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CERG 2007

"Hazard and risk perception in a popular tourist destination in Iceland – a pilot investigation"

by

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In association with

United Nations University
International Strategy for Disaster Reduction
Schweizerischer Erdbebendienst
Swiss Seismological Service
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Hazard and risk perception in a popular tourist destination in Iceland – a pilot investigation

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Postgraduate Training Course

"Study and Management of Geological Risks"

University of Geneva

Hazard and risk perception in a popular tourist destination in Iceland – a pilot investigation

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Printed in Reykjavik 2008
Photo on front cover: Mountain hut community of Langidalur taken by Deanne Bird

Abstract

Research predicts that a volcanically induced catastrophic jökulhlaup (glacier outburst flood) along the Markarfljót River, south Iceland would reach the tourist destination of Þórsmörk within approximately 2 hours after the start of an eruption of the Katla volcano. Consequently, the Icelandic Civil Protection is developing regional risk mitigation strategies. However, successful risk mitigation not only depends upon a thorough understanding of the physical aspects of the hazard in question but also the social aspects of the community within the hazard zone. Information about a community's knowledge, awareness and perception of hazard and risk gives emergency managers an insight into how the public will respond during a hazardous situation and their level of preparedness. Based on this data appropriate hazard education and communication strategies can be developed. At present, no such data is available for the region of Þórsmörk. Therefore, questionnaire survey instruments were developed for this task. The resultant questionnaires were tested in this pilot investigation in order to determine if they are suitable for each target group and if they generate data which will be useful to the Icelandic Civil Protection for designing appropriate education and communication strategies. Whilst conducting face-to-face survey interviews with tourists and tourism employees located in Þórsmörk some issues arose with respect to question structure and sequence. Recommendations are made to overcome these problems before the questionnaires are used for future research which includes a more robust investigation with a much larger sample group.

Keywords: Questionnaire design, hazard education, risk communication, jökulhlaup hazard, public perception, Katla, Iceland

Acknowledgements

The research was conducted as part of a PhD by Research thesis undertaken as a Cotutelle agreement between Macquarie University and the University of Iceland and the results of which are presented as a final thesis for the CERG postgraduate training course ‘Study and Management of Geological Risks’ at the University of Geneva. Funding was provided during 2006 and 2007 by the Department of Physical Geography and the International Office at Macquarie University, Australia and in 2007 by Landsvirkjun, Iceland. Gratitude is expressed to Reykjavik Excursions, the Icelandic Touring Association and Iceland Excursions for providing accommodation and/or transport to Þórsmörk. Great appreciation is extended to Chris Gregg and Costanza Bonadonna for their guidance and support during the CERG course. Gudrun Gisladottir from the University of Iceland, Dale Dominey-Howes from the University of New South Wales, Damian Gore from Macquarie University, Matthew Roberts from the Icelandic Meteorological Office and Rögnvaldur Ólafsson from the Icelandic Civil Protection are thanked for their helpful comments and suggestions during the research. All participants are thanked for their willingness to participate in the study.

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1 Introduction and aims

Recent studies have identified at least 10 volcanically induced jökulhlaup (glacial outburst floods) from the Katla volcano which have flooded the Markarfljót River to the west of Mýrdalsjökull glacier in south Iceland (Fig. 1; Smith, 2003; Larsen *et al*., 2005; Smith and Haraldsson, 2005). It was therefore deemed necessary by the Icelandic Civil Protection to develop an evacuation plan for the local population surrounding the Markarfljót River (Guðmundsson *et al*., 2005). The channel of the Markarfljót River cuts through a populated farming region with many farms located on a large outwash plain. The original plan, which was tested during a full scale evacuation exercise in March 2006, did not include the tourist industry and most importantly it did not include the popular tourist region of Þórsmörk (Fig. 1), west of Mýrdalsjökull glacier. If the next jökulhlaup were to emanate from the west of Mýrdalsjökull the region of Þórsmörk would be the first affected. Guðmundsson *et al*. (2005) report that a catastrophic jökulhlaup on the Markarfljót River, triggered by an eruption of the Katla volcano (Fig. 1), would produce a flood height across the floodplain in excess of 20 m, reaching Þórsmörk in approximately 2 hours after the start of the eruption.

Successful hazard reduction critically depends on a combination of understanding the hazard processes and consideration of the biophysical environment, socioeconomic conditions and cultural milieu of the society in question (Chester *et al*., 2002). Scientific literature is abundant on the physical attributes of Icelandic jökulhlaup as demonstrated by some recent publications (Tómasson, 1996; Björnsson, 2000, 2002; Björnsson *et al*., 2000; Larsen, 2000; Russell *et al*., 2000; Sturkell *et al*., 2003, 2006; Guðmundsson, 2005; Guðmundsson *et al*., 2005; Larsen *et al*., 2005; Roberts, 2005; Smith and Haraldsson, 2005; Thordarson and Larsen, 2007). However, little research exists on the social aspects of jökulhlaup hazards, whilst none exists for the tourist region of Þórsmörk.

The inclusion of social data such as the public's awareness, knowledge and perception of the hazard and risk in question aids the development of thorough and comprehensive risk mitigation strategies (Hurnen and McClure, 1997; Johnston and Benton, 1998; Gough and Hooper, 2003; Solana and Kilburn, 2003; Brilly and Polic, 2005; Bird *et al*., 2006;

Bird and Dominey-Howes, in press). Appropriate hazard education and risk communication strategies can be developed based on the community's beliefs, needs and expectations rather than just providing hazard information that reflects only the knowledge and expectations of the scientific community (Dominey-Howes and Minos-Minopoulos, 2004; Gregg *et al*., 2004a,b; Hampel, 2006; Alexander, 2007; McIvor and Paton, 2007; Paton, 2007). The issue of communication between scientists, civil authorities and the public can make the difference between a successful response to a threat and an unsuccessful one (Chester *et al*., 2002). However, by providing hazard communication and education campaigns officials must not assume that individuals will adopt self protective behaviour (Rohrmann, 2000; Paton, 2003). Through public perception investigations civil authorities can gain an insight into how the public will respond to an evacuation warning and their level of preparedness (Paton *et al*., 2001; Johnston *et al*., 2005; Gregg *et al*., 2007).

A review of the most recent literature (Bird and Dominey-Howes, in press; Gregg *et al*., 2007; McIvor and Paton, 2007; Paton, 2007) shows that the use of the questionnaire survey instrument is still a popular and fundamental tool for acquiring information about the public's awareness, knowledge and perception of hazards. However, before embarking on such a survey it is crucial to pay particular attention to the development of the questionnaire (McGuirk and O'Neill, 2005). Factors such as question design and format, questionnaire length and output and the inclusion of classification questions need to be considered in order to ensure clarity, simplicity and logic.

The next critical component in the development of the questionnaire is the pilot phase (Parfitt, 2005). This is carried out in order to test for any major defects in the questionnaire before the main study is conducted. It allows the reviewer to assess its intrinsic worth, appropriateness and whether or not it fulfils the aims of the research (McGuirk and O'Neill, 2005).

In order to investigate public perception of jökulhlaup hazard and risk in the Þórsmörk region, a questionnaire survey was designed based on a previous questionnaire designed and tested by Bird and Dominey-Howes (in press). However, modifications were made to the original questionnaire to suit jökulhlaup as the hazard, the regional setting and the groups targeted for this research. Therefore, it was deemed necessary to test the newly developed questionnaires with the target groups.

The aims of this study are to (1) present and discuss the results of the questionnaires; (2) assess the suitability of the questionnaire survey for each target group; and, (3) consider any limitations and based on these, make recommendations to overcome them in future studies. A review of jökulhlaup hazard and risk is provided, as are descriptions of the field study region and history of volcanic eruptions and jökulhlaup. A brief summary of seismic, volcanic and hydrological monitoring in Iceland is given followed by the importance of tourism in Iceland. Before addressing the aims of this study the development of the questionnaire and participant selection criteria will be examined.

2 Jökulhlaup: definition and examples

The Icelandic term jökulhlaup is defined as a sudden burst of meltwater from a glacier which may occur for a period of several minutes to several weeks (Björnsson, 2002). Roberts (2005) describes seven recognised types of jökulhlaup: (1) drainage of an ice-marginal, ice-dammed lake; (2) drainage of a supraglacial lake; (3) volcanically induced jökulhlaup; (4) drainage of a subglacial lake; (5) drainage of an intraglacial cavity; (6) drainage of a moraine dammed lake, including those dammed by ice cored moraines; and, (7) meltwater release during surge termination. Type 1, 3 and 4 are identified as the three main source types in Iceland (Björnsson, 2000). Based on discharge rates, Gudmundsson *et al*. (2005) categorised jökulhlaup into five magnitude classes (Table 1).

