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Preface

As is customary, I would like to convey a thanks to those that have enabled me to write this master thesis. I look back at the five years of studying with both pride and happiness, and realize that I have a large list of people which have, through both small and large encounters, enabled me to be where I am.

I would like to start off by thanking my parents. They have supported me through these five years of studying, both emotionally and financially. I would not be where I am now without their support, as their financial support has allowed me to stay in Longyearbyen and study at The University Centre in Svalbard for two semesters.

I also thank my supervisor, Bjørn Ivar Kruke. He has been instrumental in guiding my master thesis, especially in the first two months. His knowledge in the field and experience as a supervisor has enabled me to formulate a master thesis which is highly relevant for the future. It was also through him that I was able to be a informal part of the ArctRisk-Project, which enabled me to do data collection which I otherwise would not have been able to do.

Furthermore, I would like to thank PHD research fellow Stig Andreas Johannessen from Arctic Safety Centre, The University Centre in Svalbard. Our daily discussions at the office, both relevant and less relevant topics, are invaluable. They enable me to both reflect on my master thesis and create enjoyment in the time spent at the office. Having someone to talk to is invaluable.

Lastly, I would like to thank the faculties of both University of Stavanger (UiS) as well as The University Centre in Svalbard (UNIS). I am grateful for the opportunity through UiS to study at Svalbard through UNIS. At the same time, I am grateful for the helpful staff of UNIS which enabled me to have an office of my own, with perhaps the most advanced computer and screens. Although I may or may nor have receive the office due to an administrative error, they were very cooperative in my retainment of the office as long as it was not needed by other students. For this I am very grateful.

Summary

Climate change in the arctic is occurring at a faster rate than the rest of the world. One such example is the fact that the increase in temperature in the arctic is twice that of the rest of the world (NCSS, 2019). Change in perspiration, rising temperatures and higher frequency of flooding are some of the effects which climate change have on the environment in the arctic region (NCSS, 2019). These changes in climate affects climate-related hazard risks, affecting both the frequency of which climate-related hazard risks can occur, as well as its consequences. These changes in environment and its effect on climate-related hazard risks are of importance to Longyearbyen, the only Norwegian town located in Svalbard. Longyearbyen is faced with a multitude of different climate-related hazard risks, such as snow avalanche, flooding, debris flow and rockfall. In addition, it has a diverse population with over 40 different nationalities, and an everchanging demographic (SSB, 2012). The inhabitants of Longyearbyen must therefore live with these everchanging climate-related hazard risks right at their doorsteps, while receiving risk communication from the authorities about these risks. It is the risk communication from the authorities to the inhabitants regarding these climate-related hazard which is of interest.

This master thesis therefore seeks to explore how the local authorities in Longyearbyen are communicating climate-related hazard risks to the inhabitants of Longyearbyen, through four research questions. The method utilized in this master thesis is one of embedded single-case design, with an explorative abductive approach. The method utilized in the data collection is a methodological triangulation. The empirical chapter is based on fieldwork, quantitative survey, qualitative interviews and document study.

The major empirical findings suggests that the authorities in Longyearbyen have a strong foundation for short-term risk communication, where the foundation is utilized to focus on snow avalanche related risk communication. This enables a well working short-term risk communication for the risk of snow avalanche in Longyearbyen but leaves little to no attention for short-term risk communication regarding the risk of flooding, debris flow & rockfall in Longyearbyen. Likewise, the authorities have a strong foundation for long-term risk communication. It has been identified that their long-term risk communication focuses on snow avalanche leaving little to no attention to the risk of flooding, debris flow & rockfall in Longyearbyen. Additionally, the authorities' webpages are formulated in an academic way,

creating a barrier for ordinary inhabitant to both read and understand it, transforming the content from information to documentation.

This master thesis concludes that the authorities in Longyearbyen have a strong foundation for both short-term and long-term risk communication, but its focus on snow avalanche risk communication increases the inhabitant's reliance on society-wide networks such as webpages for information regarding other climate-related hazard risks flooding, debris flow & rockfall. The authorities are also not adequately advertising this information, reducing the awareness of such information, as well as the information being formulated in an academic way, resulting in the content transforming from information to documentation. This master thesis highlights three recommendation which could be implemented to improve the long-term risk communication of the risk of flooding, debris flow & rockfall in Longyearbyen, which overall would improve the authorities overall risk communication of climate-related hazard risks in Longyearbyen.

