

Communicating Risk in Glacier Tourism: A Case Study of the Svínafellsheiði Fracture in Iceland

Authors: Matti, Stephanie, Ögmundardóttir, Helga, Aðalgeirsdóttir, Guðfinna, and Reichardt, Uta

Source: Mountain Research and Development, 42(2)

Published By: International Mountain Society

URL: <https://doi.org/10.1659/MRD-JOURNAL-D-21-00051.1>

BioOne Complete (complete.BioOne.org) is a full-text database of 200 subscribed and open-access titles in the biological, ecological, and environmental sciences published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Complete website, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at www.bioone.org/terms-of-use.

Usage of BioOne Complete content is strictly limited to personal, educational, and non - commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

Communicating Risk in Glacier Tourism: A Case Study of the Svínafellsheiði Fracture in Iceland

Stephanie Matti^{1*}, Helga Ögmundardóttir¹, Guðfinna Aðalgeirsdóttir², and Uta Reichardt³

* Corresponding author: steph.matti@gmail.com

¹ Faculty of Sociology, Anthropology and Folkloristics, University of Iceland, Sæmundargata 2, 102 Reykjavík, Iceland

² Institute of Earth Sciences, University of Iceland, Sæmundargata 2, 102 Reykjavík, Iceland

³ Institute for Sustainability Studies, University of Iceland, Sæmundargata 2, 102 Reykjavík, Iceland

© 2022 Matti et al. This open access article is licensed under a Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>). Please credit the authors and the full source.



Every day in early summer 2018, an estimated 1000 tourists went on guided tours of Svínafellsjökull, an outlet glacier in southeast Iceland. However, this changed on 22 June 2018, when a warning was issued against glacial travel due to the risk of a large landslide caused by a fracture in the surrounding mountainside. Tourists often entrust tourism employees with responsibility for their safety; however, there is a dearth of research into the ways in which tourism employees receive and respond to risk communication. These dynamics were explored in this ethnographic study, which drew on 50 semistructured interviews and extensive participant observation. The results indicate that despite demographic shifts, Icelandic

inhabitants remain the basic unit on which risk management processes are centered, with repercussions for the ways in which exposure is calculated and risk is communicated. Tourists and tourism employees have a limited understanding of the risk and emergency protocols compared with local inhabitants. We argue that, for their own safety and that of customers, risk communication needs to be tailored to the needs of tourism employees, including guides and hospitality workers. The recommendations that emerge from this research can guide risk communication strategies in other mountainous regions of the world where tourism is an important source of livelihoods.

Keywords: climate change; large landslide; glacier; risk communication; tourism; Iceland.

Received: 2 September 2021 **Accepted:** 23 February 2022

Introduction

Given the natural beauty and accessibility of Svínafellsjökull (64.0186°N; 16.8215°W), an outlet glacier of Vatnajökull in southeast Iceland, it is unsurprising that it emerged as one of the most popular destinations in the country for glacier hiking (see Figure 1). During the 2017 summer peak season, an estimated 1000 tourists went on guided tours of the glacier each day. However, this changed on 22 June 2018, when local police together with the Department of Civil Protection and Emergency Management (DCPEM) issued a warning against travel on Svínafellsjökull due to the risk of a large landslide caused by a fracture in the surrounding Svínafellsheiði mountainside. Guided glacier tours were discouraged, and tourists were “advised to stop only for a short while at viewpoints by the glacier tongue” (IMO 2018). In the days that followed, all guiding operations shifted to nearby glaciers.

The emergence of the Svínafellsheiði fracture is part of a global trend whereby climate change has contributed to the decline of glaciers, snow, and permafrost in recent years (Hock et al 2019: 133). This has led to changes in the frequency, magnitude, and location of natural hazards, as well as the emergence of landslide risk where there was no record of previous events (Hock et al 2019: 133–134). People are also increasingly exposed to these hazards due to growing populations and tourism (Hock et al 2019: 133).

Examples of how climate change-related glacial retreat has interrupted tourism include: altering rockfall dynamics on Fox and Franz Josef Glaciers in New Zealand, and on the Rhône Glacier and Mer de Glace in the European Alps (Purdie et al 2015; Salim et al 2021); shifting routes on Everest (Watson and King 2018); and the disappearance of Bolivia’s Chacaltaya Glacier (Kaenzig et al 2016).

Risk management literature indicates that the vulnerability of tourists to natural hazards is often exacerbated by language barriers, limited interaction with locals, high mobility, and a predisposition to prioritize positive holiday experiences (Bird et al 2010; Becken and Hughey 2013: 78). Several studies have found that in times of crisis, tourists entrust tourism employees with responsibility for their safety (Leonard et al 2008; Bird et al 2010: 33; Aliperti and Cruz 2019). Despite the importance of tourism employees in managing and responding to disasters related to natural hazards, there is a dearth of research on how this demographic receives and responds to risk communication. Furthermore, while a sizable body of literature emphasizes the importance of local inhabitants participating in risk management processes (eg Pelling 2007; Cadag and Gaillard 2012; Cadag et al 2017), such analysis has not been conducted for tourism employees.

This article addresses these gaps by examining how Icelandic risk management processes interfaced with the tourism sector in the case of the Svínafellsheiði fracture. We

FIGURE 1 Tourists at the Svínafellsjökull viewing area, November 2019. (Photo by Stephanie Matti)



paid particular attention to foreign tourism employees, who constitute a large proportion of tourism employees in the area. A key finding is that despite demographic shifts, local Icelandic inhabitants remained the basic unit on which risk management processes were centered, with repercussions for the ways in which exposure was calculated and risk was communicated. Both tourists and tourism employees had a limited understanding of risk and emergency protocols compared with local inhabitants. We argue that for their own safety, and the safety of customers, risk communication needs to be tailored to the needs of tourism employees, including mountain guides and those in hospitality positions. The policy recommendations that emerge from this research can guide the development of risk communication strategies in nature tourism destinations facing sudden, large-scale hazards, including avalanches, flash floods, landslides, and volcanic eruptions.

The remainder of this article is structured as follows. The next section provides an overview of the relevant background to risk communication and how it relates to the Icelandic tourism sector. The research design, including the study methodology, study area, and risk management strategies, is then described. Next, the results are presented and discussed. Finally, the conclusions are presented.

Background

Risk communication

Risk communication is widely accepted as a key strategy for mitigating vulnerability and reducing the effects of disasters (Paton 2006). The term “risk communication” refers to interactive flows of information to notify people of the probability of a hazard occurring, likely consequences, and

mitigation actions (Plough and Krimsky 1987: 6). Since the 1980s, the theory and practice of risk communication have shifted from a top-down flow of information from experts to the public to a broader approach that takes into account community participation, cultural factors, social relationships, and trust (Khan et al 2017; Lin et al 2020).

Risk communication strategies are more effective when tailored to intended audiences (Paton 2006: 9; Seeger 2006). Factors that affect how people engage with, and act upon, risk communication include, but are not limited to, cultural background (Lindell and Perry 2004), trust in risk management authorities (Haynes et al 2008), confidence in emergency procedures (Barberi et al 2008), duration of exposure to risk (Stancu et al 2020), and level of social capital (Cadag et al 2017; Anderson-Berry et al 2018). Social capital refers to the networks of relationships among people who live and work in a particular society. As communities become more diverse, the social context in which information is received is characterized by increasingly varied experiences, beliefs, needs, expectations, and interpretations of risk (Paton 2006; Lin et al 2020).

Participatory risk communication involves community members engaging in two-way dialogue with risk managers; it also provides an opportunity for both groups to raise and understand concerns (Pelling 2007; Cadag and Gaillard 2012; Demeritt and Nobert 2014: 319; Cadag et al 2017). When local actors are not familiar or do not recognize response and evacuation plans in advance, these protocols are less likely to be followed during an emergency (Voight 1990; Carey et al 2012). A sizable body of literature indicates that community participation improves the implementation and quality of risk management (eg Pelling 2007; Cadag and Gaillard 2012; Cadag et al 2017; Kerstholt et al 2017). One criticism of participatory risk communication is that it

reinforces existing power dynamics within a community, for example, through the exclusion of marginalized groups or disadvantaged individuals (Cadag et al 2017: 484; Nguyen et al 2017).