Table 1. Categorisation of jökulhlaup floods in Iceland (after Guðmundsson *et al*. 2005).

Category	Discharge ($m^3\ s^{-1}$)
1	<3,000
2	3,000 – 10,000
3	10,000 – 30,000
4 - large	30,000 – 100,000
5 - Catastrophic	>100,000

Jökulhlaup have not only threatened local populations and caused severe property damage in Iceland (Björnsson, 2002) but also in many other regions of the world including Alaska, Austria, France, India, Italy, Norway, Pakistan, Argentina, Peru, and Switzerland (Evans and Clague, 1994). Much of the international literature on jökulhlaup is concerned with the processes of initiation of outburst floods (jökulhlaup) from moraine dammed glacial lakes (Evans and Clague, 1994; Richardson and Reynolds, 2000) and glacier dammed lakes (Anderson *et al*., 2003; Walder and Costa, 1996). An increased risk of jökulhlaup has been linked to global warming in research from Canada (Evans and Clague, 1994); the Himalayas (Richardson and Reynolds, 2000); and, Switzerland (Kääb, 2000). Many of the moraine or ice dammed glacial lakes which are forming in the Himalayas are unstable and therefore pose a significant risk to surrounding communities. Jökulhlaup risk is heightened by an increase in the permanent and transient population located within narrow valleys that lie beneath these lakes (Abraham, 2002).

3 The field study region: Katla and Mýrdalsjökull

Located on the south coast of Iceland, the Katla caldera is entirely covered by the ~ 590 km^2 Mýrdalsjökull icecap (Fig. 1). Extending approximately 80 km in a north easterly direction, the Katla volcanic system consists of a central volcano and an embryonic fissure swarm (Óladóttir *et al.,* in press). Björnsson *et al*. (2000) generated digital elevation maps (DEM) of the bedrock and surface topography of Mýrdalsjökull by interpolating data from radio echo soundings and existing geodetic maps. These maps show that the Katla caldera has a 30 – 35 km diameter base, with rims of 1,300 – 1,380 metres above sea level (m asl) surrounding a 650 – 750 m deep caldera.. Sturkell *et al.* (2003) suggest that Katla has a 5 km wide magma chamber sitting at a shallow depth of 1.5 km beneath sea level or 3 km below the topographical surface of Mýrdalsjökull.

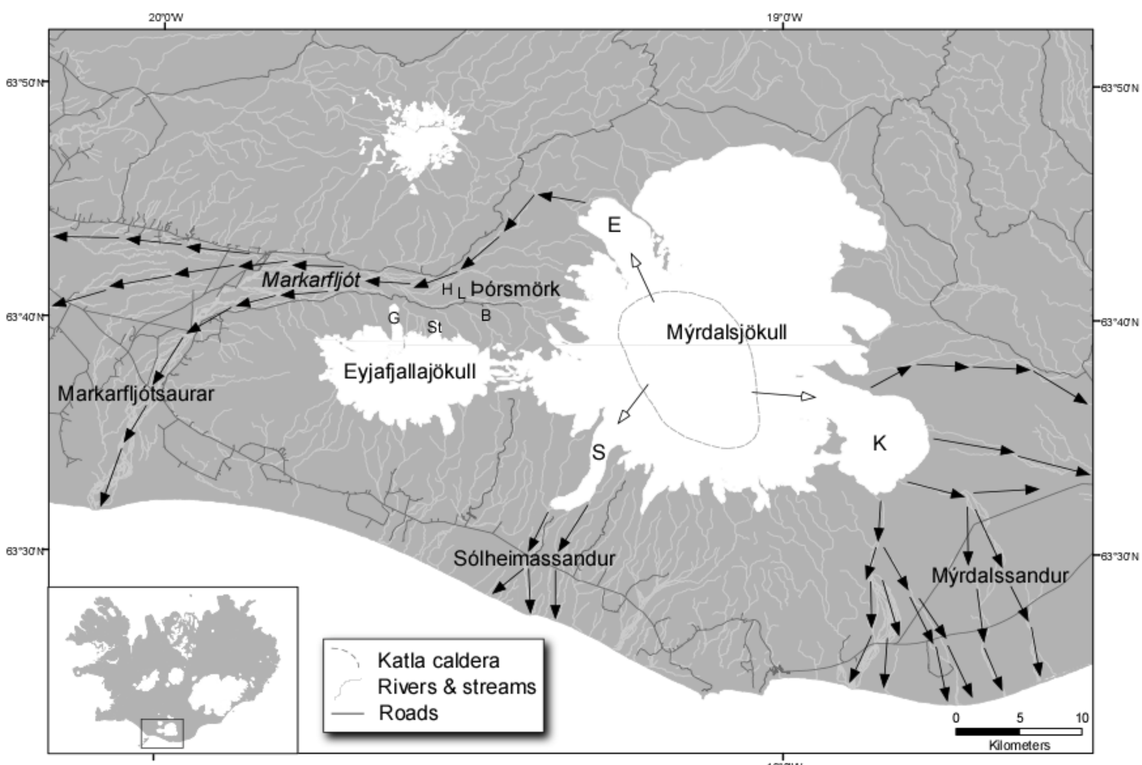

Figure 1. The Mýrdalsjökull icecap atop Katla volcano on the south coast of Iceland. Black arrows indicate principal jökulhlaup flood routes (after Almannavarnir, 2007). White arrows indicate the three subglacial catchment outlets from the caldera:

Kötlujökull (K), Sólheimajökull (S) and Entujökull (E) each contributing water and sand to the outwash plains Mýrdalssandur, Sólheimasandur and Markarfljótsaurar, respectively. The area and volume of each catchment is given in Table 2. Jökulhlaup have emanated from Eyjafjallajökull's outlet glaciers Steinsholtsjökull (St) and Gígjökull (G) in 1967 and 2007, respectively. Three mountain huts communities, Húsadalur (H), Langidalur (L) and Básar (B), are located within the Þórsmörk region.

Table 2. Catchment areas within the Katla caldera (Björnsson *et al*., 2000).

Outwash Plain	Area (km^2)	Volume (km^3)
Sólheimasandur	19	8
Markarfljótsaurar	23	12
Mýrdalssandur	60	28
Total	102	48

4 The volcanic history of Katla and jökulhlaup from Mýrdalsjökull

Katla has been the most productive (Thordarson and Larsen, 2007) and the third most active volcanic system in Iceland since settlement (Larsen, 2000). All but one of Katla's historic eruptions has occurred on fissures within the ice-filled summit caldera (Thordarson and Larsen, 2007). The one exception is referred to as the 934-938 AD Eldjgá flood lava eruption and is undoubtedly the largest eruption in the Katla system. Taking place along a 75 km discontinuous and partly subglacial volcanic fissure, this eruption extended from the Katla caldera northeast to the tip of Vatnajökull icecap (Larsen, 2000).

The historical frequency of Katla eruptions has been recorded at one to three per century with the exception of a ~ 240 year long interval of quiescence following the massive Eldgjá eruption in the 10th Century (Thordarson and Larsen, 2007). Twenty-one known eruptions have occurred during historic times, the last of which occurred in 1918 AD (Table 3). Changes in seismic activity in 1955 AD and 1999 AD were accompanied by small jökulhlaup and subsidence cauldrons formed in the glacial surface above the caldera rim (Sturkell *et al.*, 2003). These jökulhlaup flooded Mýrdalssandur and Sólheimasandur, respectively. Despite no eruption column penetrating the glacial surface, it is believed that these jökulhlaup were produced from minor volcanic activity (Björnsson *et al*., 2000; Russell *et al*., 2000; Guðmundsson, 2005). Russell *et al*. (2000) further suggests that the 1999 AD Sólheimajökull flood may be a precursory indication of a major subglacial eruption from Katla.

All recorded Katla eruptions have produced jökulhlaup (Thordarson and Larsen, 2007) after penetrating ≥ 400 m of ice cover within a matter of hours (Larsen, 2000). A category 5 jökulhlaup, triggered by a Katla eruption, can rapidly melt large volumes of ice and break off massive blocks from the glacier margin. Peak discharge rates of 100,000 – 300,000 m^3s^{-1} may be attained within a few hours, delivering a total volume of 1 – 8 km^3 over 3 – 5 days (Björnsson, 2002).

