Chapter 12

Uncertainties in Arctic Socio-economic Scenarios

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Abstract Scenarios are neither predictions nor forecasts, but explore a range of possible futures. Socio-economic scenarios enable the consideration of different uncertainties related to the future and may improve decision-making by enabling the development and analysis of robust decisions. The development of socio-economic scenarios in the Arctic has been a fairly popular topic for scenario analyses. This study reviews ten selected socio-economic scenarios developed for the Arctic region that differ in structure and geographic focus. The analysis shows that the key uncertainties are fairly similar across the different scenarios. The key uncertainties are mainly related to governance or management and natural resources, but recently the uncertainty and importance of political factors have risen. Climate change is included in all scenarios, but its contribution to the future development of the region and its perceived uncertainty varies depending on the scenario.

12.1 Introduction

The Arctic includes regions, countries and communities with different histories, cultures, political environments and economies. Some of these follow the national borders; others do not. However, some characteristics are common across the region: the Arctic is remote, peripheral and sparsely populated, with challenges regarding accessibility and connectivity, its climate is challenging, it has limited socio-economic resources with constraints on human capital, and a proportionally high dependence on the public and primary (extractive) sectors (Stępień 2016). All these characterize the region, and will also characterize, to different extents, its future.

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Due to inter-linked global and local developments taking place at the moment, the Arctic and in its sub-regions will witness changes that are difficult to evaluate. In addition to the characteristics of the Arctic, there are several other uncertainty factors that shape its future: for instance globalization, technological development, global economic situation, climate change, climate policy and its implementation, resource prices and demand, and geopolitical situation are all global developments that will have regional and local impacts (Haavisto et al. 2016). Decision-making in the Arctic is in the interface of all these uncertainties. In the face of this uncertainty and the accelerating change witnessed in the Arctic, decision-making is facing increasing challenges, and the robustness of decisions under different futures is key for successful decision-making.

Futures studies address the long-term developments and alternative futures with different approaches, of which scenario development and scenario planning are two examples. Scenario development is a process of creating future stories, while scenario planning is a more comprehensive foresight study methodology that includes scenario development as one part of the analysis. According to Bishop et al. (2007, p.8) “— a scenario is a product that describes some possible future state and/or that tells the story about how such a state might come about.” Socio-economic scenarios present possible futures and address social and economic change, governance structures, social values and technological change (McCarthy et al. 2001; Shackley and Deanwood 2003; van’t Klooster et al. 2011).

In this chapter, the importance of understanding different socio-economic futures in the Arctic context and the potential of socio-economic scenarios to support decision-making are discussed. This is achieved by reviewing a selection of published Arctic socio-economic scenarios and analysing how they have been developed and how they address the key uncertainties regarding the future of the Arctic. A specific focus is put on the role of climate change as an uncertainty factor in the region, because the Arctic is considered to be a climate change hotspot (Diffenbaugh and Giorgi 2012), and climate change is projected to increase the average temperatures in the Arctic substantially more than the global temperatures (Collins et al. 2013). This chapter draws upon existing literature and research, but is motivated by the TWASE- research project (Towards better tailored Weather and marine forecasts in the Arctic to serve Sustainable Economic activities and infrastructure), funded by the Academy of Finland.

12.2 Towards Better Informed Decision-Making in the Arctic

12.2.1 *Socio-economic Scenarios*

Scenarios have a long history in business planning, and a great deal of the methodological literature on scenarios is based on scenario exercises in business environments (e.g. Schwartz 1991). Nowadays, scenario development is also used for instance in local community management (e.g. van Oort et al. 2015) and in public policy (e.g. van Asselt et al. 2010), where scenario development is a tool to address inherent uncertainty and complexity in environmental decision-making (Carter and White 2012). Despite their potential value, scenarios are not fully utilized in the mainstream decision-making (Carter and White 2012). Socio-economic scenarios, in particular those allowing for uncertainty considerations, can contribute to decreasing decision failures (Berkhout et al. 2002; Chermack 2004). To avoid decision failures, participatory scenario development methods, where the organizations using the socio-economic scenarios developed are involved in their development, should be used. They increase the effectiveness of the scenarios (Berkhout et al. 2002; Chermack 2004; van Drunen et al. 2011), enable policy and organizational learning (Berkhout et al. 2002) and stakeholder engagement (Shackley and Deanwood 2003).

