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Multi-scale scenario building for community development: Exploring transport infrastructure futures in the Circumpolar North

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ABSTRACT

The severe environment and remoteness of the Circumpolar North elevate transport infrastructure to a crucial factor in community development bridging global trends to local realities. Understanding plausible infrastructure futures is therefore key to robust development planning. To ensure realism and local relevance, scenario building requires a transdisciplinary approach. However, standard participatory methods are often hampered by practical constraints, like high resource demands and community research fatigue, necessitating more adaptive frameworks. This paper applies a methodology of consecutive translation across scales utilizing researcher-constructed, ethnographically informed scenarios as shared discussion prompts (boundary objects) for community deliberation. We developed four coherent scenario narratives for each of the circumpolar communities of Churchill, Canada and Kirkenes, Norway, spanning futures from resource extraction to environmental conservation, to decline. In community workshops, we engaged local stakeholders with these scenarios visualized through illustrations by local artists. Both communities shared a sense of being at a crossroads, voicing concerns about climate change impacts, economic sustainability, and infrastructure adaptation needs. Workshop participants in both communities assessed resource- and transportation-oriented futures as more possible than conservation and decline scenarios. Some community priorities diverged: discussions in Churchill centered on port diversification and tourism, while deliberations in Kirkenes focused on balancing industrial development with environmental preservation and transportation hub feasibility. We conclude that integrating ethnographic inquiry and artistic illustration into a pre-constructed multi-scale scenario framework prompts a meaningful community dialogue and offers a practical approach for contexts where fully participatory scenario development faces resource or feasibility constraints.

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1. Introduction

Infrastructure futures in the circumpolar North – pivotal for long-term community development – are being shaped within the context of regional and global systems. Climate change, geopolitics, and resource markets exert external pressures that can reshape local futures beyond the control of regional actors (Nilsson et al., 2019). Climate change is altering permafrost, sea ice, and seasonal patterns, challenging existing transportation networks while opening new possibilities and catalyzing unprecedented interest in the region's economic potential from both Arctic and non-Arctic stakeholders (Thomasen et al., 2023). Geopolitical shifts are reshaping Arctic cooperation and regional development trajectories (Kauppila & Kopra, 2022). Meanwhile, global markets for minerals, energy, and shipping capacity drive infrastructure proposals that local communities must navigate, often with limited input into decisions affecting their futures (Hanaček et al., 2022).

Scenarios offer a structured approach for exploring these uncertainties. By articulating multiple plausible futures, scenarios can help communities think beyond business-as-usual assumptions and prepare for diverse possibilities. Crucial for these efforts is a meaningful dialogue involving key stakeholder groups, recognising that infrastructure developments are inextricably linked to local communities (Johnson, 2020; Simonsen Abildgaard et al., 2022).

Participatory scenario building methods offer clear advantages: by incorporating Indigenous and Local Knowledge (ILK), they create shared system representation, build community ownership and produce locally relevant outcomes (Falardeau et al., 2019; Nilsson et al., 2017, 2021). Yet highly participatory approaches face practical constraints, particularly in circumpolar contexts. Political tensions within communities can complicate collaboration (Aldridge, 2015), while repeated engagement requests can lead to research fatigue among local stakeholders (Chambers et al., 2021). The resource demands of iterative co-production – multiple workshops, sustained engagement, travel to remote sites – often exceed what research projects can sustain (Barendregt et al., 2024). Alternatively, top-down approaches avoid these burdens but introduce different challenges. Scenarios developed without community input risk lacking relevance to local concerns (Zurek & Henrichs, 2007) and may reproduce extractive research patterns (Healey

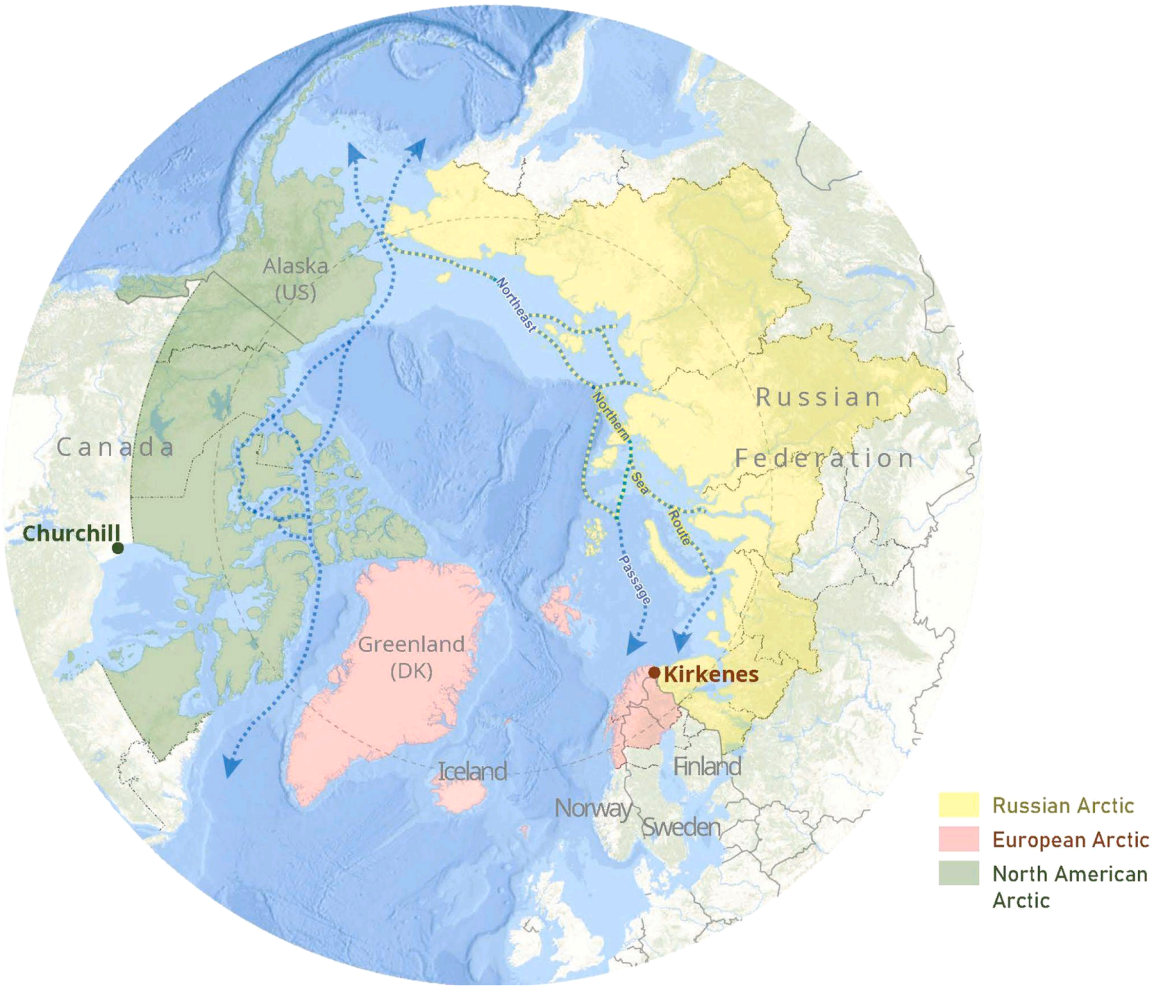


Fig. 1. Location of the scenario sites: Churchill, Canada, and Kirkenes, Norway. Source: authors' own elaboration.

Akearok et al., 2024). Thus, if fully participatory and purely top-down approaches are untenable, how can researchers facilitate community dialogue about possible futures?

Although hybrid scenario methodologies are gaining traction (Pedde et al., 2025), no studies to date have empirically examined whether and how pre-constructed scenarios function as tools for deliberations on transport infrastructure futures in circumpolar communities. Without such evidence, researchers lack guidance on the appropriate application and inherent trade-offs of this middle-ground approach. To address this gap, we apply a consecutive multi-scale scenario approach to study plausible futures of transport infrastructure in two circumpolar port towns: Churchill, Canada, and Kirkenes, Norway (Fig. 1).

Churchill is a unique deep-water port on the Arctic Ocean directly linked to the North American rail system - exemplifying the challenges of maintaining critical transportation infrastructure in harsh (sub)-Arctic conditions. In contrast, Kirkenes is an Arctic borderland town whose rapid transformation from a hub of international cooperation to a geopolitical frontier exemplifies the challenges of maintaining community resilience amid uncertainty. Both communities comprise diverse population groups, including Indigenous and non-Indigenous residents. We selected these communities primarily for their historical and strategic importance within circumpolar transportation networks and the distinct infrastructure challenges they face, including the renovation and expansion of railways and seaports under harsh environmental conditions and a rapidly changing climate. Together, Churchill and Kirkenes provide contrasting yet complementary benchmark cases for engaging local stakeholders in envisioning circumpolar infrastructure futures and broadening their understanding of the potential impacts of infrastructure projects across distinct geopolitical, economic, and environmental settings.

Drawing on ethnographic fieldwork, we developed four scenarios per site using morphological analysis. We commissioned local artists to create illustrations to facilitate scenario presentation to stakeholders at community workshops and to spark dialogue.

This paper makes two contributions: (1) an empirical demonstration of how pre-constructed scenarios can function as shared discussion prompts (boundary objects) for community dialogue in circumpolar contexts, and (2) a comparative analysis of infrastructure futures deliberation across two circumpolar communities facing different challenges. We conclude with reflections on the practical trade-offs of this approach and implications for circumpolar futures research.

The remainder of this paper is organised as follows. Section 2 reviews literature on anthropological futures methodologies and scenario approaches for transport infrastructure in the circumpolar North. Section 3 describes our case study communities and the eight-step scenario development, presentation, and analysis process. Section 4 presents scenario narratives and illustrations as well as outcomes of the local scenario workshops. Section 5 discusses methodological reflections and limitations. Section 6 concludes.

2. Related work

2.1. Anthropological approaches to futures studies

In recent decades, anthropology has increasingly engaged with questions of temporality and, in particular, the future (Bryant & Knight, 2019, pp. 3–6). Valentine and Hassoun (2019) identified three main anthropological preoccupations with the future: ethnographic worlds, the planet, and the discipline itself. The discourse surrounding climate change and the Anthropocene has prompted anthropologists to examine how futures emerge from histories of colonialism and capitalist extraction, seeking alternative framings that prioritise sustainability and inclusivity for both human and non-human species. This shift has also led to a re-evaluation of temporal concepts, moving from distinctions between "Western" linear time and "Other" cyclical times to a focus on temporal multiplicities (Valentine & Hassoun, 2019, p. 244).

This epistemological and ontological turn has created space for Indigenous, local, and non-mainstream concepts of anthropology of the future, often associated with forms of protest and resistance to violence or assimilation into settler societies and mainstream culture. In this vein, new methodologies have emerged to study futures anthropologically. Akin to foresight and scenario planning, anthropology of the future does not seek to predict 'the future' but rather aims to "identify and examine the major alternative futures which exist at any given time and place" (Dator, 2005). A distinct anthropological take on future studies is the field of anticipatory anthropology, aiming to "use … anthropological knowledge and ethnographic methods, appropriately modified and focused, to anticipate change" (Textor, 1985, p. 4). Ethnographic Futures Research (EFR), developed by Textor and his students (Textor, 1978), is a methodology for "systematically mapping images of the future held by various individuals and communities" (Candy & Kornet, 2019, p. 5). EFR utilizes local and Indigenous-led methodologies, such as "talking circles", providing space for storytelling and trust-building (Cheok et al., 2025; Gordon, 2021) and enabling participants to consider potential changes in their socio-cultural system that they want, fear and expect (Veselsky & Textor, 2007, pp. 31–32).

An "experiential turn" in foresight studies (Candy & Dunagan, 2016) has recently introduced more design-oriented approaches that add material and sensory elements to verbal descriptions. Experiential Futures is one such approach, aiming to make futures "visible, tangible, interactive, and otherwise explorable in a range of modes" (Candy & Kornet, 2019, pp. 5–6). Building on ethnographic and experiential methods, the Ethnographic Experiential Futures (EXF) framework uses interviews and design to materialise possible futures, mobilising "plural futures" through stakeholder insights and crafted artefacts (Candy & Kornet, 2019, p. 4). EXF offers a practical way to engage diverse participants and supports the development of richer, more varied scenarios.

Several studies have demonstrated the value of blending scenarios with ethnographic research in diverse cultural contexts. For example, Gordon (2021) applied EFR in an Alaskan Native community, demonstrating its potential to foster proactive attitudes towards the future through storytelling and scenario discussions. Similarly, Heemskerk (2003) combined anthropological methods with scenario planning to explore futures for the Suriname Maroons. Heemskerk argues that ethnographic data enriches futures thinking by accounting for uncertainty and non-linear trends, respecting local mental models and providing culturally specific understanding of

futures. Both studies highlight how scenarios can assist anthropologists in systematically evaluating potential socio-cultural changes while enabling stakeholders to explore a wider range of possible futures. These approaches, whether through individual interviews or group workshops, offer practical ways to engage with local communities and integrate their perspectives directly into future planning. On the other hand, while EFR approaches effectively foster local engagement, they often lack linkages to broader global dynamics (Barendregt et al., 2024). Yet socio-cultural anthropology understands scales such as the local, regional, and global as socially produced and mutually constitutive, with processes at one level shaping and being shaped by those at others (Gupta & Ferguson, 1992; Marcus, 1995; Tsing, 2005). This suggests the value of methodological approaches that can bridge ethnographic engagement with multi-scale scenario frameworks – approaches we examine in the following section.