Risk communication in Iceland

Situated in the North Atlantic Ocean, Iceland is prone to a range of hazards, including avalanches, volcanoes, earthquakes, landslides, floods, and extreme weather. DCPEM is responsible for preparing for and managing risks due to natural hazards (Parliament of Iceland 2008). At the local level, police are responsible for developing and implementing preparedness and response strategies together with Regional Civil Protection Committees (Parliament of Iceland 2008).

In Iceland, information about risks and emergency protocols are shared through different media, including broadcasters, public meetings, email, telephone calls, brochures, face to face, government websites, social media, the Safe Travel website, and the 112 (national emergency number) mobile application (Bird and Gísladóttir 2020). Public meetings conducted by risk managers with presentations by scientists have been espoused as a particularly effective way to communicate information to local residents, listen to their concerns, build trust, and learn from local knowledge (Guðmundsdóttir 2016: 37). Emergency response and evacuation drills have also been trialed for some volcanic hazards (Bird et al 2010). Authorities typically rely on risk communication rather than access restrictions to promote personal safety in Icelandic glacial, volcanic, and geothermal landscapes (Bird and Gísladóttir 2020).

Risk communication in tourism

Both tourism and risk management literatures indicate that the tourism sector globally is poorly prepared for disasters related to natural hazards (eg Prideaux et al 2003; Hystad and Keller 2008; Bird et al 2010). Reasons include unclear communication by emergency management authorities, a lack of formal consideration of tourism in risk management, poor adoption of risk management protocols by tourism businesses, and a passive approach by tourism businesses toward risk management (eg Glaesser 2003; Cioccio and Michael 2007; Hystad and Keller 2008; Becken and Hughey 2013).

Tourists visiting hazardous environments have different perceptions of and aversions to risk. Visitors to volcanic sites often: adopt their own precautionary measures; hope nothing dangerous will happen when they are in the area; rely on having enough time to get to a safe location; and expect hazards will be managed by tourism operators (Erfurt-Cooper 2010: 6; Purdie et al 2015: 198). However, studies of volcanic tourism indicate tourists are not always provided with sufficient information to make informed decisions about their personal safety (Knafou 2019; Bird and Gísladóttir 2020). This was the case for the Whakaari/White Island disaster, when 21 tourists and guides died in a volcanic eruption in December 2019, despite an increased eruption alert (March et al 2020). Tourism operators may fear that communicating risk with tourists will lead to a reduction in demand and associated profits (Bird and Gísladóttir 2020); however, a reputation for unsafe practices

can have the same effect (Purdie et al 2015: 197). There have been calls to improve risk management within the tourism sector, including tourism disaster spokespeople, dedicated web pages, disaster drills, mainstreaming risk management into training, and tourism-oriented risk communication strategies (eg Hystad and Keller 2008; Bird et al 2010; Becken and Hughey 2013; Mair et al 2016; Aliperti and Cruz 2019).

Iceland has experienced a dramatic increase in tourism in the last decade, from 448,000 foreign visitors in 2010 to over 2 million in 2019 (Icelandic Tourist Board 2018). By 2019, tourism was the most important source of foreign currency earnings and the largest provider of jobs in the country (Müller et al 2020: 51). The number of foreign tourism employees rose from 2427 in 2008 to 10,551 in 2019 (Halldórsdóttir and Júlíusdóttir 2020: 13). An estimated 30% of staff in the sector—and 75% of staff in hotels and guesthouses—are not from Iceland (Statistics Iceland cited in Wendt 2019: 27). Foreign workers are often employed in low-paid, low-skilled jobs, on short-term or temporary contracts (Skaptadóttir and Wojtynska 2019). Foreign tourism employees typically have strong social ties with their employer (Wendt 2019; Halldórsdóttir and Júlíusdóttir 2020). English is often the main language of communication (Mirra 2019), with almost half of all foreign tourism employees reporting inadequate or nonexistent Icelandic language skills (Hauksson 2019).

The few studies available suggest that tourism employees and foreigners are commonly overlooked in risk communication. In Japan, researchers found that disaster management structures were not well adapted to the needs of foreigners, for whom language barriers and inexperience with emergency protocols can lead to panic and confusion during disasters (Sakurai and Adu-Gyamfi 2020). In Iceland, Bird et al (2010) found that tourism companies operating in an area with significant volcanic risk (63.4186°N; 19.0060°W) had not provided emergency training for their employees.

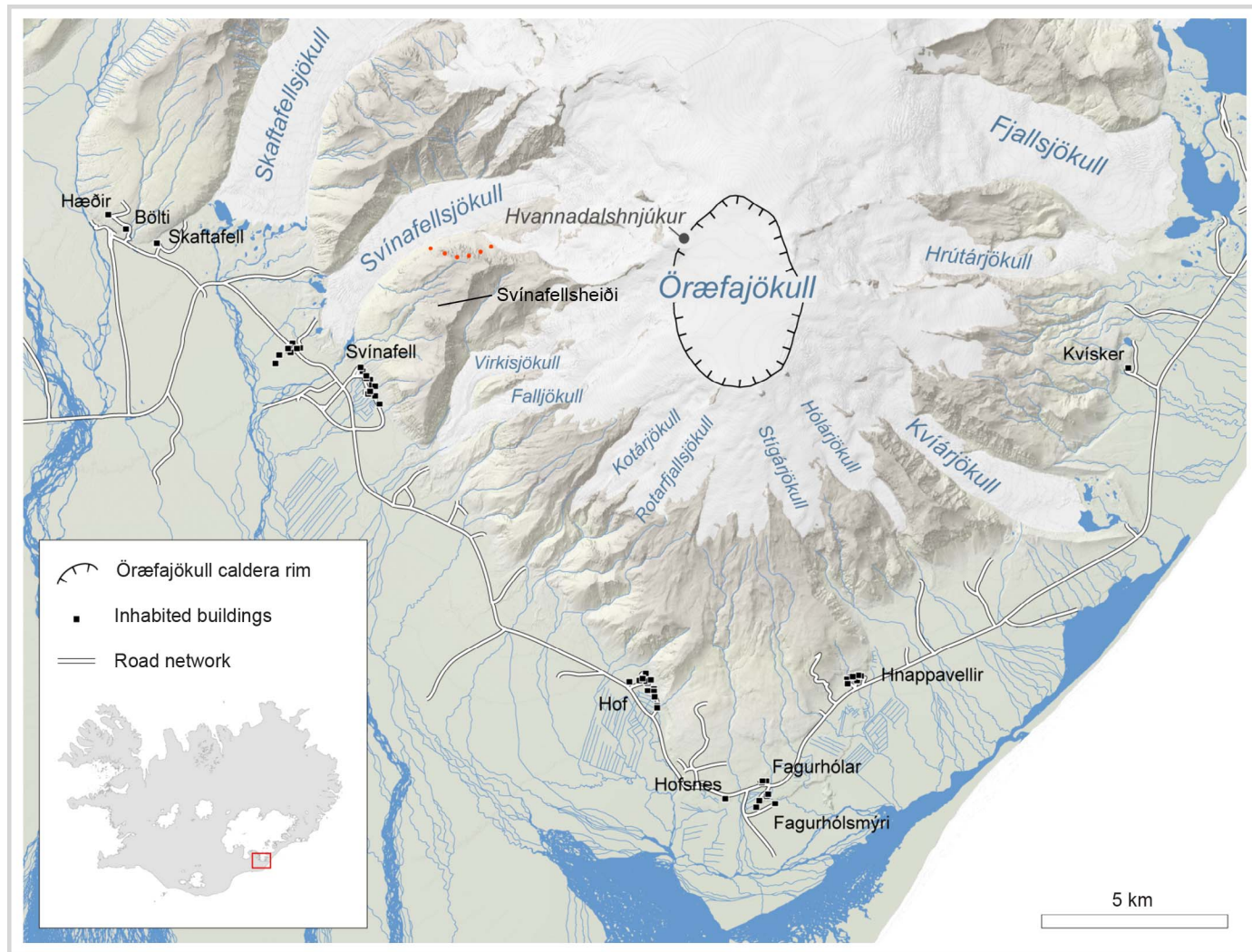
Glacier guides constantly observe and respond to hazards, including steep and slippery terrain, crevasses, rockfalls, extreme weather, and river crossings (Purdie et al 2015). In addition, climate change has made glacier tourism in some regions more dangerous and challenging for both clients and guides (Purdie et al 2015; Salim et al 2021), adding new and large-scale hazards to the existing risks.

