evolved through adaptive processes and handed down from generation to generation" (Berkes, 1999; Tremblay et al., 2008).	(Brattland et al., 2018; Buchanan et al., 2016; Budreau & McBean, 2007; Dale & Armitage, 2011; Ford et al., 2009; Ford, Smit, & Wandel, 2006; Ford et al., 2008; Goldhar et al., 2014; Hovelsrud et al., 2018; Keskitalo & Kulyasova, 2009; E. C. H. Keskitalo et al., 2011; Lundmark et al., 2008; Pearce et al., 2010; Tremblay et al., 2008)
Technology	Availability and access to technology and equipment that support local viability.	(E. C. H. Keskitalo et al., 2011; Lundmark et al., 2008; Pearce et al., 2010)
Infrastructure	Refers to the physical infrastructure and available maintenance services that support local viability.	(Ford & King, 2015; Ford & Pearce, 2010; Keskitalo & Kulyasova, 2009; E. C. H. Keskitalo et al., 2011)
Equity/access to resources	Refers to "Social institutions and arrangements governing the allocation of power and access to resources . . . [that] assure that access to resources is equitably distributed" (Smit & Pilifosova, 2001; Keskitalo et al., 2011).	(Baehler & Biddle, 2018; Ford, Smit, & Wandel, 2006; Ford, Smit, Wandel, et al., 2006; E. C. H. Keskitalo et al., 2011; Lundmark et al., 2008)
Economic resources and/or financial capital	Relates to commodities (Armitage 2005), including "economic assets, capital resources, financial means, wealth or poverty" (Smit & Pilifosova, 2001; Keskitalo et al. 2011).	(Armitage, 2005; Biesbroek et al., 2018; E. C. H. Keskitalo et al., 2011)

these opportunities and how they should be managed (Ford et al., 2012). Moreover, not all coastal communities will benefit from this development as port infrastructure and local water deepness present crucial aspects of accommodating shipping during the ice-free season (Andrachuk & Smit, 2012).

In addition to opportunities, scholars underline that there are some risks associated with increased shipping. Riabova and Klyuchnikova (2018, referring to Davydov & Mikhailova, 2011) give the example of risks from ship traffic passing through Vaygach Island in the Russian Arctic. They argue that the community is increasingly accessible to ship traffic and visitors that exchange imported goods for local natural traditional resources. This trend has resulted in the changes of traditional economy and exploitation of natural resources (ibid). Based on the examination of shipping impacts on community of Solovetsky, Olsen and Nenasheva (2018) argue that growth in the number of

passenger vessels has led to a significant increase in the absolute number of tourists and thus overcrowding. The same study suggests that overcrowding may be perceived as a source of disturbance, and increased pressure on existing building and transport infrastructure and waste facilities that were originally designed to cover basic community needs (ibid.) Shipping can also have negative impacts on Arctic natural environments and sensitive ecosystems (Ford et al., 2018; O'Brien et al., 2006) including those inhabited by marine mammals (Bunce et al., 2016; Christie et al., 2018).

Ford et al. (2012) refers to Cameron (2012) and argue that "shipping and resource development are likely to be major factors affecting vulnerability and adaptation in Arctic communities." Olsen and Nenasheva (2018) also identify several salient determinants of adaptive capacity for the community of Solovetsky, such as local involvement in shipping decision-making, infrastructure,

local values, the natural environment and economic resources. The authors argue that adaptive capacity is also shaped by the interlinkages of the determinants, as they may lead to trade-offs and or co-beneficial support (*ibid.*)

Discussion

Development of the adaptive capacity framework

The results captured by this study illustrate that the adaptive capacity framework (at the community level) has developed significantly during the past two decades (e.g. Ford et al., 2018) in regards to Western scholarly traditions. The adaptation framework (at the community level) its later recognition by Russian scholars (Riabova & Klyuchnikova, 2018), however, the selected studies are developed around the concept of adaptation rather than the concept of adaptive capacity.

In general, the adaptive capacity framework applied to study Arctic communities in the context of climatic and non-climatic changes has advanced theoretically and methodologically. This has been occurred most significantly by Western scholars, particularly after the publication of the Third Assessment Report by IPCC in 2001. As such, this framework is useful for understanding community aspects that support, activate or hinder local adaptation in response to impacts from climate change and other changing conditions. In line with Mortreux and Barnett (2017), I argue that the development of adaptive capacity framework can be divided into two overlapping paths that have been developed in parallel, rather than sequentially. The first path is characterised by the development of the concept and its relationship with other community characteristics, such as vulnerability, resilience, adaptation and sustainability. It is also defined by its establishment of methodological perspectives and by its examination of local factors or contexts (also known as determinants and capitals) and their roles. The second path questions the role of determinants in enhancing a community's ability to adapt to new and emerging cross-scale changes, both climatic and non-climatic, such as shipping growth. I align myself with earlier scholars' findings that the determinants are context dependent, and that there is a need to examine those determinants and their interrelations in order to assess local adaptive capacity.

In terms of the applied methodology, the majority of Western studies were qualitative, single case study research designs, with only a few establishing multiple cases within and outside the Arctic region. The literature review process revealed that Russian studies are characterised by three main methodological differences. First, the unit of analysis in studies published by Russian scholars pertain mostly to individual capacity (usually refers to health conditions) in the context of harsh Arctic climatic conditions and to the regional or sectorial capacity to adapt to climatic. Those units of analysis are not considered in this review – that is, local level communities. In contrast with Western studies, the local community level – where the impacts are often first felt – is not yet thoroughly explored by Russian scholars (Lopulenko, 2009; Riabova & Klyuchnikova, 2018, p. 110). However, I would not argue that those studies do not exist. I would rather suggest that the Western-developed vocabulary of adaptation studies is not always used in studies that describe the impacts of changes taking place in Russian local communities.

