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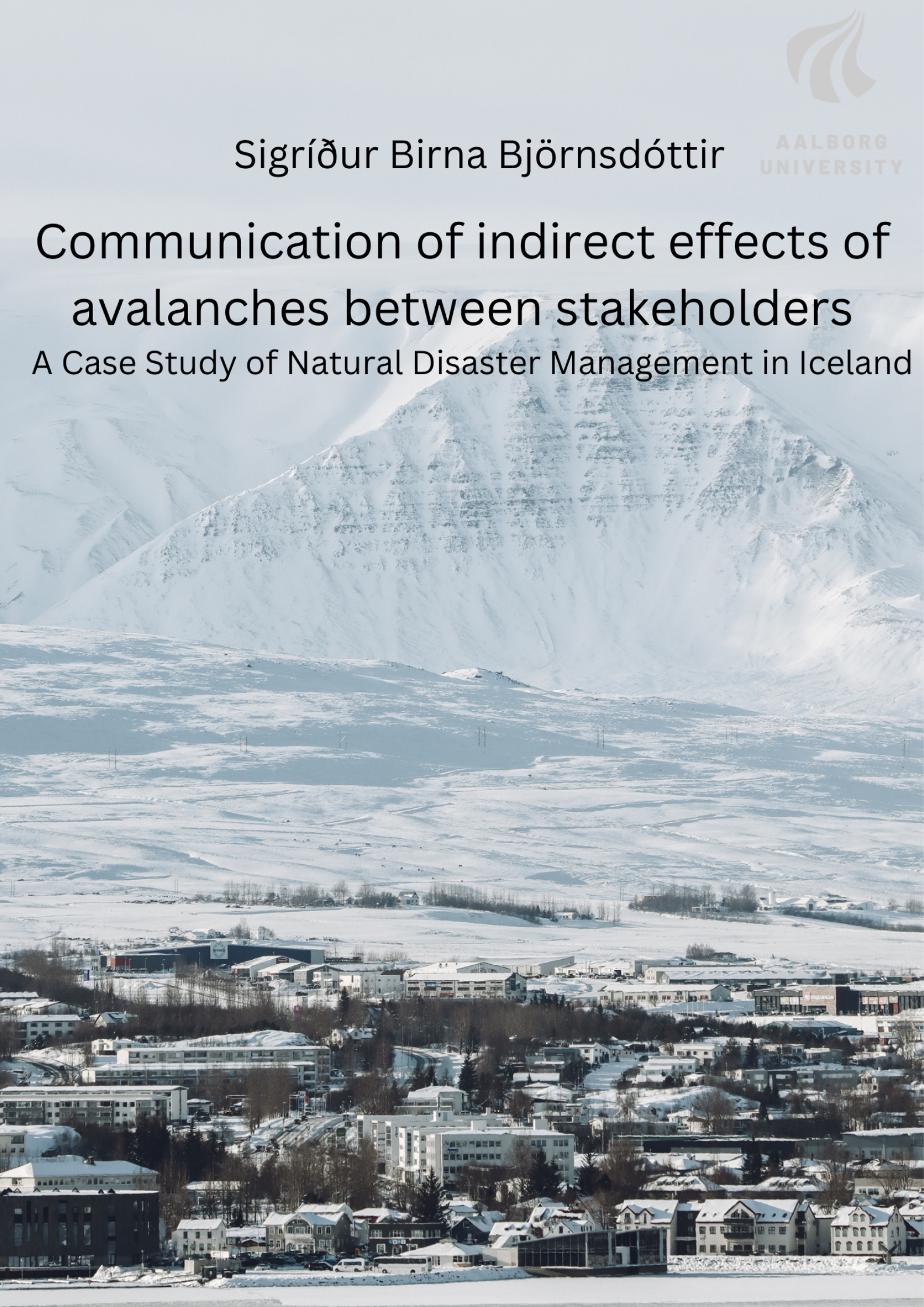
Communication of indirect effects of avalanches between stakeholders

A Case Study of Natural Disaster Management in Iceland



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Summary

The Icelandic population has been prone to deal with a multitude of natural disasters affecting the island, including extreme storms, earthquakes, volcanic eruptions, floods, avalanches and landslides, which all have caused catastrophic harm in the past and continue to threaten livelihoods, communities and infrastructures. Natural disasters have over the past few decades become more frequent due to climate change, making them one of the greatest modern threats to human well-being. Climate change presents increased challenges to the world, not only in the form of warming of earth, melting of glaciers and sea level rise but climate change also provokes disturbance in political, social and economic systems.

Natural disaster impacts are often divided into direct effects and indirect effects both causing economic and social structural disruptions. Direct effects can lead to indirect effects since they are associated with each other and can cause ripple effects within economic activities. The indirect effects can include; supply chain disruptions, loss of revenue, unemployment, increased indebtedness and change in human welfare and equality. Indirect effects have occurred in Iceland after avalanches e.g.; after the avalanches in Flateyri 2020 hit the industrial site at the harbour, almost all shipping activities and fish processing came to a stop due to the destruction of infrastructure, which led to a higher percentage of unemployment in the district. Secondly, the avalanches of 1995 in Flateyri and Súðavík have shown a long-term effect on human well-being regarding the mental health of affected people. Although losses from indirect effects of natural disasters can be greater than damages from direct effects, indirect effects were first implemented into Icelandic laws in 2008 and since then involvement of indirect effects of natural disasters has been lacking in Iceland. In scholarly literature, there has been no clear mention of how indirect effects are being communicated between different stakeholders, only a brief mention that communication between different institutions is needed for long-term planning.

Natural Disaster Management (NDM) is an effective strategy and a key element in minimising natural disaster impacts on humans, the built environment, or both. NDM is a long and complicated process divided into four phases; prevention, preparedness, response and recovery. Those phases are also the building blocks of the Disaster Management Cycle (DMC). Communication is a form of strategy for NDM where coordination and communication between different actors involved in natural disasters are needed for both understandings of disasters and risk reduction of disasters.

The frequency of natural disasters in Iceland, the rich heritage of local knowledge and the development of formal institutions of NDM provide a unique opportunity to assess NDM already in place in Iceland. The project's main objective is two-folded. Firstly, to map out which stakeholders are involved in the indirect effects of avalanches in NDM in Iceland. Secondly, to study how indirect effects of natural disasters are communicated between different stakeholders through all four phases of Disaster Management Cycle regarding avalanches in Iceland.

This project's research follows the epistemological approach of abductive reasoning. Abductive reasoning recognizes the process based on the logic of justification rather than the outcome, allowing the research process to alternate between data and argument. This methodological approach integrates continuous reflections on data against theory, allowing

me to continuously reconstruct research and recognize and account for scientific creativity in the process.

This study is structured as a case study of NDM in relation to avalanches all over Iceland, since NDM is the same throughout the country and involving the same institutions. The difference in NDM in Iceland has to do with the stakeholders in each institution, which may vary depending on location. Likewise, various expert knowledge may be sought depending on what natural disaster has occurred (e.g. avalanches, flooding, earthquakes, volcanic eruption).

Data collection was achieved with document analysis and stakeholder interviews. Document analysis was used to collect data in order to identify stakeholders involved in management of indirect effects to answer SubRQ1. It is considered an effective, practical and manageable way to gather relevant data. Official documents and scientific papers are generally accessible and reliable sources of information. Stakeholders were sampled through information-oriented selection. Data was collected through eight qualitative interviews by interviewing stakeholders, using an interview guide. The interviews were semi-structure, to allow important issues, perceptions and ideas to be raised and discussed during the interviews.

The initial process was to create a stakeholder map regarding indirect effects of avalanches in Iceland, showing that there are many stakeholders in NDM in Iceland. Those stakeholders are some involved in all 4 phases of the DMC, yet some in fewer phases. Continuing on this journey, the flow of communication amongst stakeholders was explored. The results showed that the flow of communication is considered relatively good, with trust being present between stakeholders, which allows for better communication and collaboration.

When it comes to indirect effects of avalanches, the results show that they are being recognized in NDM in Iceland. The indirect effects with most attention are for example: prevention strategies, risk assessments, hazard mapping, funding for prevention infrastructure and social well-being. Indirect effects are included in some strategies and policies in NDM in Iceland. It is important to continuously direct attention to indirect effects, as they can have quite serious and long-lasting effects. Additionally, indirect effects of avalanches should be communicated(and are being so in Iceland) to all relevant stakeholders using various platforms.

List of abbreviations

Conceptual Framework (CF)
Department of Civil Protection and Emergency Management (DCPEM)
Disaster Management Cycle (DMC)
National Commissioner of the Icelandic Police (NCIP)
Natural Catastrophe Insurance of Iceland (NTI)
Natural Disaster Management (NDM)
Research Question (RQ)
Risk Communication Theory (RCT)
Sub-research question (SubRQ)
The Icelandic Association for Search and Rescue (ICE-SAR)
The Icelandic Meteorological Office (IMO)
The Institute of Earth Sciences (IES)

Abstract

The Icelandic population has been prone to deal with multitude of natural disasters, including extreme storms, earthquakes, volcanic eruptions, floods, avalanches and landslides, which all have caused harm in the past and continues to threaten livelihoods and infrastructures. Natural disaster impacts are often divided into direct effects and indirect effects both causing economic and social structural disruptions. Direct effects can lead to indirect effects since they are associated with each other and can cause ripple effects within economic activities. This paper aims to address the research gap concerning how indirect effects of avalanches are being communicated between different stakeholders in Natural Disaster Management (NDM) in Iceland and how much attention those effects get. Additionally, a stakeholder map for indirect effects of avalanches in Iceland will be created. This study is structured as a case study of NDM regarding avalanches all over Iceland. Data collection was achieved with document analysis and stakeholders' qualitative interviews. Theoretical approaches of Risk Communication and Disaster Management Cycle were used to create a conceptual framework to guide the analysis. Analysis shows that indirect effects are recognized and communicated in NDM in Iceland. Attention in Iceland regarding indirect effects is mostly in relation to prevention of indirect effects and social well-being. With the creation of the stakeholder map, a visualization of involved stakeholders is made available.

1. Introduction

Icelandic population has been prone to deal with a multitude of natural disasters including extreme storms, earthquakes, volcanic eruptions, floods, avalanches and landslides (Matti et al., 2022b; Thordardottir et al., 2018), which all have caused catastrophic harm in the past and continue to threaten livelihoods, communities and infrastructures (Khan et al., 2022; Thordardottir et al., 2018; Wex et al., 2014). Disasters can have negative physical and mental effects as well as negative effects on social well-being.(UNISDR, 2009). Natural disasters such as avalanches and landslides have over the past few decades become more frequent, due to climate change, and therefore damages have become more severe and affected areas have increased (Dorasamy et al., 2013; Khurana et al., 2022; Matti & Ögmundardóttir, 2021; Matti et al., 2022b; Oktari et al., 2020), which makes it one of the greatest modern threats to human well-being (Chen et al., 2020; Djoumessi & Mbongo, 2022). It is predicted that because of climate change, avalanches and landslides will become more frequent in the upcoming years (Abdulla et al., 2014; Matti & Ögmundardóttir, 2021). Climate change provokes disturbance in political, social and economic systems, where (Hochrainer-Stigler & Reiter, 2021). post-disaster disruptions can affect long after the initial event as well as create a chain reaction that leads to additional damage that can be hard to recover from (Ágústsdóttir, 2015).