Research design

Methodology

This article is based on ethnographic fieldwork conducted in the Öraefi district of Iceland between August 2018 and April 2021 (see Table S1, *Supplemental material*, <https://doi.org/10.1659/MRD-JOURNAL-D-21-00051.1.S1>). Fifty semistructured interviews were conducted with 52 people (25 female; 27 male) identified through purposive sampling. The participants included 14 Icelandic local inhabitants, 9 foreign glacier guides, 9 tourists, 7 foreign inhabitants working in the tourism sector, 3 risk management experts, 3 scientists, 2 municipal government officials, 2 tourism experts, 2 search and rescue coordinators, and 1 park ranger. While some tourism employees in the area were Icelandic, most were foreigners. This research focused on the latter, with comparisons made between tourists and local

FIGURE 2 Location of Öraefi district showing Svínafellsjökull and the approximate location of the fracture in orange. (Adapted from Roberts and Gudmundsson 2015: 18)



inhabitants. While most interviews were conducted with individuals, 5 were conducted with 2 people at the same time, and 1 interview was conducted with 4 people together at their request. Some participants were interviewed twice. All interviews were conducted in English, except 1, which was held in Icelandic, with a translator. The interviews typically took between 60 and 90 minutes and were conducted face to face (47 interviews) or online, due to regulations related to the coronavirus-19 (Covid-19) pandemic (3 interviews).

The core issues covered in the interviews with people living or working in Öraefi included their role in the community, understanding of the hazard, perception of risk information, and involvement in risk management. The questions were open-ended to allow important issues, perceptions, and ideas to be raised and discussed. The interviews were recorded, transcribed, and analyzed using QSR NVivo 12®. The results were analyzed through a bottom-up, inductive approach to allow themes, commonly held views, and connections to emerge from the data (Hammersley and Atkinson 2007: 153). Data coding was initially open to facilitate the identification of themes and categories, but it became increasingly focused over time (Esterberg 2002: 160). In some cases, further interviews were

conducted to shed light on a specific topic or to saturate identified categories (Hammersley and Atkinson 2007: 158). To ensure anonymity, interviewees were broadly categorized and coded as local inhabitants (LI), foreign inhabitants excluding glacier guides (FI), glacier guides (GG), municipal government authorities (MG), scientists (S), risk managers (RM), tourism experts (TE), and tourists (T).

The interview findings were triangulated with data gathered through participant observation conducted during 2 scientific monitoring missions (October 2018 and August 2019), 3 formal public risk briefings (October 2018), and 12 additional study trips to the field site. The first author conducted active research while working as a glacier guide in the community between April and October 2019.

Study site and overview of risk management

Svínafellsjökull is an outlet glacier of Öraefajökull, an ice-covered volcano that extends south from the massive Vatnajökull ice cap, in the Öraefi district of southeast Iceland (Evans 2016: vi; see Figure 2). Between 1890 and 2010, Svínafellsjökull retreated approximately 800 m and decreased in volume by 30% (Hannesdóttir et al 2015: 567). This is part of a global trend of recent decline in glaciers due

to climate change (Hock et al 2019: 8–42). As glaciers retreat, they provide less buttressing support for oversteepened valley flanks, leaving them susceptible to failure (Seneviratne et al 2012: 189; Hock et al 2019: 159).

The fracture in the Svínafellsheiði mountainside is understood to be 1.7 km long (see orange dots in Figure 2 for approximate location) and widening at a rate of up to 1.3 cm per year (Sæmundsson et al 2019). The potential landslide volume is estimated to be from 60 to 100 million cubic meters (Sæmundsson et al 2019). A large landslide resulting from the fracture could fall up to 500 m onto the surface of the glacier, with glacial ice incorporated into the body of material moving downhill. The Icelandic Meteorological Office (IMO) has warned that such a slide may sweep water from the proglacial lake “creating a fast-flowing slurry of rock, ice, water and even air” (IMO 2018). The risk to downhill settlements and infrastructure is predicted to increase over coming decades as the proglacial lake grows (IMO 2020).

Recent decades have seen dramatic changes as the community shifted from a dependence on agriculture to large-scale tourism (Welling and Abegg 2019). The population of Öraefi was reported to be 151 people in 2018 (Statistics Iceland 2019); however, this does not include most non-Icelanders living and working in the area. Until June 2018, Svínafellsjökull was one of the most important sites for glacier tourism activities in the country (Welling et al 2020: 4). Some 37% of tourists who visited the area joined a guided glacier tour, while 76% viewed glaciers at a short distance (Welling et al 2020: 8).

The neighboring hamlet of Freysnes (63.9907°N; 16.8969°W) and the westernmost sections of Svínafell (63.9792°N; 16.8913°W) are potentially at risk from the hazard. Freysnes lies approximately 800 m southwest of the proglacial lake, while Svínafell lies 600 m southeast (see Figure 2). Freysnes consists of 17 buildings, including a hotel, petrol station, cafeteria, search and rescue coordination center, farm, and several houses; it is traversed by the country’s main highway, referred to locally as the Ring Road. In 2018, approximately 80 people lived in Freysnes, including 25 Icelanders and 55 foreigners working in tourism-oriented hospitality jobs (LI.1). Most foreign tourism employees were from central Europe, including the Czech Republic, Hungary, Poland, and Slovakia. People working in these positions were provided with accommodation and lived full-time in Öraefi during the peak season.

In June 2018, before operations shifted to other glaciers, 4 main companies conducted daily commercial glacier walks on Svínafellsjökull. Typically, in peak summer season, an estimated 1000 tourists went on the glacier every day (GG.2). Some 80 to 100 glacier guides and support personnel lived in temporary accommodation in Skaftafell (64.0704°N; 16.9752°W), 6 km northwest of Freysnes. Most glacier guides were from countries with strong mountaineering traditions. While some glacier guides were highly skilled and experienced, most had less than 2 years of glacier guiding experience. Some guides were based in the district permanently, while others worked on shifts of up to 2 weeks. There was a high staff turnover rate among glacier guides, with many only working 1 or 2 seasons.

On an average day in summer 2018, an estimated 1500 people spent time in the area exposed to the Svínafellsheiði

hazard, including 1000 on glacier tours or staying at the hotel, 100 foreign tourism employees, 25 local inhabitants, and 1200 people passing on the road, many of whom also participated in glacier activities (Matti and Ögmundardóttir 2021). The vast majority of people living in the at-risk area were foreign tourism employees. When glacier tours shifted from Svínafellsjökull, they still passed areas exposed to the risk for approximately 15 minutes each way on the road. As a result, the overall number of people exposed to the hazard on an average day remained similar, but the level of risk decreased significantly.

Planning and risk management related to the Svínafellsheiði fracture were coordinated by local police, DCPEM, and Regional Civil Protection Committees, with hazard monitoring conducted by the IMO and University of Iceland. Risk communication activities took the form of emails and risk meetings with local residents, as well as announcements in the media, on government websites, and through the Safe Travel website (www.safetravel.is). Large warning signs were erected on access routes (Figure 3), and information boards were set up at viewpoints. During the first year of this research, businesses pushed back on the idea of displaying information about the fracture at accommodation venues, fearing it would discourage tourists. Boards were later developed and displayed by tourism businesses in collaboration with risk managers.

Risk meetings in Öraefi were conducted with different—often overlapping—audiences. These included closed meetings with members of the community living in the immediate vicinity, meetings of the Regional Civil Protection Committee, and townhall briefings open to the public. In addition, in December 2020, a meeting was held for managers of tourism businesses operating in the area. Table S2 (*Supplemental material*, <https://doi.org/10.1659/MRD-JOURNAL-D-21-00051.1.S1>) lists the public meetings conducted in the area or online (due to Covid-19 restrictions) during the study period. All meetings were conducted in Icelandic (correspondence with risk manager, 8 June 2021).