2.2. Scenario approaches for transport infrastructure in the circumpolar North

Scenario analysis plays an increasingly crucial role in transport infrastructure planning, particularly for addressing uncertainties in investment priorities, capacity requirements, and demand projections (Lyons et al., 2021). Yet most scenario-building exercises remain top-down and expert-led, despite recognized benefits of participatory approaches (Tori et al., 2025). While scenarios have been widely used in circumpolar studies (Erokhin & Rovenskaya, 2020), their application to local transport infrastructure remains limited (Nilsson & Sarkki, 2022). The unique challenges of circumpolar regions – exacerbated climate change, fragile ecosystems, diverse communities, and high infrastructure costs – demand tailored approaches that integrate environmental, economic, social, and cultural dimensions into infrastructure planning and investment decisions (Nilsson et al., 2017).

Methods for developing local scenarios span a spectrum from top-down approaches, based on desk research and existing frameworks, to bottom-up approaches prioritising local stakeholder participation (Lovecraft & Preston, 2017; Petrov et al., 2021). Top-down approaches maintain scenario consistency with broader trends and facilitate cross-regional comparisons (Vafeidis et al., 2024), but tend to miss local specificities (Zurek & Henrichs, 2007) and fail to incorporate Indigenous and Local Knowledge, which is essential for understanding circumpolar socio-cultural systems (Maraud & Roturier, 2023). Bottom-up approaches capture context-specific nuances and ensure local relevance (Dawson et al., 2020; Nilsson et al., 2017, 2019). By fostering stakeholder ownership, they produce more meaningful and actionable scenarios for local communities (Vafeidis et al., 2024). However, bottom-up approaches struggle to integrate broad trends like global economic shifts or technological breakthroughs (Cradock-Henry et al., 2021) and may lead to overly conservative scenarios that fail to anticipate radical external changes (Nilsson et al., 2017).

Recognising these limitations, researchers increasingly advocate for multi-scale scenarios combining bottom-up and top-down elements (Nilsson et al., 2017). Multi-scale scenarios examine interactions across geographical scales, integrating global and regional context with unique local community characteristics (Biggs et al., 2007; Stratigea & Giaoutzi, 2012; Zurek & Henrichs, 2007). Zurek and Henrichs (2007) identify five types of multi-scale scenarios – *equivalent*, *consistent*, *coherent*, *comparable*, and *complementary* – shaped by different scenario development processes – *joint*, *parallel*, *consecutive*, *iterative*, and *independent*. Biggs et al. (2007) distinguish *loosely linked* scenarios, which allow diverse stakeholder perspectives within an overall framework, from *tightly coupled* scenarios which maintain strict consistency but require greater resources and may reduce local ownership.

The application of multi-scale scenarios has expanded significantly in recent years, particularly in the context of downscaling the Shared Socioeconomic Pathways (SSPs) to regional and local scales. A recent systematic review of 155 studies regionalising SSPs reveals that while top-down quantitative approaches dominate, bottom-up and mixed approaches are emerging that treat SSPs as "boundary objects" for flexible knowledge integration rather than rigid "boundary conditions" for technical downscaling (Pedde et al., 2025). When used as boundary objects, scenarios can serve as shared reference points that different stakeholders can interpret and adapt according to their contexts, facilitating dialogue across knowledge systems without imposing uniformity (Pereira et al., 2020).

Multi-scale scenario frameworks are particularly relevant for circumpolar contexts, where community futures depend heavily on forces originating far beyond regional boundaries. Nilsson et al. (2017) developed "extended SSPs" for four locations in the Barents region using a combined participatory bottom-up and top-down methodology. They found that, while maintaining cross-scale coherence, local engagement brings nuance to global narratives highlighting issues of adaptive capacity often underemphasized in global scenarios. Falardeau et al. (2019) developed a participatory scenario planning approach with an Inuit community in the Canadian Arctic that combined the "Scenarios from seeds" method with an adapted Three Horizons framework. The latter facilitated structured exploration of pathways to positive futures by identifying what needs to diminish, what needs to grow, and which actors and conditions enable or constrain transitions. Art and collage were used to refine scenario narratives. The authors found that co-producing scenarios featuring pathways from present to future fostered a sense of agency among participants, potentially catalysing motivation toward positive change.

To date, two scenario studies have addressed our case-study communities. Newton et al. (2002) used backcasting to develop desirable sustainable development scenarios for Churchill through community surveys, though this study presents only normative visions without accounting for uncertainties and predates significant recent developments. Höller (2021) applied design fiction as well as porosity and liminality concepts to reimagine Kirkenes port development, but the absence of participatory elements may reduce local stakeholder appeal. Neither study employs multi-scale scenarios linking local infrastructure futures to broader circumpolar and global dynamics – a gap our research aims to address.

3. Methods and data

3.1. Description of the scenario sites

The town of Churchill is situated at the confluence of the boreal forest, the Arctic tundra and Hudson Bay in Northern Manitoba, Canada. The community of 870 people (Statistics Canada, 2023) is notable for its distinctive transport infrastructure. While the town is not accessible by road, it is home to Canada's sole Arctic deep-water port, which is linked directly to the North American railway system. The section of the railway connecting Churchill to the town of The Pas and further south is the Hudson Bay Railway. Its recent history of infrastructural disruption, particularly the 2017 washout, highlights the vulnerabilities faced by Northern communities (Budka, 2025; Lin & Ng, 2019). In addition to the railway and seaport, Churchill has a relatively large airport, originally constructed by the Canadian and United States military during World War II. Following the departure of the military, this airport became a crucial component of the expanding tourism industry, which has designated Churchill as the "Polar Bear Capital of the World." Since 2021, and for the first time in history, the Hudson Bay Railway and the Port of Churchill have been owned entirely by local communities through the Arctic Gateway Group, a consortium of 41 Northern communities formed through a community-led initiative. Subsequent redevelopment efforts involving Indigenous and non-Indigenous communities and residents have offered valuable insights into local adaptive strategies and agency in northern contexts (Budka, 2023, 2025). In the summer of 2022, in response to the war in Ukraine, the governments of Canada and Manitoba announced investments of up to 147 million Canadian dollars to upgrade the railway and port as part of a proposed "new trade corridor" (Sanders, 2022). By 2023, port activity had begun to resume under the new ownership structure, including the return of cruise ship visits (Froese, 2024). In 2025, the federal government revised this commitment to up to 175 million Canadian dollars, including funding for railway operations and maintenance and port pre-development (Government of Canada, 2025).

Kirkenes is a town in the multicultural Sør-Varanger municipality of the county of Finnmark in northeastern Norway, close to the Finnish and Russian borders, a geopolitically and strategically important location. Among its around 3500 residents, Norwegians constitute the majority, but the community is also home to Indigenous Sami people, Finns, Kvens and Russians, as well as to a number of other ethnic groups represented by migrants from around the world. In 1993, the declaration on cooperation in the Barents Euro-Arctic Region (BEAR) was signed in Kirkenes by Norway, Finland, Sweden and Russia. It opened up opportunities for business, tourism, cultural exchange and joint infrastructure projects and strengthened the relations between Norway and Russia, its biggest and closest neighbour. The seaport of Kirkenes was expected to turn into an international logistics hub, serving primarily the transportation of oil and mineral resources from West Siberia to Europe via the Northern Sea Route (NSR). The projected Arctic Railway (also known as the Arctic Link) was supposed to connect Kirkenes with Rovaniemi and, thus, with the Finnish railway system and European markets. Although these plans were put on hold because of the lack of economic prospects (and Sami protests against the railroad), both projects remained part of public imaginations and discussions. The war in Ukraine has dramatically affected the architecture of the Barents cooperation, leading to a decline of cross-border relations and mobility between Norway and Russia and reconsideration of infrastructural strategies in line with the reconfiguring military alliances (Vereykina, 2023). This severance from the neighbouring region strongly affected local businesses. Simultaneously, there are uncertainties regarding reopening the Sydvaranger mine, which constituted a pillar company in the local economy for decades. Kirkenes' efforts to reinvent itself as a centre for green innovation amid these challenges illustrate potential pathways for economic diversification in the Arctic (Arctic Economic Council, 2022). Kirkenes thus faces an uncertain future as its residents navigate a period of dramatic geopolitical and economic change.

3.2. Scenario development and presentation methods

We developed multi-scale scenarios across three nested levels: global, regional, and local, drawing on frameworks established by Kok et al. (2007) and Vafeidis et al. (2024). Following the taxonomy of Zurek and Henrichs (2007), we employed a consecutive scenario-building approach, in which larger-scale scenarios provide a clear starting point for smaller-scale ones. We combined top-down and bottom-up approaches to integrate global assumptions with local knowledge (Pedde et al., 2025).

Our scenario development and community engagement methodology comprised eight consecutive steps (Fig. 2), systematically linking global scenarios to local contexts while ensuring community participation. The first four steps constructed a desk-based, multi-scale scenario framework informed by ethnographic research conducted by socio-cultural anthropologists for the InfraNorth project in Churchill and Kirkenes. These steps progressively downscaled from global to local elements. Steps 5 and 6 involved translating this analytical framework into accessible narratives and illustrations. The final two steps centered on community workshops, where local stakeholders engaged with the scenarios. Each step is described in detail below.

3.2.1. Step 1: Selecting the global scenario framework

At the global level, we adapted previously developed scenarios of Arctic freight shipping in 2050 (Rovenskaya et al., 2024), hereafter referred to as the "original scenarios". Finalised just before our study began, these scenarios combine global and circumpolar developments relevant to circumpolar transport infrastructure development and lead to varying socio-economic outcomes:

1. The "Global Resource Base" scenario depicts a world divided into geopolitical blocs. Slow technological progress and limited decarbonisation lead to increased demand for Arctic fossil resources.

Fig. 2. Eight-step methodology for multi-scale scenario development and community engagement. Source: adapted from (Vafeidis et al., 2024).

2. In the "Global Transportation Route" scenario, strong global cooperation facilitates rapid technological progress and climate action, making the Arctic a key source of raw materials for a low-carbon economy and enabling extensive Europe-Asia transit via the Northern Sea Route.
3. The "Abandoned Land" scenario portrays a world of unilateral action amid a global recession and slow innovation. Extreme climate change effects manifest, and Arctic activities focus solely on extracting fossil fuels for domestic use, resulting in low shipping volumes.
4. The "Sanctuary" scenario envisions strong international cooperation and Arctic Council governance, resulting in rapid decarbonisation, nature conservation and limited climate change effects, with severe restrictions on economic activities in the Arctic.
5. The "Transpolar Shortcut" scenario represents economic and technological cooperation coupled with suboptimal decarbonisation. While continued warming and melting permafrost destroy onshore infrastructure, significant sea ice retreat makes the Transpolar Sea Route viable for transit shipping.

In line with the original scenarios, we set 2050 as the time horizon for our multi-scale scenarios.

3.2.2. Step 2: Regionalising global scenarios

We adjusted the regional components of the original scenarios – developed for the Euro-Asian Arctic – to reflect plausible developments in the Norwegian and Canadian Arctic.[1] This adjustment drew on a synthesis of scientific and grey literature. We omitted details on shipping and navigation technologies that were not directly relevant to our research aims. Ultimately, we translated four of the five original scenarios for both regions and discarded the “Transpolar shortcut” scenario as it was not pertinent to either of the studied communities. Limiting the number of scenarios to four allowed us to cover the uncertainty space while avoiding cognitive overload among stakeholders (Vafeidis et al., 2024).

3.2.3. Step 3: Defining local scenario elements

To elicit scenario elements at the community level, we conducted literature reviews and engaged with local stakeholders through consultations and ethnographic methods, such as semi-structured interviews and participant observation, guided by the project aims and community needs (Budka, 2025; Schweitzer et al., 2026). To structure this process, we used the *Factor–Actor–Sector (FAS)* framework (Absar & Preston, 2015; Kok et al., 2006; Rotmans et al., 2000), where a *factor* is “an aspect of a social or natural system around which there are broad policy issues of particular interest”, an *actor* is “an individual or organisation of individuals with the

[1] Providing vast geographical distances and heterogeneity within the countries, we developed scenarios at the regional level for Norwegian or Canadian Arctic, rather than on the scale of entire countries as discussed by (Kok et al., 2007) and Absar and Preston (2015).

capacity to effect and/or influence change" and a *sector* is "a sub-component of a natural or social system" (Kok et al., 2006). The FAS framework uses pre-selected elements that guide scenario development, providing a flexible yet structured approach for producing internally consistent scenarios. It enabled us to systematically link elements across scales and integrate diverse evidence to address scale discordance and information gaps (Absar & Preston, 2015). In this way, we identified key local factors (e.g., environmental conditions, population), actors (e.g., governing bodies such as federal, provincial and local governments, mining and shipping companies, NGOs) and sectors (i.e., leading economic activities and existing transport infrastructure).

The overall multi-scale scenario framework developed in Steps 1–3 is presented in Fig. 3.

3.2.4. *Step 4: Constructing scenario skeletons*

To ensure coherence between global, regional, and local scales, we employed morphological analysis as a structured method for scenario development (Johansen, 2018; Zwicky, 1969). First, we constructed morphological matrices specifying factors and their possible values at each scale for both scenario sites (Talebian et al., 2021). Second, for each global scenario represented by a specific combination of global factor values, we derived a mutually consistent set of regional factor values coherent with the selected global configuration. Third, for each global-regional pairing, we identified a consistent set of local factor values focusing on how the global and regional developments could impact the identified factors, actors, and sectors at the local scale. The resulting morphological matrices displaying the scenario skeletons are presented in Fig. 4.

