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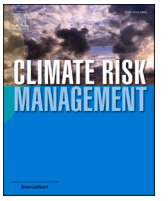

Capturing complexity: Environmental change and relocation in the North Slope Borough, Alaska

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A B S T R A C T

This paper explores the knowledge, attitudes, and behaviors about emerging hazards, environmental change, and relocation among community groups in Utqiaġvik (Barrow) of the North Slope Borough (NSB), Alaska. This region has been experiencing accelerating erosion and warmer temperatures, permafrost thawing, more frequent and intense storm surges, and increased maritime traffic and extractive industries with ice loss, with direct or cascading effects on the mixed ethnic and indigenous communities. This paper used engagement activities (Participatory Applied Theater) and qualitative approaches (focus groups) during three consecutive summers 2016–2018 to evaluate the risk perceptions and interpretations towards coastal changes and relocation as an adaptive response in this U.S. strategic yet remote location. Each focus group session started with risk ranking activities about regional hazards to assess knowledge and perceptions of risk, followed by an interactive script reading of an Iñupiat disaster legend to facilitate discussion about risk reduction options and engagement with the survey questions. Focus groups were audio recorded, transcribed, and analyzed using qualitative data analysis software Nvivo and a hybrid coding strategy. Results indicate that relocation is considered by some participants but is not planned for nor implemented by community groups, families, or the local government to reduce the hazard risks. However, widespread recognition of accelerated hazards and environmental changes, and the need for adaptation could lead to consideration of relocation in the future. This study provides a case of disaster risk reduction in a remote place with unique place-specific characteristics (e.g., particular forms of subsistence, corporate monopolies, Traditional Ecological Knowledge, and social organizations), but also shaped by significant external influences, accompanied by a changing landscape of risk from the slow and rapid onset of environmental changes.

1. Introduction

While risk is understood to be a function of exposure, hazard, and vulnerability, risk perceptions involve complex socio-cultural, psychological, and environmental interactions (Rayner & Cantor, 1987). People respond, prepare for, or adapt only to risks they perceive as a threat (Slovic et al., 1986). Although risk perception depends on personal knowledge and attitudes, it also has elements of collective structure, in which communities' risk perceptions are similar due to cultural, demographic, political, and socioeconomic circumstances (Fothergill & Peek, 2004). Similarly, many indigenous communities rely on generational knowledge and oral histories to adapt to environmental changes and respond to hazards (Kronmüller et al., 2017). Still, it is not fully clear whether that knowledge leads to any proactive preparedness actions. Therefore, it is important to explore the role of cultural and psychological dimensions that shape behaviors and how they differ between the local population or "insiders" and more impartial external actors or "outsiders"

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(Cannon, 2008). Such place-based values and sentiments will likely drive the individual and community adaptation decision-making about suitable adaptation strategies, especially household or community relocation as a viable response to irreversible and permanent environmental and climate changes.

Historically, the concept of environmental migration emphasized the role of the environment over other factors (McGregor, 1994), such as sociocultural aspects, place attachment, and economic concerns (Oliver-Smith, 1977). More recently, Marino and Lazrus (2015) showed how disasters are just one of many factors that influence migration, with other drivers including employment, rural infrastructure deterioration, and place attachment. While it is broadly accepted that climate and environmental change will impact migration (Lazrus, 2012; Morrissey, 2009; Tacoli, 2009), attributing migration to these changes alone masks the underlying social vulnerabilities and processes that shape the extent and nature of this outcome. Relocation policy is in its infancy in the U.S., including the lack of policies and governance structures to manage mass migration (Bronen, 2011). Although some Indigenous groups have achieved progress with the relocation (e.g., the Isle de Jean Charles Biloxi-Chitimacha-Choctaw Tribal Council in Louisiana) (Jessee, 2020), it has been slower in Alaska amongst villages that have voted to relocate, such as Kivalina (Shearer, 2011) and Shishmaref. In part, this reflects the legacy of constructed social issues related to colonialism and the marginalization of local voices in policy dialogue (Marino, 2012) and attests to this governance, policy, and legal barrier (Ristroph, 2019). Additionally, there are concerns about who decides to move, selects the destination and timing of relocation, and provides financing (Lazrus, 2012). For example, in Alaska top-down forms of governance are often insensitive and inappropriate for local contexts, often ignoring tensions and underlying power structures (e.g., Kontar et al., 2015). Some have argued that reactive, post-disaster relocation has had negative consequences for Indigenous peoples because of histories of forced relocation and present-day disempowerment (Thomassin et al., 2019; Timms, 2011).

These concerns are mirrored in the earlier disaster resettlement literature, in which Scudder and Colson (2019) identify resettlement as yet another disruption to which the community needs to adapt. Nevertheless, there are some circumstances where relocation in response to climate/environmental change and hazards serves as a more effective and long-lasting adaptation strategy. For instance, nomadic lifestyles in the form of seasonal migration are a testament to the historical ability of human populations to adapt to their environments (Nelson, 1973). Increasingly, research is being done on proactive relocation, in which people move in anticipation of hazards and disasters, despite being a long-established response to perceived risk (Farbotko et al., 2020; Oliver-Smith, 2006). Relocation in remote areas and involving indigenous communities conceptually differs from the relocation occurring in the densely-populated urban areas such as the Mid-Atlantic or the Gulf Coast. Namely, just like Isle de Jean Charles in Louisiana, smaller tribal communities may prefer to relocate together and at the same time to a new, preferably nearby location that would allow them to try to recreate the same lifestyle and preserve their cultural and historical identity (Simms et al., 2021).

However, implementing collective relocation may be a difficult endeavor, highly dependent on the political will, resources, and community cohesion related to the relocation process and planning. For example, several Alaskan villages have been denied relocation assistance due to the high cost of relocation, regardless of their mutual willingness to pursue this option (GAO, 2003; Ristroph, 2017). Additionally, the village of Shishmaref reversed its decision to relocate after it was determined that the preferred relocation site was unsuitable for development and after the Federal government decided to withhold funding for critical infrastructure if the town relocated (Lynch & Brunner, 2007). Due to this publicly-accountable decision to relocate and respective uncertainty about Shishmaref's future, almost all state and federal funds for the development projects have been restricted, leading to the degradation of critical infrastructure and the public health crisis (Marino & Lazrus, 2015). While case studies of places such as Shishmaref are important, they are not representative of all settlements in Alaska. As an island, the options available to Shishmaref are limited due to high exposure to more severe storm surges and erosion.