Natural disaster impacts are often divided into direct effects and indirect effects (Berlemann, 2016; Saban, 2014) both causing economic and social structural disruptions (Saban, 2014). Direct effects are relatively straightforward where those losses occur during disaster or shortly after (Botzen et al., 2019). Direct effects are listed as; loss of life, injury, morbidity (Berlemann, 2016; McDermott, 2012), damages to assets, infrastructures, businesses, housing, crops, livestock, raw materials and extractable natural resources (Berlemann, 2016; Botzen et al., 2019; Saban, 2014). The indirect effects can include; reduced economic production or income due to business disruption, supply chain disruptions (Botzen et al., 2019; Hochrainer-Stigler & Reiter, 2021; Reiter et al., 2022), loss of revenue, unemployment, market destabilization, increased indebtedness, inflation and also change in human welfare and equality (Berlemann, 2016; Hochrainer-Stigler & Reiter, 2021; Reiter et al., 2022; Saban, 2014). Direct effects can lead to indirect effects since they are associated with each other and can cause ripple effects within economic activities. Losses from indirect effects can even be greater than damage from direct effects (Botzen et al., 2019; Hochrainer-Stigler & Reiter, 2021). Figure 1 shows how direct effects can lead to indirect effects, e.g. loss of infrastructure can lead to a business supply disruption and unemployment if the infrastructure destroyed was a factory building.

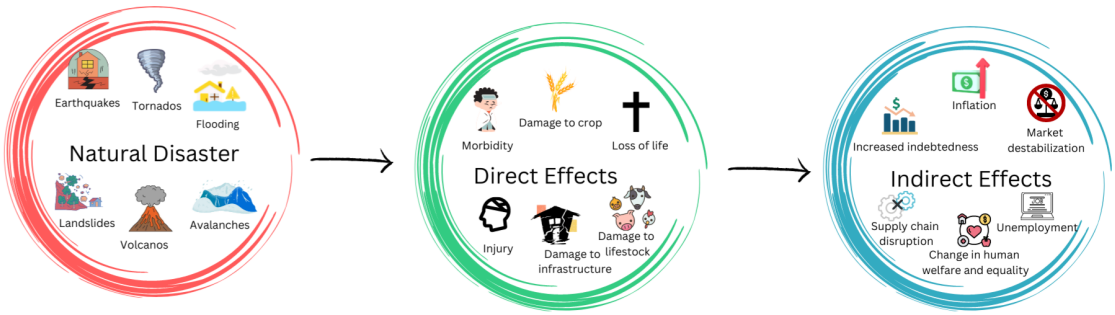

Figure 1. Direct effects and indirect effects of natural disasters. Figure created in Canvas (own creation).

Indirect effects have occurred in Iceland after avalanches such as the avalanches in Flateyri 2020 hit the industrial site at the harbour, almost all shipping activities and fish processing came to a stop due to the destruction of infrastructure, that lead to a higher percent of unemployment in the district (Einarsson et al., 2020). Also, the avalanches of 1995 in Flateyri and Súðavík have shown a long-term effect on human well-being regarding the mental health of affected people (Thordardottir et al., 2015). Long-term economic effects of natural disasters are not as well understood as direct effects, as fewer studies have explored the indirect economic effects (Botzen et al., 2019; McDermott, 2012). Nonetheless, they appear as relevant as direct effects and need further attention (Antonioli et al., 2022) and therefore, more focus is needed on strategies to prevent and manage indirect effects of natural disasters (Hochrainer-Stigler & Reiter, 2021). In recent years, indirect damages have been gaining attention in risk management (Reiter et al., 2022). Hochrainer-Stigler & Reiter (2021) mentions that indirect effects face obstacles in their integration in disaster risk management since they are harder to assess and model and are not as straightforward as direct effects.

Natural Disaster Management (NDM) is an effective strategy and a key element in minimising natural disaster impacts on humans, the built environment, or both. NDM is a long and complicated process divided into four phases; prevention, preparedness, response and recovery. Those phases are the building blocks of the Disaster Management Cycle. Successful management requires proper planning, structured response and well-coordinated efforts across all four phases (Djoumessi & Mbongo, 2022; Dorasamy et al., 2013; Oktari et al., 2020; Saban, 2014). Some of the major catastrophic natural disasters that have taken place in Iceland have been documented and described in detail. Documentation of natural disasters from the time of the settlement in Iceland has given the Icelandic population rich heritage and valuable local risk knowledge to handle natural disasters (Jóhannesdóttir & Gísladóttir, 2010). This documentation has made it possible to develop advanced monitoring and warning systems and reduce fatality rates almost to zero through well-developed disaster management protocols (Matti & Ögmundardóttir, 2021). Iceland is part of the Sendai Framework for Disaster Risk Reduction (2015-2030)[1] where all countries that take part in the framework need to involve both scientific knowledge and

[1]The Sendai Framework for Disaster Risk Reduction (2015-2030) was the first agreement that involves actions to protect development gains from disaster risk *"The substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries."*(for Disaster Risk Reduction, n.d.)

local knowledge when developing and implementing NDM policies and strategies (Matti & Ögmundardóttir, 2021).

Various scholars e.g. Palttala et al. (2012), Owolabi & Ekechi (2014), Inggrida et al. (2017) and Marcillo-Delgado et al. (2022) have emphasised the importance of communication as a factor when it comes to NDM. Communication is a form of strategy for NDM where coordination and communication between different actors involved in natural disasters are needed for both understanding of disasters and risk reduction of disasters (Inggrida et al., 2017; Owolabi & Ekechi, 2014). Along with communication strategic importance being recognized by international agreements like the Sendai Framework for Disaster Risk Reduction (2015-2030) and included within the Sustainable Development Goals (Marcillo-Delgado et al., 2022; United Nation, 2015; United Nations Office for Disaster Risk Reduction, 2015). The scope of communication is to share knowledge, experiences and information between stakeholders in NDM (Inggrida et al., 2017). The stakeholders in question can be, e.g. the general public, the police, fire services, the government and non-governmental agencies (Owolabi & Ekechi, 2014), scientists (Denis, 1995), private sector organizations, volunteer groups (Smith & Dowell, 2000) and media (Palttala et al., 2012).

Communication revolves around how information flows between different actors, to ensure variety of interaction, participation and association within an NDM system (Marcillo-Delgado et al., 2022). The Media takes part in that flow, such as; radio, television, social media and newspapers (Bird et al., 2010; Djoumessi & Mbongo, 2022) to spread the information far and wide to reach a diverse audience (Owolabi & Ekechi, 2014). It is vital to achieve synergy in relation to media use and communication with communities and stakeholders involved in natural disasters. This is necessary when distributing information to enhance shared performance through all phases of NDM process. (Inggrida et al., 2017; Owolabi & Ekechi, 2014; Palttala et al., 2012). (Marcillo-Delgado et al., 2022). Bird et al. (2010) mention that stakeholder's lack of knowledge is a challenge, but increasing knowledge distribution can improve communication. They state that information needs to be accessible through multiple sources. While Dorasamy et al. (2013) claim there is a need for a common platform to help with better flow of information.

The literature search of NDM in Iceland showed that literature written directly about volcanic research (Ágústsdóttir, 2015; Bird et al., 2010; Dugmore & Vésteinsson, 2012; Jóhannesdóttir & Gísladóttir, 2010; Ómarsdóttir et al., 2022; Räsänen et al., 2020) is more common, while there is less mention of avalanches. Thordardottir et al. (2018) included avalanches as part of the research while researching earthquake and volcano eruption and Matti et al.'s (2022b) included avalanches as a minor part of his research

Although losses from indirect effects of natural disasters can be greater than damages from direct effects (Botzen et al., 2019; Hochrainer-Stigler & Reiter, 2021), indirect effects were first implemented into Icelandic laws in 2008. This could be due to indirect effects being harder to assess and being less straightforward than direct effects (Hochrainer-Stigler & Reiter, 2021). Additionally, in 2008, a book called Longterm responses to natural disasters [2] was published. The book was written as a guide for municipalities on how to implement long-term effects into their strategies and policies. The focus was mostly on response

[2] [*Langtímaviðbrögð við náttúruhamförum*]

and recovery phase of natural disasters. Along with providing help for municipalities to minimize the effects of natural disasters, hasten recovery and increase community resilience long-term (Þorvaldsdóttir et al., 2008). Jóhannesdóttir (2011) considered the guidelines from the book in management work and acknowledges that indirect effects are important but there is no further elaboration on it. There has been lack of mention how long-term effects are being communicated between different stakeholders, only a brief mention that communication between different institutions is needed for long-term effects (Jóhannesdóttir, 2011). Bernharðsdóttir et al. (2020) published an article to draw attention back to the topic of long-term effects to show that the guidelines were still relevant over a decade later. The article implies that focus and knowledge on the indirect effects is lacking in Iceland.

The frequency of natural disasters in Iceland, the rich heritage of local knowledge and the development of formal institutions of NDM provide a unique opportunity to assess the NDM already in place in Iceland. It was decided that avalanches were a relevant natural disaster to focus on in this research for two main reasons; it fills a knowledge gap as a less researched subject concerning NDM in Iceland and is affected by climate change, making it an increasing threat. Furthermore, this paper aims to address the research gap concerning how indirect effects of avalanches are being communicated between different stakeholders in NDM in Iceland and if so, how much space the involvement of it has in NDM. Additionally, a stakeholder NDM involvement map for indirect effects of natural disasters through all four phases of NDM in Iceland will be created, considering that this has not been done before.

This paper aims to answer the following research question (RQ);

> How much attention do indirect effects of avalanches get in Natural Disaster Management in Iceland and how are those effects being communicated between stakeholders?

With the following sub-research questions (SubRQ);

1. Which stakeholders are involved in Natural Disaster Management of indirect effects from avalanches in Iceland?
2. How is the flow of communication regarding indirect effects between stakeholders in Natural Disaster Management in Iceland?