Berkhout et al. (2002) define two major approaches of socio-economic scenario development: the normative and the exploratory approaches. Normative scenario approach reminds of objective-based planning, in which the future is built on positive or negative visions and pathways to the desired end point. Exploratory scenario approach builds on alternative socio-economic conditions, constructing plausible representations of the future and supporting establishment of robust strategies. In comparison to the two approaches in Berkhout et al. (2002), Börjeson et al. (2006) categorize scenarios into predictive, explorative and normative scenarios, predictive scenarios trying to foresee what will or is expected to happen.

Socio-economic scenarios can be used to test and develop robust policies, plans and investments in two ways: (1) by drafting a plan, developing the scenarios, and testing the plan within the scenarios, one ends up with a robust plan; or (2) by developing the scenarios, which inspire plan elements, and testing elements across scenarios, one ends up having a robust plan (Palazzo et al. 2016). Scenarios can influence strategic policy, help the development of forward plans, and assess the potential performance of strategies, policies and actions under different futures. They can also raise awareness of possible factors that drive change and stimulate the development of more robust future oriented decisions and actions. (Carter and White 2012). In addition, they help to open up the uncertainties in the decision-making context (Shackley and Deanwood 2003).

12.2.2 *Socio-economic Scenarios for the Arctic*

The literature on the Arctic future is miscellaneous and consists of various methodological approaches. Arbo et al. (2013) review approximately 50 Arctic futures studies and identify six methodological approaches in studies dealing with socio-economic and political aspects: implicit futures, visions, high probability scenarios, qualitatively different scenarios, simulations, and games. These 50 studies include all kinds of forward-looking and policy oriented studies, of which not all present holistic socio-economic scenarios. Yet, socio-economic scenarios may be developed with any of the above approaches. Implicit futures are seen as a continuation of the past, leaving little room for uncertainty consideration, and visions tend to be of predictive nature and have only one future vision. Simulation and game approaches tend to be modelling exercises including a set of (uncertain) assumptions of socio-economic change and they may both create socio-economic scenarios and include them as input to the models.

To complement the study by Arbo et al. (2013) and to identify the recent developments in the field, a selection of different Arctic socio-economic scenarios creating multiple possible futures were identified. The content characteristics of different Arctic scenarios were of interest; the factors and uncertainties identified within them, and how they addressed climate change. The starting point for the sampling was the literature list provided by Arbo et al. (2013).¹ Studies chosen were such studies that allow reasonable consideration of uncertainties of possible development trends or futures, and that also create a clear set off different future visions or narratives – not just a single story. However, simulations and games were left out from the analysis. Furthermore, the list of Arbo et al. (2013) was complemented with recent studies found by various Google Scholar and Web of Science searches, and also with the socio-economic scenarios developed by the authors in the TWASE-project (Haavisto et al. 2016). The following criteria was applied to choose the items added to the list of Arbo et al. (2013):

1. The language of the study is English and the study is available in an electronic format (article, report or website).
2. The geographic focus of the study is on the Arctic as a whole or a more specific Arctic area.
3. The study describes the methodology for the socio-economic scenario development and describes the resulting scenarios.
4. The study deals with decision-making or at least has strong connection to it (implying that impact studies were left out).

It was acknowledged that this sample does not include all relevant studies addressing the future of the Arctic; yet, it was believed to give a good overview of the methods that have been used to create the Arctic socio-economic scenarios relevant for holistic decision-making. The sample also presents qualitatively different

¹ <http://site.uit.no/arcticfutures/arctic-futures/7-references/>

scenarios for the Arctic or its sub-regions, which implies that the relevant uncertainties are considered.

The final sample consisted of 10 studies, listed below in the ascending order of publication year. In addition to the reference, the list consists of the geographic focus, time horizon, decision-making context and the purpose of the scenarios.

- Arbo et al. (2007): the Barents Sea (Finnmark County and Murmansk Oblast); 2030; oil and gas businesses; to discuss the consequences of oil and gas development;
- Brigham (2007): the Arctic; 2040; Arctic development in general; to provoke thinking of the Arctic future;
- AMSA (2009) and GBN (2008): Arctic marine areas; 2050; actors related to marine navigation; to consider the long-term social, technological, economic, environmental and political impacts on Arctic Marine Navigation and providing material for decision-making;
- Cavalieri et al. (2010): the Arctic; 2030; European Union's environmental footprint and policy in the Arctic; to aid the discussion and inform long-term policy development to decrease EU's Arctic footprint;
- Loe et al. (2014): the Arctic; 2020; businesses in the petroleum, mining and seafood sectors, and regional and transit shipping; to enable businesses to identify opportunities and challenges;
- Wesche and Armitage (2014): Slave River Delta, Northwest Territories, Canada; 2030; community level; to understand community vulnerability and adaptation responses to climate change;
- Van Oort et al. (2015): Barents region (Kirovsk in Murmansk Oblast and Bodø in Nordland); 30–50 years ahead; county and municipal levels; to aid climate change adaptation related decision-making;
- Nilsson et al. (2015): Barents Region: Pajala, Sweden; 30–50 years ahead; county and municipal levels; to aid climate change adaptation related decision-making;
- Beach and Clark (2015): Southwest Yukon, Canada; 2032; local and regional wildlife managers; to understand community vulnerability and adaptation responses to climate change;
- Haavisto et al. (2016): Eurasian Arctic; 2040; weather and marine services; to assess the need for and development of weather and marine services in shipping, tourism and resource extraction.