While the global framework remained consistent across both scenario sites, the elements and the content of the scenarios varied at regional and local scales (see Fig. 3). Specifically, in Churchill, we considered the following plausible options for the leading economic activity: "military", "shipping of oil and mining products", "ecotourism" and "shipping of grain and containers", while in Kirkenes, we considered the following alternatives: "military", "mining and shipyard", "tourism and services" and "logistics, education and commerce". In the same vein, we mapped distinct plausible developments of various infrastructure types (railways, roads, airports, etc.) and population projections for both scenario sites.

3.2.5. *Step 5: Fleshing out scenario narratives*

After establishing multi-scale scenario skeletons through morphological analysis, we developed scenario narratives that emphasised local transport infrastructure. We first produced a detailed expert version with references to substantiate key assumptions. Recognizing that these dense versions were unsuitable for broad stakeholder engagement, we translated them into accessible lay-language texts (Nilsson et al., 2017; Oteros-Rozas et al., 2015). To facilitate an easier understanding of the narratives, we aimed to keep them as short as possible (Özkaynak & Rodríguez-Labajos, 2010). We then distilled these into a highly condensed bullet-point format, reducing each scenario to its core concepts, for workshop presentations. This three-tier scenario presentation (expert, lay, and bullet-point) was a deliberate methodological choice to ensure materials were both rigorous for local expert review and accessible for effective public engagement. In Churchill, local facilitators from the Town of Churchill reviewed the scenario narratives before their further use. In Kirkenes, colleagues at the Barents Institute reviewed the narratives and provided input.

3.2.6. *Step 6: Translating scenarios into visuals*

To enhance engagement with the local communities, we collaborated with local artists to create illustrations of the completed scenario narratives (Heras et al., 2021). In Churchill, a local artist created eight illustrations, two for each of the four scenario narratives: one depicting a bird's-eye view of local transport infrastructure futures and the other a close-up view. In Kirkenes, a local artist

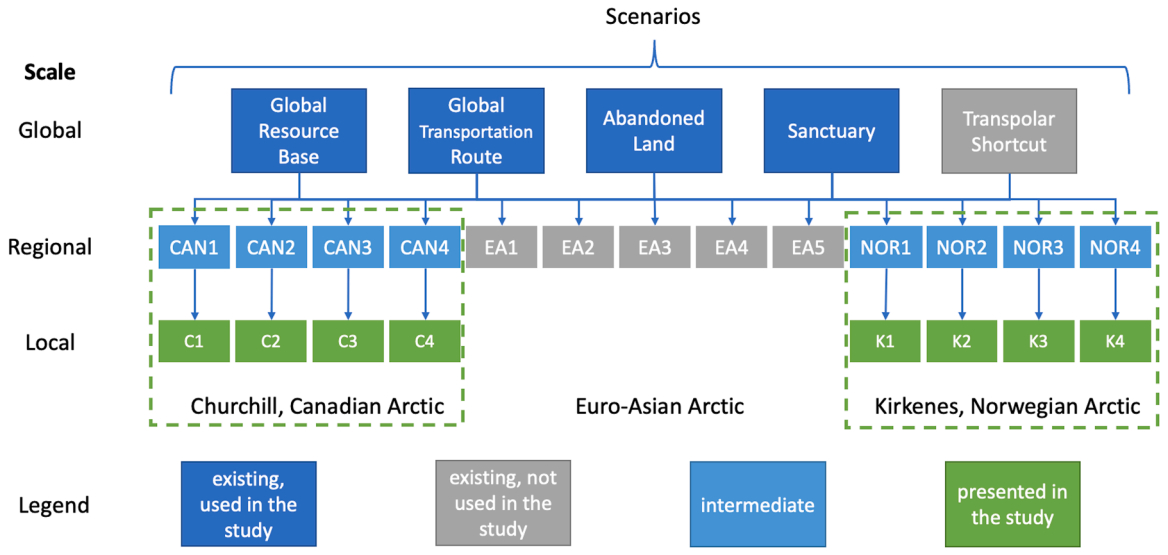
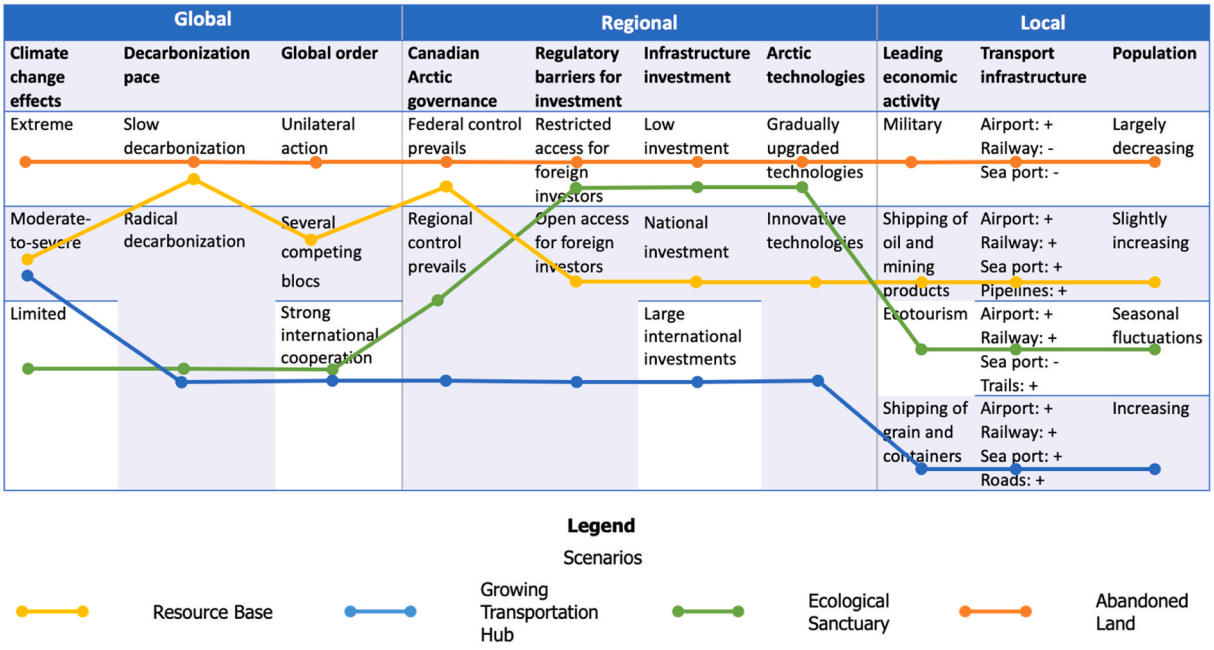
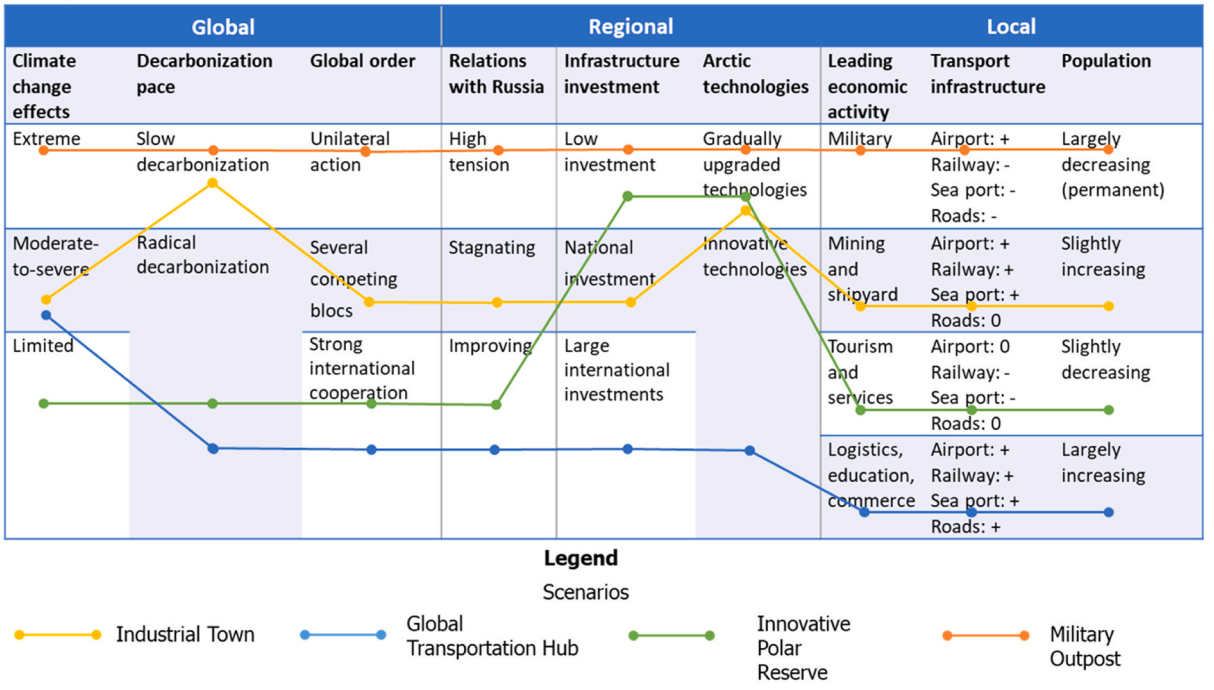


Fig. 3. Multi-scale scenario framework. Source: adapted from (Absar & Preston, 2015).



a) Canadian Arctic and Churchill.



b) Norwegian Arctic and Kirkenes.

Fig. 4. Morphological matrices visualising scenario paths across global, regional and local scales. Source: authors' own elaboration.

developed four coloured illustrations reflecting the key elements of the four local scenarios. These illustrations were printed in poster format and displayed at the workshop venue (Fig. 5). In addition to illustrating the respective narratives, the visualisations served as inspiration for discussions among the workshop participants.

3.3. Scenario workshops

3.3.1. Step 7: Setting up and conducting scenario workshops

The local scenario workshops in Churchill and Kirkenes followed similar formats but differed in scheduling and recruitment. At each site, we held two workshops: one for the general public and one for professionals from transportation-related sectors, including municipal administration, transport and tourism services, and extractive industries. In Churchill, our local partner, the Town of Churchill, compiled the invitee list for the professional workshop; in Kirkenes, this was done in collaboration with the Barents Institute (BI), the regional development agency Sør-Varanger Utvikling, the Sør-Varanger municipality, and the Sør-Varanger library. To attract the general public, we promoted the workshops on the InfraNorth project website, on locally relevant social media, through posters, by spreading the word within our local networks, and, in Kirkenes, in the local newspaper. Local facilitators chaired all workshops.

The Churchill workshops took place in August 2023 at the town's main administrative building: a 2.5-hour evening session for the public, and a morning session the following day for the professionals, attended by representatives of regional transport companies and the tourism industry. The Kirkenes workshops were held in September 2023 at the Sør-Varanger municipal library, with the morning (professional) and evening (public) sessions on the same day. The professional session involved experts from the Sør-Varanger municipality, the development agency, the transportation agency, the seaport administration, the mining company, the environmental NGO, the International Barents Secretariat, and other key organisations represented in Kirkenes.

All workshops followed a common structure. After an introduction to the project, its team, and the workshop objectives, participants were randomly split into four breakout groups, each assigned to a table to discuss one of the four scenarios. Research team members moderated and recorded the ensuing discussions. Groups rotated between the tables every 15 minutes until all scenarios had been discussed. In Kirkenes, groups could switch from English to Norwegian as needed.

Following the discussion of all four pre-constructed scenarios, participants were encouraged to adapt and reimagine them to describe, both verbally and in drawing, and then discuss their own desired future scenarios – what Heemskerk (2003, p. 939) terms "personal visions on the future". Participants recorded their ideas on sheets of paper and completed a brief anonymous questionnaire. The questionnaire comprised six items: five identical Likert-scale questions assessing scenario perceptions and preferences across both sites, and one location-specific open-ended question. We also collected basic demographic data (gender, birth year, ethnic status, and duration of residence). Questionnaires were distributed in paper format after each workshop and made available online via QR code to ensure anonymity for participants who were less comfortable sharing opinions publicly. Both the sketches of participants' "ideal futures" and responses to the questionnaires were collected for analysis.

3.3.2. Step 8: Analysing scenario workshop outcomes

Likert responses were analyzed descriptively, with cross-site comparisons enabled by the shared global scenario framework underlying both sets of local scenarios. Open-ended responses and workshop transcripts were analyzed using thematic analysis complemented by ethnographic content analysis (Altheide & Schneider, 2013; Braun & Clarke, 2006) to identify key themes and concerns. This combined approach captured both individual aspirations and broader societal trends, providing a comprehensive view of possible

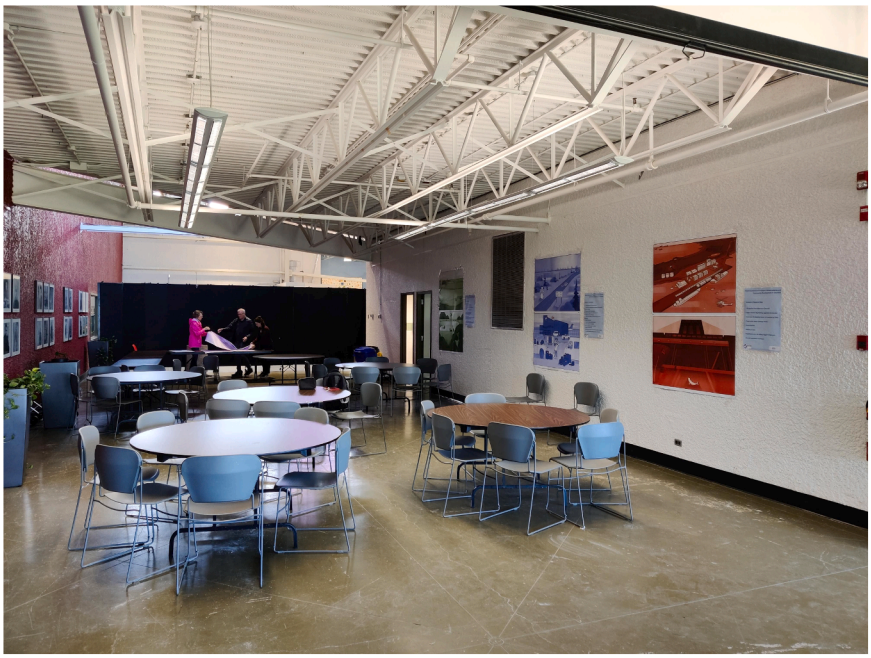


Fig. 5. Public workshop setting in Churchill, MB, Canada. Photo by the authors.

community futures.