2. Methodology

This project's research follows the epistemological approach of abductive reasoning. Abductive reasoning recognizes the process based on the logic of justification rather than the outcome, allowing the research process to alternate between data and argument. This methodological approach integrates continuous reflections on data against theory, allowing me to continuously reconstruct research and recognize and account for scientific creativity in the process (Conaty, 2021; Kennedy & Thornberg, 2018). Furthermore, the prior knowledge shaped by the researcher's role and educational background is recognized as relevant and inevitable dynamics in research. Therefore, the analysis may be biased by

the researcher's frame of reference. However, the abductive approach permits reflexivity regarding cognitive biases, as researchers can reflect on new perspectives gained during the study and apply them to additional data analysis (Timmermans & Tavory, 2012). The abductive reasoning for this research went as the following figure 2 shows;

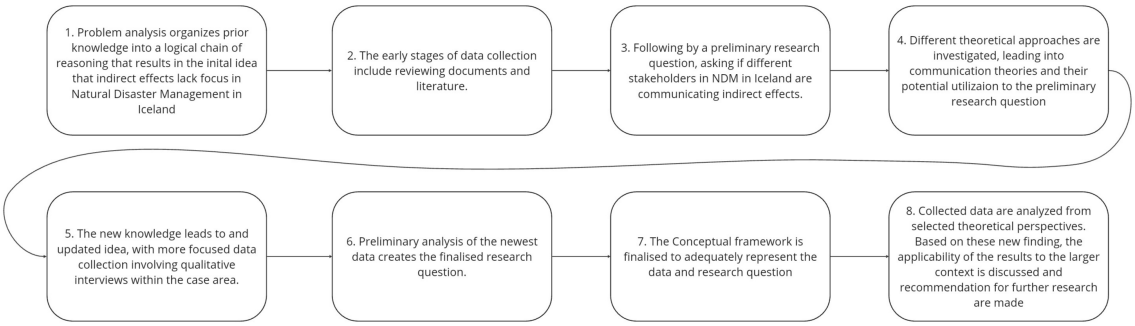

Figure 2. Abductive reasoning (own creation)

2.1. Case Study

A case study consists of an in-depth investigation of one or more organizations involved in the phenomenon being studied or a detailed examination of a particular case happening in a real-world situation (Inggrida et al., 2017; Meyer, 2001). According to Flyvbjerg (2006), the scientific method of case study approach produces knowledge that can be generalised for a broader context.

This study is structured as a case study of Natural Disaster Management (NDM) in relation to avalanches all over Iceland since NDM is the same throughout the country, involving the same institutions. The difference in NDM in Iceland has to do with the stakeholders in each institution, which may vary depending on location. Likewise, various expert knowledge may be sought depending on what natural disaster has occurred (e.g. avalanches, flooding, volcanic eruptions). Since I am Icelandic, I have an understanding of background knowledge and access to open-source data in Icelandic.

This report uses a case study approach to describe how indirect effects of avalanches are communicated between different stakeholders through NDM in Iceland. The applicability of those findings can help shed light on the status quo of indirect effects in NDM. This knowledge can be used in similar contexts for researching the involvement of indirect effect of natural disasters.

Data collection was achieved with document analysis and stakeholder interviews. Data triangulation refers to the use of different sources of data and methods in qualitative research to develop a holistic understanding of phenomena. It is also viewed as a strategy to test validity of research finding (Flick, 2018). Triangulation of the data from the qualitative interviews, the collected documents and supporting literature enhance the validity of the data for this research. It reduces the chance of systematic bias and possible limitations associated with using single data source (Flick, 2018). During the analysis phase, qualitative interviews and documents regarding Iceland NDM provide two perspectives on NDM in Iceland; the stakeholder personal perspective and researched

perspective. With the combination of those perspectives, a more valid analysis of NDM system in Iceland could be achieved.

Stakeholders were sampled through *information-oriented selection* (Flyvbjerg, 2006). *"To maximize the utility of information from small samples and single cases. Cases are selected on the basis of expectations about their information content"* (Flyvbjerg, 2006, s. 230). Documents revealed expected relevant institutions as possible interviewed stakeholders during literature search. The preconditions for inclusion of institutions in the case study were that they all had to be a part of one or more phases of NDM as well as including indirect effects in their work. Eight stakeholders are selected to represent the diverse institutions involved in NDM in Iceland.

A limitation of this methodology is not interviewing all stakeholders in NDM. Interviews with local individuals in Iceland could have offered a new analytical viewpoint of the current flow of communication of indirect effects in NDM in Iceland. However, they were not interviewed since individuals are very diverse and only a large sample of local individuals would be able to capture different viewpoints and opinions.

2.2 Research Design

Research design *"provides a framework for the collection and analysis of data."* (Flick, 2022) It shows the overall strategy that was chosen to integrate different elements of the project and arrange it in a coherent and logical way. Thereby, it ensures that the research problem is effectively addressed; by showing the data collection methods, involved theories that will analyse the data to answer the research question (Flick, 2022). The following Figure 3 of the Research Design outlines how the research question and sub-research question are being investigated throughout the study.

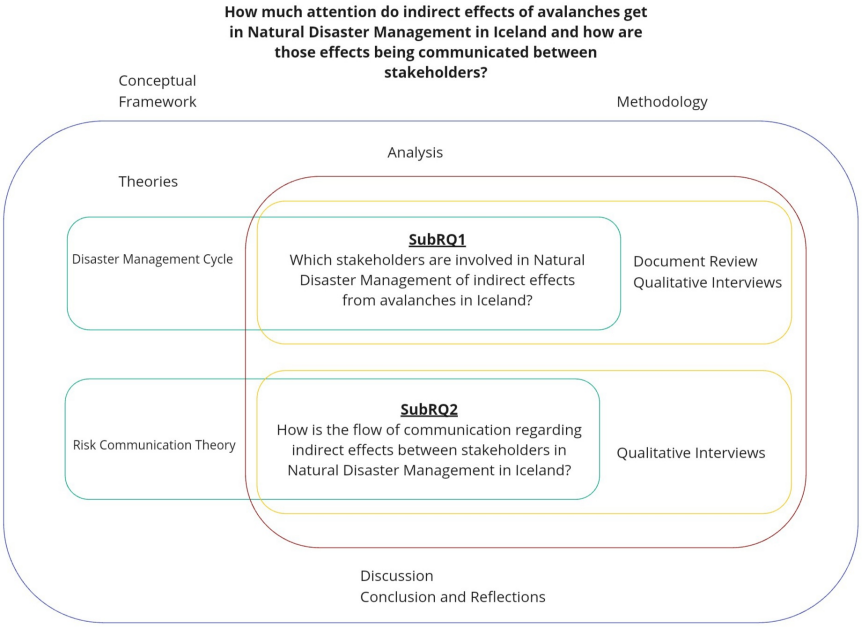

Figure 3. Research Design (own creation)

2.3 Document Analysis

Document analysis was used to collect data to identify stakeholders involved in management of indirect effects to answer SubRQ1. It is considered an effective, practical and manageable way to gather relevant data. Official documents and scientific papers are generally accessible and reliable sources of information (Bowen, 2009). Documents were gathered with an unstructured literature approach allowing snowballing [3] methods to occur. The documents were in English and Icelandic as the author is fluent in both languages. The aim was to use mostly peer-reviewed articles, though grey literature [4] and official institution web pages were allowed.

The research keywords were applied to titles, abstracts and keywords and they were kept sufficiently broad to avoid any artificial limitation on the documents that were retrieved. Boolean operators such as "AND", "OR", and asterisk (*) were used on the search strings to gather as much relevant data as possible. The research keywords for this document analysis were; natural disasters Iceland, natural disaster management, indirect effects of natural disasters, and disaster governance Iceland.

The included articles were those that were open and accessible through Aalborg University. Relevant literature from State-of-the-art and internet research was applied to the document list to compile a list of stakeholders involved in NDM regarding indirect effects in Iceland. Snowball sampling made it possible to add relevant stakeholders to the map during the interviewing process. In the end 17 documents, and some were web pages, were analysed in Section 4.1. for answering SubRQ1.

2.4 Qualitative Interviews

Data was collected through eight qualitative interviews by interviewing stakeholders, using an interview guide. The interviews were semi-structure, to allow important issues, perceptions and ideas to be raised and discussed during the interview.

Key stakeholders identified in the document analysis were contacted by email and asked to participate. 17 were contacted, 11 replied with either accepting or declining an interview, and eight emails turned into an actual interview. The email included a short introduction about the main concepts of the project, the estimated length of the interview and why the person contacted was relevant to the study. Closer to the interview date, all stakeholders received an email with the interview guide (See Appendix A for the interview guide) to allow for familiarisation with the questions and topics. To ensure the reliability of the data, the same interview guide was used for all interviews and ensured that comparative data was collected for all the interviews. Furthermore, all interviews allowed follow-up questions as necessary. This allowed for identification of repeated arguments made by stakeholders which allowed for to be viewed as representative of the case. One interview was, however, scheduled abruptly and it was therefore not possible to send the interview guide ahead.

All the interviewees were shown a draft version of Stakeholder map (See Figure 5) during

[3] Snowballing is a research technique, it allows the researcher to add in more literature and to have the sample grow in size, like a rolling snowball (Reiter et al., 2022)

[4] Grey literature is material produced by organizations outside of traditional publishing and distribution channels (Börjesson, 2015)

the interviews. Allowing stakeholders to cooperate by giving input and commenting on the map and taking part in the final creation of the stakeholder map of indirect effects from avalanches in NDM in Iceland. The stakeholders interviewed will show up in the Stakeholder map in bold.

The interviews took place from the 13 of April 2023 to 15 of May 2023. Four interviews were conducted in person, while four interviews were conducted via Microsoft Teams. The length of the interviews varied from 25 - 60 minutes. All interviews were recorded and transcribed to a Microsoft Office Excel document. Coding was used since it is thought to be the primary categorization method in qualitative research (Maxwell, 2009). The coding was done manually, starting with coding the already set themes from the interview guide; indirect effects, communication, climate change & stakeholder involvement. While coding, following the abductive approach allows for adding further themes to the coding; trust, sufficient messages,, municipalities and line of authority. A limitation regarding data analysis methodology was not coding with coding software. That could have provided a more quantitative evaluation of the data.

Table 1 shows the list of interviewees and how relevant they turned out after conducting the interviews regarding how much focus they had on indirect effects and what their work area consisted off.

Institution	**Work area and/or Focus**	**Relevant**
Avalanches and Landslide Fund	Municipal employee, natural disasters, monitoring and research	Yes
Department of Civil Protection and Emergency Management	Long-term response, risk communication and education regarding risk and disaster management	Yes
EFLA	Geotechnical engineering, prevention infrastructure	Yes
Icelandic Meteorological Office	Work area was hazard mapping focus on direct effects	No
Icelandic Red Cross	Team leader of Emergency Protection	Yes
Municipality	Mayor, needs to be involved in all phases of DMC	Yes
Natural Catastrophe Insurance of Iceland	Work area CEO - recovery	Yes
Rainrace	Co-author of Long-term response to natural disasters	Yes

Table 1. Relevance of interviews

It can be conducted that most of the interviewees were considered relevant for the data collected for this research, which makes the data valid. I managed to speak to some highly relevant people during the data collection for this project and I consider that an advantage to this project. Interviewing relevant people led to the possibility of answering the research question.