Additionally, the Shishmaref economy is highly dependent on subsistence (Marino & Lazrus, 2015), which is not the case with all Alaskan settlements with more diversified economies. The attitudes toward relocation also vary with the economic growth and opportunities, housing options, infrastructure, social services and benefits, and other sociodemographic considerations (Huskey, 2009). This is especially true of communities in the NSB that have more infrastructure and are multi-ethnic with an increasingly diverse economic base. In the 2015 Hazard Mitigation Plans for Utqiaġvik (HMP, 2015), the strategy and goals indicate relocation of infrastructure as an effective measure to reduce or eliminate the risk of coastal erosion under a medium priority. The Comprehensive Plan (CPD, 2015, pg. 34–50) and Capital Improvement Plan (CIP, 2020) for Utqiaġvik include text considering relocation or abandonment of infrastructure. Severe storm surges in 2015 and 2017 eroded roads, berm barriers, and a U.S. Army Corps of Engineers 2005 revetment. Damages to this infrastructure led to disaster declarations for Public Assistance to rebuild. Currently, no relocations or abandonment of infrastructure have been implemented since protect in place approach continues. Instead, a 2019 USACE Barrow Coastal Erosion Feasibility Study approved five miles of raised coastal roadway as a seawall (USACE, 2019). Funding was approved in 2022 using the Disaster Relief Supplemental Appropriations Act under the Infrastructure Investment Act (Naiden, 2022). USACE reviewed the challenges and lessons learned about this approval process, including dismissing infrastructure relocation as an alternative due to higher costs (Upah & Cate, 2019).

The main objective of this paper is to evaluate the perception of hazards and environmental change and attitudes toward relocation among community groups in Utqiaġvik (Barrow) as an example of a more developed, diverse, and economically resilient settlement than other Alaska's native communities facing similar coastal issues. Our mixed-method approach has been designed of context-relevant engagement activities and qualitative queries structured to capture the experiences with coastal hazards and changes and possible adaptation solutions, namely relocation. This bottom-up approach that captures the concerns and perspectives of residents themselves can support the development of DRR and adaptation policies that will be aligned with the preferences and priorities of the local population and, as such, more likely to be accepted. Scientists have traditionally viewed local knowledge as inferior to scientific information (Mercer et al., 2010). However, both types of knowledge reveal "certain truths" (Lewis, 1973, p.585), with their

advantages and disadvantages. Moreover, some participants were Indigenous. Indigenous Knowledge has been historically marginalized and dismissed as anecdotal, yet it is based on centuries of observation and is a form of science itself (IPCC, 2022; Smith, 2021). Thus, the consideration of local knowledge, including Indigenous Knowledge, ensures the appropriateness of research in the context of chronic events such as sea level rise and sudden-onset disasters (McMichael et al., 2021).

Mercer et al. (2010) advocate for the integration of the two knowledge systems in DRR, prioritizing community engagement. The most common type of local knowledge is Traditional Ecological Knowledge (TEK) or generational knowledge about the relationship between humans and their environment, emphasizing long-term adaptation to and economic use of natural resources (Berkes, 1999). TEK can establish types of risks and coping strategies (Kelman et al., 2012), which are culturally sensitive and place-specific. One such example is presented by Sakakibara (2008), who used Iñupiat storytelling to highlight how Iñupiat relocated to Point Hope in 1977 to adapt to environmental change, intertwining historic risk into locally-relevant stories. The optimal local capacity reflects a balance between the use of TEK (and other forms of local knowledge) and external or scientific knowledge.

2. Methods

2.1. Case study location

Utqiaġvik (Barrow), Alaska (Fig. 1) is the regional hub of the North Slope Borough (NSB), with headquarters of the Arctic Slope Regional Corporation (ASRC). Between 1981 and 2021, its population increased from 4,199 to nearly 10,972, primarily due to in-migration from surrounding villages to work in the Native Corporations (Bureau of the Census, 1981; US Census Bureau, 2022). The area has been experiencing accelerated retreat of coastal bluffs composed of ice-rich permafrost, facilitating shoreline erosion (Barnhart et al., 2014). The observed decrease in sea ice extended the fetch, resulting in more destructive waves further contributing to coastal erosion (Lynch et al., 2004). As such, Utqiaġvik has been recognized as one of 31 Alaskan Native Villages deemed to be facing 'imminent' threats of flooding and erosion that may eventually face relocation (USGAO, 2009). Historically, Alaska Natives led a semi-nomadic lifestyle, allowing them to adapt to the harsh environment (Nelson, 1973) until colonialism when they were encouraged to settle permanently in one location (Marino, 2012).

Even though subsequent construction of infrastructure reduced their vulnerability to some hazards, it also created dependencies on utilities and lessened their reliance on TEK to mediate the risks (Aporta et al. 2005). Since Utqiaġvik has a sophisticated infrastructure, exclusive use of TEK to cope with risks is less relevant. Due to continual coastal erosion from permafrost thaw and storm surges, native residential allotments, leasehold, fee simple property ownership, and utilidor hubs are now nearshore (i.e., a buried utility corridor containing fiber optics, hot water, sewerage, electric, and telecommunications) which exacerbates exposure to flooding and property vulnerability despite federally funded retrofitting (Lynch & Brunner, 2007). However, compared to other smaller communities facing similar challenges, Utqiaġvik is not exploring relocation due to its strategic location, advanced infrastructure, critical assets, relative wealth from oil leases, and available resources to address coastal hazards.

