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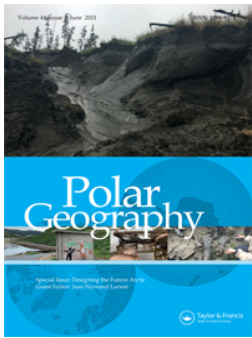
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Towards improved participatory scenario methodologies in the Arctic

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ABSTRACT

Participatory scenario methodologies are increasingly used for studying possible future developments in the Arctic. They have the potential to contribute to several high-priority tasks for Arctic research, such as integration of indigenous and local knowledge in futures studies, providing a platform for activating Arctic youth in shaping their futures, identifying Arctic-relevant indicators for sustainable development, and supporting decision-making towards sustainable futures. Yet, to achieve this potential, several methodological challenges need to be addressed. These include attention to whose voices are amplified or silenced in participatory research practices, with special attention to diversification and the engagement of youth. Given the historic and potential future role of disruptive events for Arctic development trajectories, methods are needed in participatory scenario exercises to include attention to the dynamics and consequences of such events and regime shifts. Participatory scenarios can also be further improved through approaches that effectively combine qualitative and quantitative information. Finally, there is a need for systematic studies of how the results of scenario exercises influence decision-making processes. This article elaborates on ways in which attention to these aspects can help make scenarios more robust for assessing a diversity of potential Arctic futures in times of rapid environmental and social change.

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Introduction

Rapid environmental and social change in the Arctic increases the need to understand and discuss different potential futures in a systematic manner. Scenario methods have been used

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in a wide range of fields to map and assess potential futures and to support planning in both business and the public sector. For example, scenarios have been used in studies of global change to identify uncertainties relating to economic, political, technological, socio-cultural, and environmental change (e.g. in studies of biodiversity: Carpenter, Pingali, Bennett, & Zurek, 2005; Takeuchi et al., 2017; and in climate change research: Moss et al., 2010). For the Arctic, where there is a plethora of futures studies (Arbo, Iversen, Knol, Ringholm, & Sander, 2012; Pelyasov, 2015), scenarios have been used in national strategic planning (e.g. Hansen & Larsen, 2015), to assess cross-regional societal development (e.g. Andrew, 2014; Karlsdottir, Smed Olsen, Greve Harbo, Jungsborg, & Rasmussen, 2017), and to consider developments in specific sectors such as shipping, defence, reindeer herding, and economy (Arctic Council, 2009; Bourmistrov, 2015; Cole et al., 2016; Heikkinen, Sarkki, & Nuttall, 2012; Horstkotte et al., 2017; Loe, Fjærtøft, Jakobsen, & Swanson, 2014; Mugridge, Avis, & Race, 2011). While some scenarios take the whole circumpolar North into account (Arctic Council, 2009; Cavalieri et al., 2010), others are geographically limited, e.g. to the Nordic or European context (Haavisto, Pilli-Sihvola, Harjanne, & Perrels, 2016; Karlsdottir et al., 2017; Stepien, Koivurova, & Kankaanpää, 2014) or to the subnational and local scales (Beach & Clark, 2015; Falardeau, Raudsepp-Hearne, & Bennett, 2018; Lovecraft, Fresco, Cost, & Blair, 2017; Nilsson, Bay-Larsen, Carlsen, van Oort, et al., 2017; Wesche & Armitage, 2014). Scenario development exercises are often expert driven, but there is also an increasing interest in using participatory methods that engage local communities or other groups of local and regional actors (for reviews, see Flynn, Ford, Pearce, & Harper, 2018; Lovecraft & Preston, 2017; Nilsson, Bay-Larsen, Carlsen, Jylhä, et al., 2017). Visioning about Arctic futures has a long history and has often been driven by outside interests (see e.g. Wormbs, 2018). Future studies methods that involve people who live in the Arctic therefore become especially relevant when the region is now undergoing rapid social and environmental changes. This provides a motivation both to consider participatory methods and to critically examine their potential strengths and weaknesses.