A large landslide from Svínafellsheiði could fall with little warning (S.2; RM.2). This has complicated emergency protocols, including evacuations. A phone alert system allows DCPEM to send emergency alerts to all mobile phones in a given area (RM.2). However, a risk manager warned that the landslide may have “already collapsed, and when the message arrives, it’s too late” (RM.2). At the time of writing, these messages were only available in Icelandic and English, but a system is being developed to allow translations in up to 10 languages (RM.1). In 2018, there were discussions about setting up a siren system in high-risk areas; however, as of September 2021, no such system had been established. Experience from New Zealand suggests that using sirens as a warning system can “confuse or frighten tourists without providing clear instructions for what to do” (Becken and Hughey 2013: 81). As of early 2021, the emergency protocol was to exit the area either to the east or west by vehicle or to take shelter in Freysnes. With the risk set to escalate in coming decades due to the expansion of the lake, taking shelter in Freysnes will no longer be an option. There was no written response plan available.

FIGURE 3 Large warning signs on access roads to Svínafellsjökull. (Photo by Stephanie Matti)



Results

Focus on Icelandic inhabitants

Foreign tourism employees and tourists represented the vast majority of people exposed to the risk. However, risk managers and scientists initially underestimated the number of people exposed from both groups (GG.5; LI.3; S.5). For example, a guide recalled how a scientist appeared “surprised” during a public briefing in early 2018, when he was informed about the daily number of tourists visiting Svínafellsjökull (GG.5). The guide explained the scientist had estimated there to be “20, 30, or 40 people on the glacier every day,” but the guide clarified that “in the summer there can be hundreds and hundreds of people each day” (GG.5). In an interview, one scientist referred to there being 100 people on the glacier each day, which still drastically underestimated the scale of glacial tourism (S.1). Another interviewee explained that “foreign workers are a group of people that definitely get left out in decisions and information about these kinds of things.” She believed that it was because “people outside the area don’t realize how many people live here” (LI.3).

In later public meetings, more accurate figures were cited; however, the focus on Icelandic inhabitants persisted. In late 2018, a risk manager described the Öraefi district as a “sparsely populated area” (RM.3); while another estimated the people living close by the hotel at “about 10” (RM.2). In both cases, these estimations appeared to only account for Icelandic inhabitants. Foreign tourism employees, who constituted the largest demographic residing in the area, were not included. A scientist reflected that “maybe risk managers should have looked at the demographics of people” in the area before making risk management decisions (S.5). Several interviewees reasoned that the risk management system in Iceland has not adapted to the expansion of the tourism sector over the preceding decade

(GG.2; GG.3; LI.1; S.5). One scientist explained that “it’s a relatively recent phenomenon that foreign workers come here to work in tourism; it started on a larger scale 5 or 6 years ago. I think they are not taken into consideration, not because risk managers don’t want to include them, but because the bureaucracy is lagging behind” (S.5).

The focus on Icelandic local inhabitants was also evident in risk management policies and funding structures. In Iceland, acceptable risk for floods and avalanches is calculated based on time spent in different residential and commercial buildings at risk (IMO 2020; Parliament of Iceland 2000). The applicability of this system to tourists is undermined by the different behavior patterns of tourists. The government had not established a policy on acceptable risk limit for tourists; it was also unclear how risk was evaluated for temporary foreign tourism employees (IMO 2020). Local-level policing remained staffed and funded based on the Iceland population, despite the impact of tourism on the number and diversity of people in the area, leaving police severely understaffed and struggling with an immense workload (RM.2; RM.4). Risk managers acknowledged that procedures should change in light of the influx of tourism, including the review of emergency plans across the country (RM.2).

Understanding risk and emergency protocols

No tourist interviewed was aware of the risk of a large landslide falling onto Svínafellsjökull. Of the 8 tourists interviewed at the Svínafellsjökull viewpoint, only 1 had read the warning signs on the access road, but they had misinterpreted the warning to be about small-scale rockfall (T.1; Figure 3). Another tourist mentioned safety was a top priority during their trip. However, when asked about the warning signs, she had understood them to include “some tourist information, some history information about this

place, and probably some safety warning,” but explained that “we didn’t read them” (T.8). Another tourist intentionally ignored the signs: “Sometimes it better not to know what’s happening around you. . . sometimes you want to cut yourself off” (T.5). A third tourist mentioned that natural hazards were among the experiences that attracted him to the country, and that if there was a risk that he “wouldn’t like to hear about it” (T.6). In identifying risks in the area, tourists focused on the most visible and immediate risks such as slipping on ice, falling into cold water, small-scale rockfall, or weather conditions (T.1; T.7; T.8). During these discussions, a wide range of risk aversity among tourists was evident.

Communicating risk information with tourists in Iceland is complicated by the large number of tourists on short visits to Iceland who have little previous experience with the terrain and hazards of the country. Risk managers drew attention to the low risk knowledge of most tourists visiting Svínafellsjökull and Iceland (RM.1; RM.3). Tourists lacked an understanding of emergency protocols beyond normal instincts to avoid debris and move to higher ground (T.1–T.8), which is not an appropriate response given the massive scale of the hazard and the degree of exposure at the viewpoint. This was unsurprising given the almost total lack of awareness that tourists showed about the potential risk of a large landslide onto the glacier.

A common sentiment expressed by foreign tourism employees and local inhabitants was feeling responsible for the safety of others, including clients, tourists, staff members, and family members. This was particularly pronounced among glacier guides, hotel receptionists, and tourism managers (GG.4; GG.6; GG.8; LI.1; LI.3; LI.6; FI.6). A local inhabitant reflected that “if you have a company, then you’re always responsible for the people who are working for you, and you’re also a bit responsible for your guests” (LI.6). A glacier guide also explained that “I feel like I have responsibility for other people, even if they are not on my tour” (GG.6).

All local inhabitants interviewed had a comprehensive understanding of the fracture and emergency protocols (LI.1–LI.16). Local inhabitants frequently referred to the findings presented in risk briefings and were aware of recent developments (LI.1–LI.16). However, there was some initial disagreement between scientific and local knowledge about what areas would likely be affected (Matti and Ögmundardóttir 2021). One local inhabitant reasoned that floodwaters from the glacier have “always come down these two rivers. . . why would this be any different?” (informal discussion, 24 October 2018). Based on their risk knowledge, some local inhabitants had developed personal response plans (LI.1; LI.12). All local inhabitants were aware that a warning of imminent collapse would come through the DCPEM phone alert system (LI.1–LI.16). Some expressed concerns about poor mobile reception (LI.1; LI.3; LI.13), whether they would wake up to a message sent at night (LI.3), and about how tourists would react to such a message (LI.1).

By comparison, foreign tourism employees varied greatly in their understanding of the risk and how to respond. All those interviewed who had lived in the area for less than a year had heard of the fracture but were aware that they lacked a comprehensive understanding of the risk: “I don’t know very much about this” (FI.2); “I know about the fracture but I don’t know exactly what caused it or what is

BOX 1: Understanding of emergency communication protocols by foreign tourism employees

That’s an interesting question. I don’t know. I think maybe talk with people who know about what is happening there and what you should do, like [national park] rangers. And then do whatever they say.

(FI.2)

Hopefully through a government source, but maybe the search and rescue teams or the park rangers or the police. I feel they should be a little bit more organised. I hope that if they were alerting people that something was happening, they would have a plan in place. I wouldn’t expect a personal communication but a general announcement, maybe over the radio, or the [national park] rangers talking to shift managers and then giving us instructions on how to evacuate people.

(GG.6)

I would probably just hear about it from somebody else. I’m not entirely sure about how that would come to us. Either through the news, national park, or from another guide. I would hope that the company that we work for would be like quick on the uptake and send an email and make sure that everyone was out of the area.

(GG.7)

actually happening” (FI.4). Glacier guides and foreign tourism employees who had lived in the area for longer—especially those present when operations shifted from Svínafellsjökull—tended to have a stronger understanding. However, the knowledge of glacier guides and foreign tourism employees was typically less up-to-date, less evidence based, and less technical than that of local inhabitants (FI.3; FI.5; LI.3). Foreign tourism employees were also unsure of emergency protocols, including communications (Box 1) and response strategies (Box 2). Furthermore, a foreign tourism employee living in an area at risk mentioned that in the case of an emergency “most of us here don’t have a car, so it’s hard for us to go some place” (FI.4).