Document analysis showed what stakeholders were relevant to contact, depending on their tasks in NDM and in how many documents they were mentioned in. Stakeholders I thought were the most relevant were contacted and when emails were sent out responses varied. I did not receive replies from everyone right away and some never replied back After 2-4 weeks a second round of email were sent out and two positive responses came. My selection of stakeholders and lack of response created the final list of stakeholders I eventually got to interview. Stakeholders I would have liked to include were; local individuals, health sector, local businesses, National Commissioner of the Icelandic Police and Ministries involved. However, only eight interviews were conducted and I consider that a limitation regarding this project. A limitation since it does not cover opinions and views from all the involved stakeholders in indirect effects of avalanches in NDM in Iceland which could have given a

different analytical perspective.

With avalanches as the focus, interviewees mentioned other types of natural disasters more often when listing examples. Therefore, to narrow focus can be considered a limitation towards possible data gathering regarding indirect effects.

3. Theory

The theoretical perspective from which the data is analysed in this project is based on Risk Communication Theory (RCT) as the base layer. This theory was considered very relevant to this research, as within the scholarly exploration of risk, risk communication has emerged as an area with immense potential to affect how communities react to and deal with risk, especially those related to climate change and natural hazard events (Agrawal et al., 2022). Following this, the Conceptual Framework (CF) will be introduced. A CF allows for visualiation of the research project and puts it into perspective. Both relevant theory and empirical research are incorporated in qualitative research to help structure the CF (Rocco & Plakhotnik, 2009). For my CF, RCT is integrated with the theoretical approach of Disaster Management Cycle (DMC). The addition allows for a more complete analysis of the communication concerning indirect effects of avalanches in all four phases of Natural Disaster Management (NDM).

3.1. Risk Communication Theory

Before venturing to RCT, it is important to address the theory of communication. Communication theory is an interactive process of exchange of information between stakeholders and it provides a way for a sender to send a message in the form of speech, writing or signs to a receiver in exchange for feedback (Xiang et al., 2012). Communication theory is an extremely broad theory with branches in various directions This makes it relevant for this case to zoom into a more focused area of communication. The focus was set on Risk communication, as it is shown to be crucial for successful natural disaster risk reduction (Xiang et al., 2012). Risk Communication *"is an interactive process of exchange of information and opinion among individuals, groups, and institutions. It involves multiple messages about the nature of risk and other messages, not strictly about risk, that express concerns, opinions, or reactions to risk messages"* (National Research Council (US) Committee on Risk Perception and Communication, 1989, s. 21). Risk communication is an important pillar of disaster risk management as it involves people and increases their understanding of risk through communication, creating more awareness for disaster preparedness and response, as well as influencing decision-making throughout the DMC (Agyepong & Liang, 2022; Shaw et al., 2013). Many studies show how risk communication has evolved through the decades to the theory it is today (see Gurabardhi et al. (2004), Xiang et al. (2012) and Balog-Way et al. (2020) for a literature review).

Under RCT can be found more branches of disaster communication theories (Agrawal et al., 2022). Theories regarding risk communication can be e.g. risk perception theory, participation theories and place-based attachment theory. Risk perception theory is conserning how risk is effectively assessed, understood, managed and communicated among stakeholders. Risk perception theory includes risk framing, which emphasizes how risk

information is presented by different stakeholders, along with it explaining how and why risk communication influences local values, concerns and previous experiences. In this framing, trust between different stakeholders plays an important role in successful risk mitigation measures (Agrawal et al., 2022). Participation theories emphasize the importance of involving the public in co-creation of disaster knowledge, empowering creation of long-term community resilience. This is a new development form the prior top-down one-way communication appraoch which fails to enable response and preparedness for natural hazard risks (Agrawal et al., 2022).Place-based attachment theory suggests that during natural disasters, individuals' emotional state towards their location plays a rolei n how they face and cope with risk.It can alter their preparedness and adaptation actions along with lowering their mitigation acceptance (Agrawal et al., 2022). Thus, RCT both focuses on stakeholders' communication among each other and the messages that are being communicated. These can be messages regarding indirect effects. Therefore, it was decided that RCT is the most relevant theory to answer the research questions. Additionally, RCT covers the important aspects of stakeholders and messages in a wider sense than merely in relation to involvement of participants or how risk perception is among stakeholders.

3.2. Disaster Management Cycle

Disaster Management Cycle *"illustrates the ongoing process by which governments, businesses, and civil society plan for and reduce the impact of disasters, react during and immediately following a disaster, and take steps to recover after a disaster has occurred"* (Vasilescu et al., 2008, s. 48). The impact of disasters can be viewed as direct and indirect effects. Many different versions of DMC have been created (Coetzee & van Niekerk, 2012; Muzamil et al., 2022; Saban, 2014; Vasilescu et al., 2008), with these different versions including from a few to many steps. The DMC version used for this project, includes 4 phases; prevention, preparedness, response and recovery. The advantage of going through the relevant steps of the cycle is that it leads to better preparedness, improved warnings, reduced vulnerability and creates knowledge of how to use the cycle, which makes greater prevention for when the next disaster occurs. Further, the complete DMC can be used as a tool for development of policies and plans with for example mitigation (of) the effects on people and infrastructure (Vasilescu et al., 2008). This makes a DMC therefore a useful tool in NDM (Saban, 2014). Coetzee & van Niekerk (2012) unfolded the origin of the DMC in their paper, as prior to that very little agreement existed about where it originated from. Saban (2014) points out an important advantage of DMC, as it simplifies the understanding of disaster management process, by breaking the system down into smaller scale phases. Then each individual phase can be looked at separately in terms of who is involved in each phase, its institutions, measures related to each phase and the focus each phase sets.

3.3. Conceptual Framework

The conceptual framework for this research is shown in Figure 4. It was inspired by combining ideas from the already existing frameworks from Muzamil et al. (2022), Shaw et al. (2013) and Xiang et al. (2012). The framework from Shaw et al. (2013) groups stakeholders into two groups, information senders and information receivers, and only one group is involved in sharing risk information which I see as a limitation. Therefore, I see the need to expand this framework where stakeholders are not grouped and all risk information

is considered valuable, creating the opportunity for all stakeholders to communicate with each other. The Natural Disaster Risk Communication framework from Xiang et al. (2012) fulfils that. This CF's purpose and usefulness is to study how stakeholders communicate about indirect effects in NDM in Iceland.

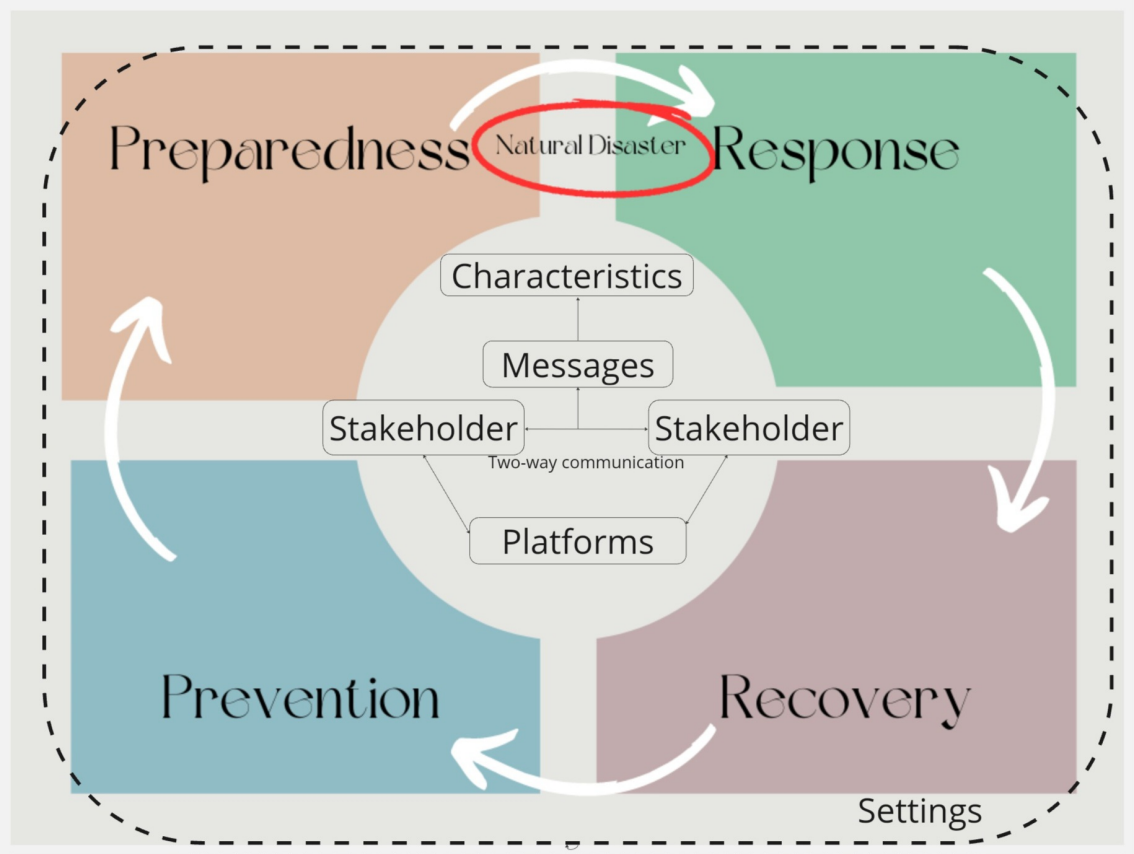

Figure 4. Conceptual framework (own creation)

Concepts from the image are described as following.

The core of the CF is the two-way communication between stakeholders. Stakeholders include a wide range of governmental organizations, non-governmental organizations and individuals, which all have in common that they deal with risk and effects of natural disasters. All stakeholders are important for the flow of information; both sides need to feel that they can share their thoughts, experiences, knowledge and opinions (Gurabardhi et al., 2005).

Messages are created by the stakeholders about natural disaster events. They are created from information gathered from NDM, knowledge, opinions, experience, concerns, etc., making it possible to create a message relevant to any aspect of natural disasters. The characteristics of messages are important since they impact the effectiveness of the communication. Those characteristics can be truth, accountability, clarity, concreteness, structure, correctness etc (Xiang et al., 2012).

Platforms are where discussion and dialogue on natural disaster risk and impacts between stakeholders occur. It can be e.g. physical meetings, conferences, exercises and formal letters along with technology platforms like TV/Radio, social media, emails, online

meetings and phone calls (Xiang et al., 2012).