Participatory scenario approaches have been credited with many positive outcomes. One study analyzing experience with these methods from around the world identifies three particularly important benefits: social learning across different stakeholder groups, promoting community-owned solutions, and facilitating the sharing of experiences in a creative and collaborative way (Oteros-Rozas et al., 2015). However, the authors also identify certain weaknesses in the cases studied, including a lack of diversity among the participants and lack of follow-up on whether the process led to any action. They also emphasize the potential benefits of efforts that would facilitate the sharing of experiences. Given the growing use of participatory methods for developing scenarios for Arctic futures, it is therefore timely to reflect on lessons learned from the region and on what steps need to be taken to help realize the promise of participatory scenario methodologies. The objective of this paper is to present the results of a reflective analysis of strengths and weaknesses of participatory methods for developing scenarios of Arctic futures and to suggest further method development. The purpose of the paper is to contribute to making participatory scenario methods and visioning about Arctic futures inclusive of more voices, more robust in a context of multiple uncertainties, and more salient for decision makers. It responds to a need for methods for engaging a greater diversity of Arctic voices in decision making and planning for Arctic futures at a time of rapid environmental and social change.

Methodology

A useful way to foster reflection within a research field is to gather scholars with a range of relevant experiences to discuss emerging challenges (Ford et al., 2016). For the purpose of reflecting on the increasing use of future scenarios and their potential for informing development of indicators for sustainable development in the Arctic, researchers active in these fields were invited to a two-day workshop in September 2017 at Stockholm Environment Institute, Sweden. A specific aim was to support further method development within the Nordic Centre of Excellence ‘Resource Extraction and Sustainable Arctic Communities’ but the ambition was also to critically reflect on the growing use of scenario methodology. The workshop participants ($n = 14$) represented different academic disciplines (including economics, social sciences, education, geography and climate science), research organizations (universities ($n = 6$), independent ($n = 3$), governmental ($n = 3$) and other ($n = 3$)) and countries (Sweden, Finland, Iceland, Denmark, Norway, Russia, United States, and Austria) as well as a different types of experience with interdisciplinary and participatory research in the Arctic. To prepare for the workshop, the participants were asked to reflect on two questions:

- (1) How could scenario methods help inform the development of relevant indicators for sustainability in the context on the long-term impacts of extractive industries on Arctic communities?
- (2) How might different indicators or indicator domains be integrated into tools that can be used in social and environmental impact assessments and policy?

Following presentations of on-going or recently completed research, a session was devoted to a facilitated exercise aimed at identifying specific issues that would need to be addressed to make scenario methods more useful – both in a general sense and in the context of developing indicators. Workshop participants agreed on six major themes as especially important to discuss further: the potential for learning through co-production of knowledge, engaging with young people, linking scenario exercises with indicators for sustainable development, recognizing the importance of disruptive events and the change they can initiate, avoiding false dichotomies, and ensuring that scenarios are useful for decision-making. Workshop participants who were interested in exploring these issues further were invited to participate in an iterative writing process, the end result of which is this co-authored paper. The remainder of the paper elaborates on these themes and discusses future research needs to overcome some important shortcomings of participatory scenario approaches.

Learning and engagement in co-production of knowledge

A major benefit of participatory scenario approaches is that they can serve as a forum for learning among a diverse set of actors, creating potential for developing mutual understanding, shared terminology, and common narratives (Johnson et al., 2012; Oteros-Rozas et al., 2015). Participatory settings for collaborative work are particularly relevant in the Arctic, given the strong call for co-production of knowledge across knowledge traditions (see e.g. Petrov et al., 2016). There are several examples where engaging with local communities has brought issues to the fore that have not been as prominent in expert discussions, including the importance of social factors, questions regarding power over and inclusion in

decision-making, and the impact of world views on people's choices (Flynn et al., 2018; Lovecraft et al., 2017; Nilsson, Bay-Larsen, Carlsen, Jylhä, et al., 2017; Rasmussen & Jungsberg, 2016; Wesche & Armitage, 2014). The level of learning cannot be taken for granted, however. One important prerequisite is that the setting for the scenario development process allows for a diversity of perspectives as well as dialog across those perspectives.