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1. Introduction

1.1 Background

Longyearbyen is a small city in the Arctic, on the Svalbard archipelago. It is the only Norwegian city located in Svalbard. If planned today, it would never have been built at its current location, due to a variety of climate-related natural hazards present in that area. These climate-related hazard risks include the risk of snow avalanche, flooding, debris flow and rockfall. The NCCS report about Climate in Svalbard 2100 presents a picture of the arctic region where the environment is changing due to the effect of climate change. These changes include rising sea levels, change in perspiration, rising temperatures and higher frequency of flooding (NCSS, 2019). In comparison to the rest of the world, temperature increase in the arctic region is happening twice as fast (NCSS, 2019). These climate-related changes in the environment have the possibility of affecting both frequency and consequence of snow avalanche, flooding, debris flow and rockfall in Longyearbyen.

Furthermore, due to Longyearbyen's location being in the arctic region, it faces certain challenges, which are described as the "the arctic operational context" (Albrechtsen & Indreiten, 2021). These challenges consist of (1) *harsh weather conditions*, (2) *remoteness*, (3) *limited access to infrastructure and resources*, (4) *lack of knowledge and experience data in the arctic* and (5) *climate change* (Albrechtsen & Indreiten, 2021).

(1) The weather conditions in Svalbard consist of low temperatures, challenging climatic conditions such as atmosphere icing, icebergs, strong winds and heavy snowfall. Arctic fog, rapidly changing weather, extreme local variations and variable amount of daylight are some of the weather conditions, which exist in Svalbard (Værø et al., 2018). (2) Due to the location of Svalbard, the population are on their own to deal with any emergency situations, since help from the mainland will take quite a long time. This means that the population in Svalbard would need to be extra flexible (Roud et al., 2015) and having an interorganizational response to any emergencies utilizing all local resources (Andreassen et al., 2020). (3) Connected to the second point of remoteness, due to the large distance, infrastructure in the arctic are often lacking. Usually there is a lack of access to infrastructure such as maintenance facilities, communication platforms and roads (Taarup-Esbensen, 2021). (4) Limitations on available knowledge and experience makes it harder to both assess risk-influencing factors (Khan et al., 2015; Taarup-

Esbensen, 2021) and deal effectively with unforeseen problems. Lastly, (5) climate change affects the arctic twice more then on the average global mean (AMAP, 2019). This is an important factor, which will make the lack of knowledge and experience even harder to achieve, as the climate is constantly changing.

In addition to this, the demography of Longyearbyen is somewhat unique. There live around 40 different nationalities in Longyearbyen (SSB, 2012). The population of Longyearbyen is also changing rapidly, where inhabitants are leaving, and new inhabitant are joining, at a frequent rate.

Taking into account (1) *the arctic operational context*, (2) *effect of climate change in the arctic* and (3) *Longyearbyen`s demography*, the question of risk communication becomes highly relevant. Inhabitants in Longyearbyen are living with different climate-related hazard risks such as snow avalanche, flooding, debris flow and rockfall. These risks can change over time due to climate change resulting in an increasing in both the frequency, consequence, and uncertainty of climate-related hazard risks. The inhabitants who live in Longyearbyen should therefore be aware of such risks in the local communities.

Thus, the goal of this thesis is to identify how the authority in Longyearbyen`s have communicated climate-related hazard risk to its inhabitants.

With this goal in mind, a literature review has been done. The purpose of the literature review is to give the reader an overview of previous research related to risk management, risk communication, risk perception and climate change in the arctic environment.

There has been extensive research on the arctic in relation to risk and climate change. Such as (Hanssen-Bauer et al, 2019; AMAP, 2019; Mortiz et al, 2002; Eric et al, 2019;Walsh et al, 2011). There also exist research on how risk is managed in the arctic (Lauta et al, 2018; Indreiten et al, 2018; NVE, 2017; Sydnes et al, 2021; Albrechtsen & Indreiten, 2021). Research have also been done regarding climate-related risk communication. These research includes evaluation of risk communication during extreme weather and climate change (Macintyre et al, 2019), risk perception and its utilization to reduce the risk of climate change (Crosman et al, 2019; Mabon, 2020). In addition, some research has been done regarding risk communication in the arctic (Krümmel & Gilman, 2016).