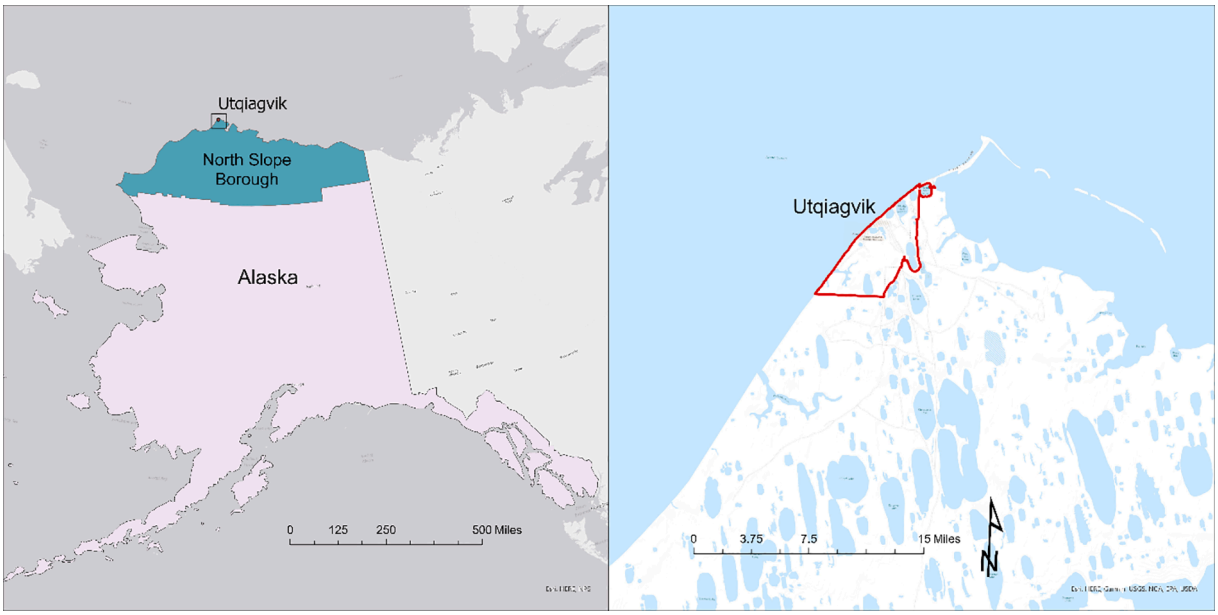

Fig. 1. Utqiaġvik (Barrow) in the North Slope Borough, Alaska.

2.2. Data collection and research approach

To capture the local knowledge and risk perceptions of hazards and environmental changes, and attitudes towards relocation, each focus group started with a series of engagement activities to communicate and assess participants' interpretations of local hazards. Following this hazard review, data collection (approved by Virginia Tech's Institutional Board Review protocol #16–506) ensued with discussion and interpretations from a scripted reading of a local disaster legend. We adopted the participatory action research (PAR) approach, recognizing the pivotal value of lived experiences with the day-to-day hazards of local participants. For this approach, a facilitator conducted focus groups in English, lasting 90 min during a group's regular meeting, with the following activities in this order:

1. A review of hazards in the area incorporated the Perception of Risk, Communication, Interpretation, and Action within Social-Ecological Systems (PERCIAS) involving hazard recognition and risk ranking, ultimately providing insight into risk perception. The discussion here was interactive and facilitated learning among the participants, whether they represent local, non-local, or transitory residents. As a group, participants were presented with 20–25 cards showing photos of various natural and man-made hazards and asked to match them to cards with hazard identifications. Next, each participant was given a table of the same hazard photos and identifications and asked to group hazards based on whether they were perceived to be already present in their community, will likely happen in the future, and have increased significantly over the past 5–10 years. They were also asked to prioritize hazards based on the level of concern by ranking ten hazards using a scale of 1, being the least to 10, the greatest concern. A comparative discussion followed the ranking activity. Considered risks were threats to subsistence, tsunami, blizzard, tundra fire, ice shove, storm surge, drought, wildfire, flood, hurricane, tornado, earthquake, sea smoke, erosion, permafrost, thin ice, rabid fox, epidemics, hypothermia, oil spill, structure fire, land fog, invasion, hunting, and whaling. The list of hazards was derived from the conversations with the local Emergency Managers and the NSB Hazard Mitigation Plan and updated through the participatory process during the focus groups. As per respondents' suggestions, additional hazards were added to the list.
2. An applied theatre activity, where participants chose the roles and read a script from the People of Kauwerak, detailed various historical disasters in the region. This served as a prompt to encourage comparisons about risk perception, disaster preparedness, and relocation in Utqiaġvik (ARIES, 2016). The script reading included four vignettes scripted from the "First Disaster" in the 'People of Kauewerak' The Iñupiat legend describes two disasters: an eclipse with an environmental change of warm to cold weather and an earthquake. In both disasters, there is a warning about an impending threat, but some residents do not act and perish. In the legend, strong leadership enables relocation and adaptation to the harsh environment. This approach has been used by Moezzi et al. (2017), who discuss the importance of stories, narratives, and storytelling in learning, communicating, and researching topics related to climate change. Applied theater is diverse theater practices to explore, educate, and encourage social change at the community, national, and global scales (Prendergast & Saxton, 2016). It is defined as a dramaturgical effort in non-theatrical settings, such as prisons and community centers, to transform human behaviors through theatrical performance by fostering engagement with challenging issues (Taylor, 2002). Participatory component, such as an active role in script reading, helps facilitate this engagement and association with the performed theme.
3. Ten interview questions were discussed as a group around the connection to place and relocation, comparing the legend script. Participants then examined the following queries: (1) Environmental changes they experienced in their community (Utqiaġvik) in recent years (5–10); (2) Impacts of changes on their livelihoods; (3) Slow and permanent versus sudden changes in hazards or risks; (4) Type of preferred response to changes (proactive or reactive); (5) Hazards that would prompt them to relocate to a safer location; (6) Relocation preferences (where would they go, what would they lose, miss the most, like to transfer to a new location/ take with them, have in a new location, and assistance they would need).
4. Presentation of a FEMA emergency supply kit, followed by discussion of what additional locally-relevant materials might be required.

The workshop sessions were conducted in person in the summers of 2016, 2017, and 2018 in Utqiaġvik, Alaska. In 2016, we collected input from 26 participants from six groups, in 2017 from 29 participants from five groups, and in 2018 from 56 participants from seven groups. The focus groups lasted 90 min. Participants were recruited from local organizations such as Integrated Behavioral Health, Rotary Club, Senior Center, Women, Infants, and Children, Prevention, Public Health Nurses, church groups, health businesses, and NSB Law Office staff members. Group members were familiar with each other, so discussions were less constrained. The same groups were asked to participate in subsequent years with the same content to reinforce the hazards and risks. Also, changes in perceptions, interpretations, and actions might be evident with repetitive content. The number of participants (5–10) in each focus group is aligned with standard research practice in social science disciplines (Bernard, 2017). Importantly, as members of community groups, participants were aware of issues in Utqiaġvik and included local populations that are otherwise difficult to access. Due to the sensitivity of the risk issues, personal familiarity among the participants facilitated discussions and improved outcomes. All focus group activities were implemented by the first author of this study, who is familiar with the local culture and language; thus, there was no need for translation and the involvement of local interpreters.

The focus groups were conducted in 2019 with the same local organizations but with different content emphasizing maritime advantages and risks with an increasing ice-free ocean. Because the focus groups were designed for in-person interactions, the COVID-19 protocols of remote communities in AK prevented facilitator visits to conduct the sessions for 2020 and 2021. Training local facilitators was considered, but social gatherings were prohibited and are still limited. Following discussions around ethics in disaster research (Gaillard & Gomez, 2015; Gaillard & Peek, 2019), including those specifically around the COVID-19 pandemic (Marino et al.,

2020; Mosurska, 2021), no in-person research occurred during this time, allowing participants to tend to the priorities of their community.