Table 3. Details of Katla eruptions and jökulhlaup*. Katla – S and Katla – K depict eruption sites within catchment areas of Mýrdalsjökull (see Fig. 1 for catchment locations). Unconfirmed location of eruption is represented in brackets (); unconfirmed eruption year, jökulhlaup route and magnitude of jökulhlaup is represented by a question mark (?) (after Guðmundsson *et al.,* 2005). Data are insufficient pre-1500 AD to develop a complete and accurate record.

Location of Eruption	Eruption Year	Flood (days)	Jökulhlaup Route	Magnitude of Jökulhlaup
(Katla – S)	1999?	-	Sólheimasandur	1
(Katla – K)	1955?	<1	Mýrdalssandur	1
Katla – K	1918	24	Mýrdalssandur	5
Katla – K (S)	1860	20	Mýrdals/Sólheima	4/1?
Katla – K	1823	28	Mýrdalssandur	4
Katla – K	1755	~120	Mýrdalssandur	5
Katla – K	1721	>100	Mýrdalssandur	5
Katla – K	1660	>60	Mýrdalssandur	5
Katla – K	1625	13	Mýrdalssandur	5?
Katla – K	1612		Mýrdalssandur	4?
Katla – K	1580		Mýrdalssandur	4?
Katla – K	1500		Mýrdalssandur	5?
Katla – K	14??		Mýrdalssandur	?
Katla – K	1440		Mýrdalssandur	?
Katla – K	1416		Mýrdalssandur	?
Katla – K	1357		Mýrdalssandur	?
Katla – K	1262		Mýrdalssandur	?
Katla – K	1245		Mýrdalssandur	?
Katla – K	1179		Mýrdalssandur	?
Katla – K	11??		Mýrdalssandur	?
Katla – K,S	934		Mýrdals/Sólheima	5/?
Katla – K	920		Mýrdalssandur?	?
Katla – K	8??		Mýrdalssandur?	?
Katla – S	8??		Sólheimasandur	?
Katla - S	7??		Sólheimasandur	?

*Table 3 shows that all recorded eruptions since settlement have occurred through K and S catchment areas whilst none have emanated from the E catchment. However, geothermal meltwater drains from subglacial lakes as small jökulhlaup through each of the three catchments (Björnsson *et al*., 2000).

With a peak flow estimated at 300,000 m^3s^{-1}, the Katla jökulhlaup on 12 October 1918 is the largest known historic flood caused by volcanism (O'Connor and Costa, 2004). Based on eyewitness accounts, Tómasson (1996) suggests that the 1918 flood attained speeds of 10 m s^{-1} and remained steady for approximately 2 hours. Following this, discharge increased rapidly transporting huge masses of ice 40 – 60 m high (Tómasson, 1996). The ice was released after the flood carved its way through the glacier creating a glacier gorge 1,460 – 1,830 m in length, 366 – 550 m in width, and more than 145 m in height.

The total amount of volcanic material that was transported by the jökulhlaup was approximately 2.5 km^3 with total flood water exceeding 8 km^3. More than half of this water was discharged in the first 8 hours (Tómasson, 1996). The estimated volume of volcanic material that was deposited during the 1918 eruption is provided in Table 4.

Table 4. The approximate quantity of eruptive and flood materials (Tómasson, 1996).

Location	Sediment km^3	Ash km^3	Meltwater km^3
Mýrdalssandur	1.00	0.90	3.15
Kötlutangi	0.40	0.35	1.25
Out at sea	0.35	0.30	1.05
Álftaver	0.05	0.05	0.15
Airborne		0.70	1.75
Pillow lava		0.20	0.70
TOTAL	1.80	2.50	8.05

Spatial and temporal locations of prehistoric jökulhlaup were determined by Larsen *et al.* (2005) through a combination of core sample data and field studies within the Markarfljót valley. This analysis identified jökulhlaup flows from west Mýrdalsjökull some 7,900, 7,500, 6,600, 6,100, 4,400, 3,500, 2,000 and 1,600 years B.P. However, more recent work conducted by Smith and Haraldson (2006) has determined that the last volcanic jökulhlaup on the Markarfljót occurred 1,200 yrs B.P.

Although the most catastrophic jökulhlaup are volcanically induced, other jökulhlaup have flooded the Markarfljót. In 1967 AD, a rock/ice avalanche caused an outburst flood from the proglacial lake of Steinsholtsjökull on the northern flank of Eyjafjallajökull (see Fig. 1). This flood transported boulders measuring up to 80 m^3 5 km from the rockslide scar (Kjartansson, 1967). More recently, a small, short-lived flood was created by ice collapse from the Gígjökull terminus into its moraine-dammed lake. On 30 August 2007 the Gígjökull gauging station, which monitors the water level in the outlet stream from the proglacial lake, recorded an increase up to 151 cm as compared to the morning level of 90 cm (Vatnamælingar, 2007), suggesting a jökulhlaup occurred.

5 Seismic, volcanic and hydrological monitoring in Iceland

Veðurstofa, the Icelandic Meteorological Office (IMO), monitors seismic and volcanic activity across Iceland through a nationwide digital network of more than 50 seismic stations. Known as the South Iceland Lowland (SIL) seismic network, this system is operated in conjunction with six volumetric borehole strain meters and 16 continuous GPS stations, with an additional three continuous GPS stations maintained by the National Land Survey of Iceland (NLSI) (Vogfjörd *et al.*, 2005). Currently, installation of 25 – 30 new continuous GPS stations is underway. These stations will record seismicity and uplift in active areas in addition to high-rate GPS monitoring of the three most active volcanoes; Katla, Hekla and Grímsvötn (Geirsson *et al.*, 2006).

IMO provides up-to-date hazard information through the IMO website (www.vedur.is) and the Skjálftavefsjá website (drifandi.vedur.is/skjalftavefsja/index.html). Skjálftavefsjá was developed by IMO for displaying near-real-time seismic data from the SIL seismic network. Using the acronym EWIS: Early Warning and Information System, the goal of the website is to provide a portal from which the public and scientific community can access the latest seismic information (Bird *et al*., in press). Other general information on hazard preparedness strategies and risk mitigation procedures can be accessed through the Almannavarnir (the Icelandic Civil Protection) website (www.almannavarnir.is).

In addition to monitoring seismic and volcanic activity as precursors to jökulhlaup initiation, IMO monitors real-time data from water level gauges and electrical conductivity meters, which are operated by the Hydrological Service Division at Orkustofnun – the Icelandic National Energy Authority (Vogfjörd et al., 2005). Orkustofnun has 190 hydrological monitoring stations throughout Iceland, 30 of which are real-time stations (Orkustofnun, 2004). Driven by solar or wind energy, each real-time station consists of a data logger, mobile and modem with sensors to detect the level, discharge rate, electrical conductivity, temperature, and chemistry of water. Expected water levels and electrical conductivities, defined by Orkustofnun engineers, are programmed into the data loggers (Orkustofnun, 2000). Authorities are immediately notified if these levels are breached.

6 Tourism in Iceland and Þórsmörk

Tourism is an increasingly important industry in Iceland. During 2006, 398,625 foreigners passed through the international airport surpassing the resident population of 307,672 (Statistics Iceland, 2007). The seasonal variability of tourism is obvious when examining airport statistics – Keflavik International airport registered 66,872 foreign passengers in July 2006 compared to 19,769 in December the same year (Statistics Iceland, 2007).

The spectacular scenery of Þórsmörk, situated west of Mýrdalsjökull (see Fig. 1), attracts many tourists each year. Despite a decrease in local tourists since 1998, overnight stays by international tourists have increased (Fig. 2). Three mountain hut communities, Básar, Húsadalur and Langidalur (see Fig.1), provide sleeping-bag accommodation and camping facilities in the region. Mountain hut wardens manage these accommodation facilities during the summer months and they provide tourist with information about the local environment. A local bus serviced each of these communities everyday from the 1st June to the 15th September during 2006. Many tour operators access this area offering day tours, overnight stays and multiple day hiking tours.