In studies of potential future development paths, a major methodological weakness of participatory methods is that the ideas about Arctic futures represent the people who are invited to and able to participate in the scenario workshops. In practice, participatory methods for studying Arctic futures have tended to favor those who already have ample access to resources and a voice in the public sphere, potentially exacerbating existing power asymmetries. Consequently, there is a need to explicitly consider whose voices are amplified by participatory research methods, and whose voices may be overlooked or even eclipsed in the process. Careful mapping of the actor landscape prior to planning participatory methods can raise awareness about relevant invitees beyond the organizer's immediate network. A clearly defined focal question, developed in collaboration with a broader group of people can also facilitate identifying participants who have the relevant expertise (Lovecraft & Preston, 2017). Furthermore, the workshop invitation and agenda should show that the exercise is likely to be salient and productive enough for the relevant participants that they will be motivated to allocate the time and energy to participate. In addition to developing a relevant focus, resources need be available for travel funding, which is often needed for participants from remote and rural communities (Karlsdottir et al., 2017) but is also a more general concern when trying to gather people. Sometimes it is also appropriate to compensate for the time spent on sharing knowledge at a workshop (recognizing that the norms regarding such financial compensation may differ depending on the context). During participatory scenario workshops, the role of the facilitator(s) is crucial. Our discussion highlighted a need to learn more about this role, which has a critical function for ensuring that all voices are heard, alleviating asymmetric power relationships among the participants (including the relationship between local participants and researchers), and ensuring a diversity of settings and forms for expressing ideas (including attention to language). The issues mentioned here reflect some practical considerations related to power over visions about Arctic futures. Important to also discuss but beyond the scope of this paper are the broader issues of power related to participatory methods (see e.g. Cooke & Kothari, 2001). It includes concerns about who controls and benefits from the process as well as power relations among the participants in the workshop, as has been identified as issues in the study by Oteros-Rozas et al. (2015).

Engaging with young people

While many different groups should be considered in scenario exercises, we highlight the importance of youth engagement (see also Davison & Hawe, 2012; Glendøs & Berliner, 2017; Kral, Salusky, Inuksuk, Angutimarik, & Tulugardjuk, 2014; MacDonald, Cunsolo Willox, Ford, Shiwak, & Wood, 2015; MacDonald, Ford, Willox, & Mitchell, 2015; Ulturgasheva, Rasmus, & Morrow, 2015). Youth perspectives have been identified as a poorly developed strand in the study of Arctic human development (Karlsdottir & Jungsberg, 2015; Larsen & Fondahl, 2014). Furthermore, young people have demonstrated both an interest and legitimate stake in being part of discussions about the future (Cost, 2017; Karlsdottir & Jungsberg, 2015). For research about potential future developments in the Arctic to be

more relevant, it will be critical to understand their priorities, aspirations, obstacles, and life paths. These factors shape young people's individual futures, affect the viability of Arctic cultures, languages, traditional activities, and communities, and influence the capacity to navigate climate change and other external pressures that shape environments and societies (e.g. Kowalczewski & Klein, 2018; MacDonald, Cunsolo Willox, et al., 2015; MacDonald, Ford, et al., 2015; Ulturgasheva, Rasmus, Wexler, Nystad, & Kral, 2014). We furthermore argue that working with youth in participatory scenario exercises and workshops engages them in shaping the future of their societies. Identifying factors that youth consider pivotal could support relevant action and may thus help sustain local human capital over time (Cost, 2017; Karlsdottir & Jungsberg, 2015; MacDonald, Cunsolo Willox, et al., 2015; Ulturgasheva et al., 2015). Thinking about the future can also be a useful complement to compulsory education and other learning processes (e.g. social learning, co-production of knowledge, or vocational training) (Cost, 2015).

Actively including young people's voices in developing scenarios for Arctic futures also provides an occasion to think more creatively about methods used for scenario development. For example, can the common low-technology sticky-note practices of many participatory scenario workshops be complemented by taking advantage of social media and other virtual platforms? The role of social media is increasing in the Arctic, with growing Internet access. For many young people, social media constitutes an essential mode of communication (for example in Greenland, see Rygaard, 2017). There is also growing interest in the potential of virtual technologies and social media for citizen science (Newman et al., 2012), and in education, where the lines between formal and informal education blur (Greenhow & Lewin, 2016). It could therefore be worth considering using social media for opinion mining or other techniques (Batrincea & Treleaven, 2015). Other more established ways to engage with young people in research could also be used more extensively in developing future scenarios. These include focus group discussions (Davison & Hawe, 2012; Karlsdottir & Jungsberg, 2015; Ulturgasheva et al., 2015), collaborating with schools (Cost, 2017), youth-led participatory video (MacDonald, Ford, et al., 2015), more qualitative and locally grounded approaches (Kowalczewski & Klein, 2018), and intergenerational processes (Allen et al., 2014).