2.3. Data analysis

Audio recordings of the focus groups' interactive discussions were manually transcribed to allow researchers to relate to the data, which can be lost if using automated transcription (Silverman, 2013). Transcripts were cleaned to remove any inconsistent, unclear, or redundant words and responses (e.g., yap, oh well, and really), organized, and imported to NVivo Plus software for qualitative data analysis (QCR International, 2021). The Computer-Assisted Qualitative Data Analysis Software (CAQDAS) has been found beneficial as it supports more structured data management and organization, automated qualitative data exploration such as keyword searching and coding, combining and contrasting, visualizing results, and overall improving the credibility of qualitative data analysis (Baralt, 2021). It further ensures that the analysis process is more transparent and replicable, increasing the value and impact of social science research (Hwang, 2008). Data were coded quantitatively using the auto coding feature in the NVivo software. Computer-assessed coding has been increasingly used over manual coding as it allows the researcher to process a higher quantity of textual data in a shorter period while benefiting from the methodical ability to examine, manipulate, and analyze segments of interest (Rademaker et al., 2012).

The coding approach is at the core of computer-assisted qualitative data analysis as it allows the researcher to identify, connect, and thematically group the same concepts and find common threads and relationships that would be less discernable if performed manually (Konopásek, 2007). In our case, a coding dictionary was developed using a hybrid coding strategy of both inductive and deductive approaches. A deductive a priory approach was used based on the codebook developed from the project's research questions and conceptual framework. In contrast, inductive analysis was based on emergent themes from the focus group discussions, similar to Fereday & Muir-Cochrane (2006) and Thomas (2006). The analysis and coding were performed by the second author of this study experienced in qualitative data analysis. The additional themes and codes identified via data immersion were used to determine their location in the text and extract the explanatory portion of the statement. Other Nvivo functions were also explored to identify recurring themes in the transcripts and verify results, such as keyword frequency and coding query.

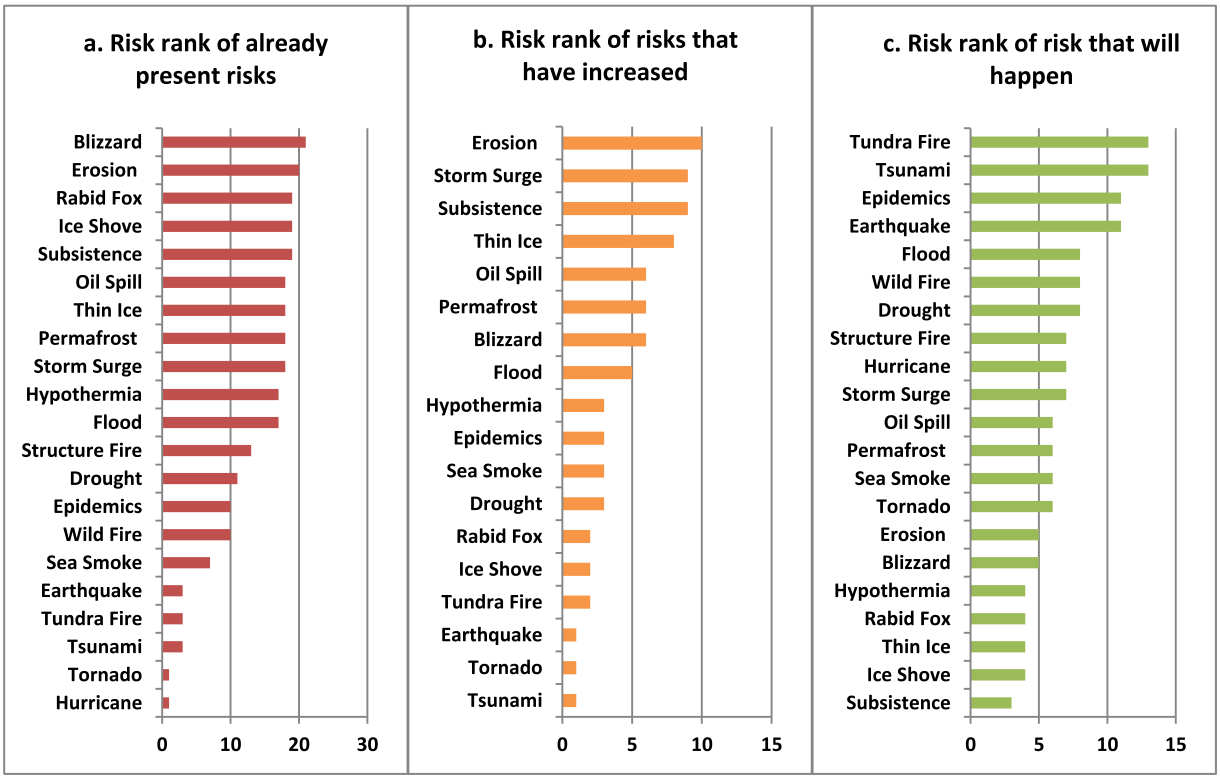

Fig. 2. Risk ranking results (horizontal axis shows the number of participants who expressed concern with presented risk).

3. Results and discussion

3.1. Risk perceptions

We first conducted two facilitated risk ranking activities to learn about the risk perceptions among the group participants. Each group either engaged in a group discussion and/or preferred the individual ranking. Some participants considered risks to be relevant among multiple ranks. These activities prepared participants for the risks in the legend script and facilitated follow-up discussions guided by the core research questions. For the overall risk level, respondents were mostly concerned with a threat to subsistence (n = 14), erosion (n = 14), thin ice (n = 13), blizzard (n = 12), storm surge (n = 12), permafrost melting (n = 12), ice shove (n = 9), flood (n = 9), sea smoke (n = 8), epidemics (n = 8), and to a lesser extent with rabid fox, hypothermia, oil spill, structure fire, drought, tsunami, tundra fire, earthquake, hurricane, tornado, and land Fog (n = 6 or less). For hazard risks already present (Fig. 2**a**), participants (15 +) primarily selected threats to blizzard, erosion, rabid fox, ice shove, threats to subsistence, oil spill, thin ice, permafrost, storm surge, hypothermia, flood, and others. As for the increased risks (Fig. 2**b**), participants acknowledged erosion, storm surge, threats to subsistence, thin ice, oil spill, permafrost, blizzard, flood, and other risks to a lesser extent. The emergent risks or risks that participants believe will happen in the future include tundra fire, tsunami, epidemics, earthquake, flood, wildfire, drought, structural fire, hurricane, storm surge, oil spill, permafrost, and others (Fig. 2**c**).