4. Results

4.1. Scenario narratives

Below, we present brief summaries of the scenario end states and developments leading to them. The full scenario narratives are available in the Appendix.

4.1.1. Churchill

4.1.1.1. Scenario 1. Resource base. Churchill has become a strategic resource base. The expansion of pipeline infrastructure and modernisation of the seaport facilitate global fossil fuel exports. Climate change has extended the shipping season on Hudson Bay to six months per year, enabling increased maritime activities. However, it has also led to wildlife degradation, which has negatively impacted the tourism sector. The town's overall population has been growing steadily, with the healthcare sector, seaport and renewed military base being primary employers.

4.1.1.2. Scenario 2. Growing transportation hub. Churchill has emerged as an international multimodal transportation hub. The seaport has been modernised and handles diverse cargo, including grain exports to Europe and Africa, containerised and bulky goods, and energy carriers. The Hudson Bay Railway has been double-tracked, and a year-round road has been built connecting Churchill to southern towns. The extended tourist season and increased airport utilisation complement the maritime activities. The expanding cargo transportation and tourism sectors have created employment opportunities, driving population growth and economic diversification in the region.

4.1.1.3. Scenario 3. Ecological sanctuary. Churchill has transformed into an environmental sanctuary. Canada has issued a ban on new resource extraction projects, such as pipelines and mining sites, and expanded protected areas, including no-shipping zones. It has led to fewer ships calling at the Port of Churchill. The town has pivoted toward sustainable ecotourism as its main economic pillar. The network of trails around the community has expanded, and train travel via the upgraded and electrified Hudson Bay Railway has been prioritised over air travel. The emphasis on conservation has led to the overall population decline, with numbers varying significantly between high and low tourist seasons.

4.1.1.4. Scenario 4. Abandoned land. Churchill has succumbed to severe climate change impacts. Accelerated permafrost thaw and extreme weather events have devastated critical infrastructure, rendering large sections of the Hudson Bay Railway inoperable due to flooding. Unpredictable sea levels have compromised port operations, effectively halting maritime activities. The local ecosystem has collapsed, with the disappearance of polar bears and other wildlife eliminating the once-thriving tourism sector. The town has experienced a population decline, with only the military maintaining presence to address strategic geopolitical priorities in the transformed Arctic region.

4.1.2. Kirkenes

4.1.2.1. Scenario 1. Industrial town. Kirkenes has evolved into an industrial centre driven by global demand for iron and steel. A new railway and port infrastructure has been built to support transportation of extracted resources. As geopolitical tensions between Russia and Western countries prevail, the use of the Northern Sea Route is restricted. The port serves dual purposes: commercial shipping and supporting naval operations. While industrial growth has attracted miners and shipyard workers, increasing the population moderately, it has displaced Indigenous Sami communities and degraded traditional lands and fisheries. As the region prioritises heavy industry, tourism has declined. Fossil fuel energy remains important, primarily serving export markets.

4.1.2.2. Scenario 2. Global transportation hub. Kirkenes has transformed into a crucial gateway for global trade. Improved Russia-Norway relations have established the town as a European access point to the Northern Sea Route. Modern infrastructure, including a deep-water port and railway connection to Rovaniemi, facilitates extensive Euro-Asian trade. The town has experienced significant growth, becoming a vibrant hub of commerce, research and education, driving population growth and urbanisation. The airport and road network have been improved to manage increasing passenger traffic. Advanced technologies and planning strategies have been used to mitigate climate change impacts. At the same time, the green industrial transition has encroached upon traditional Sami territories.

4.1.2.3. Scenario 3. Innovative polar reserve. Kirkenes has embraced environmental stewardship and Indigenous rights. The closure of the Sydvaranger mine and abandonment of major infrastructure projects such as new seaports and railways reflected a decisive shift toward conservation. Strict environmental regulations govern all activities, from tourism to transportation, with an emphasis on low-emission solutions and sustainable waste management. Traditional Sami rights have gained precedence in land-use decisions. The port exclusively services sustainable cruise vessels under stringent quotas. The economy has diversified toward eco-innovation and

regulated tourism. The permanent population has slightly declined, and most residents work in innovative startups and tourism. Restrictions on private motorised vehicles have been imposed, and local transportation is dominated by sustainable mobility options.

4.1.2.4. Scenario 4. Military outpost. Kirkenes has deteriorated as a result of severe climate change combined with geopolitical pressures. Frequent flooding and avalanches have devastated local infrastructure, while escalated tensions between Norway and Russia have led to the border closure. The strategic importance of the town has prompted expansion of military facilities and integration of Sør-Varanger into Nordic transportation networks. Economic decline and environmental degradation have triggered population exodus, particularly among non-Indigenous residents. Military personnel and their families have become the primary yet temporary residents. Security concerns have forced relocation of the town centre to the west of the Tana River, leaving behind a shrinking "old town".

The illustrations of the scenario narratives developed by the local artists are displayed in Fig. 6.

Several scenario elements reflect insights that emerged specifically from ethnographic fieldwork and would be unlikely to surface through desk-based downscaling. In Churchill, the scenarios incorporate the community dynamics surrounding Arctic Gateway Group ownership, the tension between road construction proponents and opponents, and the locally felt vulnerability of the Hudson Bay Railway – themes that emerged through participant observation and semi-structured interviews rather than literature synthesis. In Kirkenes, the emotional weight of the Russia border closure, the specific role of the Kimek shipyard, and the contested relationship between Sami reindeer herding and industrial development reflect ethnographic engagement with lived experience. These locally grounded details are what enabled the scenarios to function as recognizable boundary objects for workshop participants.

4.2. Outcomes of the scenario workshops

The workshops in Churchill and Kirkenes yielded extensive discussions, with noteworthy similarities and differences reflecting the unique context of each site. Both communities engaged actively, with diverse stakeholder groups appreciating the opportunity to discuss the future prospects of their communities. The events were well attended, with each workshop drawing 14–16 participants, despite the small populations of the communities. In both locations, workshop participants engaged with all presented scenarios and had the opportunity to sketch their own desirable futures. This approach allowed for a comprehensive exploration of plausible futures and elicited personal perspectives and reflections about the future.[2]

The workshops revealed a shared sense among participants in both communities of being at a crossroads, with a mix of hope and uncertainty about future development paths. Key themes emerged consistently across both sites, including impacts of climate change on local and regional transport, adaptation of transport infrastructure to changing economic and environmental conditions, transition to green energy and environmentally friendly transportation, and the future role of tourism – particularly in Churchill, which is known as the “Polar Bear Capital of the World”. These commonalities highlight shared concerns among circumpolar communities, particularly regarding economic sustainability and environmental change (Evengård, Paasche., 2015).

At the same time, distinct local priorities emerged. Discussions in Churchill centred more on diversifying port activities beyond grain shipping, reflecting its historic role as a key Arctic port (Budka, 2025). One of the key themes that emerged in these discussions was the capacity of local transport infrastructures to adapt to potential changes in shipping various products and the role of government subsidies in supporting such adaptation. Another significant topic was the prospective role of tourism and how climate change will influence it. Participants discussed permafrost thaw, changes in sea ice break-up, and climate-related damage to transportation infrastructure such as the railway line and port facilities. Some participants opposed the construction of an all-weather road connecting Churchill to the Manitoba provincial highway system, whereas others viewed it as an opportunity to strengthen the town’s tourism industry. Other prominent themes included population development and community sustainability. Some participants expressed concerns that Churchill could eventually disappear due to economic and population decline.

In contrast, deliberations in Kirkenes focused on the feasibility of becoming a transportation hub, with particular attention to a proposed railway project and reconsideration of seaport expansion plans (Povoroznyuk et al., 2023). Mining featured prominently in Kirkenes discussions, with debate about modernising and relaunching the local Sydvaranger mine, reflecting the ongoing importance of extractive industries for the community's identity and economy. At the same time, the workshop participants emphasised the need to balance economic development with infrastructure improvements and environmental preservation. Participants saw the town’s future as dependent on retaining and attracting residents. They identified industry revitalisation, urban redevelopment, tourism growth, and innovative technologies as key components of a prosperous future. Geopolitical considerations were evident in the Kirkenes workshops, particularly concerning relations with neighbouring Russia. This focus reflects the position of Kirkenes as a border town and underscores the importance of international relations in shaping local futures in some Arctic communities (Povoroznyuk et al., 2024).

The questionnaires administered to the workshop participants (see Section 3.3) included a question assessing scenario possibility, namely, “Are these scenarios possible in your community by 2050?”. Based on the responses to this question, the following results emerged (Fig. 7).

The future in which fossil resources extraction continues to thrive was deemed the most possible in Churchill, with the "Resource Base" scenario rated as "definitely" or "mostly" possible by 67% of respondents, while its counterpart in Kirkenes, "Industrial Town," was rated as "definitely" or "mostly" possible by 54% of respondents.

[2] The unique characteristics and specific findings for each scenario site will be explored further in other complementary research papers.

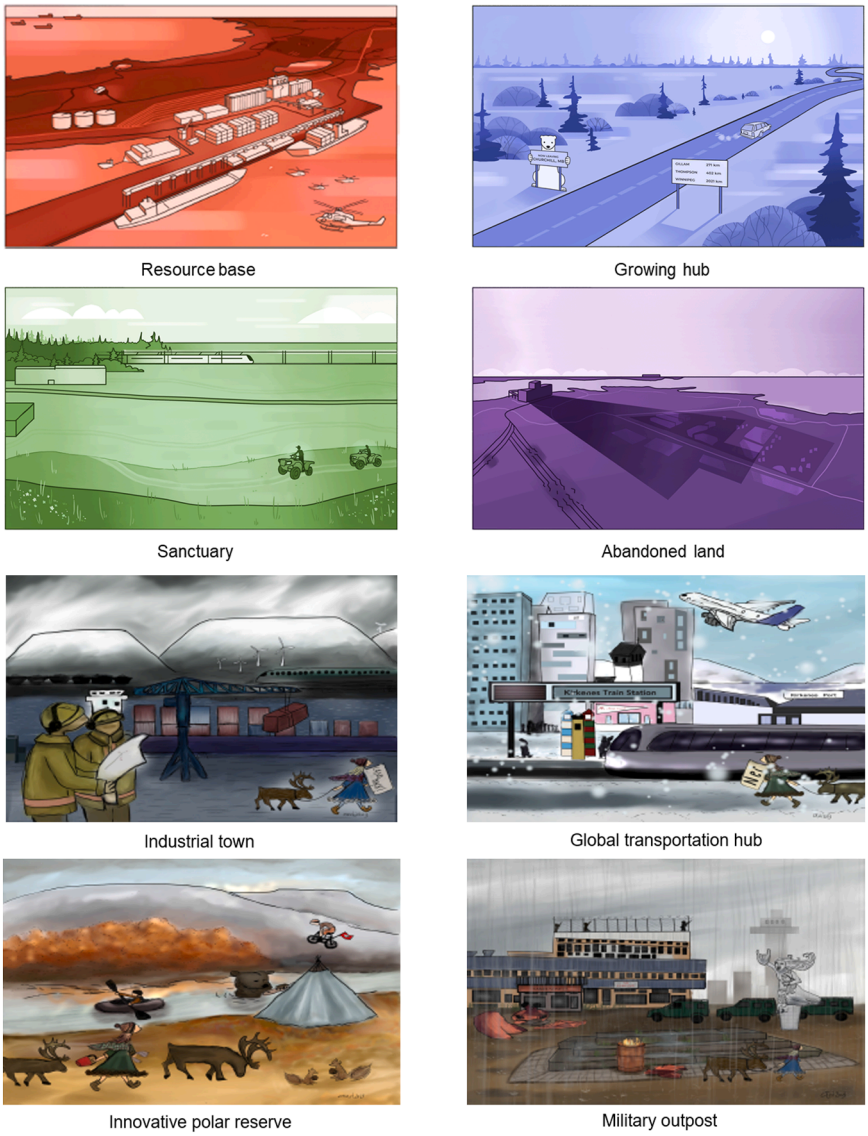


Fig. 6. Illustrations of scenario narratives created by the local artists from the scenario sites. The upper panel shows illustrations (bird's-eye view) of the scenarios for Churchill (author: Nickia McIvor), and the lower panel shows illustrations of the scenarios for Kirkenes (author: Anja Eline Danielsen).

Transportation-focused scenarios were also seen as highly possible in both communities. The "Growing/Global Transportation Hub" scenario was rated as "definitely" or "mostly" possible by 64% of respondents in Churchill and 54% in Kirkenes, respectively. This suggests strong alignment in how both communities view transportation-based development opportunities.