However, there is limited research on the climate-related risk communication in Longyearbyen between the inhabitants and the local authorities ascertaining to the risk of snow avalanche, flooding, debris flow & rockfall in Longyearbyen. Closest similar case is a PHD thesis written by Duda (2021) regarding informal disaster governance in Longyearbyen and South Dominican.

1.2 Research problem & questions

With background in the arctic operational context, climate change in the arctic and the demographic changes in Longyearbyen, this thesis seek to explore how the authority in Longyearbyen have communicated climate-related hazard risks to its inhabitants.

The main research problem is therefore:

- *How are the authority in Longyearbyen communicating climate-related hazard risks to its inhabitants?*

In order to identify how authority in Longyearbyen are communicating climate-related hazard risk to its inhabitants, several research questions have to be answered:

- *What is the most pressing climate related hazard risks that Longyearbyen is facing, and what challenge does this pose from a risk communication standpoint?*
- *What can explain the focus on snow avalanche risk communication, and how does this affect the overall risk communication?*
- *How suitable is Facebook for risk communication, and how come the authorities are sharing their news on a private Facebook group?*
- *What are the inhabitants risk perception regarding snow avalanche, flooding, debris flow and rockfall?*

The first research question is more of a descriptive one. Its intention is to identify the most pressing climate-related hazard risks which Longyearbyen is facing, as well as the potential challenges that could arise from communication climate-related hazard risk to its inhabitants. The second research question intends to identify the reasoning as to why the authorities in Longyearbyen are focusing on snow avalanche risk communication, and how this could impact the overall risk communication. The third research question intends to explore the suitability for Facebook as a medium for risk communication, as well as discuss the authority's interaction with a private Facebook group. The fourth and last research question intends to explore how

the inhabitants perceive the risk of snow avalanche, flooding, debris flow and rockfall in Longyearbyen.

1.3 Limitations

There are some limitations which needs to be implemented. These limitations will make the thesis feasible and cut out other elements which otherwise would have to be explained din depth.

The first limitation I have set is to limit the authorities to only Sysselmesteren and Longyearbyen Lokalstyre. Sysselmesteren act as both the local police and Norway's highest representation on Svalbard, acting as the local governor. As the county governor, Sysselmesteren has the responsibilities of coordinating, informing and creatin overview of the societal safety and preparedness on Svalbard (DSB, 2016). They are therefore mostly responsible for short-term risk communication. Longyearbyen Lokalstyre on the other hand, act as the local municipality. Through the civil protection law, they are obligated to create strategies and measures through a risk- and vulnerability analysis, as well as have an overall preparedness plan (DSB, 2016). They are therefore mostly responsible for long-term risk communication. It is therefore that these two authorities have been defined as the authority, and that other entities such as the Norwegian water Resource and Energy Directorate (NVE) has been excluded. This in turn reduces the scope of the master thesis to create a reasonably amount of empirical work.

The second limitation I have set is that I will only analyze the authorities risk communication from the timeframe 2015-2021. This has been done to limit the scope of the thesis. In addition, this timeframe is the which is most relevant to analyze, due to the 2015 and 2017 snow avalanche. These snow avalanches in Longyearbyen resulted in funding for climate-related hazard risks measures and created a focus on short-term and long-term risk communication.

The third limitation that I have set is that I will only look at certain climate-related hazard risks. There are still other relevant climate-related hazard risks facing Longyearbyen, but that would increase the scope to an unsustainable size.

The fourth limitation is that I will not go into depth regarding the theory around risk strategies and how this has been used in this case study. The theory is presented in order to create a

foundation to understand risk, so that one can understand risk communication, but will not be an essential part of the empirical and discussion chapter and will thus only be utilized briefly. The fifth limitation is that this thesis will only look at external risk communication from both Longyearbyen Lokalstyre and Sysselmesteren. Internal communication between these actors and other relevant actors will not be presented, as it will broaden the scope. It is also considerable difficult to attain such records of internal risk communication, especially when important conversations are not recorded or written down.

The sixth limitations are that the thesis will not look at the entire area of Longyearbyen in regard to its risk communication. The airport, main road, the city center and Nybyen will be included, but all cabins are excluded from this thesis. There exist several areas with cabins with their own risk analysis. But an inclusion of these would not serve a purpose, as this thesis looks at the risk in Longyearbyen, and how they have been communicated. Introducing risk communication of an area with considerable distance from Longyearbyen would make interviews, surveys considerable harder and thus not realistically feasible for a master thesis.