Glacier guides were aware and actively mitigated risks in the course of their work (GG.1–GG.8). Focus was placed on the type of risks experienced regularly, including crevasses, minor rockfalls, crossing rivers, poor crampon technique, poor weather, and unstable glacial features. Guides regularly engaged in discussion and training drills—especially crevasse rescues—with more experienced guides and management on how to manage these risks. A similar culture has been documented among guides in other adventure tourism activities, including ski touring (Grímsdóttir 2004: 23) and white-water rafting (Morgan and Fluker 2006: 157). However, there was virtually no discussion among guides of the Svínafellsheiði fracture and risk of a large landslide. One glacier guide also noted that his company did not have a record of the names of all tourists going on glacier walks, so in case of a landslide “we could have easily had 200 people buried, we actually wouldn’t even know their names” (GG.3).

Communication channels

Official risk meetings were the main channel by which local inhabitants received information about the Svínafellsheiði fracture and emergency protocols. Several local inhabitants reevaluated their personal response strategies based on advice and updates given at these forums (LI.1; LI.2); this

BOX 2: Understanding of response protocols by foreign tourism employees

I don't think anything has been discussed about what we would do in that situation. As far as I know, nothing has been done about it. No protocols, nothing.

(FI.1)

I would just try to escape by some means I guess if that is what needed to happen. I admit I haven't given it much thought. But yeah I would literally just try to get away. I would try to tell people on the way out what would be the danger zone, I would tell people to come with me.

(GG.4)

I don't know. I want to say that I would yell at everyone to get in whatever bus or car and get out of there as soon as possible. . . I guess if you're driving along you could take a right [south], go through some fences, get as much distance between you and the landslide as possible, head towards the sea. Who knows if that works? That would be the first thing that comes to mind.

(GG.5)

We have the volcano plans, but I don't think we have landslide plans. If we have a landslide that comes down and it blocks the ring road, I don't think we have any plan of what do to.

(GG.7)

I don't imagine you would have much time. It would be like "it's coming, get out of the way." I would help with evacuation efforts because as far as I can tell. . . but I'm not sure actually. I don't know whether we would be affected. I don't know whether our office would be affected. I don't know.

(FI.1)

indicates that information provided was trusted and taken seriously. The main concern about meetings was that they were not conducted according to the pre-arranged time line. For example, in October 2018, people were told that they would receive an update in spring 2019, yet it did not take place until the end of autumn (LI.1). The meetings were typically dialogic and participatory, with information from local inhabitants used to shape emergency protocols and risk management plans (RM.2; RM.4).

While the townhall-style briefings were public, email invitations were sent almost exclusively to Icelanders (email communication, local police, 28 November 2019). All local inhabitants interviewed were aware of the meetings, and most had attended. By comparison, most foreign tourism employees were not aware that the briefings occurred; the few who were aware of the meetings understood them to be conducted "in Icelandic for locals" (FI.6). Some local inhabitants expressed concern about the exclusion of foreign inhabitants from formal risk management processes and communication channels. One woman declared that "it's not good enough that some people are left out . . . I think there's a big information gap between locals and people that are living here as foreigners" (LI.3).

Foreign tourism employees working in hospitality typically received information about the fracture from their employer or other staff members (FI.1; FI.3; FI.5; FI.6). One interviewee accessed information through mainstream media outlets (FI.3). Some employers were proactive in providing information to employees, including one who

maintained that the "more information you can give to the staff is better . . . we try to update them as much as possible" (LI.1). This included in-house meetings and updates on employee-specific social media pages (LI.1). However, some foreign tourism employees had not received any information about the risk from their employer. For example, one woman explained: "I wasn't informed about anything like this when I came here. After some time, I hear something but not officially and not how we should proceed if it happens" (FI.2). Furthermore, when asked if foreign tourism employees would be in direct contact with risk managers, one local business owner responded that they are "probably going to come to us as they don't know where to get information" (LI.6). There was no evidence of information about the fracture being provided to glacier guides by their employers. Instead, developing an understanding of the risk was viewed by guides as something they have to personally "put the time into" (GG.4). Some experienced glacier guides had attended a scientific briefing at the University of Iceland in early 2018 in their free time, but they had not received any subsequent updates (GG.4; GG.6; GG.7).

Risk managers acknowledged that they "relied on locals" to "tell your employees about the hazard" (RM.2). However, at least one local hotel was managed by a foreigner who did not attend the briefings (LI.3), and even the most proactive employers did not update their staff after each briefing (FI.6). The information passed to employees was left to the discretion of employers (R.2; FI.6). There was no evidence of risk managers providing tourism employers with material or support on how to inform their staff or of tourism businesses requesting this information.

Foreign tourism workers typically had very limited interaction with local inhabitants. One interviewee mentioned that "I don't get a chance to talk much with local people, and we have this language barrier" (FI.4). An Icelandic local inhabitant explained that it was a "very split community between the people who have always been here, who speak Icelandic, and then all the young people, who are glacier guides or working at the hotels and don't speak Icelandic" (LI.3). Opportunities for interaction were also affected by job position, with those working in housekeeping understood to have less interaction and access to information than people at reception (FI.3). Risk managers acknowledged that as a foreign worker, "you could come to work in a hotel cleaning the rooms and you will have absolutely no idea about the risk you could be facing" (RM.2). Experienced glacier guides generally had more social capital and more regular contact with local inhabitants, especially locals who had also worked as guides (GG.2; FI.1; FI.3). In recent years, large glacier guiding companies had reduced wages and working conditions, which reduced the hiring of Icelandic staff and led to the emergence of small local operations, both of which eroded opportunities for regular interaction between Icelandic and foreign glacier guides (LI.3).

Tourism operators were concerned about how risk management decisions were made, including the choice to shift operations from Svínafellsjökull. Interviewees felt that risk management and communication would have been conducted differently with a better-established sector of the Icelandic economy. One manager argued that, "if this was somewhere else and there was a fish factory in the way, it would have been dealt with in a very different way . . . but

since it's just a bunch of guides, and they don't understand tourism, they are just like 'yeah just go somewhere else'" (GG.3).

Foreign tourism employees and glacier guides expressed interest in attending public briefings if they were conducted in English. One interviewee explained, "I live here, so it's also about me, of course I would like to go" (FI.6). Another reasoned:

It's important that everyone in the area at risk is informed and knows what they can do and how they can help because, in those sorts of situations, it needs to be all hands on deck. There should be common knowledge among anyone living in the area temporarily or permanently.

An interviewee noted that the tone of the invitation message was important; she recommended that it be pitched as a responsibility to learn how to respond rather than a general conversation about the fracture (FI.1). Another interviewee further stated that if it were not pitched like this, it would not be considered a priority for tourism managers or employees (GG.6). A local inhabitant recommended that for future hazards, a basic written evacuation plan should be provided at the first briefing (LI.1).

Discussion

This study found most tourists visiting the Svínafellsjökull viewing area did not sufficiently understand the risk posed by the fracture or how to respond in the case of a large landslide. Even the one interviewee who had read the sign had misunderstood the warning and vastly underestimated the scale of the hazard. Similar problems of tourists "walking straight past warning signs, taking no notice of the information displayed" were reported at the high-risk Reynisfjara beach in Iceland (Iceland Monitor 2016). Communicating information about the risk of Svínafellsheiði to tourists was complicated because there were many significant risks in the area; it was not a tourist attraction, unlike other hazards such as volcanic eruptions and crevasses; it was not visible to visitors; and it was the first time this type of hazard has been managed in Iceland. Tourists generally understand that volcano sites are potentially dangerous, and they choose how much safety information to seek and precautionary measures to take (Bird and Gísladóttir 2020); by comparison, most tourists were not even aware they were potentially exposed to a large landslide.

In the case of an emergency, most tourists stated they would depend on people living or working in the area to keep them safe. In their study of Bolivian mountaineering, Mackenzie and Kerr (2012) found that the expectation that risks will be managed and safety ensured is more pronounced on guided tours. Our results indicate that, while tourism employees and guides feel responsible for the safety of clients, many are poorly informed about the risk and emergency protocols. This trend is more pronounced among newcomers and those with little social capital in the community. Glacier guides tend to focus on managing risks that they encounter more frequently. This may reflect: the massive scale of the Svínafellsheiði hazard; the feeling that they are unable to personally control or mitigate the hazard; the focus of management and fellow guides on other risks;

and a lack of involvement in official risk communication structures.