Nature conservation-oriented scenarios occupied an intermediate position, assessed as "definitely" or "mostly" possible by 38% of respondents in Kirkenes (the “Innovative Polar Reserve” scenario) and 29% in Churchill (the “Sanctuary” scenario). Collectively, these results indicate that economic development-oriented futures were perceived as more possible by the workshop participants in both sites, although the nature of development differs, reflecting local contexts and perceived opportunities.

Decline scenarios were perceived as least possible in both sites, though with notable differences. The "Military Outpost" scenario in Kirkenes was rated as "definitely" or "mostly" possible by 25% of respondents, while only 10% in Churchill rated the "Abandoned Land" scenario as "definitely" or "mostly" possible. At the same time, these scenarios were also perceived as least possible in both communities, with the "Military Outpost" scenario considered as definitely not possible by 21% of respondents in Kirkenes and barely possible by another 21%, while the "Abandoned Land" scenario was perceived as definitely not possible or barely possible by almost two-thirds of respondents in Churchill. This suggests that while participants were generally more sceptical about decline scenarios than others, residents of Kirkenes saw a higher possibility of military-focused development.

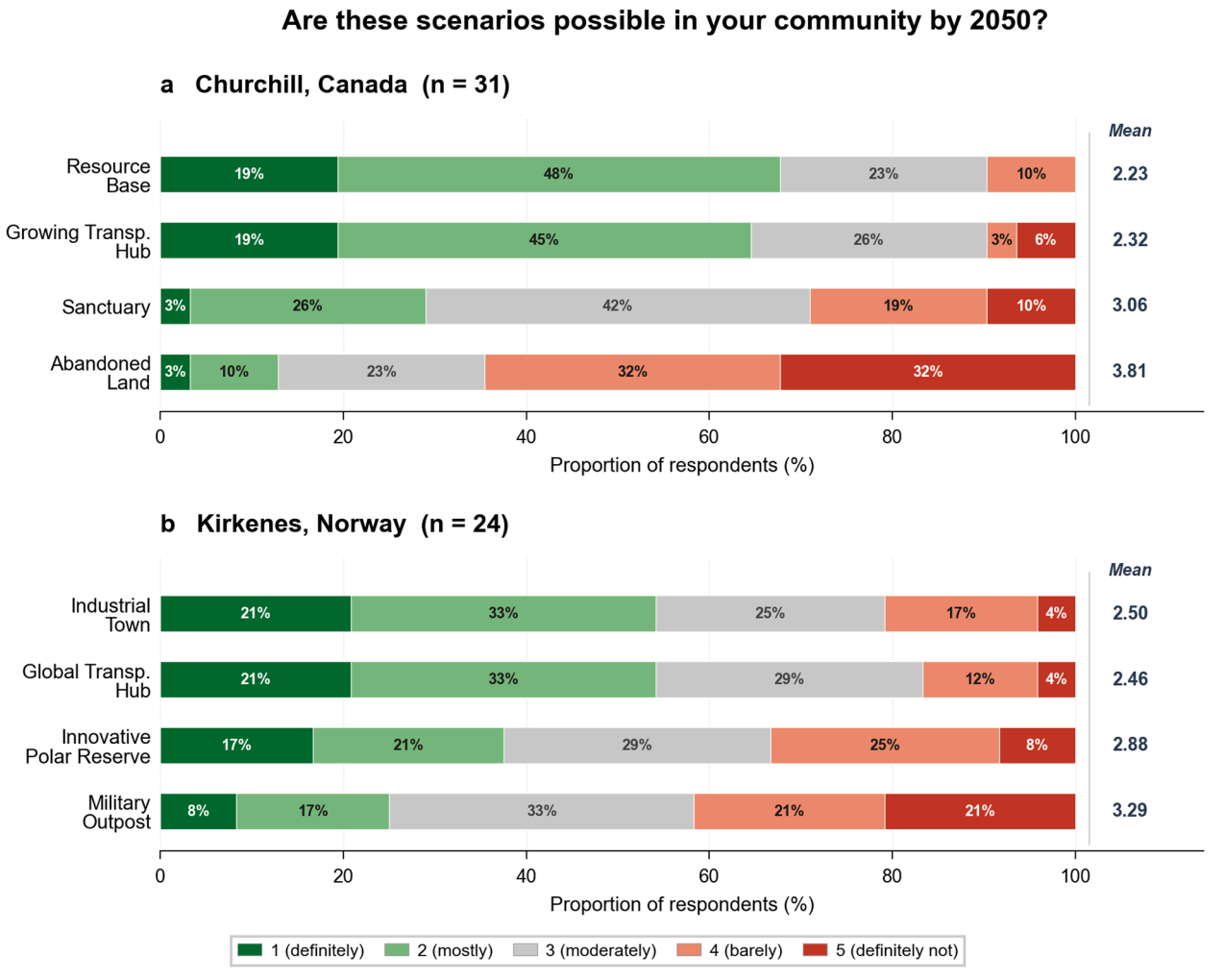


Fig. 7. Assessment of the scenario possibility by the workshop participants. Responses from participants in both workshops (for professionals and the general public) were combined with equal weights. Source: authors' own elaboration.

5. Discussion

This paper has developed several alternative plausible futures of community development in Churchill, Canada and Kirkenes, Norway, with a focus on transport infrastructure. It then has examined how stakeholders in both communities engaged with and reinterpreted these scenarios at scenario workshops. These workshops generated substantive community dialogue about infrastructure futures, with participants engaging critically with all presented scenarios and articulating both shared circumpolar concerns and place-specific priorities. By integrating multi-scale scenario building with ethnographic research and artistic illustration, our research offers a novel contribution to the growing body of futures research in the circumpolar context (Nilsson et al., 2021; Erokhin & Rovenskaya, 2020). The following subsections examine the methodological choices that shaped these outcomes (Section 5.1), the workshop design and stakeholder engagement process (Section 5.2), and the limitations that inform directions for future research (Section 5.3).

5.1. Methodological reflections

The selection of a particular multi-scale scenario development approach and the type of connection between scales constituted essential methodological choices (Kok et al., 2019). We employed a consecutive scenario development process, creating coherent scenarios where local narratives followed higher-level archetypes while allowing scale-specific differences (Zurek & Henrichs, 2007). This balance between consistency and flexibility proved essential for capturing both global trends and local contexts. By relaxing the expectation of strict downscaling and instead developing loosely linked scenarios (Biggs et al., 2007), we avoided generating overly similar local outcomes from the same global scenario (Kok et al., 2007). For instance, the "Abandoned Land" scenario in Churchill and the "Military Outpost" scenario in Kirkenes derive from identical global assumptions, yet represent distinct trajectories, demonstrating successful comparative differentiation of scenarios (Spaniol & Rowland, 2019). This loosely linked approach, however, limits direct cross-community comparability (Kok et al., 2007) – a trade-off deemed acceptable to preserve local authenticity and ownership of the scenarios in this study. To accommodate diverse local contexts while capturing shared circumpolar concerns and maintaining a balance between scenario consistency and flexibility, we ensured scenario coherence through a two-step validation process: internal cross-scale reviews using morphological matrices to verify logical consistency, and external validation through workshop discussions in which participants confirmed that local scenarios felt like plausible consequences of the described global contexts.

Following the terminology of Absar and Preston (2015), our scenarios were developed through a nested rather than a downscaling approach. Although we did not explicitly restrict ourselves to a "one-to-one" nesting of storylines, we aimed to keep the number of local scenarios manageable to ensure they could be communicated and understood effectively (Absar & Preston, 2015). Using the taxonomy introduced by Pedde et al. (2025), our approach belongs to the "multi-scale first" perspective, as it employs participatory methods and develops contextualized narratives nested between local and global scales, treating the larger-scale scenario as a "boundary object" for knowledge sharing rather than rigid "boundary conditions" for strict downscaling. Global scenario frameworks, such as the SSPs, often miss the diversity of voices needed for locally credible scenarios (Pereira et al., 2020) and their technical downscaling to local scales ("impact first" in Pedde's et al. 2025 taxonomy) typically lacks the contextual texture needed to engage community stakeholders meaningfully (Vafeidis et al., 2024). By contrast, co-production processes that incorporate ethnographic methods can capture place-specific social dynamics, such as community ownership struggles, geopolitical anxieties, and identity narratives, that shape how people experience and evaluate plausible futures (Zandlová et al., 2023).

In our case, the ethnographic dimension is what gave pre-constructed scenarios sufficient local texture to function as credible boundary objects rather than abstract projections – a quality that participants confirmed when they recognized specific local realities within the narratives and engaged critically with them. Without such locally recognizable detail, pre-constructed scenarios risk the same lack of relevance that limits purely top-down approaches (Zurek & Henrichs, 2007). At the same time, our approach differs from fully participatory co-production (e.g., Barendregt et al., 2024; Gordon, 2021) in that community members shaped the scenarios indirectly before introducing them at the workshops – through discussing draft narratives and assessing local relevance and factual accuracy as well as collaborating with local artists to visualise the scenarios – rather than through iterative co-design. This process yielded accessible, visually engaging materials that workshop participants found useful for reflecting on and debating infrastructural futures. This positions ethnographically informed pre-construction as a practical middle ground: more locally grounded than expert-led downscaling, yet less resource-intensive than full co-production.

5.2. Stakeholder engagement

Our scenarios served a dual purpose: as an integral component of a broader anthropological inquiry to understand local experiences, perspectives, and aspirations in the context of large-scale processes such as climate change and geopolitical shifts (Schweitzer et al., 2026) and as a valuable, standalone resource for envisioning circumpolar futures.

Engaging the local communities with scenarios enabled knowledge co-production both during and after the workshops (Falardeau et al., 2019). Integrating ethnographic insight into scenarios and involving local stakeholders in pre-workshop scenario discussions and workshop organisation was essential for ensuring relevance and credibility of the scenarios within this ethnographic context (Heemskerk, 2003). Broad community participation required thorough planning, wide outreach to diverse stakeholder groups, and careful process structuring to accommodate varying comfort levels with participatory activities (Bryson et al., 2013). Early involvement of local authorities and facilitators was critical for building trust and ensuring cultural appropriateness (Reed et al., 2013). Collaboration with local artists to create illustrations proved instrumental in making scenarios more concrete and relatable, stimulating rich discussions among participants. This confirms the potential of creative and visual methods in scenario building

(Lederwasch, 2012; Shaw et al., 2009).

Using pre-constructed, methodologically rigorous scenarios grounded in ethnographic data enabled stakeholders, even those with limited scenario experience, to engage meaningfully in discussions about their futures (Houet et al., 2017). While some community members eagerly embraced our scenario-building activities from the start, others approached them with initial caution before gradually engaging. The workshop participants perceived all scenarios, even the more pessimistic ones, as possible (see Section 4.2), providing additional validation of our approach.

The flexible workshop design – in which rotating groups discussed scenarios at dedicated tables while also providing individual questionnaire feedback – effectively captured diverse perspectives. A key achievement was bringing together stakeholders from different sectors with diverse socioeconomic and professional backgrounds who might not typically engage in dialogue, fostering cross-sector interactions and a more collaborative understanding of potential futures. However, holding separate workshops for the general public and professionals yielded mixed results: while enabling targeted discussions, it may have limited the valuable cross-sector dialogue. Future scenario workshop designs should more carefully balance between fostering focused discussions and incorporating diverse perspectives (Nygrén, 2019).

The high level of engagement we observed reflects both the timeliness of this research in regions experiencing rapid change and the value of scenarios in fostering community dialogue about complex, long-term challenges (Oteros-Rozas et al., 2015). It also demonstrates the value of the methodological approach, which enabled participants to relate local experiences to wider regional and global processes. While our study focused on transport infrastructure, discussions extended beyond mobility and logistics to reveal broader social, cultural, and environmental issues – such as the thawing of sea ice and permafrost – that had been less visible in previous ethnographic fieldwork.

Several workshop participants in Churchill noted they could already see precursors of each scenario in current trends, highlighting community sensitivity to both positive and negative regional transformations. Participants' assessment of development-oriented scenarios as more possible than conservation or decline futures – may reflect what Özkaynak and Rodríguez-Labajos (2010) characterize as accommodation of larger-scale influences in contexts of constrained local agency: both communities, despite recent empowerment efforts such as the establishment of the Arctic Gateway Group in Churchill, remain substantially dependent on external decisions regarding resource markets, geopolitical alignments and infrastructure investment.

We argue that the relative dismissal of decline scenarios, particularly in Churchill, does not indicate failed engagement but rather reflects (over)optimism bias – a tendency in futures research for stakeholders to assess positive outcomes as more probable than negative ones when evaluating their own communities (Andersen & Silvast, 2023). In Churchill specifically, participants' lived experience of community resilience – having collectively responded to the 2017 railway washout – may make total infrastructure collapse feel implausible rather than merely undesirable. Conversely, the higher acceptance of the "Military Outpost" scenario in Kirkenes aligns with the tangible proximity of geopolitical disruption, confirming that plausibility assessments are shaped not only by scenario content but also by the visibility of analogous disruptions in participants' lived experience.