The scenarios were developed following two different lines of technique categories, either based on judgmental choices ($n = 4$) or based on thinking of the dimensions of uncertainty ($n = 6$). Judgment refers to not having specific methodological support, whereas dimensions of uncertainty techniques do have support of for example scenario-axes techniques (Bishop et al. 2007). Furthermore, taking into account the uncertainties in development trends is part of the latter technique and included in the whole scenario development processes. The studies addressing uncertainties with dimensions of uncertainty techniques include AMSA (2009) and GBN (2008), Cavalieri et al. (2010), van Oort et al. (2015), Nilsson et al. (2015),

Beach and Clark (2015), and Haavisto et al. (2016). Also three judgement based studies, (Arbo et al. 2007; Brigham 2007, Wesche and Armitage 2014) expressed that there are uncertainties related to the development trends but in the final scenarios (narratives) these might not be addressed. Loe et al. (2014) did not discuss uncertainties.

12.2.3 Key Uncertainties and Climate Change in the Scenarios

All the studies identified and addressed multiple possible factors influencing the future of the Arctic, but not all identify key uncertainties. Key uncertainties are those factors that have high impact on the future development but which occurrence is highly uncertain. From the many possible factors, key uncertainties were identified and narrowed down from one to four in AMSA (2009) and GBN (2008), Cavalieri et al. (2010), Wesche and Armitage (2014), Beach and Clark (2015) and Haavisto et al. (2016). This was mainly done with the scenario axes techniques. For example in Haavisto et al. (2016), the key uncertainties were identified by anonymous web-based voting which resulted in the heat map shown in Fig. 12.1. This, however, was only a starting point for the discussion on the final scenario axes,

Fig. 12.1 Heat map representing the likelihood/certainty and impact of chosen development trends in Haavisto et al. (2016)

because the resulting key uncertainties were thematically far apart from each other. The key uncertainties (or axes) of the above studies include governance, resources and trade, EU economic growth, EU resource efficiency, climate change in the Arctic, management of environmental pressures in the Arctic, resource development, the human factor, land use, changing ecological-social interactions (which includes climate change), perception of the Arctic as open or closed, initiator of actions being private or public, and dirty or clean environment.

In van Oort et al. (2015) and Nilsson et al. (2015) all factors (16 in Bodø, 10 Kirovsk and 18 in Pajala) were ranked based on their importance and uncertainty but key uncertainties have not been indicated – the chosen uncertainties are discussed in the scenario narratives. However, here the rankings were analysed in order to find which factors could be considered to have the highest importance and highest uncertainty. No such factor stands out, except for ‘international security’ in Pajala. Compared to ‘international security’, ‘climate impacts’ are considered less uncertain and important, but ‘climate change’ is considered a lot less uncertain but a bit more important than ‘international security’. In Bodø, the closest factors to key uncertainty were ‘global economy’ and ‘local politics’, which have highest uncertainty but a rather low importance, ‘climate change’ and ‘demography’, which have a lower uncertainty but higher importance compared to the previous, and ‘energy/petroleum’, which has the highest importance but the lowest uncertainty. In Kirovsk, ‘climate change’ was the most uncertain factor, but had a rather low importance. ‘Mineral resource market’ and ‘foreign policy’ were slightly less uncertain but more important and environmental conditions and technological development had the least uncertainty but the highest importance.

In Arbo et al. (2007), the main factor driving the future development of the Arctic was hunt for oil and gas resources, but it was assumed as a certain trend and only uncertainties that may have impact to it were mentioned. Loe et al. (2014) and Brigham (2007) identify key factors but did not address their uncertainties.