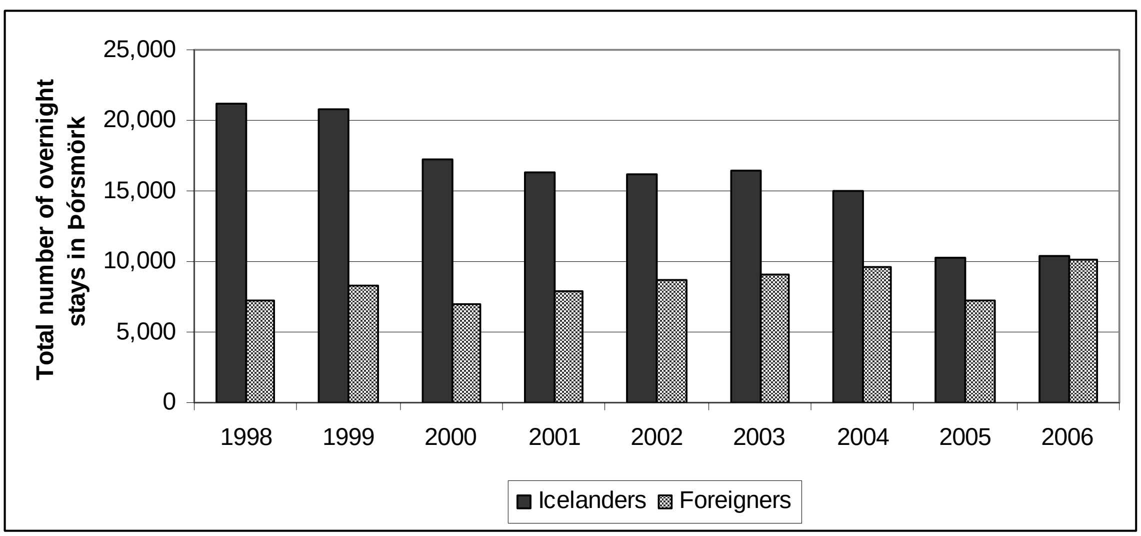

Figure 2. The total number of overnight stays by local and international tourists in Þórsmörk from 1998 to 2006. Information supplied by Statistics Iceland.

7 Developing and conducting the questionnaire survey

Many techniques are available for investigating public perception of natural hazards. The questionnaire survey instrument was chosen for this research. In order to determine whether or not the techniques applied for the development and implementation of the questionnaire deliver appropriate and useful data, a pilot investigation should be conducted. The techniques applied during the development and implementation of the questionnaire for assessing public perception of jökulhlaup hazard and risk in Þórsmörk are discussed here. Details on participant selection and the interview process follow.

7.1 The questionnaire

The design and format of the questionnaire was based on a previous questionnaire developed and tested by Bird and Dominey-Howes (in press). However, some questions were added whilst others were adjusted or removed from the original questionnaires in order to suit the regional setting and jökulhlaup hazards. Further variations arose as the questionnaire developed and therefore it was concluded that two separate surveys should be drafted to suit each target group within the tourism industry, i.e. tourists and tourism employees.

As per the original questionnaires, demographic data such as participant age and level of education were asked in the first section of each questionnaire. Additionally, country of residency was also included since the survey was aimed at both local and international tourists and tourism employees. A series of questions were integrated for both groups to assess the participants' self protective behaviour, their knowledge and awareness of Katla and jökulhlaup hazards, their perception of jökulhlaup hazards in the Markarfljót region and their knowledge and perception of evacuation procedures. In order to be counted as correct participants needed to give the approximate regularity of eruptions in Katla and the year of the last eruption. Their definition of jökulhlaup was counted as correct if the participant mentioned something about flood waters from a glacier. Additional questions were incorporated for the tourist group to gather information on their length of stay and purpose for visiting Þórsmörk. Extra questions in the tourism employees group collected data on company training, group characteristics and guiding techniques.

Another component of questionnaire development is determining the most appropriate mode of delivery. A general description of various modes is given in Table 5. Due to the length of the questionnaire a face-to-face delivery method was chosen to be the most appropriate. Other researchers (such as Solana and Kilburn, 2003) have preferred to distribute the questionnaire, either by mail or through local authorities, for collection at a later date in order to prevent (1) the participant feeling uncomfortable in front of the interviewer, and (2) natural pressure felt by the participant in giving a 'correct' response. However, honest answers and opinions were sought for this survey and therefore the face-to-face mode was deemed to be the most appropriate as it prevented the participant from taking time to study or research the 'correct' answers.

Favouring the face-to-face delivery mode is the fact that errors and misunderstanding of questions can be corrected during the interview process. Solana and Kilburn (2003) found with their questionnaire surveys, which were completed without an interviewer present, that participants did not fully comprehend the instructions for some questions. This can be avoided through the presence of an interviewer as it allows the participant to seek clarification when necessary. Furthermore, the interviewer may offer assistance if they perceive, through body language or an irrelevant response, that the participant does not understand a question. This is a critical factor during the pilot phase as the researcher can assess if a certain aspect of the questionnaire needs to be changed before the main survey is conducted.

Table 5. Common modes of questionnaire distribution: their strengths and weaknesses (Bird and Dominey-Howes, in press)

Mode of Distribution	Strengths	Weaknesses	References
Mail	• Cost effective • Greater coverage area • Anonymity • Time to consider responses • Interviewer cannot shape questions	• Limited length • Limited complexity i.e. questions must be brief and self-explanatory • No control who completes the survey • Interviewer cannot shape questions • Response rates can be poor • Difficult to check non-response biases	de Vaus (1995, p. 113); Fehily and Johns (2004); McGuirk and O'Neill (2005); Parfitt (2005);
Email	• Cost effective especially for the use of colour graphics without associated printing costs • Time to consider responses • More complex questions therefore more complex qualitative data • Strong response rate	• Distribution shaped by age, class and gender biases that shape computer use and email patronage • Interviewer cannot shape questions	Cecić and Musson (2004); McGuirk and O'Neill (2005); Parfitt (2005);
Telephone	• Cost effective when compared to face-to-face • More anonymity than face-to-face interviews • Encourage participation • Less threatening than face-to-face • Can motivate participants • Questions can be clarified • Question sequenced controlled • Longer verbal responses compared to written • Vague responses can be probed	• Time consuming therefore questionnaire length may be constrained • Question format must be kept simple • Number of response categories in closed questions limited • May create class or gender bias amongst participants • Tele surveys are becoming very unpopular in society	de Vaus (1995, p. 113); Cecić and Musson (2004); McGuirk and O'Neill (2005); Parfitt (2005);
Face-to-face	• Complex questions can be asked • Can motivate participants • Longer verbal responses compared to written • Questions can be clarified • Question sequenced controlled • Vague responses can be probed • Visual prompts can be used • Long questionnaires sustained • High response rates	• Costly • Time consuming • Spatially restricted • Answers may be filtered or censored • Interviewer's presence may affect responses	de Vaus (1995, p. 113); Fehily and Johns (2004); McGuirk and O'Neill (2005); Parfitt (2005)

7.2 Selection of participants and the interview process

All participants were selected through a purposive 'snow-ball' sampling technique where potential participants working or staying in the Þórsmörk region were directly approached. These participants were targeted as it was expected that they had an interest in the region and/or hazard. After confirming their willingness to participate an appropriate time was scheduled for the interview. Before conducting the questionnaire survey each participant was required to read a letter which explained the purpose of the survey, the content of the questionnaire and the requirements and obligations of the participant. All participants were informed that they could withdraw from the survey at any time, without consequence and that no participant would be identified through publication of the results. Their approval of these conditions and consent to conduct the interview was indicated by their signature on this letter.

In order to determine the usefulness and suitability of the designed questionnaire the pilot survey should be conducted with approximately 20 participants (Parfitt, 2005). Twenty-four participants in the tourist group and 16 participants in the tourism employees group were recruited for this investigation. During the pilot phase many aspects of the questionnaire were considered. A comprehensive list of these aspects and descriptions are offered in Table 6.

All interviews were conducted during August and September 2006. Participants were either visiting or working in the mountain hut communities of Básar, Langidalur and Húsadalur. All participants were aged 18 years and over and all interviews were conducted in English. Data analysis was carried out using *SPSS® 15.0* (Statistical Package for Social Science).

Despite the small sample size and the nature of this pilot investigation, the resulting data is presented as the findings do provide valuable information for the Icelandic Civil Protection in relation to evacuation planning and hazard education. Additionally, details of the questionnaire design and interview process will be included because any problems highlighted within this pilot investigation should be addressed before a more robust investigation is conducted with a larger sample size.