The second issue relates to how the adoption of the adaptive capacity framework in community-based research by Russian scholars has been challenged by the use of Western terminology

to describe the empirical reality (Olsen & Nenasheva, 2018; Stammer-Gossmann, 2010). Even though the selected studies describe communities' abilities to adapt to multiple changes, a standard framework of terminology is not necessarily applied in Russian. As described in the Methodological section, the term adaptive capacity can be translated into Russian in three different ways, and a test search identified that all three translations are commonly used by Russian scholars. For example, the Russian translation of the IPCC's AR5 Synthesis report (IPCC, 2014) uses at least two of these variations ("spособnost" and "potencial") to refer to adaptive capacity. A concept of adaptive capacity as a social attribute of local communities is not explicitly used in Russian studies. Moreover, compared to other Arctic nations, Russia was late to address some of the climate change measures, including adaptation. For example, Russia issued a national plan for adaptation in December, 2019 (The Russian Government, 2019). Hence, I would argue that there is a possibility that several community-based studies in Russian described community responses to climatic and non-climatic changes without using the adaptation and/or adaptive capacity approach.

The third methodological limitation in pan-Arctic research, one which influences the scope of reviewed literature, is the definition of the Arctic. The geographical boundaries of the Russian Arctic region, that are described by the western researcher (e.g. AHDR, AMAP), differs from those defined by Russian authorities (Arctic Council, 2017; The President of the Russian Federation, 2014). Moreover, the published studies by the Russian authors do not necessarily use the term "Arctic" to describe the geographical area of their research, but rather substitute it with a term "North".

It is important to understand that the methods applied in any literature review create limitations with implications for the study results. To be more specific, a systematic literature review that includes only peer-reviewed journal articles overlooks important resources, such as government reports, technical papers and conference proceedings (Ford et al., 2012). The last category, in particular, could offer a unique source of information, especially in the Russian case (many research results from eLIBRARY.ru's database were published in the form of conference proceedings). Moreover, a significant portion of scientific results are published in assessments reports (e.g. AMAP, 2011; AMAP, 2017; IPCC, 2001, 2007, 2014; Rasmussen et al., 2014) and anthologies that provide a stronger synthesis of adaptive capacity's theoretical development (e.g. Fondahl & Wilson, 2017; Hovelsrud & Smit, 2010). This type of literature may also present several determinants, capitals and/or factors of adaptive capacity that are not listed in Table 2. However, some of these results and conclusions were cited by the authors in the selected literature, and thus are partially reflected in this study. Further studies may overcome this limitation by extending the inclusion of other sources of scientific literature.

Understanding adaptive capacity through shipping growth

It must be reiterated that shipping development is described in the reviewed literature as a result of climatic and socio-economic changes in the Arctic, but also as a contributor to changes in local communities. As such, Arctic shipping development presents new opportunities and risks for Arctic communities. The reviewed literature describes both positive and negative impacts on environmental, sociocultural and economic realities.

The results of this review also align with existing studies that describe increasing shipping in the opening Arctic as a new concern

for coastal communities (see, for example, Davydov & Mikhailova, 2011; Dawson et al., 2020; Dawson, Stewart, Johnston, & Lemieux, 2016; Olsen, Carter, & Dawson, 2019; Olsen, Hovelsrud, & Kaltenborn, 2020; Stewart et al., 2015). Shipping development brings new (usually seasonal) economic opportunities to communities, which, in combination with other factors, may present a trade-off. Hence, we can use these studies to discuss the risks and opportunities that Arctic communities experience in the context of multiple changes.

Moreover, shipping trends are predicted to increase in regions with projected sea ice decline and increasing demand for shipping operations (Smith & Stephenson, 2013 in Ford et al., 2018). This prognosis for the future of Arctic shipping operations might challenge the examination of future adaptive capacity and local adaptation to ship traffic. Given the rate of change in the Arctic, in a line with Ford et al. (2012), I would argue that more knowledge is needed to understand how changes in industries like shipping affect communities' experiences and responses to climate change.

Conclusion

In this paper, I have performed a review of developments in adaptive capacity research on local Arctic communities in the context of climatic and non-climatic change, in particular, examining if and how the shipping development is addressed in those studies. The results of this review lead to three main conclusions.

First, the study illustrates that the framework has been significantly developed theoretically and methodologically since inception. The review illuminates the diversity of contextual determinants of adaptive capacity, arguing that their availability might strengthen adaptive capacity and lead to adaptation when activated. However, the relationship between any given determinant of adaptive capacity may result in trade-offs that weaken a community's overall adaptive capacity. Second, this study describes several challenges for the inclusion of Russian language literature on the subject in a review process. Hence, it is important to mention that even though the adaptation framework has been used by Russian scholars throughout recent decades, the results of this research are yet to be integrated into the pan-Arctic research. Finally, studying local communities as a unit of analysis provides first-hand knowledge about emerging changes, as they are often the first to feel the concrete impacts of global and national changes – this makes such communities important stakeholders in adaptation responses and research.

Acknowledgements. The author gratefully acknowledge Grete K. Hovelsrud, Kathinka F. Evertsen and Camilla Risvoll for reviewing and providing valuable comments to the earlier versions of the paper and Malinda Labriola and Nikolai Holm for providing language help. I am particularly appreciative of the comments by the two anonymous reviewers that helped significantly to improve the paper.