Climate change was taken into account in all of the studies but with varying point of views. In Cavalieri et al. (2010), Brigham (2007) and Wesche and Armitage (2014), climate change was appointed as critical uncertainty or key factor, and in Beach and Clark (2015) it was included in critical uncertainty cluster named as “changing ecological-social interactions”. In van Oort et al. (2015) and Nilsson et al. (2015), climate change was ranked based on its perceived importance and uncertainty by stakeholders, the ranking depending on the region in question. Climate change received the highest uncertainty and sixth importance ranking in Kirovsk, Russia and “climate change + impacts” fourth uncertainty and second importance ranking in Bodø, Norway (van Oort et al. 2015), and fifth uncertainty and the highest importance ranking in Pajala, Sweden (Nilsson et al. 2015). In Pajala, climate impacts were ranked separately from climate change, and it received second highest uncertainty and eleventh highest importance ranking. In contrary, in the scenarios in Haavisto et al. (2016), climate change was considered to be a high impact but rather certain development trend. Also in AMSA (2009) and GBN (2008) scenarios, climate change was assumed to continue with rather high certainty. In Arbo et al. (2007), climate change was mentioned but not underlined and in Loe

et al. (2014), climate change was considered as one of the nine clusters of factors influencing the development but mainly just for the sake of mentioning.

12.3 Discussion

The scenarios in the selected studies were mostly developed through participatory processes; only Arbo et al. (2007) and Brigham (2007) had not involved stakeholders. This is partly due to the strict criteria used in selecting the studies and due to the attempt here to select scenarios oriented toward decision-making. Furthermore, presumably the benefits of stakeholder participation in scenario development (Berkhout et al. 2002; Shackley and Deanwood 2003; Chermack 2004; van Drunen et al. 2011) have motivated the use of participatory methods in the more recent studies. Because of the small sample size and the extensive criteria used to choose it, heavy conclusions cannot be drawn, but those studies that involve stakeholders tend to take uncertainties into account through analytical exercises, not only by relying on single judgement of the uncertainty. Since the review by Arbo et al. (2013), four out of six studies have applied dimensions of uncertainty techniques (Bishop et al. 2007) to develop socio-economic scenarios. The considered uncertainties are case-dependent but similar uncertainties are considered in all of the sample studies. The key uncertainties standing out relate to governance or management and natural resource use. This supports the rather traditional view of the Arctic. However, it seems that uncertainty and importance of political factors are on the rise and already being addressed with higher importance and uncertainty in the more recent studies, published since 2015.

One interesting remark is that the uncertainty related to climate change is seen rather differently across the selected studies. While some consider progressing climate change as a rather certain development, some find it highly uncertain. This may depend on the perceptions of the participants (or the authors) in the scenario development process and also how climate change is actually defined and understood. To some it might mean the impacts of climate change and not the physical phenomenon itself. According to Arbo et al. (2013), the connection between physical climate change and socio-economic scenario development is still lacking in Arctic future studies. Perhaps this is still the case.

Even though the use of socio-economic scenarios in decision-making may decrease decision failures, understanding the uncertainties in scenario definitions and scenario construction, and communicating it to stakeholders is important and requires more research efforts (Mahmoud et al. 2009). To further enhance the use of socio-economic scenarios, research should demonstrate the benefits of scenario approaches in practice (Carter and White 2012).

To be prepared for future changes, to adapt to climate change, and to decrease the vulnerability of societies, the chosen policies and policy measures should be robust and flexible enough so that resources are used as sensibly as possible regardless of the future. The development process of the scenarios and the final socio-economic

scenarios have the potential to inform decision-making. Still, further research should address how these kind of scenarios are actually utilized in decision-making and do the final scenarios ever find their way to decision-makers who have not been part of the development process. In theory, socio-economic scenarios have great potential in decision-making but still more research is needed to understand their actual use (Arbo et al. 2013) and benefits (Carter and White 2012).

12.4 Conclusions

The Arctic region is projected to face many changes in the future due to both physical and socio-economic factors. The future development is still far from certain or clear. Scenarios provide a tool to address this uncertainty and strive for robust decisions, and the Arctic has been a popular topic of different scenario analyses. In this review of ten published scenario sets, the presented scenario key uncertainties were typically related to governance or management and natural resources but in more recent scenarios political factors were also brought up. Despite the already witnessed and projected changes, climate change was only considered as one factor among others and its uncertainty differed from fairly certain to uncertain. This may be a particular characteristic of broad socio-economic scenarios or the use of participatory methods since other factors may be more pressing for the stakeholders involved in the scenario development process. There seems to be certain convergence in the themes within Arctic scenarios. Exploring the reasons for this and studying if and how separate scenario development processes affect each other would be interesting topics for future research.

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