Considering undesirable scenarios can establish boundary conditions for the futures spectrum, incorporate radical views and dissident voices, and help communities prepare for unforeseen circumstances (Basu & Bale, 2023). Reframing negative scenarios as resilience stress-tests rather than predictions, and presenting them through pathway-based formats that highlight decision points leading toward or away from decline, may help stakeholders transform potentially negative scenarios into actionable strategies, thereby fostering a sense of human agency (Falardeau et al., 2019). Involving stakeholders earlier in the development of challenging scenarios and allowing them to co-shape the narrative logic can increase perceived relevance and buy-in, even when the scenario content remains pessimistic (McBride et al., 2017). Visual and experiential methods, which our study employed through artistic illustration, may also help make abstract futures that do not easily resonate with present-day circumstances more tangible and therefore more amenable to critical discussion (Basu & Bale, 2023).

Beyond the scenario workshops themselves, post-workshop semi-structured interviews and informal conversations conducted by the project team members with prior ethnographic fieldwork experience in Churchill and Kirkenes (Schweitzer et al., 2026) revealed the complementary relationship between scenario-based approaches and traditional anthropological methods. Scenario workshops can enhance ethnographic research by incorporating uncertainty, non-linear trends, and stakeholders' own understandings of the future (Heemskerk, 2003). This finding aligns with the broader methodological perspective that scenarios are valuable tools for thinking and debating about the future, particularly when combined with anthropological methods (Strzelecka, 2013). This combination enabled us to capture not only participants' current experiences and perceptions but also their anticipatory orientations toward uncertain futures – a dimension that conventional ethnographic methods alone may not fully illuminate.

The research team's commitment to reporting findings back to communities through various means, including oral presentations, online resources, and printed summaries, ensures that the insights from the scenario workshops continue to inform local discussions and decision-making. For instance, a summary of the findings from the workshops in Churchill was prepared for the Town of Churchill (Budka et al., 2024) and subsequently presented at a symposium and a community talk to a broader audience. Nevertheless, sustained stakeholder engagement beyond the initial workshops remains necessary to foster long-term dialogue and planning (Latola et al., 2020).

5.3. Limitations and future research directions

Several limitations should be considered when interpreting our findings. The consecutive nature of our scenario development approach (moving from global to local) lacks "planned iteration or interaction between different scales" (Zurek & Henrichs, 2007, p. 1291). While it helped us expose key divergences between the two case studies derived from the same global scenario, this approach

did not accommodate iterative feedback from local narratives back to higher scales (Özkaynak & Rodríguez-Labajos, 2010). Hence, recursive, mutually constitutive interconnections, in which local agency can influence regional and even global dynamics, such as Indigenous governance models influencing international policy, were not explicitly included (Maraud & Roturier, 2023). Future circumpolar scenario studies could employ an iterative or parallel scenario development process to better capture bottom-up and cross-scale feedback (Nilsson et al., 2017), though this would require greater methodological complexity and additional resources, as well as overcoming practical constraints such as political tensions and community research fatigue.

Workshop time constraints limited the depth of engagement with each scenario. Moreover, it is inherently difficult to recruit representatives of all segments of a given community; despite efforts to achieve inclusive participation, some stakeholder groups may have been underrepresented (Fung, 2006), potentially biasing deliberations.

We also received critical feedback on the scenario narratives themselves. In Kirkenes, some participants criticized how the Sami were represented in the scenarios. Of the four scenarios, the *Innovative Polar Reserve* was the only one, in which Sami rights (for reindeer herding) were explicitly addressed. This scenario also features strong nature protection and limited development. Several participants noted that this representation reinforces a stereotypical depiction of reindeer-herding Sami as being opposed to development. This criticism underscores a broader pattern: Indigenous Peoples and Local Communities (IPLCs) continue to face challenges in asserting their visions within foresight arenas which are often shaped by hegemonic and imperialistic paradigms (Maraud & Roturier, 2023). However, the scenarios were deliberately exaggerated to provoke discussions – this very critique allowed us to gain crucial ethnographic insight into tensions between reindeer-herding Sami and other stakeholders in the region.

The complexity and uncertainty of developments in the circumpolar North necessitate nuanced scenario approaches that carefully balance global ambitions with local realities, and particularly address the needs and aspirations of Indigenous Peoples and Local Communities (IPLCs) (Coates & Holroyd, 2020). Future research should continue to develop approaches that enable IPLCs to shape foresight processes on their own terms, define themes grounded in local priorities, and explore alternative futures without contributing to research fatigue (Olsen et al., 2023). Combining scenario workshops with broader ethnographic fieldwork can help reach residents who may not participate in formal settings, thereby supporting more inclusive engagement (Heemskerk, 2003). Longitudinal studies that trace how scenario-building activities influence community decision-making over time would offer valuable insight into whether these methods help strengthen local adaptive capacity (Cradock-Henry et al., 2021; Wesche & Armitage, 2014). Further examination of interactive and immersive visualization tools could also clarify how such techniques support participant engagement and enrich discussions of plausible futures (Richter et al., 2023).

6. Conclusion

In the rapidly changing Arctic, adaptive governance is increasingly critical for navigating uncertain futures. This study contributes a replicable framework for inclusive foresight that bridges global trends and local perspectives – a key input to adaptive governance – and is suitable for contexts where conventional participatory methods are constrained by resources or feasibility. Our work demonstrates that combining consecutive multi-scale scenario building with ethnographic enquiry and artistic illustration can produce scenarios that function as effective boundary objects for community deliberation. By enabling local participants in the foresight exercise to inhabit and interrogate potential futures, we elicited culturally grounded insights into plausible future trajectories for Churchill and Kirkenes. Ultimately, this study has created a solid foundation for adaptive governance toward more equitable and sustainable futures in these and similar communities.

CRediT authorship contribution statement

Olga Povoroznyuk: Writing – review & editing, Writing – original draft, Investigation, Data curation, Conceptualization. **Elena Rovenskaya:** Writing – review & editing, Validation, Methodology, Conceptualization. **Nadejda Komendantova:** Writing – review & editing, Supervision, Conceptualization. **Alexandra Meyer:** Writing – review & editing, Writing – original draft, Investigation, Data curation. **Alexis Sancho-Reinoso:** Writing – review & editing, Formal analysis, Data curation. **Katrin Schmid:** Writing – review & editing, Validation, Investigation. **Peter Schweitzer:** Writing – review & editing, Supervision, Investigation, Funding acquisition, Conceptualization. **Philipp Budka:** Writing – review & editing, Writing – original draft, Investigation, Data curation, Conceptualization. **Dmitry Erokhin:** Writing – original draft, Methodology. **Nikita Strelkovskii:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Formal analysis, Conceptualization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix 1. Full scenario narratives

Churchill

Scenario 1. Resource base

Global decarbonization efforts have stalled, particularly in the European Union, which maintains significant dependency on fossil fuels and agricultural inputs. This has led to increased demand for Canadian resources, particularly oil and fertilizers. Climate change continues to progress, with Arctic regions experiencing accelerated warming, though this creates both challenges and opportunities for circumpolar development.

The Port of Churchill undergoes major expansion and modernization, supported by joint Canadian-EU investment. A new oil pipeline connects Alberta to Churchill, establishing the port as a critical export hub for petrochemical products. The Hudson Bay Railway receives substantial upgrades from extraction companies, reinforcing the track bed against weather-related challenges. Modern ice-class vessels enable extended shipping seasons, with navigation possible for up to six months by 2040 due to diminishing sea ice.

The warming climate and intensified industrial activities significantly impact local wildlife. The polar bear population decreases markedly as sea ice diminishes, while increased shipping disrupts beluga whale habitats. These changes fundamentally alter Churchill's tourism sector, though some visitors still come for summer activities and winter aurora viewing.

Global geopolitical tensions prompt the re-establishment of military facilities in Churchill. The federal government, prioritizing national security in the changing Arctic, invests significantly in military infrastructure. Local authorities welcome this development for its economic benefits.

The town's employment structure shifts dramatically, with healthcare, port operations, and military service becoming the primary sources of employment. While seasonal tourism employment decreases, the overall population grows due to permanent military personnel and infrastructure workers.

Employment in Churchill is mainly connected with the healthcare sector, the upgraded and extended port facilities, and servicing the reestablished military base, much less with tourism. While the overall population is increasing, the influx of seasonal tourism workers is declining. On the other hand, some military personnel are stationed in Churchill permanently.

Scenario 2. Growing hub

International cooperation strengthens among Western nations, driven by the need to address global food security challenges. Technological advancement and climate adaptation strategies create new opportunities for northern transportation routes. The global economy shows robust growth, facilitating significant infrastructure investment in Arctic regions.

Churchill emerges as a vital node in global transportation networks. The port expands its capabilities to handle diverse cargo types, from grain exports to containerized freight. An energy corridor develops, featuring both traditional and renewable infrastructure - a gas pipeline evolves to accommodate hydrogen transport by 2050. Small-scale shipping between Churchill and other Hudson Bay communities intensifies, though seasonal variations persist.

Major infrastructure upgrades reshape the region's connectivity. The Hudson Bay Railway undergoes double-tracking and receives advanced protection against natural hazards. A year-round road finally connects Churchill to Thompson and Gillam, fundamentally altering the town's accessibility. The airport sees significant expansion to accommodate increased passenger and cargo traffic.

Despite declining polar bear populations by the 2030 s, tourism adapts and diversifies. New activities emerge, including dog sledging, hiking, and berry picking, extending the tourist season. Improved rail infrastructure facilitates increased tourist arrivals from Asia and Europe, while the enhanced airport supports both business and leisure travellers.

Churchill's economy transforms into a dynamic, dual-pillar structure based on cargo transportation and tourism. This evolution creates diverse employment opportunities, from logistics experts to hospitality professionals. The expanding job market attracts people from across Canada and internationally, fostering a multicultural community marked by sustained population growth and economic vitality.

Scenario 3. Sanctuary

Technological breakthroughs in renewable energy, particularly solar and wind power, successfully address global energy security concerns. Environmental protection becomes a paramount priority in national policies, leading to fundamental shifts in Arctic development approaches. Climate change continues but at a moderated pace.

The federal government implements strict environmental protection measures, banning new pipeline construction and mining operations. National parks expand, and no-shipping zones are established in sensitive areas. Sea ice in Hudson Bay maintains a significant presence through 2050, reflecting partially successful climate mitigation efforts.

Port operations undergo dramatic downsizing, with shipping restricted to essential supply runs for Hudson Bay communities and limited cruise vessels. Environmental considerations dictate strict seasonal limitations on maritime traffic to protect wildlife.

Tourism evolves toward an eco-conscious model. Local authorities actively promote sustainable tourism practices, emphasizing rail travel over air transportation through environmental taxation policies. The trail network expands to support small-group, environmentally conscious activities. The Hudson Bay Railway receives sustainable upgrades, including electrification in the 2030 s.

The town experiences overall population decline but with significant seasonal fluctuations due to tourism employment patterns. The research sector expands modestly, with increased activity at the Churchill Northern Studies Centre and Churchill Marine Observatory, though most researchers maintain temporary residence.

Scenario 4. Abandoned land

Climate change accelerates, with Arctic regions experiencing temperature increases four times the global average. Economic recession becomes a persistent global condition, severely limiting adaptation capabilities. The combination of environmental degradation and economic constraints leads to widespread infrastructure failure.

Accelerated permafrost thaw devastates critical infrastructure, particularly affecting the Hudson Bay Railway's track bed. The port becomes increasingly unusable due to unstable sea levels and extreme weather events. Winter roads, crucial for connecting remote communities, become unreliable.

The local ecosystem undergoes dramatic changes. Polar bear populations virtually disappear as sea ice vanishes, while unpredictable weather patterns, including ice rain and heat waves, become commonplace. Biodiversity loss accelerates, effectively ending wildlife tourism.

Security concerns prompt Canadian and US governments to maintain a joint military presence, establishing Churchill as a strategic outpost despite its deteriorating conditions. The airport primarily serves military supply operations, with occasional use for equipment delivery by sea.

Churchill experiences a severe population decline, transitioning into an isolated outpost primarily staffed by rotating military personnel and researchers. Despite year-round accessibility to Hudson Bay for shipping, the lack of economic activity and hostile environmental conditions render the town largely uninhabitable for permanent civilian residents.

Kirkenes

Scenario 1. Industrial town

Global demand for raw materials remains strong, particularly for iron and steel production. Geopolitical tensions persist between Western countries and Russia, reshaping Arctic trade routes and regional development patterns. Climate change continues to progress, though its impacts are partially mitigated by technological adaptation.

Mining companies make substantial investments in Kirkenes, capitalizing on the region's mineral wealth. The Sydvaranger iron mine undergoes major modernization, becoming Norway's largest iron ore producer by 2030. Industrial development extends beyond mining to include steel manufacturing, attracted by the availability of relatively cheap hydropower.

A new port at Høybukta Vest, completed in the late 2020 s, serves both commercial and military purposes. The Sydvarangerbanen railway extends to connect with this new facility. The airport receives upgrades to accommodate larger aircraft, while the local road network sees modest improvements. However, plans for the Kirkenes-Rovaniemi railway are abandoned due to economic and geopolitical concerns.

Despite general tensions with Russia, the new port maintains a unique position as Norway's only port permitted for Russian vessel use. The border checkpoint remains formally open but sees minimal traffic. The port serves as a reserve supply base for petroleum industry operations in the Barents Sea.

The population experiences moderate growth, primarily through the influx of miners and industrial workers, many from abroad. However, this industrial expansion forces some Sami people to relocate due to impacts on traditional lands. Tourism remains minimal, with the town's character dominated by its industrial function.

Scenario 2. Global transportation hub

International cooperation improves, particularly between Nordic countries and Russia. Technological advancement enables effective climate change adaptation, while economic growth drives significant infrastructure investment. Environmental concerns are balanced with development through careful planning and regulation.