In addition to offered risks, the participants identified threats such as changes in seasonality, hypothermia, ice shove, structural fire, terrorism, meteorite, tornado, and international conflict as present risks. While NSB depends on economic support from leasing the land to the extractive industry at Prudhoe Bay, oil spills were often ranked as a present and emerging risk. Land versus ocean spills were further discussed related to extractive companies for offshore drilling. None of the participants mentioned ocean pollution, an emergent risk due to warming and ice-free regions that increasingly allow Arctic shipping and increase the risk of accidental releases from ballast waters and fuel spills (Jensen, 2008). Participants may perceive the rise in the maritime industry as an economic opportunity rather than a hazard risk. While risks of earthquakes, tsunamis, and epidemics have been ever-present, the participants perceived them only as emerging. For example, Alaska is one of the globally most seismically active areas, with multiple earthquake epicenters in the Bering Straits and the Chukchi Sea and along the Denali fault, causing tremors at various levels along the North Slope (ASHSC, 2021). In 2018 the largest quake occurred near the Kaktovik community and threatened the Prudhoe Bay oil pipelines and the access road, i.e., the Dalton Highway (UAF, 2018). Consequently, Alaska's coastal communities have one of the highest tsunami risks in the United States, with minutes rather than hours to evacuate to higher ground (UAF, 2021).

As of follow-up discussion on the risk ranking activity, many participants commented on the thinning ice as both risk to life ("falling through the ice") and subsistence livelihood ("not going anymore on ice") due to later ice cap formation ("that used to happen in October but nowadays doesn't form even until February"). The ice cover also breaks up earlier in the spring and moves constantly, representing a risk to boating, fishing, and whaling. Because of increasing sea ice loss and thinning, ice does not protect the shoreline from surges anymore, leading to increased erosion. Permafrost thaw is also problematic as it accelerates erosion and limits the use of ice cellars. Participants also engaged in extensive discussion about more mud or "mutant mud" as a new phenomenon resulting from changes in weather patterns with more precipitation and causing incidents for people and wildlife. One participant noted, "three kids were stuck shoulder high and had to be pulled out by other people. It was like quicksand; they could not get out." They further noted that the storm surge and threat to subsistence have increased, as well as the risk of tundra fires that can quickly burn shrubs, willow bushes, and moss that serve as habitat and food sources for caribou and other wildlife.

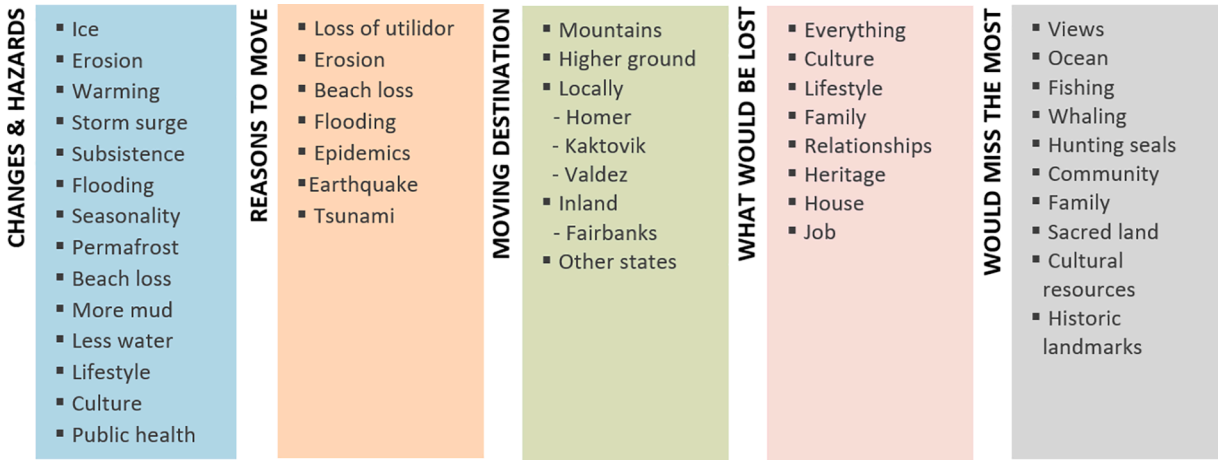

Fig. 3. A summary of identified relocation preferences.

3.2. Perceptions of environmental changes and hazards

To assess risk perceptions and interpretations, all community groups were asked about the environmental, economic, and sociocultural changes they observed, hazard risks and responses, and the possibility of relocation and the relocation process. In response to these inquiries, the respondents mostly talked about people, moving, houses, water, and years frequently to discuss things that happened in the past, that are currently happening, and those that may occur in the future should some of the hazards continue affecting their community (e.g., how the way of life changed from the time many years ago when they used to do certain things).

When asked about the observed changes, most respondents across all groups evoked both environmental and sociocultural changes mostly from personal experiences (Fig. 3). For example, participants often used temporal benchmarks to discuss changes in Utqiaġvik, such as "I see just from what I remember as a little girl" and "We used to go [on ice] the first week of October when I was growing up. We don't have ice in October. It rained last year in October." Changes in the sea ice were one of the most common concerns among participants who noted it is getting thinner (affecting boating/time one can spend on the boat, risk of falling through the ice/more holes in the ice), does not stay very long or does not form at all, and forms later in the season (used to be in October but now in December, or even February, melting and freezing much later). Many participants mentioned changes in weather patterns and seasonal variability, with milder/shorter/warmer winters, warmer summers (although one respondent noted that summers are colder and more humid than they used to be), more snow, and worsening storm surges in the later summer and fall. They also recalled specific seasons and months when they felt the weather was different than usual (e.g., terminal dusting, more rain, and more mud).

Besides the ice and erosion, the beach extent led to concerns about the beach becoming narrower, being almost gone or completely gone, being deeper/longer, and the ocean that was far away now closer and closer to roads and homes. Similar concerns were expressed about the storms and storm surges that washed out roads, beaches, and cabins/homes (e.g., homes lost to the ocean, cabins moved due to storm-driven erosion, and the wide road, big beach – all gone). One respondent recalled: "when I was a little kid, I lived right by the school district. The ocean used to be way down there. Now it's close to the houses. The ocean is washing up the houses." The NSB General Assembly already initiated dialogue about moving some assets from the shoreline in the 1960s in response to flooding, suggesting a broader acceptance that some localized relocation may be necessary to accommodate changing conditions.