Disclosure statement. No potential conflict of interest was reported by the author.

References

- ACIA. (2005). *Arctic Climate Impact Assessment*. Cambridge University Press, p. 1042. Retrieved from <https://www.amap.no/arctic-climate-impact-assessment-acia>
- Adger, N., Brown, K., & Tompkins, E. L. (2005). The political economy of cross-scale networks in resource co-management. *Ecology and Society*, 10(2), 9.
- AHDR. (2004). Arctic Human Development Report. Iceland: Akureyri.
- AMAP. (2011). Snow, Water, Ice, and Permafrost in the Arctic (SWIPA). Climate change and the Cryosphere. Oslo, Norway (Xii+538 pp).
- AMAP. (2017). Adaptation Actions for a Changing Arctic: Perspectives from the Barents Area. Arctic Monitoring and Assessment Programme (AMAP), Oslo, Norway (pp. xiv + 267).
- AMAP. (2017b). Snow, Water, Ice and Permafrost in the Arctic (SWIPA) 2017, Arctic Monitoring and Assessment Programme (AMAP). Oslo, Norway (xiv + 269 pp).
- AMSA. (2009). Arctic Marine Shipping Assessment 2009 Report. Arctic Council.
- Andrachuk, M., & Smit, B. (2012). Community-based vulnerability assessment of Tuktoyaktuk, NWT, Canada to environmental and socio-economic changes. *Regional Environmental Change*, 12(4), 867–885. doi: 10.1007/s10113-012-0299-0
- Angell, E., & Stokke, K. B. (2014). Vulnerability and adaptive capacity in Hammerfest, Norway. *Ocean and Coastal Management*, 94, 56–65. doi: 10.1016/j.ocecoaman.2013.11.009
- Arctic Council. (2017). Agreement on Enhancing International Arctic Scientific Cooperation, signed at the Fairbanks Ministerial meeting, 11 May, 2017. Fairbanks, USA
- Armitage, D. (2005). Adaptive capacity and community-based natural resource management. *Environmental Management*, 35(6), 703–715. doi: 10.1007/s00267-004-0076-z
- Baehler, K. J., & Biddle, J. C. (2018). Governance for adaptive capacity and resilience in the U.S. water sector. *Ecology and Society*, 23(4). doi: 10.5751/ES-10537-230424
- Bay-Larsen, I., & Hovelsrud, G. K. (2017). Activating adaptive capacities: Fishing communities in northern Norway. In G. Fondahl & G. Wilson (Eds.), *Northern sustainabilities: Understanding and addressing change in the circumpolar world* (pp. 123–134). Switzerland: Springer.
- Bay-Larsen, I., Risvoll, C., Vestrum, I., & Bjørkhaug, H. (2018). Local protein sources in animal feed - Perceptions among arctic sheep farmers. *Journal of Rural Studies*, 59, 98–110. doi: 10.1016/j.jrurstud.2018.02.004
- Berkes, F. (1999). *Sacred ecology: Traditional ecological knowledge and resource management*. Philadelphia: Taylor and Francis.
- Berkes, F., & Jolly, D. (2002). Adapting to climate change: Social-ecological resilience in a Canadian western arctic community. *Ecology and Society*, 5(2).
- Berman, M., Kofinas, G., & BurnSilver, S. (2017). Measuring Community Adaptive and Transformative Capacity in the Arctic Context. In G. Fondahl & G. Wilson (Eds.), *Northern sustainabilities: Understanding and addressing change in the circumpolar world* (pp. 123–134). Switzerland: Springer.
- Biesbroek, R., Berrang-Ford, L., Ford, J. D., Tanabe, A., Austin, S. E., & Lesnikowski, A. (2018). Data, concepts and methods for large-n comparative climate change adaptation policy research: A systematic literature review. *Wiley Interdisciplinary Reviews: Climate Change* 9(6), e548. doi: 10.1002/wcc.548
- Blennow, K., & Persson, J. (2009). Climate change: Motivation for taking measure to adapt. *Global Environmental Change*, 19(1), 100–104. doi: 10.1016/j.gloenvcha.2008.10.003
- Boyakova, S. I., Vinokurova, L. I., Ignatjeva, V. B., & Filippova, V. V. (2010). Yakutia under the conditions of global climate changes: Vulnerability, risks, social adaptation. *North-Eastern Humanitarian Journal*, 1(1), 16–21.
- Brattland, C., Eythósson, E., Weines, J., & Sunnanå, K. (2018). Social-ecological timelines to explore human adaptation to coastal change. *Ambio*. doi: 10.1007/s13280-018-1129-5
- Brown, K., & Westaway, E. (2011). Agency, capacity, and resilience to environmental change: Lessons from human development, well-being, and disasters. *Annual Review of Environment and Resources*, 36(1), 321–342. doi: 10.1146/annurev-environ-052610-092905
- Buchanan, A., Reed, M. G., & Lidestav, G. (2016). What's counted as a reindeer herder? Gender and the adaptive capacity of Sami reindeer herding communities in Sweden. *Ambio*, 45, 352–362. doi: 10.1007/s13280-016-0834-1
- Budreau, D., & McBean, G. (2007). Climate change, adaptive capacity and policy direction in the Canadian North: Can we learn anything from the collapse of the east coast cod fishery? *Mitigation and Adaptation Strategies for Global Change*, 12(7), 1305–1320. doi: 10.1007/s11027-006-9053-6