Table 6. Aspects of a questionnaire that should be considered during the pilot investigation (Bird and Dominey-Howes, in press)

Aspect	Description	Reference
Question design and format	▪ Were the questions understood by the participants? ▪ Do any questions need rewording? ▪ Should any questions be omitted from the survey? ▪ Were the questions sequenced in an appropriate manner? ▪ Did any questions require the use of prompts?	Campbell and Machin (2000); Kitchin and Tate (2000); Collins (2003); Punch (2003); Fehily and Johns (2004); McGuirk and O'Neill (2005); Parfitt (2005);
Questionnaire length	▪ How long did the interviews take? ▪ Was the length appropriate for the participants?	Kitchin and Tate (2000); Collins (2003); Punch (2003); Fehily and Johns (2004); McGuirk and O'Neill (2005); Parfitt (2005)
Questionnaire output	▪ Was the data recorded in an appropriate format for analysis? ▪ Was the coding scheme appropriate for multiple responses?	Campbell and Machin (2000); Kitchin and Tate (2000); Collins (2003); Fehily and Johns (2004); McGuirk and O'Neill (2005); Parfitt (2005).
Classification questions	▪ Were any problems encountered with the classification questions? ▪ Is the classification data necessary for the analysis?	Altman (1991); Kitchin and Tate (2000); Parfitt (2005).
Aims of the survey	▪ Did the questionnaire fulfil the aims of the investigation?	Kitchin and Tate (2000); Collins (2003); McGuirk and O'Neill (2005)

8 Participant responses and the usefulness and suitability of the questionnaire

There are significant differences between the tourist group and the tourism employee group questionnaires. Therefore the results of each will be presented separately. Each section comprises of key characteristics of the participants together with their responses to specific survey questions. The results are presented in the same sequence as they were asked in each questionnaire. Problems that arose during the interview process, such as questionnaire design and format, will also be presented. A summary of key characteristics and participant responses to specific survey questions for the tourist group and the tourism employee group are given in Table 7 and 8 respectively.

8.1 The tourist group

The participants were asked a series of classification questions in order to determine their personal characteristics. Participants came from varying international backgrounds such as the Netherlands, United States of America, Germany, the United Kingdom and Iceland. The majority (84%) of participants were under the age of 50 with more than half (57.5%) having achieved a Bachelor degree or higher (Table 7).

Table 7. A summary of some key characteristics and specific survey questions for the tourist group. All data are given as a percentage. *Please note – some sections do not equal 100% due to rounding*

<table>
<tr><th colspan="6">Age</th></tr>
<tr><td colspan="2">18 – 30 years old</td><td colspan="2">31 – 50 years old</td><td colspan="2">51+ years old</td></tr>
<tr><td colspan="2">42</td><td colspan="2">42</td><td colspan="2">17</td></tr>
<tr><th colspan="6">What is the highest level of education you have completed?</th></tr>
<tr><td>Some schooling</td><td>Educated from 6 to 16 years</td><td>Special Education</td><td>Undergraduate degree</td><td>University Bachelors degree</td><td>Postgraduate qualification</td></tr>
<tr><td>0</td><td>8</td><td>12.5</td><td>17</td><td>25</td><td>37.5</td></tr>
<tr><th colspan="4">Question</th><th colspan="2">Response</th></tr>
<tr><td colspan="4">Are you travelling with a guide whilst in this region?</td><td>Yes
25</td><td>No
75</td></tr>
<tr><td colspan="4">Are friends/family (or anyone else) aware of your exact location whilst you are travelling?</td><td>Yes
83</td><td>No
17</td></tr>
<tr><td colspan="4">Do you have your GSM (mobile phone) with you whilst travelling in this region?</td><td>Yes
75</td><td>No
25</td></tr>
</table>

Do you carry a satellite phone or another form of communication device with you when travelling in this region?	Yes 4	No 96	
Have you followed discussions in the media about natural hazards connected to a Katla eruption?	Yes 25	No 75	
Did you know that Iceland is a volcanically active island?	Yes 100	No 0	
Have you heard of Katla?	Yes 42	No 58	
Have you heard of the Icelandic term jökulhlaup?	Yes 50	No 50	
Do you think the Markarfljót could be affected by a jökulhlaup?	Yes 100	No 0	
Do you know whether a jökulhlaup warning system exists for the Markarfljót region?	Yes 21	No 8	Don't know 71
If you answered no or don't know do you think the Markarfljót region needs an early warning system?	Yes 95	No 0	Depends 5
Do you think they (the Icelandic Civil Protection) should practice evacuations in this region?	Yes 71	No 29	
If yes, how often?			
• Once every 6 months	12		
• Once every year	35		
• Once every two years	18		
• Once every five years	18		
• Don't know	18		
Do you think they (the Icelandic Civil Protection) should include tourists in these evacuation exercises?	Yes 9	No 91	
Would you take part if there was an evacuation exercise whilst you were travelling in this region?	Yes 63	No 29	Depends 8

Behavioural questions were then asked to determine why they were visiting the area and for how long. The most popular reason for visiting Þórsmörk was for hiking (33%). Other reasons given were volunteer work (21%) and for nature (17%). Most people (71%) were spending up to 2 days in the region but the volunteer workers were spending 2 weeks or more. These volunteer workers were included in the tourist group as they came from international backgrounds and were only staying in Iceland for a relatively short period, i.e. less than a month.

Information was gathered about whether or not the participants were travelling with a guide and if so, if the guide gave them information about natural hazards. Seventy-five percent of participants were not travelling with a guide. Of the 25% of participants that were, all stated that the guide was with them at all times and almost all of them stated that the guide had informed them of natural hazards that may affect the region. It was also judged important to determine whether or not people travelled with a GSM or satellite phone, especially if they were travelling without a guide, and if they informed anyone of their exact location whilst in this region. Thirty-three percent of participants who said that they were not travelling with a guide also did not have a GSM with them nor were they carrying a satellite phone or other emergency communication device. The majority (83%) of those participants who were not travelling with a guide had informed their family/friends of their location. Overall, all participant were either travelling with a guide, had some form of communication device or someone was aware of their exact location in this region.

Another series of behavioural questions followed in order to determine whether or not participants had actively sought personal safety measures or hazard information prior to travelling in this region. A variety of comments were given relating to personal safety precautions such as *took the bus instead of driving, booked with a tour company and they are responsible for my safety, I have travel insurance, appropriate clothing, I listened to the guide's instructions and stayed with the group, I carry first aid packages, all weather gear and have good walking shoes* and *travelling with a relative from Iceland.* Another common reply was that they were registered with the mountain huts. Only 4% of participants had accessed the Icelandic Civil Protection website prior to travelling in this region whilst 12.5% had used the Skjálftavefsjá and IMO websites at some point in time. A further 25% of participants stated that they had followed discussions in the media about natural hazards connected to a Katla eruption. The various forms of media used were newspapers, radio, books and the internet.

A general knowledge question on volcanic activity in Iceland was asked before more detailed questions about Katla and jökulhlaup. All participants knew that Iceland is volcanically active, 42% stated that they had heard of Katla and 50% stated that they had heard of jökulhlaup. After explaining Katla and jökulhlaup to those participants who were unaware, details were then sought about the group's perception of jökulhlaup in this region. All participants think that the Markarfljót could be affected by a jökulhlaup and if one was to occur 29% think that the effect on agriculture will be the greatest regional impact whilst 21% think death and injury of people and a further 21% think transport.

Participants were then asked questions regarding jökulhlaup warning systems for the Markarfljót. Twenty-one percent said 'yes' that there is a warning system for the Markarfljót region, 8% said 'no' a warning system does not exist and 71% said 'don't know' if there was a warning system. Of those participants who stated 'no' or 'don't know', 95% said that yes they think the Markarfljót needs an early warning system. The other 5% said that it depends and explained this answer by stating that *it depends on the scientific research monitoring the activity of the volcano*.

It is very important for the civil protection to know how people will respond during volcanic crises. Therefore, the participants were asked what they would do if they had suspected there was an eruption in Katla, i.e. how they would find out if they had to evacuate. The most popular response (54%) was the wardens whilst 25% said the guide and 21% said call the emergency number 112. It is interesting to note that the initial response from two United States participants was *call 911*.

Participants were asked to define the most serious hazard process associated with a Katla eruption. They were given the options of jökulhlaup, ice blocks, lightning, tephra, poisonous gases, lava, tsunami and earthquake and were told that they could chose more than one option and if so, rank them in order of the most serious in their opinion. Jökulhlaup was ranked the most serious hazard by 71% of participants. The second was tephra (35%) whilst 21% of participants ranked lava as second. If the participant opted to rank two options then both responses were treated as the same level of risk accordingly. For example, one participant ranked both jökulhlaup and ice blocks as the greatest risk as they believed they were synonymous. Another example occurred with tephra and lava whereby the participant believed both these hazards were of equal threat to the area.

Finally, participants were asked a series of questions about evacuation exercises. Seventy-one percent of tourists believe that the Icelandic Civil Protection should practice evacuation exercises in this region and 35% (the highest result) believe that they should be done once a year. An overwhelming majority (91%) said that they should not include tourists in these evacuation exercises although 63% stated that they would agree to take part if there was an exercise whilst they were travelling in this region. The 8% of participants who stated their participation in any future evacuation exercise 'depends' justified their answer with *if I was out hiking I would not like to lose 2 days* and *it depends on how big it was – if it was for just an hour or two then OK but I would not participate if it was longer*.