Despite significant demographic changes driven by tourism, Icelandic inhabitants remain the primary unit upon which risk management processes are based. In the case of the Svínafellsheiði fracture, this was evident in initial exposure calculations and communication strategies. Official risk communication was oriented toward local inhabitants and, to a lesser degree, tourists. If foreign tourism employees received any information, it was generally in the form of ad hoc and informal communications from their employer. Language and mode of invitation represented significant barriers for foreign tourism employees to attend official briefings. While some studies have examined language as a barrier to effective risk communication, most have focused on how this excludes tourists rather than tourism employees (Erfurt-Cooper 2010: 6, 20).

Risk communication that depends on informal and personal relationships can exclude demographic groups and exacerbate existing power inequalities and vulnerabilities. Foreign tourism employees typically have lower social capital, especially those who do not interact with the public through their work. This is problematic, as research has found that lower social capital and reduced access to risk information lead to more risk-taking behavior in the event of a disaster (Cadag et al 2017; Anderson-Berry et al 2018). Icelandic employers are typically older and more financially stable, while foreign tourism employees are younger and heavily dependent on their employer for salary, accommodation, and sometimes visas. Having foreign tourism employees depend on Icelandic employers for risk information reinforces the social, financial, and workplace power of Icelandic employers. The arrangement can also increase the burden on employers grappling with the risk and how it affects their livelihoods.

Risk communication channels available to foreign tourism employees were generally unidirectional, such as mainstream media, and informal, such as information conveyed by employers. Foreign tourism employees were hindered from developing a direct relationship and building trust with risk managers and scientists; in addition, there was no clear avenue for them to contribute their knowledge to risk management strategies. This increases the chances that emergency protocols do not take into account their particular circumstances, for example, vehicle ownership. Erfurt-Cooper (2010: 15) similarly found that volcanic risk management that focuses on local inhabitants can result in emergency rescue and evacuation systems that do not take into account tourists and other demographics.

Risk communication in the case of Svínafellsheiði was further inhibited by the lack of written emergency procedures. Perry and Lindell (2003: 340) argued that it is not uncommon for risk managers in small communities to depend on "informal, personal relationships for risk identification, assessment and reduction" rather than written protocols. However, the provision of written guidelines in English and other common languages would encourage greater access to information. Research in Japan found that a lack of experience with emergency protocols ahead of time contributes to panic and confusion in the case of a crisis (Sakurai and Adu-Gyamfi 2020). The consequences are compounded as foreign tourism employees are often also responsible for the safety of large numbers of tourists.

This research highlights the need for risk communication and training initiatives that specifically target tourism employees and glacier guides. These should be conducted in English, incorporate simulations/drills, and be based on the understanding that employees will likely have some responsibility for the safety of clients. In Japan, a simulation-based exercise was conducted to train tourism and hospitality staff on keeping tourists calm and communicating risk and evacuation procedures in the event of a volcanic eruption (Suzuki 2020). Given the high staff turnover in Öraefi, we recommend conducting interactive training simulations on a regular basis, for example, every 6 months.

Several crises in guided tourism have raised questions about culpability and criminal negligence. On 27 July 1999, 21 tourists and guides died in a flash flood while canyoning near Interlaken, Switzerland. In the subsequent court case, 6 managers and senior guides were convicted of manslaughter due to culpable negligence for putting profits before safety, ignoring warning signs, and not sufficiently training junior guides to assess flood risk (Morgan and Fluker 2006). On 7 January 2020, 39 tourists were stranded in a severe storm on Langjökull, Iceland's second largest ice cap, on a guided snowmobile trip. More than 200 search and rescue volunteers rescued the tourists, some of whom spent more than 7 hours in the storm. Similar questions were raised—including by the Minister for Tourism—about the decision to run the trip despite a severe weather warning (Ćirić 2020). Both cases underscore the importance of training tourism employees and guides on risk management and safety, communicating risk effectively, and implementing safety protocols.

Our results support calls for an expansion of targeted risk management actions for the tourism sector (Becken and Hughey 2013; Ziegler et al 2021: 13). In their study of the Himalayas, Ziegler et al (2021: 16) suggested that licenses or certificates could be used to demonstrate that guides or tourism workplaces adhere to safety standards. A similar initiative could be explored in Iceland. A further exploration of this goes beyond the scope of this study.

Such initiatives will better position tourism employees and guides to inform tourists of risks faced. Tourists who survived the Whakaari/White Island disaster reported that they received no information about the risk and, as a result, could not make informed decisions about their safety (March et al 2020). We agree with Bird and Gísladóttir's (2020) study, which found that some tourists will continue to ignore warning signs, pursue thrill-seeking behavior, and lack local knowledge, so we must “find other ways to reach them.” It is crucial that tourists are equipped with sufficient knowledge to make decisions about their own safety. Reducing risks and improving the safety of tourists and tourism employees are not only ethical pursuits, but they also are important for long-term business sustainability.

Conclusion

In this conclusion, we explore how the results of this research can help to improve risk communication for the Svínafellsheiði fracture and for hazards in other nature tourism hubs around the world. Some features of the specific context should be taken into account. This research relates

to a large-scale, potentially fatal, sudden-onset hazard, which has a high degree of uncertainty. The lessons are more likely to be applicable to other such hazards, for example, volcanic eruptions, avalanches, flash floods, and landslides. Tourists in Öraefi are exposed to a multitude of potentially fatal hazards that require customized risk management communication and informed decisions and actions. Even risk-averse tourists are likely to focus on more visible, frequent, and well-known hazards to which they are exposed for longer periods. Tailoring risk communication and preparation to tourism employees is more crucial for large-scale but less frequent and less visible hazards. The lessons will be particularly relevant for nature and adventure tourism hubs where large portions of tourism employees face language and cultural barriers when accessing government risk communication (eg the Alps, Japan, and Scandinavia). This case also represents the first time the risk of a large landslide onto a glacier has been managed in Iceland.

The case of the Svínafellsheiði fracture suggests that risk assessment and management processes focused heavily on the scientific basis of risk, while assessments of exposure and vulnerability were built on sweeping and dated assumptions. It should be standard practice in the initial phases of a risk assessment to develop a profile of who is exposed, existing vulnerabilities, and power dynamics within the community, perceived responsibilities in the event of an emergency, and access to evacuation infrastructure. Risk management strategies must expand from the narrow focus on nationals, especially in the context of mass tourism. Semistructured interviews and ethnographic fieldwork represent useful methodological tools for exploring these dynamics.

Authorities in Iceland rely on risk communication rather than access restrictions to ensure tourist safety, as much of the sector is based on experiencing glacial, volcanic, and geothermal landscapes, all of which have inherent risks (Bird and Gísladóttir 2020). Our results call for tailoring risk communication and training to the needs of tourism employees, guides, and tourists, as well as local inhabitants. At a minimum, this should include written emergency protocols, participatory risk briefings, and regular simulation-based training in the main language(s) of operation. This should be part of a broader push for increased dialogue and coordination between tourism operators and risk managers. This requires commitment backed by earmarked resources from the government and tourism operators.

With tourism destinations in glacial and mountainous environments increasingly exposed to hazards due to climate change (Tsai and Chen 2011; Mair et al 2016), ensuring the safety of all people is essential. Important questions for future research include: How can guides and guiding operations adapt efficiently and respond to newly emerging hazards? How can technology be harnessed to tailor risk communication to different audiences? What level of risk understanding is required for informed consent in the context of tourism?

ACKNOWLEDGMENTS

This study was financially supported by Rannsóknasjóður Háskóla Íslands/The Doctoral Grants of The University of Iceland Research Fund [grant number 1010-101343, 2019–2022].