The seventh and last limitation is that I will not go in depth about the different measures related to the risk of snow avalanche, flooding, debris flow & rockfall in Longyearbyen. One of the purposes of the first research question is to shortly present the area in which the different climate-related hazard risks affects. The purpose is not to dive deeply into the different measures, strategies etc. As such, the empirical subchapter relating to the first research question is meant to create a foundation for the reader to understand how the different climate-related hazard risks affects Longyearbyen.

1.4 Structure

The thesis is structured into 6 different parts. Those are (1) introduction, (2) theory, (3) method, (4) empiric results, (5) discussion and (6) conclusion.

The introduction is to present the background and motivation for writing. Research question is also presented along with literature review and limitations in order to understand where this thesis fits in. The theory chapter is to present the most important theories which will be utilized in this thesis, such as risk, communication, risk communication and risk perception These will

be utilized to further analyze how the authority have conducted its communication of climate-related hazard risks to its inhabitants. The method chapter has the purpose of going through the methods utilized, research design and research strategy. The empiric chapter goes though the result of the fieldwork, survey, interviews, ArctRisk interviews and document study. These findings will be discussed in the discussion chapter and then made into a short conclusion chapter.

2. Svalbard & Longyearbyen

Due to the nature of this thesis being a case study, information regarding Svalbard, Longyearbyen and its situation needs to be presented in a short chapter of context. The chapter will go through information about Svalbard, as well as information about Longyearbyen. Maps will be shown, as they are important to the context.

Svalbard is the official name of the archipelago consisting of several islands such as Spitsbergen, Nordaustland, Edgeøya, Barentsøya and several other smaller islands (Thuesen & Barr, 2022). Svalbard is located north of Norway and directly East of Greenland. Svalbard was officially recognized in 1920 as a part of the Norwegian sovereignty following the treaty concerning the archipelago of Spitsbergen. The treaty was ratified in 1925, and its official name was changed from Spitsbergen to Svalbard (Thuesen & Barr, 2022).