8.2 The tourism employees group

The tourism employees group were asked the same classification questions as the tourist group in order to ascertain their personal characteristics. Most participants (88%) in this group are permanent residents of Iceland. Although not local, the remaining participants have been travelling to Iceland for many years; the longest period for guiding tours was 14 years. The majority (56%) of participants were in the age group 18 – 30 years, whilst 38% were 31 – 50 years and only 6% were 51+ years (Table 8). All participants have completed some schooling with 44% having achieved a Bachelor degree or higher. A further 25% were taking their undergraduate degree.

Table 8. A summary of some key characteristics and specific survey questions for the tourism employees group. All data are given as a percentage. *Please note – some sections do not equal 100% due to rounding*

<table>
<tr><th colspan="6">Age</th></tr>
<tr><td colspan="2">18 – 30 years old</td><td colspan="2">31 – 50 years old</td><td colspan="2">51+ years old</td></tr>
<tr><td colspan="2">56</td><td colspan="2">38</td><td colspan="2">6</td></tr>
<tr><th colspan="6">What is the highest level of education you have completed?</th></tr>
<tr><td>Some schooling</td><td>Educated from 6 to 16 years</td><td>Special Education</td><td>Undergraduate degree</td><td>University Bachelors degree</td><td>Postgraduate qualification</td></tr>
<tr><td>6</td><td>6</td><td>19</td><td>25</td><td>25</td><td>19</td></tr>
</table>

<table>
<tr><th>Question</th><th colspan="3">Response</th></tr>
<tr><td>Does your company hold regular emergency training in relation to natural hazards associated with the regions where you work?</td><td>Yes
6</td><td>No
88</td><td>Don’t know
6</td></tr>
<tr><td>How often do you take tourists to the region around the Markarfljót?
• Everyday
• Several times per week
• Once a week
• Once every few months
• Twice a season</td><td colspan="3">Summer
56
25
6
6
6</td></tr>
<tr><td>Do you inform your tourists that Iceland is volcanically active and is subject to natural hazards?</td><td>Yes
44</td><td>No
50</td><td>Not Applicable
6</td></tr>
<tr><td>Do you inform your tourists about natural hazards associated with Katla and Mýrdalsjökull?</td><td>Yes
44</td><td>No
50</td><td>Not Applicable
6</td></tr>
<tr><td>Can you tell me a brief eruptive history of Katla?</td><td>Correct
50</td><td>Incorrect
12.5</td><td>Don’t know
37.5</td></tr>
<tr><td>How would you define jökulhlaup?</td><td>Correct
94</td><td>Incorrect
0</td><td>Don’t know
6</td></tr>
<tr><td>Do you think the Markarfljót could be affected by a jökulhlaup?</td><td>Yes
100</td><td colspan="2">No
0</td></tr>
<tr><td>Do you know whether a jökulhlaup warning system exists for the Markarfljót region?

If you answered no or don’t know do you think the Markarfljót region needs an early warning system?</td><td>Yes
63

Yes
100</td><td>No
6

No
0</td><td>Don’t know
31

Don’t know
0</td></tr>
<tr><td>Are you aware of the emergency procedures you need to follow if a jökulhlaup warning is issued?</td><td>Yes
12.5</td><td colspan="2">No
87.5</td></tr>
<tr><td>Do you have your GSM (mobile phone) with you whilst travelling in this region?</td><td>Yes
81</td><td colspan="2">No
19</td></tr>
<tr><td>Do you carry a satellite phone or another form of communication device with you when travelling in this region?</td><td>Yes
87.5</td><td colspan="2">No
12.5</td></tr>
<tr><td>Do you think they (the Icelandic Civil Protection) should practice evacuations in this region?

If yes, how often?
• Once every year
• Once every two years
• Once every five years
• Don’t know
• Other,
o Twice a summer
o 4 times per year</td><td>Yes
71

38.5
15
23
8

8
8</td><td colspan="2">No
29</td></tr>
</table>

The participants were then asked a series of questions relating to the characteristics of their company and tourist groups. Eighty-eight percent of participants stated that their company does not hold emergency training in relation to natural hazards, 6% said ‘yes’ theirs did whilst the remaining 6% were not sure. The length of time that hut wardens and tour guides stay in Þórsmörk is variable. Some wardens spend the whole summer in Húsadalur working 10 days on and 5 days off whilst others in Básar work continuously for just a 2 week period and many of the wardens were experiencing their first or second season in Þórsmörk. Some tour guides included in the analysis were taking hiking tours from 15 – 21 days during the summer. Winter tours are generally day trips to the region although one guide takes a 10 day tour once per winter season. All long tours in summer and winter usually spend a few nights in the Þórsmörk region. Tourist group sizes averaged from 4 persons for super jeep tours and up to 14 for hiking tours, 22 for rafting tours and 25 for bus tours. All guides stated that they are with the tourists the whole time during the tour. Hut wardens do not typically conduct guided tours and tourists staying in the huts are free to take the hiking paths at their own leisure.

The type of information the guides shared with the tourists was investigated. Therefore, questions relating to the volcanic activity of Iceland and more specifically about Katla and Mýrdalsjökull were asked. All of the guides informed the tourists that Iceland is volcanically active whilst also imparting information on Katla and Mýrdalsjökull. None of the hut wardens stated that they discussed any of this information. However, they do communicate information on hiking trails, hut facilities and the weather. This question was not applicable to bus drivers as they are not required to give formal talks to the tourists.

The same general knowledge questions as those asked to the tourist group then followed in order to determine the participants’ level of knowledge about Katla and jökulhlaup. Fifty percent of participants knew the eruptive history of Katla, 37.5% said ‘don’t know’ and 12.5% were incorrect. A better result was obtained when asked to define jökulhlaup with 94% correct and only 6% stating ‘don’t know’. Information about the participants’ perception of jökulhlaup hazard in this region was then collected. All participants think the Markarfljót could be affected by a jökulhlaup and if one was to occur 25% think that death and injury of people would have the greatest regional impact. Other variables that were ranked as the greatest impact were homes and businesses (19%), transport (12.5%), agriculture (12.5%) and rivers (12.5%). Twelve and a half percent of participants also ranked tourism, stating that it could have both negative and positive impacts.

Questions about a jökulhlaup warning system for the Markarfljót then followed. When asked if participants knew whether a jökulhlaup warning system exists for the Markarfljót region 63% responded yes, 6% said 'no' a warning system does not exist and 31% stated that they 'don't know' if there was a warning system. For those participants who stated 'don't know' all of them think that the Markarfljót needs one. The 6% who said 'no' a warning system does not exist clarified their response by stating that a warning system does not exist but a monitoring system does by way of seismic and hydrological stations and that 'yes', this region does need a warning system.

Considering that the tourist sector was not included in the original evacuation plan information was gathered to determine whether or not the tourist employees actually knew what to do if a jökulhlaup warning was issued. When asked if they knew of the emergency procedures they need to follow if a warning is given only 12.5 % said 'yes', whilst 87.5% said that they did not know. The participants that said 'yes' were then asked to describe what would they do. Responses included:

- *If there is an eruption I would take the tourists to higher ground. However, if there is an eruption in Goðabunga then I believe that it would be best to get out of this region as soon as possible due to the ash and tephra fall out. I believe that there will be enough time to evacuate the people from this region before the flood came through.*
- *The camping area would need to be evacuated and I would use the megaphone to warn all the tourists in the area. I would advise them to come up to the hut area and by no means try to escape. Rules 1, 2 and 3 are DO NOT DRIVE OUT! I would tell them what is happening to the extent of what I know. After the eruption*

has begun and tephra begins to fall I need to turn off all communication equipment including the radio.

Those participants that stated 'no' were also asked what they would do. In general, most responses were related to getting to higher ground. More detailed descriptions included:

- *Call 112 and inform them of how many people are in the area and also ask them for the recommended procedures. I would then try to take people to a safe area.*
- *Firstly, I would follow instructions from the head warden but if he is not present then I would take charge and call 112 to find out what is happening and what needs to be done.*
- *No idea.*
- *I would take people from the camp ground and up the mountain to where the phone is located. I would then phone to find out about the situation and then decide from there. I would probably take the hand held radio with me so I can listen to any news and/or instructions that are being broadcast.*
- *If I thought there was danger I would try to get to the nearest hut to check with the warden as soon as possible.*
- *I would check that all other guides in the region know and then figure out where the eruption is and then decide where to go.*

Furthermore, information was gathered to find out what these participants would do if there was a volcanic eruption in Katla but no warning had been issued, i.e. how would they find out if they needed to evacuate. *Call 112* was the most popular response (32%) followed by *listen to the radio* (19%), *check with the warden* (12.5%) and *call IMO* (12.5%). Again, the tourist employees group was asked the same question as the tourist group 'what would you define as the most serious hazard process if Katla would erupt'. They were also given the same options and were told that they could choose more than one and if that were the case they should rank them in order of the most serious. Jökulhlaup was ranked the most serious hazard by 69% of participants and tephra the second most serious by 37.5% of participants. Two other hazards, poisonous gases and earthquakes, were also considered as the second most serious by 19% and 12.5% of participants respectively.