Many participants discussed the cultural changes as equally concerning, the changes that are eroding traditional sociocultural values and the way of life, trust, and cohesiveness in the community. Some expressed worry about the loss of local knowledge (e.g., on "how to make the fire with flint that young generations need to know to be able to survive out there", "how to handle dogs and train dog packs", and "how to stay safe on the ice") with fewer and older subsistence hunters who can transfer the knowledge to younger generations. In addition, many residents are facing food insecurity and hunger with threats to subsistence, e.g., whaling that is becoming more challenging due to changes in the sea ice and caribou hunting due to a decrease in population and changes in habitat. As one respondent noted about the loss of cultural resources: "we weren't able to get a lot of the things that we normally get from the ocean around the time that we're used to getting them, and we're getting them much later." Other respondents shared concern with the availability of freshwater that used to be more accessible and now, with ponds drying up, is more limited and further away.

They further noted risks to the utilidor as a lifeline that would further exacerbate the availability of drinking water, electricity, and sewage disposal if flooded. Local people find it difficult to afford food in stores ("with the cost of living up here being ridiculous"), buy fuel and modern tools for subsistence like guns and ammunition, snowmobiles, and four-wheelers, and procure the permits that are now necessary for hunting. At the same time, younger generations are not listening to the stories anymore and are losing skills that do not rely on modern tools, and traditional knowledge of safety precautions and their surroundings, like reading weather from the clouds, wind, and vegetation. Dream interpretation still plays an important role in Utqiaġvik's culture, with many respondents sharing their dreams about hazardous events and changes, e.g., when they climbed on the tallest building to save themselves during flooding. Such experiences increased their confidence in "making their own decision to stay safe and not panic" or "not to be worried or scared but just wait for the rescue to come."

Other observed sociocultural changes include the loss of respect for each other and property (e.g., "if you break down with the snow machine ten miles out, you can't even leave it for two days before it's stripped of everything" and the changes in lifestyle with fewer people getting a sufficient amount of vitamin D, physical exercise/walking and with more driving around in cars and trucks. All these changes result in new problems, such as accidents with motorized vehicles, poor decisions due to alcohol consumption, and suicides. A few participants recognized potential opportunities related to the weather changes, such as visits of smaller cruise chips that would bring tourists. However, they also noted this might be highly unpredictable due to weather oscillations and extremes. Further, epidemics were recognized as one of the emergent hazards and were mentioned multiple times as a changing risk, primarily associated with increased mobility via ships and air transportation. Participants provided an example of antibiotic-resistant pneumonia that affected the regions and noted that "if something worse were to get in here, it would spread just as easily" but "with our hospital as understaffed as it is, if we get anything really bad, there's not a lot of people who can help this." Since collecting this data, the COVID-19 pandemic has spread to Utqiagvik. However, strict protocols limiting visitors and the remoteness of Utqiagvik delayed the onset of the pandemic but its spread was rapid once introduced. Thus, while participants raise understaffing issues at the hospital, there is an element of remote protection. This protection is contingent on the control of the movement of people, especially 'outsiders,' to and from the community. This aligns with previous work around Indigenous borders as sites for compassionate care for the community (Leonard, 2020).

Other risks participants mentioned include winter freeze, tundra fire, trash, algal blooms in Florida (that they could be introduced to this region by boats but not survive due to cold weather), encounters with rabid foxes and polar bears, and oil spills. A few focus groups talked about the oil spills as emergent risks with an increase in shipping traffic and plans for offshore drilling, as well as how would they notice it to respond in time, e.g., whalers, fishermen, and seal hunters who see the spill or the resulting dead fish and alert

others, or the notification by the operator as soon as the incident happens. There was a general agreement that the community needs to prepare for hazards and "always seek ways to change," with a few participants mentioning that changes cost money, depend on the people and whether they feel the changes are needed, and should not be introduced "too quickly." One respondent noted that being proactive is better than reactive but not always possible. As for some possible solutions, participants mentioned rock walls in some critical places along the coast, home elevation, and sand berms as key protection from surge flooding.

As a more creative solution, one respondent suggested using Conex boxes (shipping containers commonly used for storage in this area) to create a more sturdy retention wall instead of "putting dirt and paying people to do that all the time." One participant asked why nothing has been done besides the short-term fixes such as stacked sandbags and dredged and compacted sand that are ineffective in dealing with surges and concluded with "forget about people. It is all about money." The political dimensions of the problem on different governmental levels have often been brought up in conjunction with the economic aspects – "What are they planning to do, move all seven blocks up – that may cost a lot of money." Some of the existing options contradict the right of self-determination with elders not partaking in the decision-making process. As an underutilized resource, the elders' deep knowledge and experience are rarely considered in policy development. One conversation brought up an issue of risk communication and how it is important to "tell people what is going to happen," even though not all of them will believe it. Once they have the information and do not act upon it, they should take responsibility for the outcome.

3.3. Attitudes toward relocation

This section presents responses to questions about hazards that would prompt participants to move, where they would go, what they would miss the most, what they would like to take with them, and what they would need in a new location. The discussions were often emotionally difficult and complex (e.g.," If I could speak for myself, I would sell my home, but I can't speak for myself, so it's very difficult, yes.") with responses recognizing that sentiments on this issue differ among people who lived their whole lives in Utqiaġvik, those who recently purchased homes or are renting, those who are not yet attached to this place, and those who are transient workers. In relation to moving, a few respondents mentioned traumatic experiences or psychological impacts: "I think that for the folks who are going to have to move their homes, it's going to be a traumatic experience because there's a connection to the land and because it belonged to their ancestors and their people, the people they loved. So, they're going to endure".

As for reasons that would prompt participants to move, the key drivers would be losing their homes due to erosion that is "very visible and scary" and "I'm at the top of the hill, and I'm getting nervous." Most observed the land loss, for example, stating "the shoreline dropped and went straight down, the straight road is now curved" and "coastline is moving." A few respondents noted that with changes in the ocean, more flooding, beach loss, and elevation already at sea level, they are "ready to get out of here" and "obviously we are not going to rebuild, we're going to have to move inland." They also reflected on their past nomadic lifestyle that allowed them to move in response to environmental change, e.g., "solution from the older Inupiaq as you know is move the town. I've heard that in a number of places. Don't fight the ocean, so we are actually ignoring that right now" and "we were not settled in one place, like ducks, just roaming around." Oher concerns that would prompt them to move included infectious disease, a tsunami, and the slow economy. A few participants expressed concerns about recreating relationships and integrating into a new community, a perception that likely influenced their preference for local or regional destinations.