Identifying indicators for change towards sustainable development

The recent launch of the Sustainable Development Goals (SDGs) has thrust the notion of sustainable development into a new light. It is now followed by global, regional, and national processes to negotiate how the goals should be translated into practice and how progress should be tracked using relevant indicators. As highlighted by Sköld, Baer, Scheepstra, Latola, and Biebow (2018), the SDGs were not developed with the Arctic in mind and have also been criticized for representing a top-down approach for managing challenges that have both local and global dimensions. In their statement from the Arctic Observing Summit 2018, they advocate 'developing a suite of polar indicators to assess the state of the social-ecological systems in the Arctic, and to create guidelines for sustainable monitoring and regular assessments that track the progress on pathways towards a sustainable development.' One way to complement the current top-down approach to defining SDGs would be to use participatory scenario exercises to identify what sustainability means in different local Arctic contexts. Such an approach would contribute to the advocated process and provide an avenue for engaging local and regional actors in the discussion about Arctic-

relevant SDGs. A specific advantage is that the futures focus of scenario exercises creates a foundation for discussing whether the indicators that seem relevant today will also be relevant for future generations, and how those indicators might lead to improved capacities to navigate future uncertainty and change in the Arctic. They would serve as a useful complement to earlier attempts to identify factors that contribute to adaptive capacity (Kofinas, Clark, & Hovelsrud, 2013; Nilsson, Hovelsrud, Amundsen, Prior, & Sommerkorn, 2016 and references therein) and resilience (Arctic Council, 2016; Carson & Sommerkorn, 2017) and can build on efforts to identify and implement Arctic Social Indicators (Larsen, Petrov, & Schweitzer, 2015). Furthermore, participatory scenario exercises could help identify local needs and capacities, such as educational outcomes, that would support the needs of specific communities.

Beyond extrapolation: disruptions and interacting drivers

A key concern in the Arctic is the complex dynamics of multiple drivers of change, with feedback mechanisms that can accelerate the rate of change. Participatory scenario approaches can provide community members with an opportunity to engage, analyze, and consider the implications of changes in feedbacks within the systems in which they are part (Magga, 2006). Moreover, the open nature of the discussions around a focal question can reveal surprises as participants highlight concerns that can become key social drivers or uncertainties that are new to researchers (Lovecraft & Preston, 2017). Yet, it is difficult to think beyond extrapolation of obvious trends. People who have participated in scenario workshops sometimes highlight that the exercise allowed them to think out-of-the-box. However, reviewing the results of the scenario exercises conducted by the authors, we are struck by how often the scenarios are extrapolations of past trends or derive from recent experience. Examples include an emphasis on current events that may or may not be relevant in a longer-term perspective and status quo assumptions, such as today's major political structures staying virtually the same in the future despite major environmental and climatic transformations.

Another case of a potential blind spot in futures thinking is the difficulty of capturing 'disruptive events' that have a disproportionate effect on development trajectories but are inherently difficult to predict. Arctic development appears ripe with unexpected events that carry major consequences. One example is the breakup of the Soviet Union in 1991, causing major demographic shifts (Heleniak, 2001) as well as the transformation of circumpolar geopolitics from Cold War conflict to political cooperation. More recently, the sea-ice minimum of 2007 caught by surprise scientists and politician alike. It became a 'meta-event' that has influenced expectations regarding geopolitical developments, off-shore resources, and shipping in the polar region (Christensen, Nilsson, & Wormbs, 2013). A third example is the 2008 crash of the Icelandic economy, which led to a major restructuring of the economy where the failed financial sector has been replaced by fish export, renewable energy, and a rapidly growing tourism industry (Huijbens, Jóhannesson, & Jóhannesson, 2014).