- Bunce, A., Ford, J., Harper, S., Edge, V., & Team, I. R. (2016). Vulnerability and adaptive capacity of Inuit women to climate change: a case study from Iqaluit, Nunavut. *Natural Hazards*, 83(3), 1419–1441. doi: [10.1007/s11069-016-2398-6](https://doi.org/10.1007/s11069-016-2398-6)
- Cameron, E. S. (2012). Securing Indigenous politics: A critique of the vulnerability and adaptation approach to the human dimensions of climate change in the Canadian Arctic. *Global Environmental Change*, 22(1), 103–114.
- Christensen, T., Lasserre, F., Dawson, J., Guy, E., & Pelletier, J. (2018). Shipping. In *Adaptation Actions for a Changing Arctic: Perspectives from the Baffin Bay/Davis Strait Region*. Oslo, Norway: Arctic Monitoring and Assessment Programme (AMAP).
- Christie, K. S., Hollmen, T. E., Huntington, H. P., & Lovvorn, J. R. (2018). Structured decision analysis informed by traditional ecological knowledge as a tool to strengthen subsistence systems in a changing Arctic. *Ecology and Society*, 23(4). doi: [10.5751/ES-10596-230442](https://doi.org/10.5751/ES-10596-230442)
- Cinner, J. E., Adger, W. N., Allison, E. H., Barnes, M. L., Brown, K., Cohen, P. J., ... Morrison, T. H. (2018). Building adaptive capacity to climate change in tropical coastal communities. *Nature Climate Change*, 8(2), 117–123. doi: [10.1038/s41558-017-0065-x](https://doi.org/10.1038/s41558-017-0065-x)
- Crate, S. A. (2007). Cows and kin: Innovations and issues in post-soviet indigenous communities. *International Journal of Agricultural Resources, Governance and Ecology*, 6(6), 679–692. doi: [10.1504/IJARGE.2007.014761](https://doi.org/10.1504/IJARGE.2007.014761)
- Dale, A., & Armitage, D. (2011). Marine mammal co-management in Canada's Arctic: Knowledge co-production for learning and adaptive capacity. *Marine Policy*, 35(4), 440–449. doi: [10.1016/j.marpol.2010.10.019](https://doi.org/10.1016/j.marpol.2010.10.019)
- Davydov, A. N., & Mikhailova, G. V. (2011). Climate change and consequences in the Arctic: Perception of climate change by the Nenets people of Vaigach Island. *Global Health Action*, 4, 10.3402/gha.v3404i3400.8436. doi: [10.3402/gha.v4i0.8436](https://doi.org/10.3402/gha.v4i0.8436)
- Dawson, J., Carter, N., Luijk, N., Parker, C., Weber, M., Cook, A., ... Provencher, J. (2020). Infusing inuit and local knowledge into the low impact shipping corridors: An adaptation to increased shipping activity and climate change in Arctic Canada. *Environmental Science & Policy*, 105, 19–36. doi: [10.1016/j.envsci.2019.11.013](https://doi.org/10.1016/j.envsci.2019.11.013)
- Dawson, J., Copland, L., Johnston, M. E., Pizzolato, L., Howell, S. E., Pelot, R., ... Parsons, J. (2017). Climate Change Adaptation Strategies and Policy Options for Arctic Shipping. A report prepared for Transport Canada. Ottawa, Canada.
- Dawson, J., Johnston, M., & Stewart, E. (2017). The unintended consequences of regulatory complexity: The case of cruise tourism in Arctic Canada. *Marine Policy*, 76, 71–78. doi: [10.1016/j.marpol.2016.11.002](https://doi.org/10.1016/j.marpol.2016.11.002)
- Dawson, J., Pizzolato, L., Howell, S. E. L., Copland, L., & Johnston, M. E. (2018). Temporal and spatial patterns of ship traffic in the Canadian arctic from 1990 to 2015. *Arctic*, 71(1), 15–26. doi: [10.14430/arctic4698](https://doi.org/10.14430/arctic4698)
- Dawson, J., Stewart, E. J., Johnston, M. E., & Lemieux, C. J. (2016). Identifying and evaluating adaptation strategies for cruise tourism in Arctic Canada. *Journal of Sustainable Tourism*, 24(10), 1425–1441. doi: [10.1080/09669582.2015.1125358](https://doi.org/10.1080/09669582.2015.1125358)
- Debortoli, N. S., Sayles, J. S., Clark, D. G., & Ford, J. D. (2018). A systems network approach for climate change vulnerability assessment. *Environmental Research Letters*, 13(10). doi: [10.1088/1748-9326/aae24a](https://doi.org/10.1088/1748-9326/aae24a)
- Easterby-Smith, M., Thorpe, R., & Jackson, P. R. (2012). *Management research* (4th ed.). Los Angeles: Sage.
- Engle, N. L. (2011). Adaptive capacity and its assessment. *Global Environmental Change*, 21(2), 647–656.
- Filippova, V. (2011). Social Challenges of periodic floods in the Yakutia. *Arctic and North*, 4, 204–208.
- Fillion, M., Laird, B., Douglas, V., Van Pelt, L., Archie, D., & Chan, H. M. (2014). Development of a strategic plan for food security and safety in the inuvialuit settlement region, Canada. *International Journal of Circumpolar Health*, 73. doi: [10.3402/ijch.v73.25091](https://doi.org/10.3402/ijch.v73.25091)
- Fondahl, G., & Wilson, G. (2017). *Northern sustainabilities: Understanding and addressing change in the circumpolar world*. Switzerland: Springer
- Ford, J. D., Berrang-Ford, L., & Paterson, J. (2011). A systematic review of observed climate change adaptation in developed nations. *Climatic Change*, 106(2), 327–336. doi: [10.1007/s10584-011-0045-5](https://doi.org/10.1007/s10584-011-0045-5)