Two behavioural questions followed regarding the use of communication devices in the Markarfljót region. When asked if they always have their GSM with them whilst travelling in this region 81% of participants responded ‘yes’. The participants who stated that they didn’t were all hut wardens where connection to the GSM network is not available. A further 87.5% carry a satellite phone or other form of emergency communication device. The 12.5% of participants who said that they didn’t carry a satellite phone do carry a GSM. However, these participants were tour guides, taking tourists on trips in excess of 2 weeks in regions where GSM connection is not available.

The survey then continued with questions to investigate the participants’ perception toward evacuation exercises. The participants were asked if they thought it necessary to have another evacuation exercise which involves the tourist operators working in this region. Seventy one percent think that they should and of these 38.5% think that it should be done once every year. Some justifications given by the 29% who stated that tourist operators should not be included in future evacuation exercises were *they should be included in the plan and informed how to react, just tell them about the plan* and *don’t think it is possible*.

The last set of questions was related to the participants’ behaviour with respect to gathering hazard information from the Icelandic Civil Protection, Skjálftavefsjá and IMO websites and from other media sources. The Icelandic Civil Protection website was the least accessed with 37.5% of participants stating that they had used the site to familiarise themselves with information on possible natural hazards connected to a Katla eruption whilst 50% of participants had used both the Skjálftavefsjá and IMO websites for hazard information. Fifty-six percent of participants have followed discussion in the media about natural hazards connected to a Katla eruption and they accessed this information mainly from the internet but also newspapers, radio, television and books.

8.3 Questionnaire design and interview process

In general, the questionnaire took approximately 30 minutes to complete. This time commitment was acceptable to all participants and they were given the opportunity to spend more or less time if needed. A few problems arose with the structuring of some questions. For example, the question ‘do you know whether a jökulhlaup warning system exists for the Markarfljót region’ is a little confusing. This question should be rewritten as ‘does a jökulhlaup warning system exists for the Markarfljót region?’ so the participants have the opportunity to state ‘yes’ one does exist or ‘no’ one doesn’t exist or simply ‘don’t know’. Additionally, many participants were confused by this question because at the time a jökulhlaup warning system did not exist for the region but a jökulhlaup monitoring system did. Furthermore, the questions which asked ‘have you ever used the Skjálftavefsjá (or IMO) website for hazard information’ should be reworded. If the participant states yes it is impossible to determine whether or not this was prior to their trip into Þórsmörk or on a previous occasion. In order to make this clear the questions should read ‘did you use the Skjálftavefsjá (or IMO) website to access hazard information before travelling in this region’.

Generally the sequence of questions for both groups was well constructed. However, in the tourist group questionnaire the two questions relating to media discussions on Katla should be moved to after the question which asks ‘have you heard of Katla’. If the participant answers ‘yes’, then it is appropriate to ask them if they have followed media discussions about Katla. If they state ‘no’, then these questions can be skipped.

A discussion of the participants’ responses and the usefulness and suitability of the questionnaire survey is now presented. This discussion will include aspects about the use of the questionnaires for future research.

9 Discussion of participant responses and the value of the questionnaires for future research

This study of hazard and risk perception in the tourist region of Þórsmörk is the first of its kind to be conducted in Iceland. However, it is beyond the scope of this pilot investigation to infer that these participants represent the Þórsmörk tourist industry as a whole. Despite this issue, their responses to the questionnaires will be discussed as they do provide the Icelandic Civil Protection with an insight into the public's knowledge, awareness and perception of jökulhlaup hazard and risk in this region. This discussion will follow the same format as the results presented above.

9.1 The tourist group

The majority of participants were under the age of 50 and have a bachelor degree or higher. It is impossible to determine if this high proportion is representative of the tourists who visit Þórsmörk as no such data is collected by the local tourist companies or Statistics Iceland. The majority of participants were travelling without a guide. This result may reflect this young and well educated group of participants who mainly came to the region for the purpose of hiking or volunteer work.

It is good to know that almost all participants who were travelling with a guide were educated by their guide about the occurrence of natural hazards in this region. Ronan *et al*. (2001) found that hazard education can lead to more stable risk perceptions, reduced hazard-related fears and an increase in awareness of protective behaviour. A surprising number of participants who were not travelling with a guide said that they were not carrying a GSM or any other form of emergency communication device. Reassuringly, all of these participants stated that they had informed someone about their exact location in the Þórsmörk region. However, without any mode of communicating with these people it is difficult for the Icelandic Civil Protection to issue a warning of an unexpected Katla eruption. To further exacerbate this situation many parts around Þórsmörk are not covered by the national GSM network. Those people travelling without a guide and only a GSM may be in an area where they cannot contact emergency information services during a volcanic crisis.

It is very good to know that some people registered with the mountain hut wardens as this guarantees that someone is expecting their arrival at a certain destination and time. This is extremely important when tourists are out hiking the difficult tracks in the area especially when weather conditions are not favourable – as is often the case.

Many participants transferred the responsibility when asked about precautions taken to ensure personal safety whilst travelling in this region (e.g. *took the bus….*, *booked with a tour company….*, and *travelling with relative…*). Research has shown that when the local population assumes that community preparedness is predominantly the responsibility of civil authorities (or in this case a tour company or relative) these individuals may be less likely to heed hazard information, follow hazard evacuation plans and adopt self protective behaviour as apposed to those participants who perceive responsibility upon themselves (Mulilis and Duval, 1995; Lindell and Whitney, 2000; Gregg *et al*., 2004a).

When the relative of the participant who responded *travelling with a relative* was questioned about their precautionary safety measures he offered a story about a hike they embarked on the previous day [There were 10 people in their group – 5 adults and 5 children, with the youngest about 5 years of age]. They lost their way from the track and found the hike quite strenuous. They had not told anyone that they were leaving the mountain hut area let alone the direction where they were heading. They were carrying a GSM but discovered whilst out on the hike that it had no connection to the network. They were not carrying any other form for emergency communication. Luckily, they all returned safely.

In a similar situation to that in Þórsmörk, Brandolini *et al*. (2006) noted that there has been an increase in tourism to geomorphogically unstable mountainous regions in Italy, and quite often, these visitors are little prepared in terms of skill, experience and equipment. Whilst having travel insurance and appropriate clothing is better than taking no safety precautions at all, tourists should be made aware of the regional hazards prior to coming to Þórsmörk so they can better prepare themselves. However, as found by

Johnston *et al*. (2005), even though hazard information was successfully distributed to the local population levels of preparedness were still recorded at low to moderate.

Information on hazards in Iceland can be obtained through the Icelandic Civil Protection website in addition to the IMO and Skjálftavefsjá websites. However, hardly any of the participants had actively sourced this information. Furthermore, only a quarter of participants had followed hazard discussions about Katla in the media. Even though Johnston *et al*. (2005) reported on the lack of preparedness amongst respondents they did find that hazard education programs had been successful in terms of promoting awareness of and access to information about hazards. These campaigns had utilised several forms of media including books, posters, pamphlets, school kits, mugs and magnets in addition to warning and evacuation signs and, maps and public displays illustrating the hazard region.

It is expected that all participants would know that Iceland is volcanically active if you are to consider the surrounding landscape. A foreign visitor cannot help but notice the lava fields surrounding them when driving from the international airport to the capital city of Reykjavik. Despite all participants knowing that Iceland is volcanically active, less than half the participants knew about the Katla volcano and half had heard of jökulhlaup. This is hardly surprising considering that very few participants had actively sourced regional hazard information and that no communication/education campaign had been conducted in this region. It is therefore impossible to expect these individuals to adopt self protective behaviour if they have no knowledge about the regional hazards.

After explaining to the participants that Katla was a subglacial volcano underneath the Mýrdalsjökull icecap and a jökulhlaup is a sudden flood of water and sediment from the glacier, they all perceived the threat of jökulhlaup hazard on the Markarfljót. The participants provided mixed responses when asked what human or biophysical factor would suffer the greatest impact if a jökulhlaup were to flood this region. This may be a reflection of varying regional knowledge amongst individuals and their cultural backgrounds.