Improved Russia-Norway relations establish Kirkenes as the western terminus of the Northern Sea Route, facilitating Euro-Asian trade. A state-of-the-art port facility, completed by 2030, becomes a crucial node in Arctic shipping networks. The Kirkenes-Rovaniemi railway, built to high environmental standards and with Sami agreement, connects the port to European markets by the mid-2030s. The town becomes a gateway for Nordic countries accessing Asian markets, driving economic growth throughout the region. Comprehensive upgrades to local transportation infrastructure, including roads, bridges, and the airport, support increased activity.

Kirkenes evolves into a major Arctic transportation hub, attracting diverse industries and fostering innovation. The "Green Steel" initiative exemplifies the town's transition toward sustainable industrial development. Tourism flourishes alongside commercial

activities, with new hotels and attractions developing rapidly.

The population grows significantly as the town transforms into a vibrant centre of commerce, science, and education. The expansion attracts both Indigenous people from rural areas and international immigrants, creating a diverse, cosmopolitan community.

Scenario 3. Innovative polar reserve

Environmental protection and Indigenous rights gain precedence in Arctic governance. Technological innovation focuses on sustainability and conservation. International cooperation strengthens around environmental protection, while economic activities adapt to strict ecological standards.

The Sydvaranger mine closes by 2030, and plans for new port and railway infrastructure are cancelled. Strict environmental regulations reshape daily life, including bans on private motorized vehicles and stringent waste management rules. Renewable energy, particularly hydropower, powers the community.

Sami populations gain significant influence in community governance. Strict environmental regulations reshape traditional economic activities. The town becomes a centre for environmental research, with numerous monitoring projects studying climate change and human impacts. Green technology start-ups flourish, attracting sustainable entrepreneurs from across Norway.

Tourism continues but under strict environmental guidelines. Visitors engage in eco-friendly activities like kayaking and guided tours, while cruise ships must meet zero-emission standards. The port serves a limited number of vessels, primarily Hurtigruten ships and regulated cruise traffic.

The overall population declines slightly but stabilizes around a core of innovative technology workers and tourism professionals. The seasonal nature of tourism employment creates population fluctuations.

Scenario 4. Military outpost

Climate change impacts accelerate while geopolitical tensions escalate. Economic recession limits adaptation capabilities, and environmental degradation combines with security concerns to fundamentally reshape the community. By 2050, Kirkenes faces severe environmental challenges. The area becomes increasingly vulnerable to flooding and avalanches, while persistent run-off water destroys road infrastructure. Rising sea levels compromise the old port's functionality. The fishing industry collapses due to depleted fish stocks from overfishing and climate change impacts. Economic constraints prevent the construction of the planned new port, as the federal government struggles with recession.

The border with Russia effectively closes by 2025, with bilateral cooperation limited to nuclear safety, search and rescue, and polar research. Russian fishing vessels lose access to Kirkenes, leading to the bankruptcy of the Kimek shipyard. While direct armed conflict has not occurred, the threat perception remains high. NATO's regional presence increases substantially following Finland and Sweden's membership, with the Sør-Varanger military base expanding and the airport being upgraded for heavy military transport aircraft.

The tourism industry deteriorates as climate change eliminates traditional winter activities like skiing and sledging. The military presence and proximity to Russia further discourage visitors. The Hurtigruten ships cease operations to Kirkenes, while proposed railway developments are abandoned due to security vulnerabilities.

Data availability

Data will be made available on request.

References

Absar, S. M., & Preston, B. L. (2015). Extending the shared socioeconomic pathways for sub-national impacts, adaptation, and vulnerability studies. *Global Environmental Change, 33*, 83–96. https://doi.org/10.1016/j.gloenvcha.2015.04.004

Aldridge, J. (2015). *Participatory research: Working with vulnerable groups in research and practice* (1st ed.). Bristol University Press. https://doi.org/10.46692/9781447305651

Altheide, D. L., & Schneider, C. J. (2013). *Qualitative media analysis* (2nd ed.). SAGE Publications, Ltd. https://doi.org/10.4135/9781452270043

Andersen, P. D., & Silvast, A. (2023). Experts, stakeholders, technocracy, and technoeconomic input into energy scenarios. *Futures, 154*, Article 103271. https://doi.org/10.1016/j.futures.2023.103271

Arctic Economic Council. (2022). *Arctic tilting doll: How to revitalise the economy of a small and remote border town*. Arctic Economic Council. ⟨https://arcticeconomiccouncil.com/news/arctic-tilting-doll-how-to-revitalise-the-economy-of-a-small-and-remote-border-town/⟩.

Barendregt, L., Bendor, R., & Van Eekelen, B. F. (2024). Public participation in futuring: A systematic literature review. *Futures, 158*, Article 103346. https://doi.org/10.1016/j.futures.2024.103346

Basu, S., & Bale, C. S. E. (2023). A framework for exploring futures of complex urban energy systems. *Frontiers in Climate, 5*, Article 1145277. https://doi.org/10.3389/fclim.2023.1145277

Biggs, R., Raudsepp-Hearne, C., Atkinson-Palombo, C., Bohensky, E., Boyd, E., Cundill, G., Fox, H., Ingram, S., Kok, K., Spehar, S., Tengö, M., Timmer, D., & Zurek, M. (2007). Linking futures across scales: A dialog on multiscale scenarios. *Ecology and Society, 12*(1), Article art17. https://doi.org/10.5751/ES-02051-120117

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Bryant, R., & Knight, D. M. (2019). *The anthropology of the future* (1st ed.). Cambridge University Press. https://doi.org/10.1017/9781108378277

Bryson, J. M., Quick, K. S., Slotterback, C. S., & Crosby, B. C. (2013). Designing Public Participation Processes. *Public Administration Review, 73*(1), 23–34. https://doi.org/10.1111/j.1540-6210.2012.02678.x

Budka, P. (2023). Anthropological notes on transforming transport infrastructures in Canada. In J. Priebe, H. Lempinen, & H. Vikström (Eds.), *Arctic sustainability transformation: What is it, what can it be, and what does it need to be?* (p. 23). Umeå University.

Budka, P. (2025). Infrastructural Disruption, Entanglement and Change in Northern Manitoba. *Anthropologica, 67*(1), 1–25. https://doi.org/10.18357/anthropologica67120252709.
Budka, P., Schweitzer, P., Povoroznyuk, O., Schmid, K., & Grill, C.. The Future of Transport Infrastructures in the Town of Churchill. Executive Summary of Scenario Workshops. https://infranorth.eu/wp-content/uploads/2024/08/Churchill_Scenario_Workshop2023_Executive_Summary.pdf.
Candy, S., & Dunagan, J. (2016). The experiential turn. *Human Futures, 1*, 26–29.
Candy, S., & Kornet, K. (2019). Turning foresight inside out: An introduction to ethnographic experiential futures. *Journal of Futures Studies, 23*(3), 3–22. https://doi.org/10.6531/JFS.201903_23(3).0002
Evengård, B., Nymand Larsen, J., & Paasche, Ø. (Eds.). (2015). *The new Arctic*. Springer International Publishing. https://doi.org/10.1007/978-3-319-17602-4.
Chambers, C., King, L. A., Cook, D., Malinauskaite, L., Willson, M., Ogilvie, A. E. J., & Einarsson, N. (2021). "Small Science": Community Engagement and Local Research in an Era of Big Science Agendas. In D. C. Nord (Ed.), *Nordic Perspectives on the Responsible Development of the Arctic: Pathways to Action* (pp. 203–224). Springer International Publishing. https://doi.org/10.1007/978-3-030-52324-4_10.
Cheok, J., Velden, J. van, Fulton, E. A., Gordon, I. J., Lyons, I., Peterson, G., Wren, L., & Hill, R. (2025). Framings in Indigenous futures thinking: Barriers, opportunities, and innovations. *Sustainability Science*. https://doi.org/10.1007/S11625-024-01615-1
Coates, K. S., & Holroyd, C. (2020). The future of the Arctic: Policy prospects for the twenty-first century. In K. S. Coates, & C. Holroyd (Eds.), *The Palgrave handbook of Arctic policy and politics* (pp. 529–542). Springer International Publishing. https://doi.org/10.1007/978-3-030-20557-7_32.
Cradock-Henry, N. A., Diprose, G., & Frame, B. (2021). Towards local-parallel scenarios for climate change impacts, adaptation and vulnerability. *Climate Risk Management, 34*, Article 100372. https://doi.org/10.1016/j.crm.2021.100372
Dator, J. (2005). Foreword. In R. Slaughter (Ed.), *The knowledge base of futures studies*. Foresight International.
Dawson, J., Carter, N., Van Luijk, N., Parker, C., Weber, M., Cook, A., Grey, K., & 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. https://doi.org/10.1016/j.envsci.2019.11.013
Falardeau, M., Raudsepp-Hearne, C., & Bennett, E. M. (2019). A novel approach for co-producing positive scenarios that explore agency: Case study from the Canadian Arctic. *Sustainability Science, 14*, 205–220. https://doi.org/10.1007/S11625-018-0620-Z
Froese, I. (2024, February 22). Manitoba, Ottawa putting up $60M for Churchill railway upgrades, port redevelopment. *CBC News*. ⟨https://www.cbc.ca/news/canada/manitoba/funding-churchill-railway-upgrades-port-1.7121447⟩.
Fung, A. (2006). Varieties of Participation in Complex Governance. *Public Administration Review, 66*(s1), 66–75. https://doi.org/10.1111/j.1540-6210.2006.00667.x
Gordon, H. S. J. (2021). Ethnographic futures research as a method for working with Indigenous communities to develop sustainability indicators. *Polar Geography, 44*(4), 233–254. https://doi.org/10.1080/1088937X.2021.1881647
Government of Canada. (2025). Support for the Hudson Bay Railway and Port of Churchill Canada. ⟨https://www.canada.ca/en/transport-canada/news/2025/03/support-for-the-hudson-bay-railway-and-port-of-churchill-canada.html⟩.
Gupta, A., & Ferguson, J. (1992). Beyond "Culture": Space, Identity, and the Politics of Difference. *Cultural Anthropology, 7*(1), 6–23. https://doi.org/10.1525/can.1992.7.1.02a00020
Hanaček, K., Kröger, M., Scheidel, A., Rojas, F., & Martinez-Alier, J. (2022). On thin ice – The Arctic commodity extraction frontier and environmental conflicts. *Ecological Economics, 191*, Article 107247. https://doi.org/10.1016/j.ecolecon.2021.107247
Healey Akearok, G. K., Chaliak, A. J., Cueva, K., Cook, D., Larsen, C. V., Jóhannsdóttir, L., Nilsson, L. M., San Sebastián, M., Peterson, M., Timlin, U., Broderstadt, A. R., Dagsvold, I., Siri, S., Olesen, I., Stoor, J. P. A., Rautio, A., Rink, E., & Lavoie, J. G. (2024). Diverse methodological approaches to a Circumpolar multi-site case study which upholds and responds to local and Indigenous community research processes in the Arctic. *International Journal of Circumpolar Health, 83*(1), Article 2336284. https://doi.org/10.1080/22423982.2024.2336284
Heemskerk, M. (2003). Scenarios in anthropology: Reflections on possible futures of the Suriname Maroons. *Futures, 35*(9), 931–949. https://doi.org/10.1016/S0016-3287(03)00050-8
Heras, M., Galafassi, D., Oteros-Rozas, E., Ravera, F., Berraquero-Díaz, L., & Ruiz-Mallén, I. (2021). Realising potentials for arts-based sustainability science. *Sustainability Science, 16*(6), 1875–1889. https://doi.org/10.1007/s11625-021-01002-0
Höller, L. (2021). Porous Kirkenes: Crumbling mining town or dynamic port cityscape? *Urban Planning, 6*(3), 197–209. https://doi.org/10.17645/up.v6i3.4105
Houet, T., Grémont, M., Vacquié, L., Forget, Y., Marriotti, A., Puissant, A., Bernardie, S., Thiery, Y., Vandromme, R., & Grandjean, G. (2017). Downscaling scenarios of future land use and land cover changes using a participatory approach: An application to mountain risk assessment in the Pyrenees (France). *Regional Environmental Change, 17*(8), 2293–2307. https://doi.org/10.1007/s10113-017-1171-z
Johansen, I. (2018). Scenario modelling with morphological analysis. *Technological Forecasting and Social Change, 126*, 116–125. https://doi.org/10.1016/j.techfore.2017.05.016
Johnson, N. (2020). Extractive energy and Arctic communities. In K. S. Coates, & C. Holroyd (Eds.), *The Palgrave Handbook of Arctic Policy and Politics* (pp. 97–116). Springer International Publishing. https://doi.org/10.1007/978-3-030-20557-7_7.
Kauppila, L., & Kopra, S. (2022). The War in Ukraine as a Critical Juncture: China, Russia, and Arctic Collaboration up to 2035.
Kok, K., Biggs, R., & Zurek, M. (2007). Methods for Developing Multiscale Participatory Scenarios: Insights from Southern Africa and Europe. *Ecology and Society, 13*(1), 8. https://doi.org/10.5751/ES-01971-120108
Kok, K., Pedde, Simona, Gramberger, Marc, Harrison, Paula A., & Holman, Ian P. (2019). New European socio-economic scenarios for climate change research: Operationalising concepts to extend the shared socio-economic pathways. *Regional Environmental Change*. https://doi.org/10.1007/S10113-018-1400-0
Kok, K., Rothman, D. S., & Patel, M. (2006). Multi-scale narratives from an IA perspective: Part I. European and Mediterranean scenario development. *Futures*. https://doi.org/10.1016/J.FUTURES.2005.07.001
Latola, K., Scheepstra, A., Pawlak, J., & Saxinger, G. (2020). EU-PolarNet. *White Paper on Status of Stakeholder Engagement in Polar Research*.
Lederwasch, A. (2012). Scenario art: A new futures method that uses art to support decision-making for sustainable development. *Journal of Futures Studies, 17*(1), 25–40.
Lin, Y., & Ng, A. (2019). *Transportation disruption and sustainable communities: A case study of Churchill, Manitoba, Canada*. SAGE Publications Ltd. https://doi.org/10.4135/9781526479945
Lovecraft, A. L., & Preston, B. L. (2017). Scenarios thinking for the Bering-Chukchi-Beaufort Region. *Adaptation actions for a changing Arctic: Perspectives from the Bering-Chukchi- Beaufort Region* (pp. 217–238). Arctic Monitoring and Assessment Programme (AMAP).
Lyons, G., Rohr, C., Smith, A., Rothnie, A., & Curry, A. (2021). Scenario planning for transport practitioners. *Transportation Research Interdisciplinary Perspectives, 11*, Article 100438. https://doi.org/10.1016/j.trip.2021.100438
Maraud, S., & Roturier, S. (2023). Producing futures for the Arctic: What agency for Indigenous communities in foresight arenas? *Futures, 153*, Article 103240. https://doi.org/10.1016/j.futures.2023.103240
Marcus, G. E. (1995). Ethnography in/of the World system: The emergence of multi-sited ethnography. *Annual Review of Anthropology, 24*(1), 95–117. https://doi.org/10.1146/annurev.an.24.100195.000523
McBride, M. F., Lambert, K. F., Huff, E. S., Theoharides, K. A., Field, P., & Thompson, J. R. (2017). Increasing the effectiveness of participatory scenario development through codesign. *Ecology and Society, 22*(3). https://doi.org/10.5751/es-09386-220316
Newton, S. T., Fast, H., & Henley, T. (2002). Sustainable development for Canada's Arctic and subarctic communities: a backcasting approach to Churchill, Manitoba. *ARCTIC, 55*(3), 281–290. https://doi.org/10.14430/arctic711
Nilsson, A. E., Bay-Larsen, I., Carlsen, H., Van Oort, B., Bjørkan, M., Jylhä, K., Klyuchnikova, E., Masloboev, V., & Van Der Watt, L.-M. (2017). Towards extended shared socioeconomic pathways: A combined participatory bottom-up and top-down methodology with results from the Barents region. *Global Environmental Change, 45*, 124–132. https://doi.org/10.1016/j.gloenvcha.2017.06.001
Nilsson, A. E., Carson, M., Cost, D. S., Forbes, B. C., Haavisto, R., Karlsdottir, A., Larsen, J. N., Paasche, Ø., Sarkki, S., Larsen, S. V., & Pelyasov, A. (2021). Towards improved participatory scenario methodologies in the Arctic. *Polar Geography, 44*(2), 75–89. https://doi.org/10.1080/1088937X.2019.1648583