- Ford, J. D., Bolton, K. C., Shirley, J., Pearce, T., Tremblay, M., & Westlake, M. (2012). Research on the human dimensions of climate change in Nunavut, Nunavik, and Nunatsiavut: A literature review and gap analysis. *Arctic*, 65(3), 289–304. doi: [10.14430/arctic4217](https://doi.org/10.14430/arctic4217)
- Ford, J. D., Couture, N., Bell, T., & Clark, D. G. (2018). Climate change and Canada's north coast: Research trends, progress, and future directions. *Environmental Reviews*, 26(1), 82–92. doi: [10.1139/er-2017-0027](https://doi.org/10.1139/er-2017-0027)
- Ford, J. D., & Goldhar, C. (2012). Climate change vulnerability and adaptation in resource dependent communities: A case study from West Greenland. *Climate Research*, 54(2), 181–196. doi: [10.3354/cr01118](https://doi.org/10.3354/cr01118)
- Ford, J. D., Gough, W. A., Laidler, G. J., MacDonald, J., Irngaut, C., & Qrunnut, K. (2009). Sea ice, climate change, and community vulnerability in northern Foxe Basin, Canada. *Climate Research*, 38(2), 137–154. doi: [10.3354/cr00777](https://doi.org/10.3354/cr00777)
- Ford, J. D., & King, D. (2015). A framework for examining adaptation readiness. *Mitigation and Adaptation Strategies for Global Change*, 20(4), 505–526. doi: [10.1007/s11027-013-9505-8](https://doi.org/10.1007/s11027-013-9505-8)
- Ford, J. D., McDowell, G., & Pearce, T. (2015). The adaptation challenge in the Arctic. *Nature Climate Change*, 5, 1046–1053.
- Ford, J. D., & Pearce, T. (2010). What we know, do not know, and need to know about climate change vulnerability in the western Canadian Arctic: A systematic literature review. *Environmental Research Letters*, 5(1). doi: [10.1088/1748-9326/5/1/014008](https://doi.org/10.1088/1748-9326/5/1/014008)
- Ford, J. D., & Smit, B. (2004). A framework for assessing the vulnerability of communities in the Canadian Arctic to risks associated with climate change. *Arctic*, 57(4), 389–400. doi: [10.14430/arctic516](https://doi.org/10.14430/arctic516)
- Ford, J. D., Smit, B., & Wandel, J. (2006). Vulnerability to climate change in the Arctic: A case study from Arctic Bay, Canada. *Global Environmental Change*, 16(2), 145–160. doi: [10.1016/j.gloenvcha.2005.11.007](https://doi.org/10.1016/j.gloenvcha.2005.11.007)
- Ford, J. D., Smit, B., Wandel, J., Allurut, M., Shappa, K., Ittusarjuat, H., & Qrunnut, K. (2008). Climate change in the Arctic: Current and future vulnerability in two Inuit communities in Canada. *Geographical Journal*, 174(1), 45–62. doi: [10.1111/j.1475-4959.2007.00249.x](https://doi.org/10.1111/j.1475-4959.2007.00249.x)
- Ford, J. D., Smit, B., Wandel, J., & MacDonald, J. (2006). Vulnerability to climate change in Igloolik, Nunavut: What we can learn from the past and present. *Polar Record*, 42(2), 127–138. doi: [10.1017/S0032247406005122](https://doi.org/10.1017/S0032247406005122)
- Goldhar, C., Bell, T., & Wolf, J. (2014). Vulnerability to freshwater changes in the Inuit settlement region of Nunatsiavut, Labrador: A case study from Rigolet. *Arctic*, 67(1), 71–83. doi: [10.14430/arctic4365](https://doi.org/10.14430/arctic4365)
- Grushenko, E. (2014). Development of cruise tourism in the ports of the Western Arctic. *Arctic and North*, 14, 26–32.
- Hovelsrud, G. K., Karlsson, M., & Olsen, J. (2018). Prepared and flexible: Local adaptation strategies for avalanche risk. *Cogent Social Sciences*, 4(1). doi: [10.1080/23311886.2018.1460899](https://doi.org/10.1080/23311886.2018.1460899)
- Hovelsrud, G. K., & Smit, B. (2010). *Community Adaptation and Vulnerability in the Arctic Regions*. Dordrecht, Heidelberg, London, New York: Springer.
- IMO. (2010). *Guidelines for ships operating in polar waters*. London: International Maritime Organization
- IPCC. (2001). Climate Change 2001: Impacts, Adaptation, and Vulnerability. In J.M. McCarthy, N. Canziani, A. Leary, D.J. Dokken, K.S. White (Eds.), *Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change, published for the Intergovernmental Panel on Climate Change*. Cambridge, UK: Cambridge University Press.
- IPCC. (2007). *Report of the Intergovernmental Panel on Climate Change*, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press: Cambridge, UK, 976pp.
- IPCC. (2014). Climate change 2014: Impacts, adaptation, and vulnerability. Part A: Global and sectoral aspects. In C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, ... L. L. White (Eds.), *Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (1132 pp). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- IPCC. (2018). Summary for policymakers. In V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, ... T. Waterfield (Eds.), *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* (32 pp). Geneva, Switzerland: World Meteorological Organization.