One individual commented that reluctance to move is not something specific for this location, as in other places. For example, after riverine floods in Missouri and Arkansas, people "want to come back and rebuild in the very same place where they were wiped off because they are hardcore and that is where they're born and raised and many generations in that spot." The same is in the tornado alley, where people always come back and rebuild. A participant noted that "It would have to be something catastrophic. People aren't going to move unless the community is in real danger. It's just the way it is." Further, the discussions revealed that the discourse on moving in response to hazards differs between participants who moved around a lot and are more transient than those who invested a lot of money on the house, have been living here for generations, live off local marine resources, and are reluctant to even evacuate during hazard events, nonetheless to move permanently. In 2017 discussions, respondents noted that some homes and communities moved several times in the past but never far enough, e.g., "down the sand bar," which may perpetuate the problem.

The Comprehensive Management Plan for the NSB does not include relocation of the entire community, such as Newtok, Kivalina, or Shishmaref. Instead, it focuses on the planned relocation of facilities within the city boundaries and the abandonment of threatened structures. It does not address specifics of the process, e.g., who would be responsible for the costs of moving the structures, moving into extant structures which are severely limited, or rebuilding elsewhere. Since most of the land and properties are leaseholds held by regional tribal corporations, relocating facilities requires a private corporate decision. If rentals are available in less hazardous areas, the decision to relocate to other leasehold properties is an option for individuals and families. These changes could be achieved via assistance from the federal government to purchase land for relocation with the expansion of the utilidor and from the Native Corporations, who are the primary landowners of the native lands. The limited homesite lots owned by the Native Corporations are reserved for native shareholders or are leased to other residents. Most of the coastal lots are native allotments that are owned by family descendants (BLM, 2021).

Most discussions mentioned infrastructure as an important aspect of the decision to move, with some explicitly expressing concern with providing a continuation of services as coastal hazards accelerate: "800 million dollars' worth of piping and utilities in the ground and preparing for those storm surges involves having an above ground piping and the ability to move the entire community." Others were worried that the future impacts on infrastructure would be "a step backward" with utilities in the ground or sewage tanks next to homes. Another important consideration about the response options is who controls and owns the land, whether it is public or private, and the associated cost. As one respondent noted, "we all know Barrow is going into the ocean, but nobody has millions of dollars to

move their home inland." Others mentioned the cost of building new homes elsewhere and how expensive they are but of low quality and prone to disaster damage, with very few residents who can afford to buy or rent them.

Overall, all groups across all three summers emphasized the importance of utilidor as a lifeline that carries a fiber optic cable, gas line, water and sewage pipes, and powerlines. The loss of utilidor due to flooding and mud breach would be catastrophic, and very little can be done to protect it. Utilidor also represents a significant asset in the community, "utilidor, and 800 million dollars with the pipes in the ground, so that's why they're making a stand with the sea wall." However, other respondents were aware of the high cost of seawall and the difficulty of finding who will carry the cost of building it, noting it is likely a cost-ineffective option for this location. In most cases, nobody anticipated it would be so close to the hazard line when they "put the fiber optic with the gas line and everything else you can get in the utilidor, so you're done at that point," and if the community ends up with "washed up the seaside houses, no utilidor, bye!"

One respondent noted that "officials are spending a lot of money protecting something already in poor shape that needs to be fully updated in utilidor." Past incidents when, for example, "it all froze and around 75 homes stayed without the potable water and had to use honey buckets back to old ways" indicate dependency on utilidor and difficulty to maintain it due to extreme weather, ground shifting, and changing conditions. The same applies to other infrastructures, like roads and the airstrip. Since the loss of critical infrastructure was one of the key reasons to relocate, this concern reinforces the community's reliance on the utilidor. It suggests the support for engineering solutions to safeguard utilities at a cost that shifts decision-making from the local scale to external entities (i.e., raising the pump station platform above flood level or constructing a seawall). Appreciation for the access to modern-day ingratitude permeated all discussions, including the gas line susceptible to breaking due to shifting ground/thawing permafrost and water and sewage pipelines extending to other rural satellite neighborhoods. Participants reminisced of times when they had to use the honey bucket, store their waste next to their homes until pumped out, or bring potable water from the surrounding freshwater lakes as the ice chunks. The access to improved infrastructure was a welcome advancement for all participants, with one noting that "a number one Capital Improvement Project project everybody wanted was a flush toilet." However, now "as the ground moves and the water moves with it, there are many things that we thought were buried and would stay buried but are no longer buried," and despite the maintenance, eventually, everything will have to be replaced.

On a question of what they would lose, many respondents say everything, followed by heritage, culture, family, lifestyle, jobs, house, relationships, and everything. One respondent noted, financially, just a house, while others noted how people these days accumulate a lot of stuff (e.g., in their homes or stored in Conex boxes) they may not be able to bring with them. As of items they would miss the most, a majority of participants mentioned ocean and views and then fishing, whaling, hunting seals, community, sacred land, historic landmarks, northern lights, home, culture, patient base, livelihood, food, cats, puppies, job, skillset, coal, family, wife, and laptop. They noted how they have a strong sense of community "cause we're diverse and pretty tight-knit" and have "all the things that nobody else in the world gets to see." One participant noted that the community is so tied to the land and other communities in the region that it would not be able to persist as a community after relocation. It would be challenging to recreate existing relationships somewhere else, where everyone may go their separate ways. Another noted that he moved here but now cannot imagine living elsewhere because everything is less complicated here and just thinking about moving is stressful. This is especially true when compared to the cities, where urban life, homelessness, and the presence of advanced technologies can be overwhelming and scary. However, the same participants noted that other people in the community do not have the finances, support, experience, and confidence to choose between staying and leaving.

As for preferred relocation destinations, most participants noted they would go to the mountains and the higher ground. Some would move further inland, upwind, and nearby, e.g., to Fairbanks, Prudhoe Bay, Homer, and Kaktovik. The respondents noted that there are different environmental threats everywhere you go, and "there is no safe place," e.g., tsunami could wipe out Homer, other disasters in Valdez, and riverine flooding locations further inland. A few respondents mentioned they would move to Kaktovik as a safer option "on a higher ground," "in the mountains," and "where the mountains are," indicating Kaktovik is perceived as a safer option as an area they are already familiar with (e.g., with fishing and hunting cabins, there is "always something to hunt"). This suggests participants prefer nearby locations with a familiar physical and social environment they already understand and have some connections with, which would minimize the disruptions in their livelihoods. Among other suggestions, one respondent would wait until dreaming about moving and then consider leaving, one would consider moving to Utah, and one even expressed interest in moving to Italy where "they are paying people to live there." Others suggested that going back to migratory living may be a good option, or even living on a cruise ship that would move along the coast. A few respondents emphasized challenges to relocation, such as the provision of new homes and the ability of the local population to finance the move: "So where will they go? They don't have anything"; "the state folks were explaining to me how it would be cheaper to move the village to L.A. than it would be to bring in water and sewerage;" and "you could bring everybody to Anchorage for far less money than building new school infrastructure and all the medical equipment."