REFERENCES

- Alperti G, Cruz A.** 2019. Investigating tourists' risk information processing. *Annals of Tourism Research* 79:102803.
- Anderson-Berry L, Achilles T, Panchuk S, Mackie B, Canterford S, Leck A, Bird DK.** 2018. Sending a message: How significant events have influenced the warnings landscape in Australia. *International Journal of Disaster Risk Reduction* 30:5–17.
- Barberi F, Davis M, Isaia R, Nave R, Ricci T.** 2008. Volcanic risk perception in the Vesuvius population. *Journal of Volcanology and Geothermal Research* 172(3):244–258.
- Becken S, Hughey K.** 2013. Linking tourism into emergency management structures to enhance disaster risk reduction. *Tourism Management* 36:77–85.
- Bird D, Gísladóttir G.** 2020. Enhancing tourists' safety in volcanic areas: An investigation of risk communication initiatives in Iceland. *International Journal of Disaster Risk Reduction* 50:101896.
- Bird D, Gísladóttir G, Dominey-Howes D.** 2010. Volcanic risk and tourism in southern Iceland: Implications for hazard, risk and emergency response education and training. *Journal of Volcanology and Geothermal Research* 189(1–2):33–48.
- Cadag J, Driedger C, Garcia C, Duncan M, Gaillard JC, Lindsay J, Haynes K.** 2017. Fostering participation of local actors in volcanic disaster risk reduction. In: Fearnley C, Bird D, Haynes K, McGuire W, Jolly G, editors. *Observing the Volcano World: Volcano Crisis Communication*. Advances in Volcanology. Barcelona, Spain: Springer, pp 481–497.
- Cadag J, Gaillard J.** 2012. Integrating knowledge and actions in disaster risk reduction: The contribution of participatory mapping. *Area* 44(1):100–109.
- Carey M, Bury J, Portocarrero C, Haeberli W.** 2012. An integrated socio-environmental framework for glacier hazard management and climate change adaptation: Lessons from Lake 513, Cordillera Blanca, Peru. *Climate Change* 112:733–767.
- Cioccio L, Michael E.** 2007. Hazard or disaster: Tourism management for the inevitable in northeast Victoria. *Tourism Management* 28(1):1–11.
- Ćirić J.** 2020. Mountaineers of Iceland admits mistakes. *Iceland Review*. 9 January 2020. <https://www.icelandreview.com/travel/mountaineers-of-iceland-admits-mistake/>; accessed on 14 December 2020.
- Demeritt D, Nobert S.** 2014. Models of best practice in flood risk communication and management. *Environmental Hazards* 13(4):313–328.
- Erfurt-Cooper P.** 2010. Introduction. In: Erfurt-Cooper P, Cooper M, editors. *Volcano and Geothermal Tourism*. London, United Kingdom: Earthscan, pp 3–34.
- Esterberg K.** 2002. *Qualitative Methods in Social Research*. Boston, MA: McGraw-Hill.
- Evans D.** 2016. *Vatnajökull National Park (South Region): Guide to a Glacial Landscape Legacy*. Reykjavík, Iceland: Prentsmidjan.
- Glaeser D.** 2003. *Crisis Management in the Tourism Industry*. Amsterdam, the Netherlands: Butterworth Heinemann.
- Grímsdóttir, H.** 2004. *Avalanche Risk Management in Back Country Skiing Operations* [Master's thesis]. Vancouver, Canada: University of British Columbia. <https://open.library.ubc.ca/soa/cIRcle/collections/ubctheses/831/items/1.0099777>; accessed 10 December 2021.
- Guðmundsdóttir B.** 2016. *Best Practices in Icelandic Crisis Communication During Volcanic Eruptions: Development of a Tentative Framework* [Master's thesis]. Reykjavík, Iceland: University of Iceland. <https://skemman.is/bitstream/1946/24944/1/160604%20ENR%20thesis%20BNG%20FINAL.pdf>; accessed on 5 June 2021.
- Haldórsson Þórunn, Júlíusdóttir M.** 2020. *Aðstæður erlends starfsfólks í ferðabjónustu: Sjónarhorn stéttarfélag og starfsfólks* [Conditions of foreign staff in tourism: The perspective of trade unions and employees] [in Icelandic]. Akureyri, Iceland: Rannsóknamiðstöð ferðamála. https://www.rmfi.is/static/research/files/rmf_adstaedurerlendstarfsfólks_2020_lokapdf; accessed on 5 June 2021.
- Hammersley M, Atkinson P.** 2007. *Ethnography: Principles in Practice*. London, United Kingdom: Routledge.
- Hannesdóttir H, Björnsson H, Pálsson F, Aðalgeirsdóttir G, Guðmundsson S.** 2015. Changes in the southeast Vatnajökull ice cap Iceland, between ~1890 and 2010. *Cryosphere* 9(2):565–585.
- Hauksson A.** 2019. Íslenskukennslan fær fallelínun [in Icelandic]. <https://www.ruv.is/frett/islenskukennslan-faer-falleinkunn>; accessed on 5 June 2021.
- Haynes K, Barclay J, Pidgeon N.** 2008. The issue of trust and its influence on risk communication during a volcanic crisis. *Bulletin of Volcanology* 70(5):605–621.
- Hock R, Rasul G, Adler C, Cáceres B, Gruber S, Hirabayashi Y, Jackson M, Kääh A, Kang S, Kutuzov S, et al.** 2019. High mountain areas. In: Pörtner H-O, Roberts DC, Masson-Delmotte V, Zhai P, Tignor M, Poloczanska E, Mintenbeck K, Alegria A, Nicolai M, Okem A, et al, editors. *The Ocean and Cryosphere in a Changing Climate: A Special Report of the Intergovernmental Panel on Climate Change*. Geneva, Switzerland: IPCC [Intergovernmental Panel on Climate Change], pp 131–202.
- Hystad P, Keller P.** 2008. Towards a destination tourism disaster management framework: Long-term lessons from a forest fire disaster. *Tourism Management* 29(1):151–162.
- Iceland Monitor.** 2016. Iceland beach danger signs often ignored. *Iceland Monitor*. 26 April 2016. https://icelandmonitor.mbl.is/news/nature_and_travel/2016/04/26/iceland_beach_danger_signs_often_ignored/; accessed on 14 December 2021.
- Icelandic Tourist Board.** 2018. *Foreign Visitor Arrivals By Air and Sea to Iceland 1949–2017*. Reykjavík, Iceland: Icelandic Tourist Board. <https://www.ferdamalastofa.is/static/files/ferdamalastofa/Frettamyndir/2018/mai/foreign-visitors-to-iceland-1949-2017.xls>; accessed on 9 October 2018.
- IMO [Icelandic Meteorological Office].** 2018. Fractures in Svínafellsheiði and a potential rockslide on Svínafellsjökull. *IMO: News*. 22 June 2018. <https://en.vedur.is/about-imo/news/fractures-in-svinafellsheiði-and-a-potential-rockslide-on-svinafellsjokull>; accessed on 9 October 2018.
- IMO [Icelandic Meteorological Office].** 2020. *Hættumat neðan Svínafellsjökull: Fundur með íbúum* [Risk assessment below Svínafellsjökull: Meeting with residents] [in Icelandic]. Reykjavík, Iceland: IMO. <https://www.youtube.com/watch?v=aqGAd9kuW6A>; accessed on 28 November 2021.
- Kaenzig R, Rebetez M, Serquet G.** 2016. Climate change adaptation of the tourism sector in the Bolivian Andes. *Tourism Geographies* 18(2):111–128.
- Kersthoft J, Duijnhoven H, Paton D.** 2017. Flooding in The Netherlands: How people's interpretation of personal, social and institutional resources influence flooding preparedness. *International Journal of Disaster Risk Reduction* 24:52–57. <https://doi.org/10.1016/j.ijdr.2017.05.013>.
- Khan S, Mishra J, Lin K, Doyle E.** 2017. Rethinking communication in risk interpretation and action. *Natural Hazards* 88(3):1709–1726.
- Knafou R.** 2019. Stromboli or Russian roulette tourism. *Via Tourism Review* 16:4829.
- Leonard G, Johnston D, Paton D, Christianson A, Becker J, Keys H.** 2008. Developing effective warning systems: Ongoing research at Ruapehu volcano, New Zealand. *Journal of Volcanology and Geothermal Research* 172(3):199–215.
- Lin K, Khan S, Acosta L, Alaniz R, Olanya D.** 2020. The dynamism of post disaster risk communication: A cross-country synthesis. *International Journal of Disaster Risk Reduction* 48:101556.
- Lindell M, Perry R.** 2004. *Communicating Environmental Risk in Multiethnic Communities*. Thousand Oaks, CA: Sage.
- Mackenzie S, Kerr J.** 2012. A (mis)guided adventure tourism experience. *Journal of Sport & Tourism* 17(2):125–144.
- Mair J, Ritchie B, Walters G.** 2016. Towards a research agenda for post-disaster and post-crisis recovery strategies for tourist destinations: A narrative review. *Current Issues in Tourism* 19(1):1–26.
- March S, McGregor J, Day L.** 2020. Relatives to sue Royal Caribbean Cruise Line over New Zealand volcano tragedy. *Four Corners*. 1 June 2020. <https://www.abc.net.au/news/2020-04-27/new-zealand-white-island-volcano-disaster-four-corners/12150706?nw=0>; accessed on 29 September 2020.
- Matti S, Ögmundardóttir H.** 2021. Local knowledge of emerging hazards: Instability above an Icelandic glacier. *International Journal of Disaster Risk Reduction* 58(1):102187.
- Mirra.** 2019. *Immigrants in Icelandic Tourism: Drive for Growth and Profit*. Reykjavík, Iceland: Mirra. https://mirra.is/wp-content/uploads/2019/12/Executive_Summary_English-021219.pdf; accessed on 5 June 2021.
- Morgan D, Fluker M.** 2006. Risk management for Australian commercial adventure tourism operations. In: Mansfeld Y, Pizam A, editors. *Tourism, Security and Safety*. Oxford, United Kingdom: Elsevier.
- Müller DK, Carson DA, de la Barre S, Granás B, Jóhannesson GT, Øyen G, Rantala O, Saarinen J, Salmela T, Tervo-Kankare K, et al.** 2020. *Arctic Tourism in Times of Change: Dimensions of Urban Tourism*. Copenhagen, Denmark: Nordic Council of Ministers. <https://www.diva-portal.org/smash/get/diva2:1471328/FULLTEXT01.pdf>; accessed on 5 May 2021.
- Nguyen D, Imamura F, Iuchi K.** 2017. Public-private collaboration for disaster risk management: A case study of hotels in Matsushima, Japan. *Tourism Management* 61(3):129–140.
- Parliament of Iceland.** 2000. *Regulation 505/2000 on Hazard Zoning Due to Snow- and Landslides, Classification and Utilization of Hazard Zones, and Preparation of Provisional Hazard Zoning*. Reykjavík, Iceland: Parliament of Iceland. <https://www.government.is/publications/legislation/lex/2018/11/19/Regulation-No-505-2000-on-hazard-zoning-due-to-snow-and-landslides-classification-and-utilisation-of-hazard-zones-and-preparation-of-provisional-hazard-zoning/>; accessed on 3 March 2021.
- Parliament of Iceland.** 2008. *Civil Protection Act No. 82*. Reykjavík, Iceland: Parliament of Iceland. <https://www.government.is/publications/legislation/lex/2017/12/21/Civil-Protection-Act-No.-82-2008/>; accessed on 3 March 2021.
- Paton D.** 2006. *Promoting Household and Community Preparedness for Bushfires: A Review of Issues that Inform the Development and Delivery of Risk Communication Strategies*. Launceston, Tasmania: Bushfire Cooperative Research Centre. https://www.bushfirecrc.com/sites/default/files/managed/resource/risk-communication-summary_w-cover_1.pdf; accessed on 5 June 2021.
- Pelling M.** 2007. Learning from others: The scope and challenges for participatory disaster risk assessment. *Disasters* 31(4):373–385.
- Perry R, Lindell M.** 2003. Preparedness for emergency response: Guidelines for the emergency planning process. *Disasters* 27(4):336–350.
- Plough A, Krinsky S.** 1987. The emergence of risk communication studies: Social and political context. *Science, Technology, & Human Values* 12(3/4):4–10.
- Prideaux B, Laws E, Faulkner B.** 2003. Events in Indonesia: Exploring the limits to formal tourism trends forecasting methods in complex crisis situations. *Tourism Management* 24:475–487.
- Purdie H, Gomez C, Espiner S.** 2015. Glacier recession and rockfall. *New Zealand Journal of Geography* 71:189–202.
- Roberts M, Gudmundsson M.** 2015. Örafajökull Volcano: Geology and historical floods. In: Pagneux E, Gudmundsson M, Karlsdóttir S, Roberts M, editors. *Volcanogenic Floods in Iceland: An Assessment of Hazards and Risks at Örafajökull and on the Markarfjöt Outwash Plain*. Reykjavík, Iceland: Icelandic Meteorological Office (IMO), Institute of Earth Sciences, University of Iceland (IES-UI), National