- Keskitalo, C. (2008). Vulnerability and adaptive capacity in forestry in northern Europe: A Swedish case study. *Climatic Change*, 87(1–2), 219–234. doi: [10.1007/s10584-007-9337-1](https://doi.org/10.1007/s10584-007-9337-1)
- Keskitalo, C. (2009). Governance in vulnerability assessment: The role of globalising decision-making networks in determining local vulnerability and adaptive capacity. *Mitigation and Adaptation Strategies for Global Change*, 14(2), 185–201. doi: [10.1007/s11027-008-9159-0](https://doi.org/10.1007/s11027-008-9159-0)
- Keskitalo, C., Dannevig, H., Hovelsrud, G., West, J. J., & Swartling, A. (2011). Adaptive capacity determinants in developed states: examples from the Nordic countries and Russia. *Regional Environmental Change*, 11, 579–592. doi: [10.1007/s10113-010-0182-9](https://doi.org/10.1007/s10113-010-0182-9)
- Keskitalo, C., & Kulyasova, A. A. (2009). The role of governance in community adaptation to climate change. *Polar Research*, 28(1), 60–70. doi: [10.1111/j.1751-8369.2009.00097.x](https://doi.org/10.1111/j.1751-8369.2009.00097.x)
- Keskitalo, E. C. H., Dannevig, H., Hovelsrud, G. K., West, J. J., & Swartling, A. G. (2011). Adaptive capacity determinants in developed states: Examples from the Nordic countries and Russia. *Regional Environmental Change*, 11(3), 579–592. doi: [10.1007/s10113-010-0182-9](https://doi.org/10.1007/s10113-010-0182-9)
- Kvalvik, I., Dalmannsdottir, S., Dannevig, H., Hovelsrud, G., Rønning, L., & Uleberg, E. (2011). Climate change vulnerability and adaptive capacity in the agricultural sector in Northern Norway. *Acta Agriculturae Scandinavica Section B: Soil and Plant Science*, 61(SUPPL.1), 27–37. doi: [10.1080/09064710.2011.627376](https://doi.org/10.1080/09064710.2011.627376)
- Lazhentsev, V. (2016). The geosystem approach to the problems of social and economic development of regions of the North of Russia. *Economic and social changes: facts, trends, forecast/Экономические и социальные перемены: факты, тенденции, прогноз*, 1. doi: [10.15838/esc/2016.1.43.5](https://doi.org/10.15838/esc/2016.1.43.5)
- Leksin, V. N., & Porfiriev, B. N. (2017). Specificities of Spatial System Transformation and Strategies of the Russian Arctic Redevelopment under the Conditions of Climate Changes. *Economy of region*, 13(3), 641–657.
- Lopulenko, N. A. (2009). Народы севера в условиях глобальных природно-климатических изменений. People of the North in the Context of Global Natural Climatic Changes. Этнос и среда обитания. Том 1. Сборник этноэкологических исследований. Ethnicity and environment. *Collection of Ethno-Ecological Studies*, 1, 137–240.
- Lundmark, L., Pashkevich, A., Jansson, B., & Wiberg, U. (2008). Effects of climate change and extreme events on forest communities in the European North. *Climatic Change*, 87(1–2), 235–249. doi: [10.1007/s10584-007-9343-3](https://doi.org/10.1007/s10584-007-9343-3)
- MacDonald, J. P., Ford, J., Willox, A. C., Mitchell, C., & Productions, K. (2015). Youth-led participatory video as a strategy to enhance inuit youth adaptive capacities for dealing with climate change. *Arctic*, 68(4), 486–499. doi: [10.14430/arctic4527](https://doi.org/10.14430/arctic4527)
- Maximov, A. L., & Maximova, N. N. (2007). FEB RAS investigations on human adaptation and ecology in the North-East of Russia. *Vestnik of the Far East Branch of the Russian Academy of Sciences*, 6(2007).
- Meier, W. N., Hovelsrud, G. K., van Oort, B. E. H., Key, J. R., Kovacs, K. M., Michel, C., ... Reist, J. D. (2014). Arctic sea ice in transformation: A review of recent observed changes and impacts on biology and human activity. *Reviews of Geophysics*, 52(3), 2013RG000431. doi: [10.1002/2013RG000431](https://doi.org/10.1002/2013RG000431)
- Mortreux, C., & Barnett, J. (2017). Adaptive capacity: exploring the research frontier. *Wiley Interdisciplinary Reviews: Climate Change*, 8(4). doi: [10.1002/wcc.467](https://doi.org/10.1002/wcc.467)
- Nechiporenko, O. V. (2015). Adaptive Capacity of the Community as a Factor of Sustainable Development of Rural Areas: the Concept, Structure, Measurement. *Vestnik Novosibirsk State University*, 13(4), 151–158.
- Ng, A. K. Y., Andrews, J., Babb, D., Lin, Y., & Becker, A. (2018). Implications of climate change for shipping: Opening the Arctic seas. *Wiley Interdisciplinary Reviews: Climate Change*, 9(2). doi: [10.1002/wcc.507](https://doi.org/10.1002/wcc.507)
- O'Brien, K., Eriksen, S., Sygna, L., & Naess, L. O. (2006). Questioning complacency: Climate change impacts, vulnerability, and adaptation in Norway. *Ambio*, 35(2), 50–56. doi: [10.1579/0044-7447\(2006\)35\[50:QCCIV\]2.0.CO;2](https://doi.org/10.1579/0044-7447(2006)35[50:QCCIV]2.0.CO;2)
