

Emergency preparedness and crisis management in the High Arctic

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The High Arctic is at the forefront of global warming, with significant effects on local communities. The region, north of the 66th parallel, is home to around 4 million people spread across a vast landmass. Emergency preparedness and crisis management in the High Arctic are challenged by remoteness, limited resources of all kinds, and a constantly changing environment. Thus, what is considered a relatively manageable incident further south quickly escalates into a crisis in isolated communities in the High Arctic. High Arctic preparedness and response research is fragmented across multiple, dispersed sites, making it challenging to present well-researched solutions to the complex problems communities face. Thus, we need to improve our understanding of how crisis management is practised in the High Arctic. This paper explores the literature on emergency preparedness and crisis management in the High Arctic by reviewing research conducted in the region, and aims to answer the following research question: What is the current state of the art in research on crisis and emergency preparedness in the High Arctic? Data stems from document analysis of articles discussing emergency and/or crisis management in the High Arctic. A review reveals seven themes: Maritime Safety and Emergency Response, International cooperation and emergency response, Climate change and community resilience, Environmental risks from pollution, Training and exercising, Infrastructure and resource vulnerability, and, finally, Organising and management. We recommend that research adopt a more holistic approach, discarding the dogmatic approaches used in more populated, better-connected areas in favour of an Arctic-centric system. Research on preparedness and response in isolated settlements in the High Arctic, which are at the forefront of climate change, may also help us better understand these challenges further south, in communities that have yet to experience the full effects of climate change.

Keywords: High Arctic, preparedness, crisis management,

1. General Appearance

Traditional crisis management treats crises as linear processes that can be broken down and managed in parts. This approach assumes that failures to do so stem from an inability to grasp complexity and lapses in leadership (Alexander, 2003). Some scholars advocate for more decentralised models that involve local organisations in disaster response (Andreassen et al., 2019; Pescaroli et al., 2023). However, this

can lead to fragmented efforts and a lack of strategic oversight, which in some regions, such as the high Arctic, can lead to disastrous results. Incremental improvements may not be enough, especially if lessons are forgotten and resources are diverted elsewhere. The belief that resilience alone can protect or mitigate threats in Arctic communities is deeply embedded in current systems, influencing how responsibilities are assigned and responses coordinated.

Response times to Arctic disasters are often slow and cumbersome, and organising effective responses is challenging (see for example Rabinovych & Bjornå, 2025). The subsidiarity principle—delegating decisions to the lowest practical level—means that individuals on the ground frequently bear the burden of crisis response. While this can sometimes be effective, it risks removing strategic oversight during complex events. A more flexible, network-based model may be better suited to such conditions.

This paper explores the current research on crisis management and emergency response structures in the Arctic. The goal is to show the current state of the art and identify gaps in our knowledge about how Arctic communities manage crises. The paper begins by reviewing current research, followed by a discussion of how potential gaps may be addressed.

2. Theory

Crisis management involves the ability to demonstrate cooperation, coordination, the allocation of responsibilities, and organising an effective response to a specific threat event (McConnell & Drennan, 2006; Moon et al., 2020). It requires a multi-sectoral response that collaborates and organises efforts to effectively resolve an evolving crisis. An effective crisis response is guided by a set of fundamental principles that inform decision-making at strategic, operational, and tactical levels. These principles promote cooperation and the capacity to work with internal and external stakeholders (Haigh et al., 2018). Generally, these principles are categorised into four areas: cooperation, coordination, responsibility, and organising.

The ability to cooperate reflects the willingness of relational agents to work together when conditions require a better use of resources and an effective identification of potential common threats. Such efforts occur through formal and informal ties, which the system can utilise to enhance its ability to identify emerging trajectories during the event and thereby take steps to mitigate consequences as the crisis evolves.

Coordination, understood as management of dependencies (Malone & Crowston, 1994),

provides unity of action to pursue common goals (Andreassen et al., 2020; Roud & Gausdal, 2019). It is the added information processing and activity accomplished when multiple related parties pursue objectives that a single agent pursuing the same purpose would not achieve. This means that procedures and division of responsibilities applied daily, to the greatest extent possible, also apply in a crisis, that crisis management is not only about management of exceptions (Roux-Dufort, 2007). The greatest possible similarity between the daily and crisis management setups is maintained to minimise the extent of organisational rearrangements when activating the crisis management organisation.