Rapid global developments in the environmental, political, and economic spheres, along with strong cross-scale interactions, provide reason to believe that unexpected and disruptive events will occur more frequently in the Arctic in the years to come. In order to capture their potential impacts, it becomes important to explore multiple scenarios and also to bring in so-called black swan events – high consequence, low probability developments (Taleb, 2007) – as the exercise progresses. Introducing examples from past experiences or from films and

literature are potential ways to break assumptions about status quo and even development paths. We furthermore suggest to more frequently incorporate quantitative data to complement the established focus on narratives in participatory methods. A review of participatory scenario planning in the Arctic highlights the frequent absence of information about future climate change from climate models, despite the increasing availability and relevance (Flynn et al., 2018). Combining quantitative and narrative approaches could both provide additional information for local discussions and facilitate deeper exploration of potential disruptive events and shifts that emerge during a scenario exercise.

Multiple dimensions and risks of false dichotomies

Methodologically, many scenario exercises focus on two key drivers of change to develop four explorative scenarios. A review of published Arctic socio-economic scenarios showed that they almost always included climate change as one tier and governance or management of natural resources as the second tier, with a shift in recent years towards political factors (Haavisto, Pilli-Sihvola, & Harjanne, 2017). Such a two-dimensional approach comes with important limitations. For one, we risk underestimating the role of other factors that might powerfully influence future development. The limit of dimensions tends to create a false dichotomy between proactive vs. reactive environmental attitudes (e.g. Carpenter et al., 2005; van Vuuren, Kok, Girod, Lucas, & de Vries, 2012), where the reactive attitude is deemed to lead to unsustainable business-as-usual futures. Environmental governance officials in northern Finland pointed out in one participatory scenario exercise that it is counter-productive to frame nature and culture against each other when, in practice, business development and land use must be carried out in an environmentally sustainable manner (Sarkki et al., 2016). Similarly, during another workshop, on the implications of climate change for reindeer grazing lands, many Sámi herders wanted to avoid ‘doom and gloom’ scenarios. They had observed significant changes in terms of shrub and forest encroachment on their territories and had highly nuanced and insightful explanations but did not want an oversimplified ‘good vs. bad’ dichotomy to gain currency among scientists, the general public, and administrators (Horstkotte et al., 2017). Furthermore, scenario exercises should ideally create innovative space that allows for overcoming conflicts and actively facilitate imagination, for which the reduction of a complex reality to two dimensions is not useful.

Proposals to ease the common emphasis on doom and gloom would be to include exploration of various plausible positive scenarios. Falardeau et al. (2018) provide such an example. Actionable scenarios for a local Arctic community in Canada were developed by introducing emerging and potentially transformative local initiatives and exploring how they could contribute to positive developments. Another option is to connect exploratory scenarios with normative backcasting scenarios to explore the potential for agency of the scenario producer under varying set of divergent futures (Sarkki & Pihlajamäki, 2019). The stiff logic of a 2×2 scenario matrix (Ramirez & Wilkinson, 2014) can be opened for a more diverse discussion by inductive selection of drivers by scenario co-producers, combined with keeping attention to more drivers throughout the discussion (see e.g. Nilsson, Bay-Larsen, Carlsen, van Oort, et al., 2017). In another scenario development method, qualitative approaches were combined with quantitative algorithmic analysis to test the robustness of various scenarios that have been developed in workshop setting (Mueller-Stoffels & Eicken, 2011). When this method was used in the Northern Alaska Scenarios Project, it enabled participants to

consider a dozen or more key factors by combining the possible futures of each key factor with the possible futures of all the other key factors in cross-wise pairings (Lovecraft et al., 2017).

Making scenarios useful for decision-making in policy and planning

In our experience, participatory scenario workshops are often seen as rewarding by the participants. Participatory scenario planning exercises have also been shown to be useful for identifying local options for adaptation to climate change in the Arctic (Flynn et al., 2018). However, judged by international experience, the learning outcomes and action impacts of participatory scenario processes are not always evaluated (Oteros-Rozas et al., 2015). Moreover, local participatory workshops are unlikely to affect policy and planning decisions at higher levels without specific efforts to do so. Meanwhile, increasing awareness about the need to respond to climate change has created calls for science to deliver decision support to different levels of governance with information that is both immediately useful and considers long time horizons and uncertainties. Although some evaluations of the use of scenario exercises exist (e.g. Parson et al., 2007; Star, 2007), there appears to be little research on how scenarios influence actual decision-making or even our thinking about the future (Gong et al., 2017). Ernst and van Riemsdijk (2013) found that more varied stakeholder involvement in scenario exercises can contribute to more robust adaptation strategies, but the question remains whether the strategies are implemented in practice. Our own experiences are that it can be difficult to reach decision-makers with information from scenario studies. Following insights from Henrichs et al. (2010), we argue for more attention to how results are communicated, how fit they are for their purpose, and how they are received by the target group. Furthermore, research on the usability of climate science in decision-making highlights the importance of interaction between the information provider and user (Dilling & Lemos, 2011). Such interactions could foster participants' ownership also of scenario exercises, which is likely to affect whether the scenarios that are developed become useful and used in decision-making.