- Olsen, J., Carter, N., & Dawson, J. (2019). Community perspectives on the environmental impacts of Arctic shipping: case studies from Russia, Norway and Canada. *Cogent Social Sciences*, 5(1). doi: [10.1080/23311886.2019.1609189](https://doi.org/10.1080/23311886.2019.1609189)
- Olsen, J., Hovelsrud, G. K., & Kaltenborn, B. P. (2020). Increasing Shipping in the Arctic and Local Communities' Engagement: A Case from Longyearbyen on Svalbard. In E. Pongrácz, V. Pavlov, & N. Hänninen (Eds.), *Arctic Marine Sustainability: Arctic Maritime Businesses and the Resilience of the Marine Environment* (pp. 305–331). Cham: Springer International Publishing.
- Olsen, J., & Nenashva, M. (2018). Adaptive capacity in the context of increasing shipping activities: A case from Solovetsky, Northern Russia. *Polar Geography*, 41(4), 241–261. doi: [10.1080/1088937X.2018.1513960](https://doi.org/10.1080/1088937X.2018.1513960)
- Olsen, J., Nenashva, M., Wigger, K., Pashkevich, A., Bickford, S., & Maksimova, T. (2020). Cruise tourism development in the Arkhangelsk region, Russian Arctic: Stakeholder perspectives. In E. Pongrácz, V. Pavlov, & N. Hänninen (Eds.), *In search of Arctic marine sustainability: Arctic maritime businesses and resilience of the marine environment*. Switzerland: Springer.
- Oparin, R. V., Kulikova, N. A., & Shchigreva, S. N. (2011). Traditional and nontraditional ways of adaptation of the indigenous people of Siberia to climatic changes «learn itself, teach another». *World of science, culture, education*, 6(31), 440–441.
- Overland, J., Dunlea, E., Box, J. E., Corell, R., Forsius, M., Kattsov, V., ... Wang, M. (2018). The urgency of Arctic change. *Polar Science*. doi:<https://doi.org/10.1016/j.polar.2018.11.008>
- Pashkevich, A., Dawson, J., & Stewart, E. (2015). Governance of Expedition Cruise Ship Tourism in the Arctic: A Comparison of the Canadian and Russian Arctic. *Tourism in Marine Environments*, 10(3-4), 225–240.
- Pearce, T., Smit, B., Duerden, F., Ford, J. D., Goose, A., & Kataoyak, F. (2010). Inuit vulnerability and adaptive capacity to climate change in Ulukhaktok, Northwest Territories, Canada. *Polar Record*, 46(2), 157–177. doi: [10.1017/S0032247409008602](https://doi.org/10.1017/S0032247409008602)
- Perevalova, E. V. (2015). An interview with the Yamal herders about reindeer die-off and the future of the Nenets reindeer herding. *Ural Historical Journal*, 2(47), 39–48.
- Prno, J., Bradshaw, B., Wandel, J., Pearce, T., Smit, B., & Tozer, L. (2011). Community vulnerability to climate change in the context of other exposure-sensitivities in Kugluktuk, Nunavut. *Polar Research*, 30(Suppl.1). doi: [10.3402/polar.v30i0.7363](https://doi.org/10.3402/polar.v30i0.7363)
- Rasmussen, R. O., Hovelsrud, G., & Gearheard, S. (2014). *Community Viability and Adaptation*. In *Arctic Human Development Report: Regional Processes and Global Linkages* (pp. 500). Copenhagen: Nordisk Ministerråd.
- Rattenbury, K., Kielland, K., Finstad, G., & Schneider, W. (2009). A reindeer herder's perspective on caribou, weather and socio-economic change on the Seward Peninsula, Alaska. *Polar Research*, 28(1), 71–88. doi: [10.1111/j.1751-8369.2009.00102.x](https://doi.org/10.1111/j.1751-8369.2009.00102.x)
- Riabova, L. A., & Klyuchnikova, E. M. (2018). Social consequences of climate change in the Russian Arctic: Background knowledge of the problem and the agenda for new research. *The North and the Market: Forming the Economic Order*, 3(59), 91–110.
- Risvoll, C., Fedreheim, G. E., & Galafassi, D. (2016). Trade-offs in pastoral governance in Norway: Challenges for biodiversity and adaptation. *Pastoralism*, 6(1). doi: [10.1186/s13570-016-0051-3](https://doi.org/10.1186/s13570-016-0051-3)
- Risvoll, C., & Hovelsrud, G. K. (2016). Pasture access and adaptive capacity in reindeer herding districts in Nordland, Northern Norway. *Polar Journal*, 6(1), 87–111. doi: [10.1080/2154896X.2016.1173796](https://doi.org/10.1080/2154896X.2016.1173796)
- Schipper, E. L. F., Ayers, J., Reid, H., Huq, S., & Rahman, A. (2014). *Community-Based Adaptation to Climate Change*. Abingdon, Oxon: Routledge.
- Shestak, O., Shcheka, O. L., & Klochkov, Y. (2019). Methodological aspects of use of countries experience in determining the directions of the strategic development of the Russian Federation arctic regions. *International Journal of System Assurance Engineering and Management*. doi: [10.1007/s13198-019-00805-w](https://doi.org/10.1007/s13198-019-00805-w)
- Smit, B., & Pilifosova, O. (2001). Adaptation to climate change in the context of sustainable development and equity. In J. M. McCarthy, J. Canziani, A. Leary, D. J. Dokken, K. S. White (Eds.), *Climate change 2001: Impacts, adaptation, and vulnerability, contribution of Working Group II to the Third*