Responsibility is the capacity to assign agency to specific tasks that the response needs to perform to manage a crisis (Pahlke et al., 2015). Formal roles include managerial positions, leadership roles, incident command, or elected office. Informal obligations arise from expectations that a specific person will assume a leadership role or that members will offer guidance and advice to individuals within their network. A system with clearly defined areas of responsibility is seen as having improved ability to respond to disturbances and, thereby, to manage a crisis.

Organising is centred on the ability of the response to establish a hierarchy based on roles, competencies, and capabilities (Vogus et al., 2014). There are formal and informal forms of organising that the system can enact in an event. The principle is that decision-making should be done as close to the crisis event as possible while maintaining situational awareness.

3. Method

The methodology in this paper is based on a review of articles in high-ranked journals that have published works on emergency management and response in the Arctic region, identified in Web of Science. A deductive approach is utilised to identify articles that include Crisis management and the Arctics. The aim is to identify as many works as possible in a broad range of journals, not limited to traditional outputs on crisis, risk and emergency management. The search identified 97 individual

articles that contain the keywords (Crisis management and the Arctic). The abstracts of each of these were reviewed to identify individual research areas and categorise them into general themes. The results show that most abstracts had overlapping themes, meaning that they contained more than one contribution. The maximum number of themes identified in a single abstract was four, while the minimum was zero. Table 1 illustrates the seven themes (plus one no-theme category) and the total number of instances in which each was identified.

Theme	Number identified
Oil Spill Preparedness and Environmental Risk	85
Maritime Safety and Emergency Response	54
Climate Change and Community Resilience	48
Infrastructure and Resource Vulnerability	31
International Cooperation and Governance	20
Training, Exercises, and Simulation	13
Trust and Organizational Dynamics	9
No theme	6

Table 1: Themes

4. Analysis

Based on a thematic analysis following the logic of Braun and Clarke (2006), the following themes were identified.

4.1. Oil Spill Preparedness and Environmental Risk

Environmental changes in the Arctic have heightened risks and amplified the complexity of emergency preparedness, particularly for oil spill response, as industrial activities continue to explore opportunities further north (see for example Wynja et al, 2015). The receding sea ice and the subsequent increase in maritime traffic, including cruise tourism and offshore petroleum activities, have expanded the potential for incidents such as oil spills, posing threats to fragile ecosystems and remote communities. Harsh weather, icy conditions, remoteness, and limited infrastructure complicate response efforts, underscoring the need for preparedness.

Several of the studies emphasise the inadequacy of current governance frameworks and operational capacities to address these emerging risks. While international agreements under the Arctic Council, such as the Marine Oil Spill Preparedness and Response Agreement (Arctic Council, 2013), and the Polar Code (IMO,

2017), provide a foundation for cooperation, gaps persist in harmonising standards, improving Search and Rescue (SAR) systems, and ensuring effective oil spill response capabilities.

Emergency preparedness is not exclusively technical as it intersects with societal resilience and adaptive capacities in affected communities. Collaborative networks involving public institutions, private actors, and indigenous communities are essential for developing robust prevention and mitigation strategies. The convergence of environmental vulnerability, geopolitical tensions, and economic interests underscores the urgency of comprehensive risk assessments, infrastructure investment, and dynamic governance models that prioritise environmental protection alongside sustainable development. The papers argue that effective oil spill preparedness in the Arctic demands a scalable, interdisciplinary approach that combines technology, regulatory harmonisation, and community engagement to mitigate environmental risks amid climatic and industrial transformations that the region is experiencing.

4.2. Maritime Safety and Emergency Response

Maritime safety and emergency preparedness in the Arctic are under strain as industrial development increases, including shipping activity (See for example Kruke & Auestad, 2021), offshore installations, and cruise tourism. The papers highlight the challenges posed by these environmental conditions, the limited infrastructure, and general remoteness, which risk amplifying the consequences of maritime accidents. Despite efforts from the Arctic Council and other interstate actors, gaps persist in operational readiness, particularly in Canada and Greenland, where resource limitations and insufficient training hinder timely response.