Settings can include aspects like when, how and where messages are being communicated (Xiang et al., 2012). However, for this CF, the setting is focused on where the communication takes place. It is set out to be the four phases of DMC (See Figure 4). This allows for a narrowed focus on settings that lines with the interest in looking at communication between stakeholders inside NDM.

After the abductive coding process approach of the interviews, it was noticeable that a few themes (collaboration, future threats, messages and trust) were more eminent than others regarding indirect effects and communication in NDM in Iceland. It was therefore decided that analysing those themes would be beneficial to answer the research question. Therefore, the main relevant targets from the themes were decided on. Those targets would guide the analysis of collected data, with the relevant concepts from the CF, stakeholders, messages and platforms, in mind. With my knowledge from literature and the interviews I decided that the main relevant targers were, trust, sufficient messages and futurue communication.

- **Trust** - It is relevant to look at if there is a mutual-trustworthy atmosphere among stakeholders. All stakeholders are equal partners in natural disaster risk communication and are involved according to their responsibilities. All sit at the same table and have equal opportunities to communicate their own knowledge, understanding, opinions and feelings.
- **Sufficient messages** - It is relevant to look at if sufficient messages are provided by using clear language for appropriate audience. Thus, enabling all stakeholders with different attributes to understand the messages, interpret its relevance and make informed decisions.
- **Future Communication** - The relevance of this target lies in the increased threat of e.g. climate change. It allows for analysing opportunities and challenges that stakeholders are already facing or predict what can occur and how it can affect communication in the future.

There are other available targets out there regarding communication, see Covello (2003). These 3 were decided on as the most relevant ones for this research with the aim to answer the research questions.

This CF used for the analysis in this research is two-folded, where different parts of the CF will be the focus points for each subRQs.

The first step of the analysis will focus on the settings or the DMC since that part of the CF is needed for answering subRQ1. Therefore, the four phases; prevention, preparedness, response and recovery, are used as guidelines for the analysis of the data, locating each stakeholder in the relevant phases. This question is a stand-alone question addressing the information of what key stakeholders are involved in NDM of avalanches in Iceland regarding indirect effects. Once the key stakeholders have been identified, the interviews can be conducted afterwards, which leads to answering the other research questions.

The second step of the analysis addresses the middle part of Figure 4 and uses the circled middle part of the CF to answer subRQ2. For analysing communication among different stakeholders, the concepts in the middle (stakeholder, messages, platforms) are considered

more relevant for subRQ2 then following the four phases used for the first part of the analysis.

4. Analysis

This chapter consists of the analysis which is split into two sections. The first Section 4.1 identifies the key stakeholders and their placement in Natural Disaster Management (NDM) in Iceland regarding indirect effects, thereby answering the first SubRQ. The second Section 4.2 analyses how trust, sufficient messages and future communication influence the flow of communication in the system, answering the second SubRQ.

4.1. Creation of Stakeholder's map

The focus is on indirect effects and therefore actors involved with indirect effects are considered relevant in this case. Following is an overview of involved actors and institutions in the NDM in Iceland regarding indirect effects from current published literature and qualitative interviews:

The *national government of Iceland* is the highest authority with executive powers. While the President is the head of state, the Prime Minister of Iceland is the head of government. The government of Iceland is currently built up of 12 different ministries. Both members of Parliament and ministers have the right to present a new bill of law. The government is involved through all four phases of Disaster Management Cycle (DMC) since authorization in all those phases is their responsibility (Lög um almannavarnir nr. 82, 2008). However, Jóhannesdóttir & Gísladóttir (2010) points to the fact that the government has focused more on the responding phase when it comes to various disasters rather than the prevention and preparedness phase in disaster management. A way to balance out the focus is by increasing funding and education about natural disasters in the preparedness and prevention phase, and this would benefit the local residents by building up resilience during disasters (Jóhannesdóttir & Gísladóttir, 2010).

Ministry of Justice handles Civil Protection in Iceland and the responsibilities at the national level are in the hands of the *National Commissioner of the Icelandic Police* (NCIP). The. NCIP runs *Department of Civil Protection and Emergency Management* (DCPEM) (Almannavarnadeild Ríkislögreglustjóra, n.d.) which is responsible for assessments of natural hazards and risks, mitigation, coordinates efforts (i.e. planning, training and equipment), recovery, provide outside support to affected areas, maintains a national co-ordination center that can be activated at any given time, facilitate crisis communication and delivering information to the general public and experts. In cooperation with the Icelandic Meteorological Office, they host active social media pages, websites and mobile app. (Almannavarnadeild Ríkislögreglustjóra, n.d. Ómarsdóttir et al., 2022; van Well et al., 2018). DCPEM, therefore, has responsibilities in all four phases of the DMC.

The Icelandic Meteorological Office (IMO) is a governmental institution under the *Ministry of the Environment, Energy and Climate* (Veðurstofa Íslands, 2010). Some of their main tasks are monitoring, analysing, interpreting, forecasting, providing warnings and predicting natural processes and hazards where possible (Ómarsdóttir et al., 2022;

Veðurstofa Íslands, 2010). One interviewee pointed out that IMO should be located in recovery as well since they are always in the area monitoring and watching the consequences and giving out advice when it is safe to go into disrupted areas. Therefore the location of IMO is in prevention, preparedness and recovery phase of DMC.

The Icelandic Red Cross has a formal agreement with NCIP (Rapeli et al., 2018) along with having a legal role inside the emergency management system in Iceland (Ómarsdóttir et al., 2022). Their main tasks include; supervising emergency shelters where disaster victims can have safe facilities, meals, rest, counselling and psychosocial support (Ómarsdóttir et al., 2022; Rapeli et al., 2018). An interviewee mentioned that The Red Cross of Iceland should be located in preparedness since they are educating and building up a strong team of volunteers and ensuring that all their gear is always ready to use. That would land them in response, preparedness and recovery phase of DMC.

Natural Catastrophe Insurance of Iceland (NTI) is under *Ministry of Finance and Economic Affairs* and provides mandatory insurance that covers direct damages caused by avalanches, landslides, floods, earthquakes and volcanic eruptions (Náttúruhamfaratrygging Íslands, n.a.-a; Ómarsdóttir et al., 2022; van Well et al., 2018). Data from an interview revealed that no other insurance companies in Iceland provide insurance after natural disasters for housing. No Icelandic insurance companies insure for business disruption. NTI administrates *The Emergency Relief Fund*, located under *Ministry of Food, Agriculture and Fisheries*, it provides farming communities with financial compensation after natural disasters. Without the fund, their losses of farmland could be affected for a longer time (Náttúruhamfaratrygging Íslands, n.a.-b; Ómarsdóttir et al., 2022). (Hochrainer-Stigler & Reiter, 2021) mentioned that *insurance institutions* are part of risk management, making them an important stakeholder of NDM. Their location in the DMC is in the recovery phase of the DMC since they provide service to help minimize the financial burden after a natural disaster has occurred.

The Icelandic Avalanches and Landslide Fund was established to help municipalities and others to finance protection measures and relocate from unsafe areas (Matti et al., 2022b; van Well et al., 2018). One interview shed light on the fact that the Fund is operated under the Ministry of Environment, Energy and Climate which has the final say on handling financial distribution. Therefore, the location of this fund is in prevention phase in the DMC since it helps build up prevention from natural disasters.

Scientists and engineers monitor the equipment that can help detect possible natural disasters. Obtaining information about current situations can mean sampling, assessing, analysing and interpreting data for their expertise. They also need to communicate their findings, changes and abnormal behaviours to the right stakeholders (Denis, 1995; Jóhannesdóttir & Gísladóttir, 2010). Denis (1995) locates scientists and engineers in theory in response, preparedness and recovery phase of the DMC. For this mapping, an agreement is made with that statement of their location since the data collected is also in line with that. However, in practice and how broad the field of scientists and engineers is their location in the phases can vary.

Local authorities are the *local police* and the *municipalities*. The police in Iceland are located locally, divided into different regional jurisdictions (van Well et al., 2018). An

interviewee mentioned that the local police own the operation and is responsible for it, which makes it relevant to locate them in all four phases of the DMC.

The municipal governments in Iceland are the key authorities in mitigation and prevention of natural disasters when it comes to civil protection, planning and education in collaboration with other institutions (Matti et al., 2022b; van Well et al., 2018). They also have responsibilities in response and recovery phase giving information about emergency management and community restoration and rebuilding (Thordardottir et al., 2018). Interviews revealed that when a disaster strikes in a municipality, they will receive help to begin with but after a while, all first respondents will leave the area, leaving the municipality to deal with the aftermath. Both literature and interviews agree on locating the municipalities in all four phases of the DMC.

From the literature, it was clear that *local people* play an important role as an actor in NDM, and their role often does not get enough credit (Jóhannesdóttir & Gísladóttir, 2010; Matti et al., 2022b). The importance of local knowledge is recognized, and it is enforced by law that local people's information and consultation are involved in environmental planning. However, legislation on natural disasters and risk assessments is moving away from local involvement (Matti & Ögmundardóttir, 2021; van Well et al., 2018). Local people engage in large exercises in cooperation with civil protection local committees where pre-made plans and responses are tested (van Well et al., 2018). Therefore, with the information provided local people will be located in all four phases since they participate in all the phases of NDM. Same with the local businesses since they are run by local people and are affected similarly.

Literature on *The Iceland Association for Search and Rescue* (ICE-SAR) shows that one of their main focus is on response to direct effects. They are known for monitoring affected areas after disasters and directly supporting those affected (Ómarsdóttir et al., 2022). An interview with a member of ICE-SAR gave information about the institution and its role in prevention and preparedness phase. ICE-SAR hosts an active SafeTravel information web page that focuses on providing safety measures to tourists. That lands them a spot in NDM of indirect effects in prevention and preparedness.

Other institutions have been briefly mentioned in the literature or/and the interviews in relation to indirect effects which lands them a role in NDM in Iceland.

Health sectors main task regarding indirect effects is collaborating with other institutions to provide psychosocial support for natural disaster victims (Ómarsdóttir et al., 2022; Thordardottir et al., 2018). Allowing them to be located in the response and recovery phase of DMC.

Faith-based organisations often provide psychosocial support for natural disaster victims in collaboration with other institutions that provide similar services (Thordardottir et al., 2018) also mentioned in an interview. That lands them in the recovery phase of the DMC.

The Icelandic Food and Veterinary Authority operates under the Ministry of Food, Agriculture and Fisheries and is in charge when it comes to assessing the need for animal health and welfare, plant health and safety and quality of food and if any measures need to be taken regarding that when a natural disaster occurs. They do so by enforcing legislation

and providing education to relevant actors (Matvælastofnun, 2023; Ómarsdóttir et al., 2022). Therefore, their location in the DMC is set for prevention and recovery.