At the time of interview, a jökulhlaup warning system did not exist for this region but hydrological and seismic monitoring did. Of those participants who stated ‘no’ or ‘don’t know’ if a warning system exists nearly all of them thought that one was necessary. However, it is pointless having a warning system unless the local population knows how to respond. Most participants said that they would rely on the wardens or the guide to inform them on what to do in an emergency situation. The remaining 21% said that they would rely on their GSM to call an emergency number. Luckily for the 2 citizens from the United States the number 911 will be diverted to Icelandic emergency number 112!

Whilst most participants recognised the threat of jökulhlaup and tephra during a Katla eruption many ranked lava as the second most serious hazard. This is interesting to note since only one eruption, the Eldgjá flood lava eruption, occurred outside the glacier margin. Despite being reputed as the most historically productive volcanic system, the total volume of lava flow (not including tephra and jökulhlaup deposits) from Katla eruptions was produced during this one event in 934-938 AD (Thordarson and Larsen, 2007). Furthermore, lightning strikes were not ranked as hazardous even though people and livestock have been killed by lightning strikes up to 30 km from the volcano during an eruption (Larsen, 2000).

It is reassuring to see that most participants were in favour of practicing the evacuation plan and that this should be done once a year. It is understandable that nearly all participants did not think that tourists should be included in this exercise as most of them are only here for a short visit. Encouragingly though, many said that they would participate if they were asked to do so.

9.2 The tourism employees group

Participants from the tourism employees group were not as highly educated as the tourist group. However, many participants stated that they were undergraduate students and were in the process of completing their higher education. This result is to be expected since the majority of participants were below the age of 30 and many hut wardens take the position as a summer vacation job.

It is not a requirement for tour operators to provide emergency training for their staff in relation to regional natural hazards and this is reflected in the very low number of participants that stated that their company held such training programs. The wardens' length of stay during the summer season is variable depending upon the operating company for each mountain hut. Wardens are only present in Þórsmörk during the summer months whereas some tour guides access the area in both summer and winter.

It is good to see that the tour guides discuss Iceland's volcanic activity, and more specifically Katla and Mýrdalsjökull with their tourists as this can positively affect tourists' behaviour during a volcanic crisis. Even though hut wardens communicate information about hiking paths, hut facilities and weather conditions, they do not impart any knowledge they have on the volcanic activity in Iceland, Katla and Mýrdalsjökull. This result may have impacted on the fact that only half the tourist participants' knew about Katla and jökulhlaup.

Considering that all of the participants were either Icelandic or they had been travelling to Iceland for quite sometime it is remarkable that many of them were not sure about the volcanic history of Katla. They could, however, correctly define a jökulhlaup. All participants perceived the threat of jökulhlaup on the Markarfljót River and as with the tourist group they responded with mixed answers about what human or biophysical element would suffer the greatest impact. Interestingly, some participants perceived that the impact on tourism would be both negative and positive. These participants believe that a Katla eruption and subsequent jökulhlaup would attract people to the area as they would be curious to see such a phenomenon taking place.

It is surprising to see that a majority of participants believe that a warning system is in place for the Markarfljót. Indeed there is one established for the local residents but this does not include the tourist region of Þórsmörk. At the time of interview the Icelandic

Civil Protection were still working on the development of such a system. Some participants may have recognised the fact that a monitoring system is operating for this area as was explained by one participant.

Due to the possibility of a Katla jökulhlaup flooding this region approximately 2 hours after an eruption begins it is important that people do not try to evacuate. There are about 10 river crossings on the one road that accesses this area. With a predicted catastrophic flood height in excess of 20 m it is crucial to evacuate people to higher ground; they should not try to drive out of the area if a volcanic eruption has begun. Of the two participants who stated that they did know what to do during an eruption only one of them enforced this message. Furthermore, this participant, who stated that they should not use the radio, recognised the threat of lightning associated with Katla eruptions. Larsen (2000) states that during the 1918 eruption the telephone could not be used and electricity could not be maintained for extended periods due to lightning.

It is essential that local populations subjected to hazardous situations are aware of the hazards and know how to respond during a crisis (Solana and Kilburn, 2003). Reassuringly, nearly all of the participants who stated that they did not know of the emergency procedures for a volcanic eruption displayed commonsense with most of them stating that they would evacuate to higher ground. These participants would willingly seek information from either the emergency number 112 or other guides or wardens and they would then follow instructions. However, one participant who guides groups on multiple day tours said that they had no idea how to behave during a volcanic eruption. This is alarming because many of the tourists stated that they would rely on the wardens/guides for assistance. However, without training and education campaigns these people should not be expected to know how to behave during an emergency situation. Stemming from inadequate experience and insufficient training, erroneous perceptions provoke incorrect predictions, false assignment of blame and mitigation failures (Schumm, 1994).

As with the tourist group, the tourism employees group recognised jökulhlaup and tephra as serious hazards during a Katla eruption but similarly, lightning was not considered to be important. Larsen (2000) confirms that the greatest hazard during historical Katla eruptions has been jökulhlaup. This was attributed to the short warning time for the local population, the exposed livestock in the surrounding region and the environmental damage caused by the flood. However, it is expected that with current seismic and hydrological monitoring an adequate early warning will be issued prior to the next Katla eruption and through successful communication and education campaigns the local population will respond positively to the warning thereby reducing their vulnerability to jökulhlaup hazard. If this is to occur then potentially lightning may be the greatest hazard to people and livestock within 30 – 40 km of the eruption site (Larsen, 2000).

All participants carried some form of communication device. However, those participants who only carried GSM phones included tour guides who frequented regions where GSM network connection was not available. Furthermore, these guides take multiple day hiking tours with up to 14 clients. Without a reliable form of communication it is impossible for these guides to acquire information about imminent volcanic hazards and therefore difficult for them to advise their group on the best possible course of action.

Many participants considered it necessary to hold an evacuation exercise with tourist operators in the Þórsmörk region. As with the tourist group, many participants believed that this should be done once a year. Those who did not perceive the necessity to hold an evacuation exercise qualified their responses by stating that the tourist operators should be informed of the emergency plan and procedures. The need for frequent hazard education and training of hut wardens is emphasised by the fact that many of them only work for one season and some only spend a few weeks working in the region. It is essential that all these wardens are aware of the emergency plan and procedures.

A more positive result was obtained from the tourist employees group with respect to actively seeking hazard information with some having accessed the Icelandic Civil Protection website and half using the Skjálftavefsjá and IMO websites. Additionally, more than half the participants had followed discussions in the media about natural hazards connected to a Katla eruption. The internet was the most favourable means of acquiring this information.

9.3 Questionnaire design and the interview process

By undertaking the questionnaire survey using the face-to-face method the researcher could determine whether or not the participant was comfortable with the questionnaire length, the sequence and structure of questions and determine if there were any other defects within its design. Overall, the questionnaire length was suitable for the participants as they were allowed flexibility according to their own personal needs. The few problems that arose with the structure and sequence of some questions should be addressed as suggested in Section 8.3 before further questionnaire survey interviews are conducted.

The data generated through these questionnaires does provide the Icelandic Civil Protection with an insight into the public's knowledge, awareness and perception of jökulhlaup hazard and risk in the Þórsmörk region. Therefore each questionnaire generates data that is valuable and appropriate to the aims of this study and is consequently considered suitable for the targeted group. Following the suggested corrections, the questionnaires should be implemented within a much larger sample group in order to provide more robust results which can be used by the Icelandic Civil Protection for designing appropriate hazard education and communication strategies.

10 Conclusions

Risk mitigation strategies are being devised to reduce the potential impact of a volcanically induced jökulhlaup flooding the tourist destination of Þórsmörk. Within the risk mitigation framework, appropriate hazard education and communication strategies should be developed based on the local stakeholder's needs, beliefs and expectations rather than that of the professionals working within the Civil Protection and the scientific community. In the case of Þórsmörk, the term 'stakeholder' applies to tourists and tourism employees who frequent the region. However, knowledge, awareness and perception studies of these groups in relation to jökulhlaup hazard and risk have not been conducted until now. It is believed that the data generated from the questionnaire survey instruments used within this study will provide the Icelandic Civil Protection with valuable information for the development of appropriate hazard education and communication strategies. The minor issues that arose in relation to the structure and sequence of some questions should be rectified before a more robust investigation is conducted with a larger sample size. Overall, the questionnaire survey instruments developed for the task of investigating tourist's and tourism employee's knowledge, awareness and perception of jökulhlaup hazard and risk are considered to be effective tools. Future planning for other perception studies in Iceland and abroad can benefit from this research.

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