Research performed *ex ante* of a scenario exercise indicates that there may be conditions in the Arctic that make the anchoring and use of scenario exercises by decision-makers particularly challenging (Hansen & Larsen, 2015). This includes high turnover among government officials and politicians, and a weak – but developing – tradition for participation and political deliberations. Furthermore, resource-strapped communities and authorities have little time to participate in 'experimental' discussions, such as scenario exercises, that often have goals based on long time horizons in relation to immediate needs (c.f. Stammer & Forbes, 2009). Revisiting scenarios to update or tune adaptation strategies after the participatory process is finished is a related problem. Given the rapid rate of social and environmental change in the Arctic, visioning can become outdated within a short time span.

Volkery, Ribeiro, Henrichs, and Hoogeveen (2008) argue that stronger integration of qualitative and quantitative analysis in scenario development could help to trigger strategic conversation and decision-making. A key priority regarding methods development would thus be to incorporate quantitative methods into the participatory scenario development processes. This would be relevant in relation to studies of potential Arctic-relevant SDG indicators, as discussed above, where quantitative data are likely to feed into policy-driven evaluations of the goals. Another way to make scenario exercises more relevant for policy is to build on previous experience of using scenarios in different types of formal assessment

processes (see e.g. Parson et al., 2007). Specifically, we suggest exploring the possibility of including scenario exercises as part of environmental and social impact assessments of development and industrial projects being carried out across the Arctic, many of which have potential long-term impacts on societies and environments (see Duinker & Greig, 2007 for further discussion of a need for future scenarios in EIAs).

Scenarios also have a natural place in the broad context of strategic planning (e.g. Stimson, Stough, & Roberts, 2013). Such planning is often aimed at supporting decisions about how to use Arctic space, including attention to conflicts about land use and deployment of human resources, financial capital, and infrastructure investments. Especially relevant is attention to population dynamics at the regional scale, as such information is needed to facilitate support for economic and social development. In some countries, scenarios are routinely used in regional strategic planning but often without accounting specifically for Arctic conditions such as the fluctuations that are often associated with mono-profile economies based on extraction of natural resources. Assessing how boom-and-bust cycles interact with other short- and long-term changes in social and physical environments is therefore a major challenge for strategic planning, including but not limited to the impacts of climate change and how such dynamics in turn affect land-use and demand for space (see e.g. Nilsson, Hovelsrud, & Karlsson, 2017). In the Nordic Arctic, foresight studies and projections of demography are conducted, but it is up to individual governments whether these foresights are considered in regional development strategies. At the local scale, use of participatory scenario methods is increasing, but Flynn et al. (2018) found that although participation has increased, this only applies to some aspects of planning processes, generally with lowest participation in the driver identification, scenario creation and option rating phases. The latter is essential for creating better links to decision-making.

While the potential for using scenarios in environmental and social impact assessment has been articulated by multiple authors (e.g. Duinker & Greig, 2007), the actual implementation of scenarios in impact assessment and strategic planning requires closer collaboration between researchers working with participatory scenario approaches, the practitioners who carry out assessment and planning processes, and lay people, residents, and community members who are often at the forefront of enacting, following and providing feedback on policy. Both the potential and the challenges are well illustrated by a community based impact assessment of a proposed mine, including a scenario analysis, that was carried out in collaboration with local Sami as an alternative to the proponent's environmental impact assessment (Lawrence & Larsen, 2017). According to the authors, the community-driven assessment 'allowed space to present different narratives and visions from the community' but also revealed conflicts with the mining company about the legitimacy of different types of knowledge (Lawrence & Larsen, 2017, p. 1170).