The Icelandic Institute of Natural History (IINH) is a government agency under the Ministry of the Environment, Energy and Climate, their role is written into the Icelandic laws. The primary roles of the IINH are; broad monitoring, conducting research regarding zoology, botany and geology of Iceland, handling nature documentation in Iceland and handling research findings along with providing advice and education (Náttúrufræðistofnun Íslands, 2023). This information provides the knowledge of locating IINH in the prevention phase of DMC.

The Environment Agency operates under the Ministry for the Environment, Energy and Climate. Its role is to promote protection and sustainable use of natural resources, provide information for air quality and public welfare by ensuring a healthy environment (Ómarsdóttir et al., 2022; Umhverfisstofnun, 2023). Therefore, it seems that their location should be in the prevention phase of DMC.

Figure 5 shows a stakeholder map of the above-mentioned stakeholders and their relevant locations in the DMC in relation to this research.

Sub-conclusion

This analysis supports the answer to the research question asking what stakeholders are involved in NDM of indirect effects from avalanches in Iceland. Showing that there are many stakeholders involved in NDM in Iceland when it comes to indirect effects and their roles are wide and complicated. The stakeholder map clearly shows that some institutions and stakeholders take part in all of the phases of NDM while others have more specific tasks, which locates them in one or two phases of the DMC. Many of the stakeholders' tasks and roles are also directly related to direct effects, making it often hard to separate those two effects since many of the same stakeholders are dealing with both types of effects after a natural disaster event.

4.2. Communication of Indirect Effects

For this part, the analysis will follow the middle part of the Conceptual framework (CF) (see Figure 4 and Section 3.3.) focusing on stakeholders, messages and platforms to study the communication between different stakeholders. The relevant targets from the CF will be the guiding themes for this analysis for answering the SubRQ2, those being; trust, sufficient messages and future communication. It is not deemed necessary to divide this section into each phase of the DMC as it is evident from the analysis in Section 4.1. that the same stakeholders are often involved in all four phases. The interviews also revealed that all stakeholders recognize the issue of indirect effects. When interviewees were asked to mention indirect effects they were dealing with, examples regarding prevention and recovery phase were dominant. For examples of prevention of indirect effects it was mentioned; hazard mapping, evaluations for possible natural disasters and funding for prevention infrastructure. Lastly, in recovery after a natural disaster it was regarding social well-being with support and assistance to various social groups with insurance money to affected individuals.

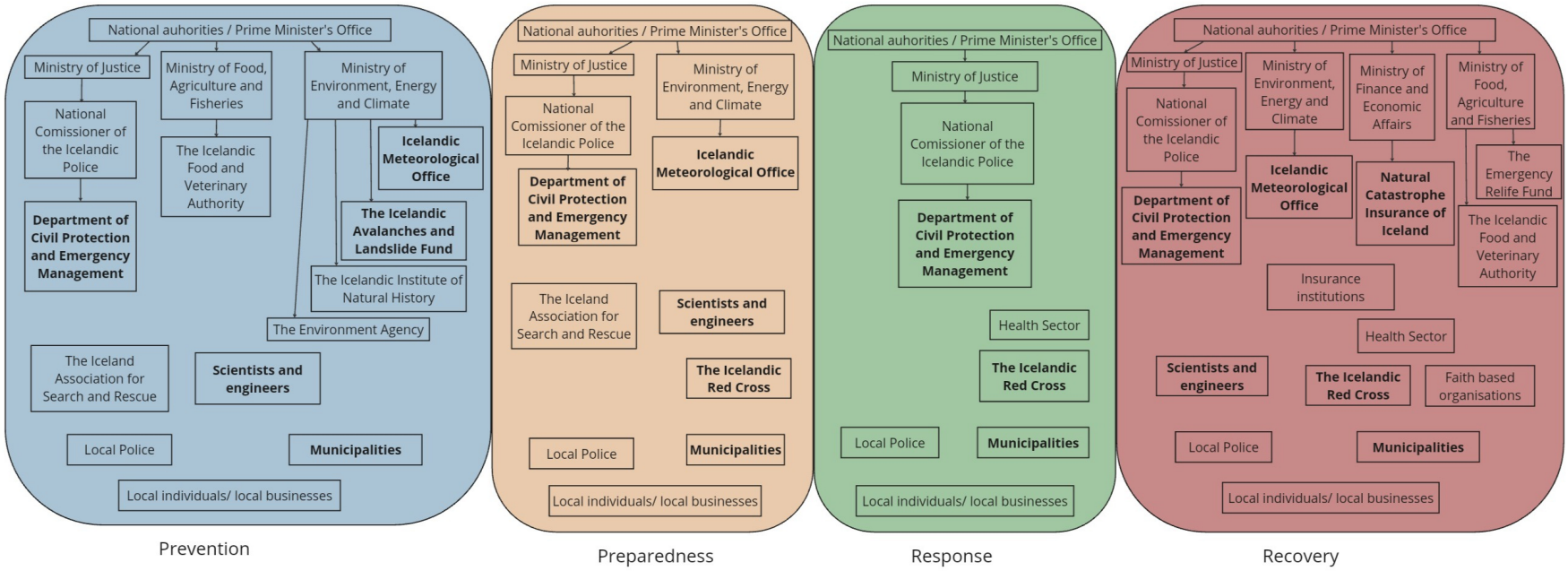

Figure 5 Stakeholder map (own creation)

4.2.1 Collaboration between stakeholders

Indirect effects are being communicated in NDM among the stakeholders. The amount of communication depends on how much the stakeholders are involved in the indirect effects, since that can vary depending on the stakeholders' tasks and responsibilities. Through the interviews it was evident that some stakeholders are more involved with some specific stakeholders over others. One mentioned how they are mostly working with Department of Civil Protection and Emergency Management (DCPEM) and the local police, another how they were mostly a driving force for the municipalities and a third pointed out that they are either working for or with the stakeholders they are communicating with.

During the interviews with stakeholders in NDM it was noticeable that the phrase long-term effects were a more common phrase to use than indirect effects in Iceland. Overall, it seemed that stakeholders were clear when examples of long-term effects were discussed that they actually were indirect effects.

Interviewers feel that they have the opportunity to express themselves freely. Both before the event and then later on during the aftermath. People have started to express themselves more openly about what could be improved. There are mandatory peer-review meetings allowing people to share their opinions. However, one interviewee stated that they sometimes can't express themselves completely freely, all depending on the situation. For example when there is an active event, there is only time for relevant discussions.

All interviewees agree that there exists trust between the stakeholders. Even though some things could be improved in NDM, such as information sharing when disaster occur. Despite frequent discord between municipalities, national government, institutions and others regarding who should have which responsibilities, there is still trust.

Stakeholder Involvement

As evident from the Stakeholder map in Figure 5, a few stakeholders have task requirements that locate them in all four phases of the DMC, while others have more focused and specific tasks locating them in one or two phases. Therefore, according to the interviews, communication between the stakeholders is happening throughout the entire DMC and is considered relatively good. They communicate prevention strategies, risk assessments, contingency plans, response and aftermath. The interviews showed that there is a general agreement about who is involved in NDM and most interviewers consider that at this point the system involved those that truly matter when it comes to indirect effects. One commented that Icelandic NDM is lucky because the cooperation is good and people are informed about each and everyone's tasks. However, the interviewees also mentioned that some stakeholders in NDM could be involved earlier in the process, as one interviewee mentioned.

> *Some stakeholders should be involved earlier in the process even though they may not have a big role, that being involved in earlier stages gives them the knowledge on what is going on and then they will have better opportunities to prepare themselves when it comes to them to take over the tasks that need to be taken over because those are long-term tasks. Then also, the ones that are*

> *early on in the process they should be informed about the long-term tasks so they could have gained deeper knowledge about what is done in the aftermath with regards to the long term. I think by doing that all stakeholders would have more insight into the whole process.* (Interview, 17/04)

Notable improvements have occurred in relation to stakeholders' involvement over the last couple of years. Furthermore, it was pointed out that the municipalities are often left out or involved too late in the process, feeling that they do not get enough space in NDM and their authority gets over-stepped. Clear disagreement existed regarding if interviewees found tasks and responsibilities clear for municipalities. While some said it was clear others criticized that the roles of mayors and municipal managers were unclear, one adding that municipalities do way more than their defined roles.

> *ICE-SAR and fire chief have all of a sudden started to run the operations, those are subordinates to the municipalities and they have started to say what needs to be done. In reality, they don't have any authority to do so. Then some staff from NCIP don't have the authority to handle capital funds of the municipalities. Once, mayors were in the system to approve and grant permissions to do things and now they are more for show is my feeling rather than they have an actual role.* (Inteview, 21/04b)

Having all responsibilities and tasks clear will help with erasing confusion and hesitation and also make sure that boundaries are not overstepped when it comes to the line of authority. This is not the case when it comes to the municipalities and therefore a closer look needs to be given to the line of authority.

Line of authority

Interviewees talked about the line of authority and confusion in the system when it comes to indirect effects. Section 4.1 shows how many ministries are operating different institutions considering indirect effects. One interviewee mentioned that it was interesting that there were many ministries operating all those different institutions and listed it as a possible challenge for communication between the different stakeholders in NDM. Another agreed that it is a challenge but the solution is not to put all the stakeholders under the same ministry. It would not work with one ministry operating everything since there are so many different angles that get affected after a natural disaster. The schools and hospitals that are affected are under different ministries. Same interviewee mentioned a possible solution regarding better coordination between ministries, and that there is only one ministry that can coordinate the other ministries, The Prime Minister's Office, with the highest authority in Iceland.

It was criticized that communication regarding natural disasters will never be efficient enough if the Ministry of Justice continues to rule over the other ministries since it is located at the same administration level. *"Minister of Justice can continue to have responders, police, fire brigade, search and rescue teams and all those. Communication needs to be strengthened on this top administration level and ensure that all ministries*

realize that." (Interview, 09/05). A possible solution this interviewee recommended was to move DCPEM under the Prime Minister, allowing true coordination without any doubt of line of authority. How the current Icelandic laws for Civil Protection is written, gives the Ministry of Justice authority. The minister in charge of civil protection is the highest officer of civil protection in the country"(Lög um almannavarnir nr. 82, 2008). That was critizised during the interviews, since that is not the ministry with the highest authority to truly coordinate the other ministries.

Some interviewees argued that communication with the national government is often unclear and stiff. There is such a hierarchy and often you are in a meeting with people where no one has the authority to make the decisions that need to be made, and this can cause a delay in actions. Communication between the government and local people and the municipalities was pointed out as defective.

Few interviewees mentioned how authority is not always clear when it comes to the municipalities. It is stated in the law that the municipalities hold civil protection responsibilities in their districts in cooperation with the administration (Lög um almannavarnir nr. 82, 2008). However, it is not clear in the laws if the NCIP needs to communicate to the municipalities when a natural disaster occurs, as it states that they have to contact the local chief of police. This ambiguity resonates with one of the respondents.