Nilsson, A. E., Eklund, N., Jürisoo, M., Klimenko, E., & van der Watt, L.-M. (2019). Regional futures nested in global structures. *The politics of Arctic resources: change and continuity in the "Old North" of Northern Europe* (1st ed.). Routledge. https://doi.org/10.4324/9781315174969

Nilsson, A. E., & Sarkki, S. (2022). Scenarios and surprises: When change is the only given. In S. Sörlin (Ed.), *Resource extraction and Arctic communities* (1st ed., pp. 89–108). Cambridge University Press. https://doi.org/10.1017/9781009110044.008.

Nygrén, N. A. (2019). Scenario workshops as a tool for participatory planning in a case of lake management. *Futures, 107*, 29–44. https://doi.org/10.1016/j.futures.2018.10.004

Olsen, T.A., Fjellheim, E.M. B., Berg-Nordlie, M., & Fraser, C. (2023). Accountability, Communication and Respect: Establishing an ethical framework for involving indigenous peoples in Arctic Research. Arctic Frontiers. ⟨https://www.nordforsk.org/events/2023/arctic-frontiers-2023-conference⟩.

Oteros-Rozas, E., Martín-López, B., Daw, T. M., Bohensky, E. L., Butler, J. R. A., Hill, R., Martin-Ortega, J., Quinlan, A., Ravera, F., Ruiz-Mallén, I., Thyresson, M., Mistry, J., Palomo, I., Peterson, G. D., Plieninger, T., Waylen, K. A., Beach, D. M., Bohnet, I. C., Hamann, M., & Vilardy, S. P. (2015). Participatory scenario planning in place-based social-ecological research: Insights and experiences from 23 case studies. *Ecology and Society, 20*(4), Article art32. https://doi.org/10.5751/ES-07985-200432

Özkaynak, B., & Rodríguez-Labajos, B. (2010). Multi-scale interaction in local scenario-building: A methodological framework. *Futures, 42*(9), 995–1006. https://doi.org/10.1016/j.futures.2010.08.022

Pedde, S., Kok, K., Kemp-Benedict, E., Johnson, O., Carlsen, H., Green, C., Talebian, S., Fagerström, S., & Xing, X. (2025). Emerging regional perspectives of global climate change scenarios: A systematic review. *Climatic Change, 178*(6), 122. https://doi.org/10.1007/s10584-025-03965-w

Pereira, L. M., Davies, K. K., Den Belder, E., Ferrier, S., Karlsson-Vinkhuyzen, S., Kim, H., Kuiper, J. J., Okayasu, S., Palomo, M. G., Pereira, H. M., Peterson, G., Sathyapalan, J., Schoolenberg, M., Alkemade, R., Carvalho Ribeiro, S., Greenaway, A., Hauck, J., King, N., Lazarova, T., … Lundquist, C. J. (2020). Developing multiscale and integrative nature–people scenarios using the nature futures framework. *People and Nature, 2*(4), 1172–1195. https://doi.org/10.1002/pan3.10146

Petrov, A. N., Rozanova Smith, M. S., Krivorotov, A. K., Klyuchnikova, E. M., Mikheev, V. L., Pelyasov, A. N., Zamyatina, N., & Yu. (2021). The Russian Arctic by 2050: Developing integrated scenarios. *Arctic, 74*(3), 306–322. https://doi.org/10.14430/arctic73242

Povoroznyuk, O., Meyer, A., & Schweitzer, P. (2024). Four Futures for Sør-Varanger: Reflecting on the InfraNorth Scenario Workshops in Kirkenes. *InfraNorth Blog*. https://infranorth.eu/blog/four-futures-for-sor-varanger-reflecting-on-the-infranorth-scenario-workshops-in-kirkenes/.

Povoroznyuk, O., Vincent, W. F., Schweitzer, P., Laptander, R., Bennett, M., Calmels, F., … Walker, D. A. (2023). Arctic roads and railways: Social and environmental consequences of transport infrastructure in the circumpolar North. *Arctic Science, 9*(2), 297–330. https://doi.org/10.1139/as-2021-0033.

Reed, M. S., Kenter, J., Bonn, A., Broad, K., Burt, T. P., Fazey, I. R., Fraser, E. D. G., Hubacek, K., Nainggolan, D., Quinn, C. H., Stringer, L. C., & Ravera, F. (2013). Participatory scenario development for environmental management: A methodological framework illustrated with experience from the UK uplands. *Journal of Environmental Management, 128*, 345–362. https://doi.org/10.1016/j.jenvman.2013.05.016

Richter, I., Gabe-Thomas, E., Queirós, A. M., Sheppard, S. R. J., & Pahl, S. (2023). Advancing the potential impact of future scenarios by integrating psychological principles. *Environmental Science & Policy, 140*, 68–79. https://doi.org/10.1016/j.envsci.2022.11.015

Rotmans, J., Van Asselt, M., Anastasi, C., Greeuw, S., Mellors, J., Peters, S., Rothman, D., & Rijkens, N. (2000). Visions for a sustainable Europe. *Futures, 32*(9–10), 809–831. https://doi.org/10.1016/S0016-3287(00)00033-1

Rovenskaya, E., Strelkovskii, N., Erokhin, D., & Ilmola-Sheppard, L. (2024). Future scenarios of commercial freight shipping in the Euro-Asian Arctic. *Futures, 163*, Article 103446. https://doi.org/10.1016/j.futures.2024.103446

Sanders, C. (2022). *Northern Manitoba railway investment 'great opportunity for Canada*. Winnipeg Free Press. ⟨https://www.winnipegfreepress.com/breakingnews/2022/08/03/northern-manitoba-railway-investment-great-opportunity-for-canada⟩.

Schweitzer, P., Povoroznyuk, O., Budka, P., Meyer, A., Schmid, K., & Strelkovskii, N. (2026). Scenarios and Ethnography: Infrastructural Futures as Windows into the Present. *Journal of Contemporary Ethnography, 55*(1), 14–36. https://doi.org/10.1177/08912416251398488.

Shaw, A., Sheppard, S., Burch, S., Flanders, D., Wiek, A., Carmichael, J., Robinson, J., & Cohen, S. (2009). Making local futures tangible—Synthesizing, downscaling, and visualizing climate change scenarios for participatory capacity building. *Global Environmental Change, 19*(4), 447–463. https://doi.org/10.1016/j.gloenvcha.2009.04.002

Simonsen Abildgaard, M., Ren, C., Leyva-Mayorga, I., Stefanovic, C., Soret, B., & Popovski, P. (2022). Arctic connectivity: A frugal approach to infrastructural development. *ARCTIC, 75*(1), 72–85. https://doi.org/10.14430/arctic74869

Spaniol, M. J., & Rowland, N. J. (2019). Defining scenario. *Futures & Foresight Science, 1*(1), Article e3. https://doi.org/10.1002/ffo2.3

Statistics Canada. (2023). Census profile, 2021 census of population [Dataset]. ⟨https://www12.statcan.gc.ca/census-recensement/2021/dp-pd/prof/index.cfm?Lang=E⟩.

Stratigea, A., & Giaoutzi, M. (2012). Linking global to regional scenarios in foresight. *Futures, 44*(10), 847–859. https://doi.org/10.1016/j.futures.2012.09.003

Strzelecka, C. (2013). Anticipatory anthropology–anthropological future study. *Prace Etnograficzne, 41*(4), 261–269. https://doi.org/10.4467/22999558.PE.13.023.1364

Talebian, S., Carlsen, H., Johnson, O., Volkholz, J., & Kwamboka, E. (2021). Assessing future cross-border climate impacts using shared socioeconomic pathways. *Climate Risk Management, 32*, Article 100311. https://doi.org/10.1016/j.crm.2021.100311

Textor, R. B. (1978). Cultural futures for Thailand. *Futures, 10*(5), 347–360. https://doi.org/10.1016/0016-3287(78)90002-2

Textor, R. B. (1985). Anticipatory anthropology and the telemicroelectronic Revolution: A preliminary report from Silicon Valley. *Anthropology & Education Quarterly, 16*(1), 3–30. https://doi.org/10.1525/aeq.1985.16.1.05x0848p

Thomasen, G., Cervasio, C., & McClafferty, M. (2023). *Arctic diplomacy at a crossroads. Addressing present and future geopolitical and strategic risk*. The British American Security Information Council (BASIC).

Tori, S., Boveldt, G. T., & Keseru, I. (2025). Exploratory scenario planning in transport: A review of applications in Western Europe. In A. Perl, R. S. Ray, & L. Reardon (Eds.), *Handbook of Transportation and Public Policy* (pp. 462–480). Edward Elgar Publishing. https://doi.org/10.4337/9781800888784.00043.

Tsing, A. L. (2005). *Friction: An ethnography of global connection*. Princeton University Press. https://doi.org/10.2307/j.ctt7s1xk

Vafeidis, A. T., Reimann, L., Ellen, G. J., Goransson, G., Koers, G., Van Well, L., Vollstedt, B., Tsakiris, M., & Oen, A. (2024). Harmonizing the development of local socioeconomic scenarios: A participatory downscaling approach applied in four European case studies. *Sustainability, 16*(6), 2578. https://doi.org/10.3390/su16062578

Valentine, D., & Hassoun, A. (2019). Uncommon futures. *Annual Review of Anthropology, 48*(1), 243–260. https://doi.org/10.1146/annurev-anthro-102218-011435

Vereykina, E. (2023, June 1). The trust is gone"—Tensions on the rise in Norway after more restrictions for Russian fishing vessels. *The Independent Barents Observer*. ⟨https://thebarentsobserver.com/en/node/11324⟩.

Veselsky, E. E., & Textor, R. B. (2007). The future of Austria: A twenty-year dialog. *Futures Research Quarterly, 23*(4), 23–56.

Wesche, S. D., & Armitage, D. (2014). Using qualitative scenarios to understand regional environmental change in the Canadian North. *Regional Environmental Change*. https://doi.org/10.1007/S10113-013-0537-0

Zandlová, M., Skokanová, H., & Trnka, M. (2023). Landscape change scenarios: developing participatory tools for enhancing resilience to climate change. *Environmental Management, 72*(3), 631–656. https://doi.org/10.1007/s00267-023-01840-x

Zurek, M. B., & Henrichs, T. (2007). Linking scenarios across geographical scales in international environmental assessments. *Technological Forecasting and Social Change, 74*(8), 1282–1295. https://doi.org/10.1016/j.techfore.2006.11.005

Zwicky, F. (1969). *Discovery, invention, research through the morphological approach*. Macmillan.

Erokhin, D., & Rovenskaya, E. (2020). Regional scenarios of the Arctic futures: A review. IIASA Working Paper WP-20-013. Laxenburg, Austria.