- Assessment Report of the Intergovernmental Panel on Climate Change, published for the Intergovernmental Panel on Climate Change.* Cambridge: Cambridge University Press.
- Smit, B., & Wandel, J.** (2006). Adaptation, adaptive capacity and vulnerability. *Global Environmental Change*, 16(3), 282–292. <https://doi.org/10.1016/j.gloenvcha.2006.03.008>
- Smith, L. C., & Stephenson, S. R.** (2013). New Trans-Arctic shipping routes navigable by midcentury. *Proceedings of the National Academy of Sciences*, 110(13), E1191.
- Stammler-Gossmann, A.** (2010). ‘Translating’ vulnerability at the community level: Case study from the Russian North. In G. Hovelsrud & B. Smit (Eds.), *Community Adaptation and Vulnerability in the Arctic Regions*. Dordrecht: Springer.
- Stewart, E., Dawson, J., & Johnston, M.** (2015). Risk and opportunities associated with change in the cruise tourism sector: community perspectives from Arctic Canada. *The Polar Journal*, 5(2), 403–427.
- The President of the Russian Federation.** (2014). Decree of the President of the Russian Federation of May 2, 2014 No. 296 “On land territories of the Arctic zone of the Russian Federation”. Retrieved from <http://www.kremlin.ru/acts/bank/38377>
- The Russian Government.** (2019). The National Action Plan for the First Phase of Adaptation to Climate Change for the Period up to 2022 (December 25, 2019). Moscow Retrieved from <http://government.ru/docs/38739/>
- Tiller, R., & Richards, R.** (2018). Ocean futures: Exploring stakeholders’ perceptions of adaptive capacity to changing marine environments in Northern Norway. *Marine Policy*, 95, 227–238. doi: [10.1016/j.marpol.2018.04.001](https://doi.org/10.1016/j.marpol.2018.04.001)
- Tomaska, A.** (2015). Demographic Factors for Social Adaptation of Rural Migrant Students of Indigenous Ethnic Minorities of the North (the Sakha (Yakutia) Republic). *Bulletin of Kalmyk Scientific Center of the Russian Academy of Sciences*, 1(2015), 141–146.
- Tremblay, M., Furgal, C., Larrivée, C., Annanack, T., Tookalook, P., Qiisik, M., ... Barrett, M.** (2008). Climate change in northern Quebec: Adaptation strategies from community-based research. *Arctic*, 61(Suppl. 1), 27–34.
- Turner, B., Kasperson, R., Matsone, P., McCarthy, J., Corell, R., Christensen, L., ... Schiller, A.** (2003). A framework for vulnerability analysis in sustainability science. *Biological Sciences*, 100(14).
- Tyler, N. J. C., Turi, J. M., Sundset, M. A., Strøm Bull, K., Sara, M. N., Reinert, E., ... Corell, R. W.** (2007). Saami reindeer pastoralism under climate change: Applying a generalized framework for vulnerability studies to a sub-arctic social-ecological system. *Global Environmental Change*, 17(2), 191–206. doi: [10.1016/j.gloenvcha.2006.06.001](https://doi.org/10.1016/j.gloenvcha.2006.06.001)
- Van Bets, L. K. J., Lamers, M. A. J., & van Tatenhove, J. P. M.** (2017). Collective self-governance in a marine community: expedition cruise tourism at Svalbard. *Journal of Sustainable Tourism*, 25(11), 1583–1599. doi: [10.1080/09669582.2017.1291653](https://doi.org/10.1080/09669582.2017.1291653)
- Vinokurova, L. I., Filippova, V. V., Suleymanov, A. A., & Grigorev, S. A.** (2016). Waiting for an ice-break: social aspects of devastating floods in rural Yakutia (late XX th – beginning of XXI century). <В ожидании ледохода: социальные аспекты разрушительных наводнений в сельской Якутии (кон. Хх – нач. ХхI вв.)>. *Humanitarian studies in Yastern Siberia and the Far East*, 1(35), 28–40.
- Vlasova, T., & Volkov, S.** (2016). Towards transdisciplinarity in Arctic sustainability knowledge co-production: Socially-Oriented Observations as a participatory integrated activity. *Polar Science*, 10(3), 425–432. <https://doi.org/10.1016/j.polar.2016.06.002>
- Walker, B., Holling, C. S., Carpenter, S. R., & Kinzig, A.** (2004). Resilience, adaptability and transformability in social–ecological systems. *Ecology and Society*, 9(2), 5. <https://www.ecologyandsociety.org/vol9/iss2/art5/>
- Wesche, S. D., & Chan, H. M.** (2010). Adapting to the impacts of climate change on food security among inuit in the Western Canadian Arctic. *EcoHealth*, 7(3), 361–373. doi: [10.1007/s10393-010-0344-8](https://doi.org/10.1007/s10393-010-0344-8)
- West, C. T.** (2011). The survey of living conditions in the Arctic (SLiCA): A comparative sustainable livelihoods assessment. *Environment, Development and Sustainability*, 13(1), 217–235. doi: [10.1007/s10668-010-9257-5](https://doi.org/10.1007/s10668-010-9257-5)
- West, J. J., & Hovelsrud, G. K.** (2010). Cross-scale adaptation challenges in the coastal fisheries: Findings from Lebesby, Northern Norway. *Arctic*, 63(3), 338–354. doi: [10.14430/arctic1497](https://doi.org/10.14430/arctic1497)