Discussion, conclusions and next steps

The context for conducting research in the Arctic has changed dramatically in the past two decades, with a strong call for approaches that favor co-production of knowledge and local engagement as well as local ownership of the research processes (e.g. Petrov et al., 2017). Ongoing environmental and social changes have created demands for making research useful not only for advancing knowledge but also for making sound decisions about adaptation actions to meet potential future developments (AMAP, 2017a, 2017b, 2017c). While future visions of the Arctic are plentiful, this emerging context requires continuous reflection

Table 1. Overview of promises, challenges, and proposed solutions to identified challenges in the use of participatory scenario approaches in the Arctic.

Theme	Promises of participatory scenario building	Remaining challenges	Proposed action
<i>Learning and engagement in co-production of knowledge</i>	Quality and ownership of futures thinking is improved by people working together in co-production processes	Limited participation in scenario processes may amplify already well-resourced voices while marginalized voices remain silenced	Stakeholder analysis prior to scenario exercises to ensure that relevant actors are invited and have the resources and support needed to participate
<i>Engaging with young people</i>	Including youth in scenario development could help prepare them for potential futures and challenges	Limited attention, so far, on methods that are specifically designed to attract young people	Frame invitations and design the scenario process in ways that are relevant for young people, including innovative design of participatory methods
<i>Identifying indicators for change towards sustainable development</i>	Potential to identify Arctic specific and locally relevant monitoring needs	Compression of knowledge and assumptions about the future that may mask equally relevant driver of change and trends	Maintain attention to uncertainties by refraining from reducing complexity to single variables and by supporting parallel lists or products
<i>Moving beyond extrapolation by attention to disruptions and interacting drivers</i>	Potential for out-of-the-box thinking that leads to creative identification of future drivers and their implications	Scenarios are often limited to ideas based on present and past experiences	Including the potential for disruptive events and their consequences by using examples of radical and fast changes in the past and/or from popular culture to boost imagination
<i>Attending to multiple dimensions and risks of false dichotomies</i>	Focusing on a few key drivers and their uncertainties can capture what is perceived as most important in shaping the future	Dichotomies mask shades of grey and other relevant drivers and may disfavor learning that could otherwise lead to new creative solutions	Allow participants to identify multiple relevant drivers of change and focus on participants' potential for agency under various plausible futures
<i>Making scenarios useful for decision making in policy and planning</i>	Potential for ownership among participants that could facilitate use of scenarios in decision-making	Implementation of insights from scenario exercises depend on: (1) how fit they are for their purpose, (2) how they are viewed by the target group, and (3) how and to whom they are communicated	Mainstream scenario processes into relevant decision-making processes, such as strategic regional planning and impact assessments. Enhance ownership by complementing scenario workshops with other methods (e.g. Delphi panels) to reach relevant target groups

about how research in and about the Arctic is designed and how participatory methods can contribute to co-production of knowledge and local engagement. This may be especially relevant in research that includes visioning about Arctic futures in scenario exercises, as such visions can play an important role in shaping the future and thus also the well-being of people in the region. Against this backdrop, we have identified a range of potential uses of participatory scenarios in the Arctic, with attention to important promises of such approaches but also to some of the shortcomings that need to be addressed and possible solutions. [Table 1](#) summarizes conclusions from the six themes addressed in this paper.

For researchers planning to use participatory scenario exercises, the take-home message is that attention is needed to the purpose and desired outcome of the scenario process, who needs to be involved, and how the process should be designed to facilitate relevant involvement and desired outcomes. In addition to improving practice, there is a need for method development and further research about scenario processes. We have identified the following priorities:

- Systematic follow-up on how the results of scenario exercises are used to inform decision-making.
- Greater effort to incorporate the possibility of disruptive events and regime shifts, including exploration of relevant feedbacks and potential indicators.
- More attention to whose voices are amplified in studies of Arctic futures, and whose voices are absent or silenced in current research practices, including efforts to evaluate the effects of different facilitation techniques on group dynamics.
- More attention to exploring multiple drivers of change, including dimensions that are excluded from current monitoring efforts and quantitative models of social and environmental change in the Arctic.
- Development and evaluation of innovative web-based technologies that can engage a broader variety of actors and especially youth in developing scenarios for Arctic futures.










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