Respondent argued that the law puts the local chief of police in each district in many places where the municipalities should be at the front. Since the local chief of police cannot tackle prevention, preparedness, or other responsibilities regarding institutions inside the municipalities, this should be the responsibility of the municipalities alongside the national government. Two interviewers considered that the laws were written as such possibly because smaller municipalities lack the resources to be drivers of civil protection in their districts. It was mentioned that the municipalities in the capital region have better resources to follow through on this matter. In the end, the municipalities are the ones that need to solve the problems that occur inside their district. There is a need of an empowerment to the municipalities so they can step up to the role, which is an important factor when it comes to involvement in communication.

> *...if the role and the responsibilities of each stakeholder are not clear, then it is not clear who is supposed to do what. When everyone has a clear role and responsibilities communication is so much easier because people know their tasks and people just have to coordinate their tasks. When it is not certain where the responsibility lies then the flow of communication is much less effective and so much time that goes into the discussion about what belongs to who and where.* (Interview, 17/04)

Lastly, interviewee talked about how ultimately the municipalities need to be in the driver's seat for NDM in their region. All uncertainty of what their tasks and responsibilities are, and what the line of authority is, needs to be erased.

4.2.2. Sufficient messages

Most stakeholders partaking in the interviews commented that they hoped that all messages that came from them were clear and easy to understand. It is a priority for them to communicate efficient messages. They work on trying to simplify the messages that are being sent out. *"That is the goal. We try to send everything out from us in as simple way as possible. We take away a lot of the references to the law"* (Interview, 21/04a). Messages of indirect effects are mostly targeted towards Icelandic audiences. Some stakeholders however, communicate their messages in other languages, English being the second language, followed by Polish which few of the stakeholders mentioned. *"Because that is very often at least large position of people from Poland that live in Icelandic societies. We have translated information into other languages (...) But when it has involved natural disaster events in the last years we have translated it into those three languages"* (Interview, 17/04). The understanding of having clear and sufficient messages was high among the interviewees.

The most frequent messages of indirect effects communicated among stakeholders can depend on who the audience is. Messages sent to national authorities can differ from those sent to local individuals. Interviewees most frequently mentioned messages regarding indirect effects were;

- Being aware of possible indirect effects
- Mental aspects
- The importance of providing information in different ways to be able to reach everybody
- Roles of each individual institution
- What people can expect in the long-term and the rebuilding of the society in the recovery phase.

The interviews revealed that different platforms are being used to communicate with other stakeholders. Individual preference and work area effects what type of platforms are most frequently used. Meetings in person and online, emails, phone calls, formal letters, conferences and exercises were listed as ways of communicating.

Few interviewees mentioned improvements after Covid regarding communication. DCPEM hosted more frequent online meetings regarding information for civil protection. Those online meetings have helped tremendously regarding information sharing since the location of people does not matter and during those meetings the institutions involved can go through their operations and possibilities regarding natural disasters. This also created a connection between different stakeholders, as some interviewees mentioned that communicating and sending messages is deemed easier when stakeholders are acquainted.

Finally, it is not always only the messages that matter when it comes to trusting the messages but also who communicates the messages *".... all proposals that we provide are built on some personal trust. It depends on who is saying things. We are always watching who says that and what experience that person has. It might not always be just the company but also what individual provided the information"* (Interview, 08/05)

4.2.3 Future communications among stakeholders

There was consonance in the interviews that increasing climate change will create new challenges in NDM for institutions, such as; increase in areas that will be listed as hazard zones, more resources needed, monitoring new and different challenges, more extreme weather and increased indirect effects. On the other hand, climate change is not something that is coming as a surprise regarding indirect effects of natural disasters. Indirect effects that are climate change related go into similar paths as other challenges that stakeholders are currently facing. Climate change is already incorporated as one of the focus points into policies regarding civil protection and security matters in Iceland. People living in areas prone to natural disasters are well prepared. However, natural disasters are now occurring in new areas, with people who are less prepared. Increased tourism increases the risk of less prepared people in possibly affected areas, an issue listed as a challenge for climate change. Some municipalities are facing the threat of not having any more land to build on since hazard zones are increasing, which can affect future insurance claims since there is already text in Natural Catastrophe Insurance of Iceland (NTI) regulations stating that obligation to compensation can be eliminated if a house is built on land that is known in advance to be in a hazard area.

There was incoherence amongst the interviewees regarding future indirect effects from climate change challenges, and if those would be considered opportunities or a challenges concerning flow of communication between stakeholders. Some interviewees did though mention that it could be both. Where it was mentioned that *"I think flow of communication will be much more complicated and difficult"* (Interview, 21/04b). One talked about the challenge that people in smaller municipalities might not be ready to accept that municipalities might need to change their land use or run out of building areas due to increased disaster threats. This can cause stiffness in communication between involved stakeholders, e.g. municipalities and NTI.

Even though there are increased challenges, there are also opportunities for communication in NDM. Few mentioned that there was an opportunity for more collaboration, both with strengthening cooperation with agencies that stakeholders have less communication with and practicing more frequently will increase knowledge among the stakeholders, allowing people to get to know one another better. One interviewee mentioned that trust increases when the channel of communication is shorter. Another opportunity mentioned lied in visibility regarding natural disasters in the media, increased visibility can lead to more communication.

Additionally, another possible future opportunity that could help in communication between stakeholders and make it smoother in times of stress, as said by one interviewee could be;

> *Could see that the Icelandic Association of Local Authorities had some specialists that would go out to the municipalities when they are hit with disasters because everyone inside the area are in distress. Some neutral party to go in and be their ally that could catch some balls that are up in the air and help with that* (Interview, 21/04a)

One interviewee mentioned similar idea, that was tried recently in Neskaupsstaður after the avalanches in March 2023. The municipalities provided the affected residents a neutral lawyer who main role was being there for the people and he would even attend meetings with the people. That was a positive experience and step in the right direction according to interviewee since talking to people that are emotionally upset can be difficult.

Furthermore, it was mentioned that sustainability is an area that should be more in focus from the municipalities side since, in the long run, that will help them tackle indirect effects from inside their own communities. If regional development inside the municipalities is not sustainable, then the future is unsecured and challenging with lack of knowledge on how to tackle indirect effects.

Sub-conclusion

Results show that trust has been cultivated through communication and collaboration between stakeholders, by ensuring everyone that needs to be involved is in the loop of the system. Though some stakeholders in NDM in Iceland could be involved earlier in the process. Municipalities are often left out or involved too late in the process, feeling that they do not get enough space in NDM and that their authority gets over-stepped.

Stakeholders communicate with each other throughout the entire DMC. Communication is considered relatively good. Indirect effects that stakeholders are dealing with and communicating in Iceland are; prevention strategies, risk assessments, hazard mapping, contingency plans, funding for prevention infrastructure, social well-being, and assistance through insurance compensation.

The study supports Risk Communication theory that there is an interactive process in NDM in Iceland, where stakeholders can communicate information and opinions. Trust between stakeholders means that communication is easier, and cooperation is better when people know each other. People were open about how they and others could express themselves. Stakeholders are providing sufficient messages, with the most frequent messages of indirect effects being; awareness of possible indirect effects, the importance of sufficient information that can reach everybody, institutions' roles, mental aspects and rebuilding of society.

With the awareness of future challenges and opportunities, there is a chance for better cooperation and communication in the future. There was consonance in the interviews that increasing climate change will create new challenges for institutions in NDM in Iceland. Stakeholders look at those increased threats as either opportunities, challenges or both regarding future communication.

5. Discussion

To my knowledge, this is the only study on how indirect effects of avalanches are communicated between stakeholders in Natural Disaster Management (NDM) in Iceland. Previous studies in Iceland have focused on one or more of the following aspects; communication, management, indirect effects and natural disasters, usually on volcanic studies, emergency management and response, risk perception and risk communication

towards tourists, see (Bird et al., 2010; Bird & Gísladóttir, 2020; Bird et al., 2011; Bird et al., 2018; Jóhannesdóttir & Gísladóttir, 2010; Matti et al., 2022a; McCoy & Hartmann, 2015; Räsänen et al., 2020).

5.1 The Stakeholders Map's Contribution

Section 4.1 in the Analysis supports the theoretical approach of Disaster Management Cycle (DMC) and that the entire cycle is used in NDM in Iceland. It supports the advantage of using the entire cycle with all phases, which leads to better preparedness, improved warnings, reduced vulnerability, reduced impact and creates knowledge and prevention. Document and interview analysis revealed that key stakeholders communicating indirect effects of NDM in Iceland are at its core the same as the stakeholders listed in the literature in Introduction (see Section 1). The stakeholder map also shows that there are quite a few key stakeholders in the management system of indirect effects, which could complicate the line of communication between all the different stakeholders.

Never in the study process nor during the interviews, was a mention of a map currently existing. Therefore, the map is a contribution towards NDM in Iceland and creates a clearer understanding of who is involved in management of indirect effects of avalanches in NDM in Iceland. The creation of the stakeholder map aimed to simplify and visualize the stakeholders in the system. With all different ministries operating different institutions, interviewees mentioned how complicated communication could get.

5.2 Current and Future Communication of Indirect Effects

Indirect effects of avalanches in NDM in Iceland are recognized by stakeholders, suggesting that indirect effects are involved, on some levels, in strategies and policies regarding NDM in Iceland. Despite this, it was noticeable how connected direct effects and indirect effects are, when stakeholders talked about them and gave examples. It is clear that these concepts follow each other closely and are often not separated in discussion inside NDM in Iceland. When examples were given stakeholders often listed both direct- and indirect effects, with direct effects having more attention. This is in line with the literature, stating that direct effects and indirect effects are associated with one another (Botzen et al., 2019). Less focus on indirect effects can be due to long-term economic effects of natural disasters not being as well understood as direct effects, with fewer studies exploring the indirect effects (Botzen et al., 2019; McDermott, 2012).

Climate change will be increasing pressure on all involved stakeholders in NDM, with more frequent avalanches in the upcoming years and decades (Khurana et al., 2022). With increased challenges, it is important to focus more on indirect effects, since literature has shown that those effects are just as important as direct effects (Antonioli et al., 2022), as prevention of indirect effects will benefit risk reduction. Current communication is considered good regarding indirect effects. However, it is not given that future communication will remain good if communication stays the same. Increased climate change threats can cause a challenge for communication, and natural disasters are not only going to increase, but the scale of disasters will also increase. Concern was raised that communication of indirect effects will become more complicated with more threats. Furthermore, current challenges regarding clear definitions of roles and responsibilities

for stakeholders to understand where their line of authority lies can escalate with an increased scale of threats. With the increased threat of climate change, it is important that the existing funds for prevention and compensation from insurance after avalanches are intensified to fulfil all the future needs of threats as best as possible.