Regulatory measures such as the IMO Polar Code (2017) aim to enhance competence, yet studies reveal deficiencies in evacuation and survival training for both crew and passengers on ships operating in the region. Again, oil spill mitigation remains a major concern, with research emphasising ecosystem-specific risk assessments and integrating scientific knowledge into operational frameworks. Adaptive management and governance are recurring themes that

advocate for strengthened cooperation among Arctic states and local communities to address emerging risks.

Ensuring maritime safety in the Arctic requires a holistic approach that combines regulatory improvements, advanced training, technological innovation, and international collaboration to mitigate the heightened risks associated with increased Arctic navigation and environmental vulnerability.

4.3. Climate Change and Community Resilience

The theme explores the challenges and opportunities arising from climate change and increasing human activity in the Arctic (see for example, Fox et al., 2023). A dominant subject is emergency preparedness and resilience, particularly in the face of extreme weather events, maritime accidents, and environmental hazards. The studies emphasise the vulnerability of Arctic communities to storms, flooding, wildfires, and tsunamis, highlighting the need for robust disaster management frameworks encompassing prevention, preparedness, response, and recovery.

The role of community-based strategies emerges as critical for adaptation, alongside calls for improved infrastructure, training, and resource allocation. The governance institutions in the Arctic are central to discussions on cooperative frameworks for search and rescue, oil spill response, and harmonisation of safety standards. However, geopolitical tensions and economic interests tend to complicate governance, underscoring the need for adaptive and inclusive approaches.

Environmental and health dimensions are addressed through studies on freshwater security, ecosystem shifts, and public health impacts. Climate-driven changes in snowpack, permafrost, and coastal erosion pose long-term risks to infrastructure and biodiversity.

4.4. Infrastructure and Resource Vulnerability

The Arctic region faces challenges in infrastructure resilience and resource vulnerability due to wear and tear caused by changes in weather and increased use driven by economic and demographic changes (See, for example, Taarup-Esbensen, 2022). Limited infrastructure, vast distances, and harsh climatic

conditions constrain emergency preparedness and response capabilities to support and coordinate resources, leaving communities and industries exposed to failures. The articles highlight vulnerabilities in critical systems such as transportation networks, energy supply, water provisioning, and telecommunications, where disruptions from storms, avalanches, and changes in ice patterns can impact liveability and economic stability.

Municipalities and remote settlements often rely on outdated or insufficient planning frameworks, with adaptation strategies focused on current hazards rather than future climate trajectories, thereby increasing long-term exposure. Freshwater resources are particularly at risk, as communities in places like Arctic Canada, Svalbard, and Greenland often rely on a single freshwater source. Such examples underscore the need for more robust risk and vulnerability analysis. Governance and cooperation frameworks, while evolving, struggle to reconcile environmental protection with resource development imperatives, leaving preparedness uneven across scales. Indigenous knowledge and community-based monitoring emerge as critical adaptive capacities but require integration with formal planning and preparedness.

The interplay of environmental change, infrastructural limitations, and resource dependence requires comprehensive strategies that combine technology and governance systems adapted to the climate to safeguard Arctic communities against present and future vulnerabilities.

4.5. International Cooperation and Governance

The review highlights the evolving landscape of international cooperation and governance, emphasising the relationship between geopolitical, environmental, and governance bodies (see, for example, Loukacheva, 2020). Central to these discussions is the role of multilateral frameworks, which facilitate legally binding agreements on search and rescue, oil spill preparedness, and scientific collaboration. These agreements underscore the potential for cooperation despite growing geopolitical challenges, such as Russia's invasion of Ukraine and the renewed interest in Greenland by the

United States, which have disrupted established norms and challenged adaptability at the local and regional levels.

The articles also stress the importance of trust-building, shared challenges, and structured mechanisms for cooperation in areas such as healthcare, maritime safety, and disaster risk management. Adoption of more formal partnerships illustrates how scientific collaboration, technology transfer, and joint infrastructure projects can enhance resilience and sustainability, but also that such structures become fragile when geopolitical concerns outweigh the need for effective crisis response.

Future crisis management approaches must address these complex socio-ecological risks, strengthen institutional capacity, and foster inclusive participation, including that of Indigenous communities. Strengthening international law, enhancing preparedness, and promoting science diplomacy are critical pathways to maintaining stability and cooperation in the Arctic.