As of provisions they would like to have in a new location, participants mentioned PS4 video game console, laptop, important docs like passport, social security, birth certificate, food, running water, medications, heat, fresh fruit and vegetables, flush toilets, a pina colada, warm showers, hot springs, each other, fishing and hunting gear, community, and credit card that will allow them to travel. When asked about the help they would need, participants noted it would be important to get support for this from all residents, and that would be possible only if there are no other options and unless they are severely affected by changes: "getting buy-in from everyone else would be difficult unless it's happening unless you're right in it." They also discussed logistics on how to move more people simultaneously, for example, by using helicopters or a deep-water port to allow larger ships to dock and evacuate the population. Others noted assistance needs with funding that would enable them to prevent the worst impacts, "start from scratch" in a new location and have a leader who can be trusted with a plan and information.

4. Discussion

Due to the persistence of coastal sedentism, post-disaster relocation is a possible scenario given the environmental changes since the 1963 storm surge (e.g., Lynch & Brunner, 2007). Participants recognized that coastal hazards have increased with decreased sea ice, resulting in erosion, and two hub pump stations of the utilidor situated close to the coastline. Consequently, a repeat of the 1963 storm could have greater impacts and challenges in recovery (Lynch & Brunner, 2007) due to erosion affecting critical infrastructure. Since participants recognized that damages to the utilidor are reasons to migrate inland, frequent storm surges and flooding could eventually favor relocation and avoid reactive decision-making, which exacerbates vulnerability (Ingram et al., 2006). However, proactive relocation, proposed by Oliver-Smith (2006) as a conventional response to perceived risk is being resisted in Utqiaġvik, despite some participants expressing the need for these public and private precautions. Alaska coastal settlements, such as Newtok, Kivalina, and Shishmaref that have voted to relocate to a new site, have significant challenges due to lack of funding assistance (Huntington et al., 2012), so it is unlikely that Utqiaġvik, as a regional hub with funds for sophisticated infrastructure (Lynch & Brunner, 2007), will be granted assistance for community relocation.

Additionally, some participants want to relocate, so inland migration is likely to occur on a household level rather than as a community adaptation strategy. However, this could lead to household entrapment, in which those most vulnerable do not have the means to migrate inland and remain living in a high-risk location (Collins, 2013). Several participants agreed that entrapment is a consideration, highlighting the financial difficulties of buying or renting a property in Utqiaġvik and migrating inland as households. Choices to migrate inland are affected by the lack of flood zoning and the government's resistance to participating in National Flood insurance or investing in reducing flood risks through the Community Rating System (FEMA, 2020). Establishing a flood zone could lessen entrapment, especially if the inland property were available to rebuild extant houses and extend the utilidor to mitigate hazard exposure and vulnerability. To acquire land for an inland house and utilidor construction would likely require government negotiations with native corporations and the Federal Government to expand native and city lands into the National Petroleum Reserve.

5. Conclusions

This study conducted among the community groups in Utqiaġvik offers contrasting results to other Alaskan communities experiencing increased hazards and influencing risk interpretations and actions, such as planned migration or relocation. For example, the majority of studied communities are western Alaskan tribal villages that are more reliant on subsistence and highly affected by accelerated coastal hazards. Mainland coastal communities in Alaska face significant risk from the ice-free seas (and other hazards), which rely on a mixed economy, are multi-ethnic, have advances and more complex infrastructure, and are exposed to external influences. Utqiaġvik and other coastal settlements, such as Bethel, Kotzebue, and Nome, also have complex infrastructure, which increases the cost-benefits ratio to justify investments into protection rather than relocation. The results among the community groups indicate relocation and regional migration are considered by some but not planned nor implemented to reduce risks. To minimize risks, the lack of plans for planned relocation may result in disaster-driven displacement and spontaneous migration, reinforce entrapment of vulnerable residents due to limits on land ownership and lack of resources, and substantiate that critical infrastructure (in this case primarily utilidor) keeps coastal residents in place. However, recognizing the increased hazards by the community groups could lead to a more robust discourse on the possibility of relocation and regional migration. Circumstances are inevitably changing in this area with sea ice minimums that expose open waters, and risks and hazards from the Arctic extractive industry are increasing with offshore drilling. These risks include oil spills, ship collisions, pollution from ballast water and smoke, transitory workers in rural populations, and noises that affect migratory marine mammals harvested for subsistence. These risks are associated with socio-economic and environmental processes that can cascade disaster consequences, especially if interdisciplinary and holistic scenarios are not considered.

While Utqiaġvik is unrepresentative in Alaska, since it is a larger community in the wealthiest borough due to the presence of extractive industries in this region, the high-cost benefits of risk reduction may differ from other locations. This study provides a case of DRR in a remote place and place-specific characteristics that are unique (e.g., particular forms of subsistence, corporate monopolies, TEK knowledge, and social organizations) but where there are significant external influences accompanied by a changing landscape of risk from rapid environmental changes. There are similar communities within Alaska as well as communities in Canada to which this case study could apply (e.g., Igloolik, Nunavut, due to the degree of critical infrastructure and interest in resource extraction). In this case study, many challenges to reducing risk are not limited to the Arctic or indigenous communities. However, the specific socio-political and economic context of this remote community has been influencing the cost benefits of reducing risks as hazards increase.

Further, the community is also experiencing other complex sociocultural changes that may affect their risk perceptions and, most notably, confidence (or overconfidence) in the ability to manage risks for the long term. The focus groups highlighted the increasing dependency of younger generations on modern-day skills, tools, and technology, even for subsistence. This finding can have positive and negative impacts on the local individual and collective resilience, with some of these improvements giving them a competitive advantage amidst rapidly changing environmental conditions but also contributing to the loss of traditional and local skills and knowledge that may sometimes be vital in disaster response. This study reveals that even though many residents still appreciate the traditional lifestyle, many others welcome modern life's conveniences and are no longer willing to revert to lives without them. As such, utilidor, improved housing options, amenities, and opportunities can incentivize planned relocation or migration. And lastly, not all people are the same, even in remote and cohesive Alaskan communities. It is important to recognize that as much as some would prefer to preserve traditional and local ways of life in the same place, others would like to broaden their experiences and consider moving elsewhere, away from coastal threats.

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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.

Data availability

The data that has been used is confidential.

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