Commissioner of the Icelandic Police, and Department of Civil Protection and Emergency Management (NCIP-DCPEM).

Sæmundsson P, Helgason JK, Ben-Yehoshua D, Bergsson BH, Ófeigsson B, Magnússon E, Hjartardóttir AR, Drouin V, Belart IMC, Grímsdóttir H, et al. 2019. Risk of major rock slope failure at the Sínafellsheiði mountain, SE Iceland. *Geophysical Research Abstracts* 21:EGU2019-9650. <https://meetingorganizer.copernicus.org/EGU2019/EGU2019-9650.pdf>; accessed on 7 March 2021.

Sakurai M, Adu-Gyamfi B. 2020. Disaster-resilient communication ecosystem in an inclusive society: A case of foreigners in Japan. *International Journal of Disaster Risk Reduction* 51(1):101804.

Salim E, Ravel L, Bourdeau P, Deline P. 2021. Glacier tourism and climate changes: Effects, adaptations, and perspectives in the Alps. *Regional Environmental Change* 21:120.

Seeger M. 2006. Best practices in crisis communication: An expert panel process. *Journal of Applied Communication Research* 34(3):232–244.

Seneviratne SI, Nicholls N, Easterling D, Goodess CM, Kanae S, Kossin J, Luo Y, Marengo J, McInnes K, Rahimi M, et al. 2012. Changes in climate extremes and their impacts on the natural physical environment. In: Field CB, Barros V, Stocker TF, Qin D, Dokken DJ, Ebi KL, Mastrandrea MD, Mach KJ, Plattner G-K, Allen SK, et al, editors. *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC)*. Cambridge, United Kingdom, and New York, NY: Cambridge University Press, pp 109–230.

Skaptadóttir U, Wojtyńska A. 2019. Sveigjanlegur vinnumarkaður og harkvinna innflytjenda á Íslandi [in Icelandic]. *Íslensk þjóðfélagið* [The Icelandic Society] 10(2):14–28.

Stancu A, Ariccio S, De Dominicis S, Cancellieri UG, Petruccioli I, Ilin C, Bonaiuto M. 2020. The better the bond, the better we cope: The effects of place attachment intensity and place attachment styles on the link between perception of risk and emotional and behavioral coping. *International Journal of Disaster Risk Reduction* 51:101771.

Statistics Iceland. 2019. *Population by Postcodes, Sex and Age 1998–2019*. Reykjavík, Iceland: Statistics Iceland. <https://statice.is/>; accessed on 8 May 2018.

Suzuki T. 2020. Disaster information provision for international tourists using an interpreter application. *Sustainable Tourism* 248:103–116.

Tsai C, Chen C. 2011. The establishment of a rapid natural disaster risk assessment model for the tourism industry. *Tourism Management* 32(1):158–171.

Voight B. 1990. The 1985 Nevado del Ruiz volcano catastrophe: Anatomy and retrosppection. *Journal of Volcanology and Geothermal Research* 44(3):349–386.

Watson C, King O. 2018. Everest's thinning glaciers. *Geology Today* 34(1):18–25.

Welling J, Abegg B. 2019. Following the ice: Adaptation processes of glacier tour operators in southeast Iceland. *International Journal of Biometeorology* 65(12):703–715.

Welling J, Árnason Þ, Ólafsdóttir R. 2020. Implications of climate change on nature-based tourism demand: A segmentation analysis of glacier site visitors in southeast Iceland. *Sustainability* 12(5338):1–19.

Wendt M. 2019. "A Good First Job"? Migrant Workers in Icelandic Hotels [Master's thesis]. Reykjavík, Iceland: University of Iceland. <https://skemman.is/bitstream/1946/34487/3/A%20good%20first%20job%3F%20Migrant%20workers%20in%20Icelandic%20hotels.pdf>; accessed on 5 June 2021.

Ziegler AD, Wasson RJ, Sundriyal Y, Srivastava P, Sasges G, Ramchunder SJ, Ong CE, Nepal SK, McAdoo BG, Gillen J, et al. 2021. A call for reducing tourism risk to environmental hazards in the Himalaya. *Environmental Hazards, Published Online First*. <https://doi.org/10.1080/17477891.2021.1984196>.

Supplemental material

TABLE S1 Interviews.

TABLE S2 Risk management meetings in research period.

Found at: <https://doi.org/10.1659/MRD-JOURNAL-D-21-00051.1.S1>