4.6. Training, Exercises, and Simulation

The literature highlights the critical role of training, exercises, and simulation in enhancing preparedness and resilience across Arctic governance, emergency response, and climate adaptation contexts (see, for example, Whæler, 2023). Several studies emphasise the necessity of joint exercises and coordinated drills to address complex risks in healthcare delivery, mine rescue, and maritime emergency response in remote regions such as Svalbard and Greenland. These exercises foster mutual trust, improve interoperability, and mitigate barriers posed by cultural and linguistic differences.

Simulations can inform systems analysis and robustness testing of networks to support targeted prevention strategies, highlighting the importance of personnel competence, communication skills, and resource readiness. Similarly, climate change adaptation studies advocate for scenario planning and anticipatory exercises to prepare organisations for environmental and socio-economic impacts.

Across these domains, exercises and simulations serve as mechanisms for stress-testing organisational structures, principles and

cross-border coordination. They enable response professionals to address uncertainties, align resources, and develop adaptive capacities.

4.7. Trust and Organisational Dynamics

The themes highlight the role of trust and organisational dynamics in cooperation and coordination within Arctic contexts. Trust emerges as a foundational facilitator for collaboration, enabling joint exercises, resource sharing, and effective crisis management (see for example Roud & Gausdal, 2019). Trust is closely linked to shared challenges and existing collaborative frameworks, which foster confidence in achieving agreed goals. Barriers such as cultural and linguistic differences, personnel turnover, and differences in preparedness systems underscore the roles of trust in these complex environments.

Organisational dynamics are central to managing crises in the Arctic settings. Effective coordination and structuring mechanisms are necessary to foster collaboration between professionals and non-professional stakeholders, including governmental bodies, indigenous communities, and international organisations. Adaptive frameworks are increasingly emphasised to address turbulence caused by geopolitical disruptions, climate change, and socio-economic pressures. These frameworks rely on flexible decision-making processes, institutional linkages, and managerial roles that promote resilience and responsiveness.

Trust, intra- and inter-organisational dynamics enable preparedness, risk management, and sustainable approaches. Building trust requires transparent communication, shared norms through agreed governance standards, and continuity in personnel. These dynamics are pivotal for addressing emerging risks, ensuring the robustness of health systems, and enabling collaborative responses to emergencies in the Arctic's changing socio-ecological landscape.

5. Discussion and future research

The main theme from the analysis relates to cooperation and coordination, distribution of responsibilities and organising an effective response (McConnell & Drennan, 2006; Moon et

al., 2020). These areas fit well with the literature review results of this paper and reveal that crisis response in the Arctic is shaped by complex, interrelated factors that go beyond climate change and 'remoteness'. Governance structures, geopolitical changes, and institutional frameworks influence preparedness and well-established cooperation structures. High personnel turnover, cultural and language barriers, and fragmented emergency systems limit the extent of effective coordination and collaboration. Infrastructure constraints, resource allocation, and technological gaps further hinder effective crisis response and adaptability. Media narratives and national economic interests often overshadow emergency preparedness, while sustainability priorities and adaptive governance remain uneven. An effective crisis response in the Arctic requires integrated systems that address governance, socio-economic vulnerabilities, cross-border collaboration, and environmental uncertainties. In the section below, we provide examples of challenges in Arctic crisis management, based on the results from the literature review.

5.1. Infrastructure and increased activity

As shown in the results, the Arctic consists of limited infrastructure facilities, especially technical and physical ones. Of course, there is not necessarily a lack of infrastructure, but there are vast distances between concentrations of it. In many ways, the nature of existing infrastructure and the vast distances lead to failures that are more severe than in locations where geography allows for redundancy in capacity and resources. System breakdown in the Arctic is, in this sense, more fragile and contingent on using what is already available – the ability to 'bricolage' becomes even more important.

Another important point to make is the distinction between physical infrastructures (power, fuel, food, water) vs function-based infrastructures (health and care services, firefighting, law enforcement, etc.). Meaning, there is a challenge in redistributing resources, both in the context of scarce physical infrastructure and in the context of function-based infrastructure. Both require redundancy, although in different formats.

5.2 Local communities and first responders

As is the case in any crisis or emergency, the first to respond to the threat are those experiencing it. In remote Arctic areas, this point is enhanced because of the distance between concentrations of localities. Being isolated is more the norm than the exception, meaning that more responsibility lies on the locals to stabilise situations before formal emergency or crisis services arrive.