Successful implementation of indirect effects in communication needs robust strategies and policies. With more focus on strategies, policies and legislation regarding indirect effects the chances for more focus will increase. Additionally, there are also good things in current communication among stakeholders which focus should continue on. Trust is high, there is freedom to express yourself, and sufficient messages are provided. All those are worthy qualities for future communication.

Significance in the data showed discord between the clear definition of tasks and responsibilities for the municipalities and others overstepping the municipalities' authority. Analysis in Section 4.1 on the municipalities shows that they have tasks and responsibilities throughout the entire DMC and are the ones that should be making strategies and policies regarding indirect effects that could occur in their region. These results build on existing evidence that there is lack of focus regarding indirect effects and involvement of municipalities (Bernharðsdóttir et al., 2020). Implications towards the lack of focus regarding indirect effects can have negative consequences, such as; less communication directives and missed opportunities regarding risk reduction. For municipalities to grow stronger and step up and take the driver's seat for indirect effects, empowerment would have to come from inside the municipalities. This allows the municipalities to set their own agenda for reaching more inclusion.

The municipalities are often marginal in communication when it comes to recognition and their responsibilities, identifying a problem that goes beyond the scope of this project. It is beyond the scope of this study to look at the inner structure of the municipalities and what they can do to ensure that their involvement in NDM is not overlooked. Further research is needed to establish a better understanding on the municipalities and how the problems regarding lack of defined tasks and responsibilities and authority being overstepped can be resolved. Further research could also point towards how to incorporate indirect effects more into the responsibilities of municipalities.

6. Conclusion

Natural disaster management (NDM) is vital to be able to mitigate risk, direct- and indirect effects of natural disasters. An important aspect of NDM is communication, which provides both opportunities for collaboration and increased visibility and understanding of natural disasters, but also more complexity in the future. With increased climate change, natural disasters will become more frequent and severe, showing the importance of attention towards communication for risk reduction. Even losses from indirect effects can be more severe than those of direct effects. Furthermore, indirect effects are less understood than direct effects and are a less researched phenomenon. They do, however, appear as relevant as direct effects and need further attention, something that this research has addressed. To fill the research gap, the research explores stakeholder in NDM in Iceland, communication between stakeholders and how much attention indirect effects get in NDM in Iceland.

To explore stakeholders in NDM in Iceland, a stakeholder map regarding indirect effects of avalanches showed many stakeholders in NDM in Iceland. Making it noticeable that some institutions have tasks and responsibilities in all four phases of Disaster Management Cycle (DMC), while others are involved in fewer phases.

As communication is an important aspect of NDM, the flow of communication amongst stakeholders was explored. Many different aspects can impact the flow of communication, like; trust, connections and cooperation. The study shows that the flow of communication is considered relatively good. There is trust between the stakeholders, allowing smoother communication and better cooperation when people are at least acquainted.

Indirect effects of avalanches are recognized in NDM in Iceland. The indirect effects gaining the most attention were e.g. prevention strategies, risk assessments, hazard mapping, funding for prevention infrastructure and social well-being. It is important to show continuous attention to indirect effects, as they can linger on for a long time, such as mental side effects from avalanches in Iceland almost 30 years ago. Hazard mapping is also required to ensure that new infrastructure and residential homes are not built in hazard areas. The indirect effects are part of some strategies and policies in NDM in Iceland. However, their connection to direct effects seems hard to break and more often those two concepts are communicated simultaneously.

To communicate these indirect effects, stakeholders use various platforms, which supports the literature stating that information needs to be accessible through multiple platforms. A few interviewees pointed to opportunities in future communication such as local authorities sending independent specialists to affected areas to help in times of distress.

One significance of the data was the discord between the clear definition of tasks and responsibilities for the municipalities and unclear lines of the municipalities' authority. Implications towards the unclear line of authority can lead to frustration and confusion for the institutions which can end up harming communication and trust. For risk reduction, communication must be strong between the stakeholders. As long as at least one involved stakeholder is criticizing that roles and authority are unclear, then there is a flaw regarding how laws and legislation are written, which can harm future communication. Better and clearer definitions of tasks and responsibilities will lead to a better understanding of who is doing what. These improvements may only be achievable with changes to the laws.

Lastly, as this research conceivably is the first research on how indirect effects of avalanches are communicated between stakeholders in NDM in Iceland, it can be used as a starting point for further research regarding communication between different stakeholders and the involvement of indirect effects in NDM in Iceland. This will help increase the attention on indirect effects and give them more focus, since they are just as important as direct effects.

6.1. Reflections - Applicability of the Research

Stakeholders, legislation and disaster management regarding avalanches are considered similar between other natural disasters in Iceland e.g., volcanic eruptions, earthquakes, flooding and severe storms. Therefore the applicability of the research to other natural disasters that occur in Iceland is considered to be high. One aspect that might vary is the different actors inside institutions participating in NDM. There are specialists in different

natural disasters, different municipality members, police officers, local people e.g. that could change depending on location and event.

Furthermore, this research is applicable to other Nordic countries where there is a similar and strong NDM systems. Some of those Nordic countries are facing challenges regarding avalanches and landslides. Therefore, governments of Nordic countries are likely to have a political and legislative focus on indirect effects of avalanches, making this research relevant for Nordic Countries. However, there might be aspects such as different structures of their NDM systems or their legislation that differentiate cases.

Nonetheless, most countries with NDM systems and those that face increased natural disaster challenges due to climate change can also apply and learn from this research for inclusion of indirect effects. One interview mentioned that after talking with a specialist in earthquakes in Türkiye in February 2023 and how the municipalities are dealing with their regular responsibilities day-to-day. Then when the earthquakes happened their civil protection department and even the Ministry of Foreign Affairs came and pushed the municipalities to the side. They did not know how the municipalities work, and were there for a short period and then left making the municipality deal with the aftermath. Overall, other cases looking at applying indirect effects in NDM and how to incorporate well-established communication around those effects might be inspired by this research. It might be interesting for similar studies to apply this extended conceptual framework to analyse the flow of communication of stakeholders to derive the opportunities and challenges to establish a good communication among stakeholders.

Declaring of competing interest

The author declares that they have no known competing interests in any form that could have appeared to influence the work reported in this paper. There was no financial support regarding this research.

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Appendix A

Interview Guide

Briefing

- The interview's purpose is to gather information about the current status of communication in Natural Disaster Management in relation to avalanches in Iceland. With a focus on indirect effects through all phases of Natural Disaster Management cycle.
- Names will be anonymous. The aim is not to use names for the analysis.
- The interview is estimated to take around 30-60 minutes
- The meeting will be recorded - unless asked not to. Only reason for recording is to help with transcription for data analysis. All records will be deleted after graduation.

Indirect effects:
Natural disaster impacts are often categorized into direct effects and indirect effects and both cause economic and social structure disruptions. Direct effects can lead to indirect effects since the latter is often connected with the former and it can cause ripple effects along the economic activities. Losses from indirect effects can even be greater than damage from direct effects. The indirect effects can be listed as examples;

- reduced economic production or income due to business interruption
- supply chain disruptions
- loss of revenue
- unemployment
- market destabilization
- increased indebtedness
- inflation
- change in welfare and equality
- poverty increase

Stakeholders:
Through literature, these have been considered as key stakeholders in Natural Disaster Management

- Natural Government
- Municipalities
- Department of Civil Protection and Emergency Management
- The Icelandic Meteorological Office

- Iceland Association for Search and Rescue
- The Icelandic Red Cross
- Local people (volunteers) / local businesses
- Insurance companies (funds)
- Scientists / engineers

Any information about other key stakeholders especially in relation to indirect effects of natural disasters are greatly appreciated.

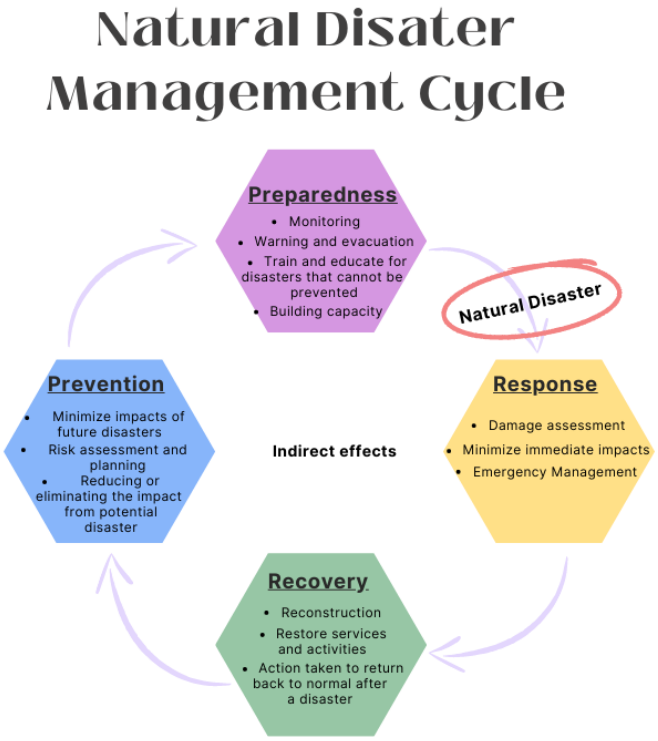

Figure 6. Natural Disaster Management Cycle (own creation)

Questions

1. What is your work area and position? (position, time in position, responsibilities etc)
2. Do you recognize the issue of indirect effects of natural disasters in your work?
3. How is your company/department/institution affected by indirect effects caused by natural disasters/avalanches?
4. Is your institution using adaptation or management strategies/policies to target the reduction of indirect damages caused by avalanches?
5. Is your institution communicating indirect effects with other key stakeholders in Natural Disaster Management?
6. Are indirect effects being communicated between stakeholders through all four phases of Natural Disaster Management?
7. What are the most frequent messages of indirect effects that are being communicated through your institution?

8. How are messages presented so all stakeholders with different abilities understand the messages?
9. Where do you see the need for more communication/cooperation between stakeholders/decision makers?
10. Do you believe that all stakeholders are involved that need to be involved in communication about indirect effects of avalanches in Natural Disaster Management?
11. How would you describe the status of trust between stakeholders in Natural Disaster Management in Iceland?
12. Do you sense that all individual stakeholders have the opportunity to express themselves?
13. Are there any opportunities in flow of communications between different stakeholders in relation to indirect effects?
14. What challenges/obstacles are or could be in the flow of communication between different stakeholders in relation to indirect effects?
15. Do you expect your institution to face new challenges in managing indirect effects caused by climate change? If yes, then which challenges?
16. Do you see new climate change challenges as opportunities or obstacles when it comes to collaboration and communication with other stakeholders?
17. Are you aware of those who are involved in Natural Disaster Management in relation to avalanches through all four phases of NDM cycle; prevention, preparedness, response and recovery?
18. Do all stakeholders get enough space in the Natural Disaster Management?
19. Who do you collaborate/communicate with the most outside of your work in relation to natural disasters?