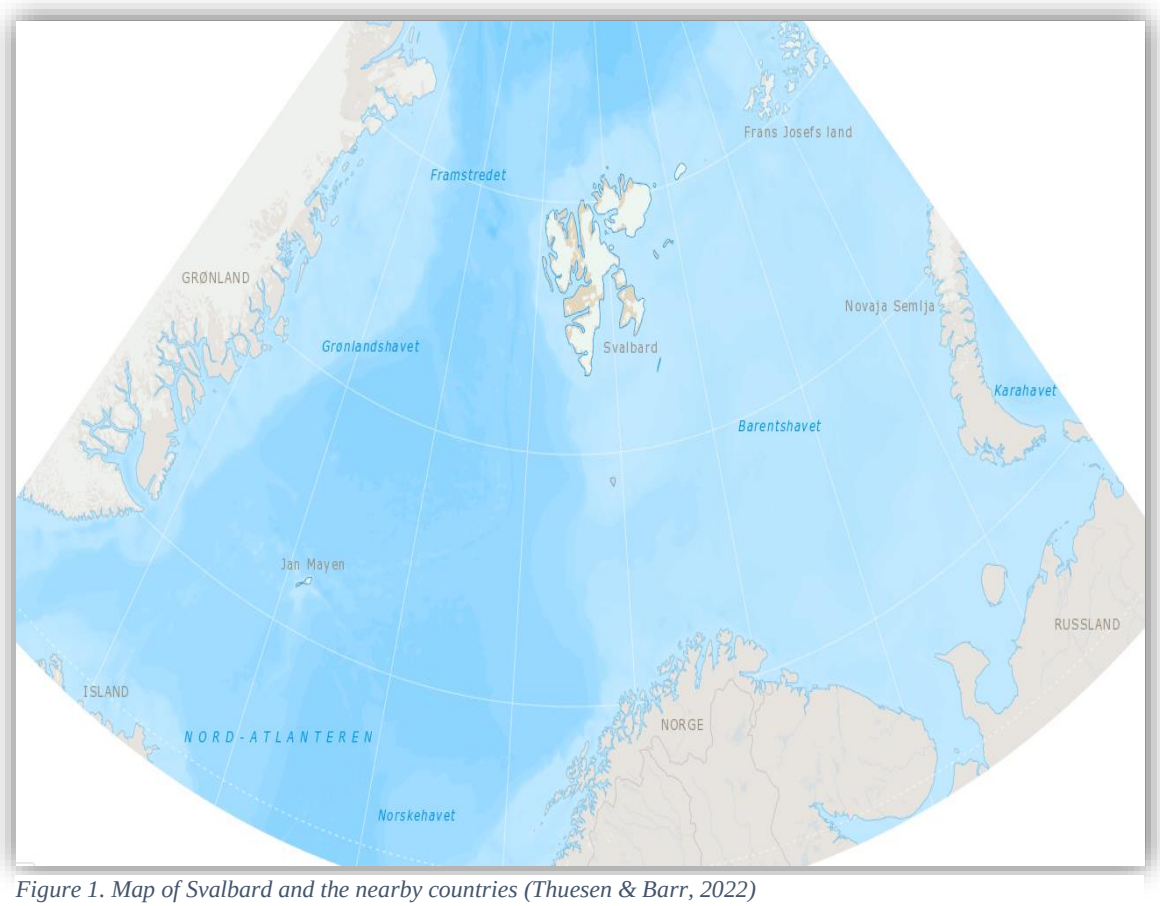

Figure 1. Map of Svalbard and the nearby countries (Thuesen & Barr, 2022)

Most of the inhabitants on Svalbard live in Longyearbyen, the only Norwegian city in Svalbard. There are some researchers who lives on several research station, such as Ny-Ålesund. A small number of Ukrainians and Russians live in the Russian settlement of Barentsburg.

Figure 2. Map of Svalbard (VisitSvalbard, 2022)

Longyearbyen is a small Norwegian town located at 78 degrees north at the archipelago of Svalbard. Throughout time it has been used for whale hunting in the 17 & 18th century, Russians used it for overwintering hunting and trapping in the 18th and 19th century, and Norwegians has used it for overwintering hunting and trapping in the late 19th and 20th century (VisitSvalbard, 2022). After 1906 and until 1989 it was a company town used for coal mining, before it was sold to Store Norske Spitsbergen Coal Company (VisitSvalbard, 2022). The coalmine is to close in 2023, making tourism Longyearbyen's main source of income (NRK. 2021). There is also an extensive research community in Longyearbyen, including both The University Centre in Svalbard (UNIS), and other research stations. This in turn has create a huge international community, where Longyearbyen's sparse population of around 2500 inhabitants has around 42 different nationalities (SSB, 2012).

Figure 3. Close-up map of Longyearbyen (Toposvalbard, 2022)

3. Theory

The theory regarding risk, communication, risk communication and perception will be presented in this chapter. These theories will create a foundation for the discussions in the discussion chapter.

3.1 Risk

The theoretical definitions of risks have been included in the theory chapter, as it is essential to understand what risk is. The theoretical definition of risk server as a foundation to understand both risk communication and risk perception. The classical definition of risk refers to risk as uncertain consequences of events or activities with respect to something which humans value (Aven & Renn, 2009). There is no universally agreement on the exact definition of risks (Solberg & Njå, 2012). There are however, a scientific agreement on three elements, which explain risks (Kates et al, 1985, p. 21):
(1) *outcomes that have an impact upon what humans values*
(2) *the possibility of occurrence (uncertainty)*
(3) *a formula to combine both elements*

The definition which will be utilized in this master thesis is the risk definition from ISO 31000. The definition of risk is something that has an "effect on uncertainty on objectives" (ISO 31000, 2018). The effect can be of a positive and negative nature, where there is an uncertainty regarding different consequences and the frequency (probability) of different events occurring. Lastly, the objectives in this definition are related to both health and safety of individuals and objects (ISO 31000, 2018). The reasoning for utilizing such a definition of risk, is that this thesis focuses on climate related risks, and as such there is a large degree of uncertainty involved in these risks. If a definition of risk was utilized which mainly focuses on risk = consequence x probability, an important element of uncertainty would be lost. Such a definition would therefore be inadequate, as it fails to capture the importance of uncertainty related to complex and ambiguous risks such as climate related risks.

3.1.1 Categorization of risk

A definition of risk on its own is insufficient to be a foundation for understanding risk communication and risk perception, and there is a need to look at (1) how to describe a risk and (2) how the description categorizes risks into four different risk problems.