Remote communities will need to manage the early phase of any crisis, regardless of formal plans, and in the event of weather conditions making it impossible for formal agencies to arrive in time, they will need to manage larger parts of it without the help of formal agencies. The 'window of opportunity' for avoiding the escalation of the crisis is often in the hands of the locals, and not the formal management authorities.

Further, plans often revolve around preparedness strategies that target the state level, or how local authorities normatively should perform, not how local communities respond to the crisis. There is a need to facilitate for the local communities that will be the first to respond, and which is the norm rather than the rule when it comes to the Arctic.

5.3 Trust as a premise for crisis management

Throughout the analysis, it becomes clear that trust is a central factor for success in crisis management. Although it seems formal agreements lead to standardisation of cooperation in a crisis setting, trust in these agreements requires an element of 'show, don't tell'. As such, agreements lay the foundations for building trust, but exercises that test them are needed if trust is to be translated from strategy to practice.

As there is often more than one way to solve a problem, understanding how actors do so reduce uncertainty in crisis management through knowledge generation. Trust, in this setting, means you can expect how the actor will respond because you have knowledge about them. High turnover further exacerbates these challenges, as trust takes time to build and when someone new fills a role, some of the practicalities of crisis management need to be figured out again.

5.4 Discussion

There is a challenge posed by the non-harmonisation of standards and procedures, though any given planning framework will be revised often and should not be seen as 'final'. There needs to be a continuous revision of preparedness and crisis plans if they are to be operational in the ever-changing conditions of the Arctic.

Because of the geopolitical situation in the area, there has always been a military presence, which requires civil-military coordination, both within the region and between countries outside. How the geopolitical situation will evolve, as tensions grow, has not been part of the original data collection in this paper, although it is of course possible that such tensions could weaken crisis management that requires cooperation and coordination between states. At a minimum, it erodes trust.

Crisis management is a practical activity, but much of the research focuses on policy analysis and planning. There is an overemphasis on risk assessment vs. response capability, which should be the logical next step. While some results from the analysis lead to decreases in vulnerabilities through technical means i.e. building infrastructure and creating structural barriers. There is always a residual risk, which would be too costly or even undesirable to remove through technical solutions. To address these risks, an effective crisis response is needed to reduce consequences and ensure recovery within an acceptable timeframe. Crisis management is tasked with managing risks deemed irreducible by other means because it is less expensive than increasing the robustness of what is being threatened. Engaging the response capability involves both estimating the resources needed and organising them to ensure effectiveness. In the high Arctic region, these challenges are even more salient and place local decision-makers under increased pressure to improve their capacity to coordinate priorities and utilise resources. However, contemporary approaches to dimensioning crisis preparedness in the Arctic continually fall short of configuring a response that adequately addresses this residual threat. Either overestimating the resources needed or being chronically deprived of response capabilities.

6. Concluding remarks

The Arctic is experiencing a series of regime shifts that are impacting the established order and forewarn that a new equilibrium will establish itself, presenting very different living conditions (Arctic Council, 2016). These shifts are catalysts for environmental and social change in the region, although warmer weather can, to some extent, create conditions for socio-economic growth. For individuals and communities, these climatic shifts constitute the most dangerous consequence of climate change, leading to unpredictable threats. The future becomes more volatile and thereby uncertain, making future planning for safety regimes more challenging.

Emergency response actors, civil society and other actors find it challenging to meet the increasing complexity that these changes entail. As the Arctic changes, becoming warmer, wetter, and wilder, so do the crisis events that emergency services are tasked with managing. In the high Arctic, there is a need for research examining how different actors can adapt and make use of available resources to ensure liveability in the region. This information is currently unavailable and needs to be developed to increase local capacity.

As the review in this paper suggests, there are several gaps in our knowledge of how to manage these new threats. These known unknowns, as in we know that change is coming or has already arrived and that we do not know its consequences, entail a pressing need for research that will help solve dilemmas and suggest a path forward for how communities in the region can live in relative safety.

There is a need to create a 'knowledge-bank' that can incorporate both indigenous knowledge of terrain and weather, and technological monitoring and forecasting, alongside scientific climate projections and current oversight of the 'threatscape'.

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