Table 1. Classification and dividing of risk through risk assessment criteria's and risk description (Engen et al, 2016)

Risk Assessment Criteria's	Risk description
Extent of damage	What is the effect of risk, damage-type, physical damage, wounded, stop in production?
Probability of occurrence	What is the likelihood of occurrence, frequency distribution?
Uncertainty	What indicators of uncertainty exists?
Extent	What is the geographical extent of potential damage?
Duration	Duration of damage, generational damage?
Reversibility	Potential to reverse damage?
Delayed effects	Distance between event and consequence
Destruction of equity	Discrepancy between risk takers and decision-makers
Potential for mobilization	Will the event create social conflict and/or psychological reactions?

As the definition of risk is established, there is a need to understand how the description of the risk creates risk categorizations. These nine risk assessment criteria's helps identifying crucial aspects of a risk such as probability of occurrence, extent of damage and how uncertain is our knowledge of the event. These aspects are utilized to identify which risk type we are dealing with. Depending on the risk type, certain strategies and actors are involved. These risks categorizations are called risk problems, and are split into four risk problems (Renn, 2008, pp. 178-180):

(1) *Linear risk problems*
(2) *Complex risk problems*
(3) *Risk problems due to high unresolved uncertainty*
(4) *Risk problems due to interpretative and normative ambiguity*

Linear risk problems are risks which has known consequences and low degree of uncertainty. Such examples are car crashes and known food and health risks. These risks are handled through

tradition-decision making which include measures such as risk-benefits analysis, changes in technical standards and education, labelling and information (Renn, 2008, p. 178).
Complex risk problems are usually characterized by a major scientific dissent about the effect of measures in regard to decrease vulnerability. The objective for risk management in a complex risk management is to agree on the different causal relations so that effective measures can be applied. These instruments can vary from technical standards, cost benefit analysis or risk-comparison (Renn, 2008, p. 188).

Uncertainty risk problems are risk problems with a high degree of uncertainty. This uncertainty creates a need for the whole system to be resilient, as to be able to handle any potential damage from the risk. Our lack of knowledge prevents us from identifying the exact type of risk and where in the system it will cause damage. By creating a resilient system, irreversible damage should be prevented, and vulnerability should also be reduced. The problem is that our lack of knowledge prevents us from knowing exactly which part of the system should be resilient. This creates a challenge in regard to overprotection versus under protection. It is typical to use the principles of ALARP in the uncertainty risk problem, as certain aspects of the system must be prioritized in front of another (Renn, 2008, p. 188). ALARP is the principle of lowering the risks as low as reasonably practicable. Ambiguity risk problem are risk problems where different actors or stakeholders have different values, and a consensus can be hard to reach. The objective is to find the most acceptable path, in order to resolve the conflict of value and to ensure the fair treatment of all involved actors (Renn, 2008, p. 188).

These risk problems are then placed into two tables, one showing a risk management strategy for the different risk problems, and the second one showing how different risk problems require different resources to solve. The purpose of these tables is to illustrate how different risk problems require different resources and strategies, and how these are important factors to take into consideration when doing risk communication.

Table 1. Risk management challenges and corresponding strategies (Renn, 2008, p. 188)

Challenge	Objective	Function	Strategies	Instruments
Complexity	Effective, efficient and adequate protection	Agreement on causal relations and effective measures	Reducing damage potential; limiting overall risk level	Standards, risk-risk comparison, cost effectiveness, risk-benefit analysis
Uncertainty	Resilience	Avoiding what is irreversible and vulnerable	Diversity and flexibility limiting range of effects	Containment in time and space, development of substitutes
	Efficient and fair distributions of burden(s)	Balancing of underprotection versus cost of overprotection facing uncertain outcomes	Trade-off analysis	Negotiated rule-making; mediation; roundtables
Ambiguity	Socially acceptable development path	Resolving value conflicts and ensuring fair treatment of concerns and visions	Consensus-seeking discourse	Stakeholder dialogue; citizen panels, consensus conferences

In table 2 it is shown how different risk problems require different approach and strategies. Table 2 will be used in the discussion of how Longyearbyen Lokalstyre and Sysselmesteren have done their risk communication strategy. By identifying which kind of risks, they are dealing with, one can compare the generic strategy to the actual strategy which has been utilized.

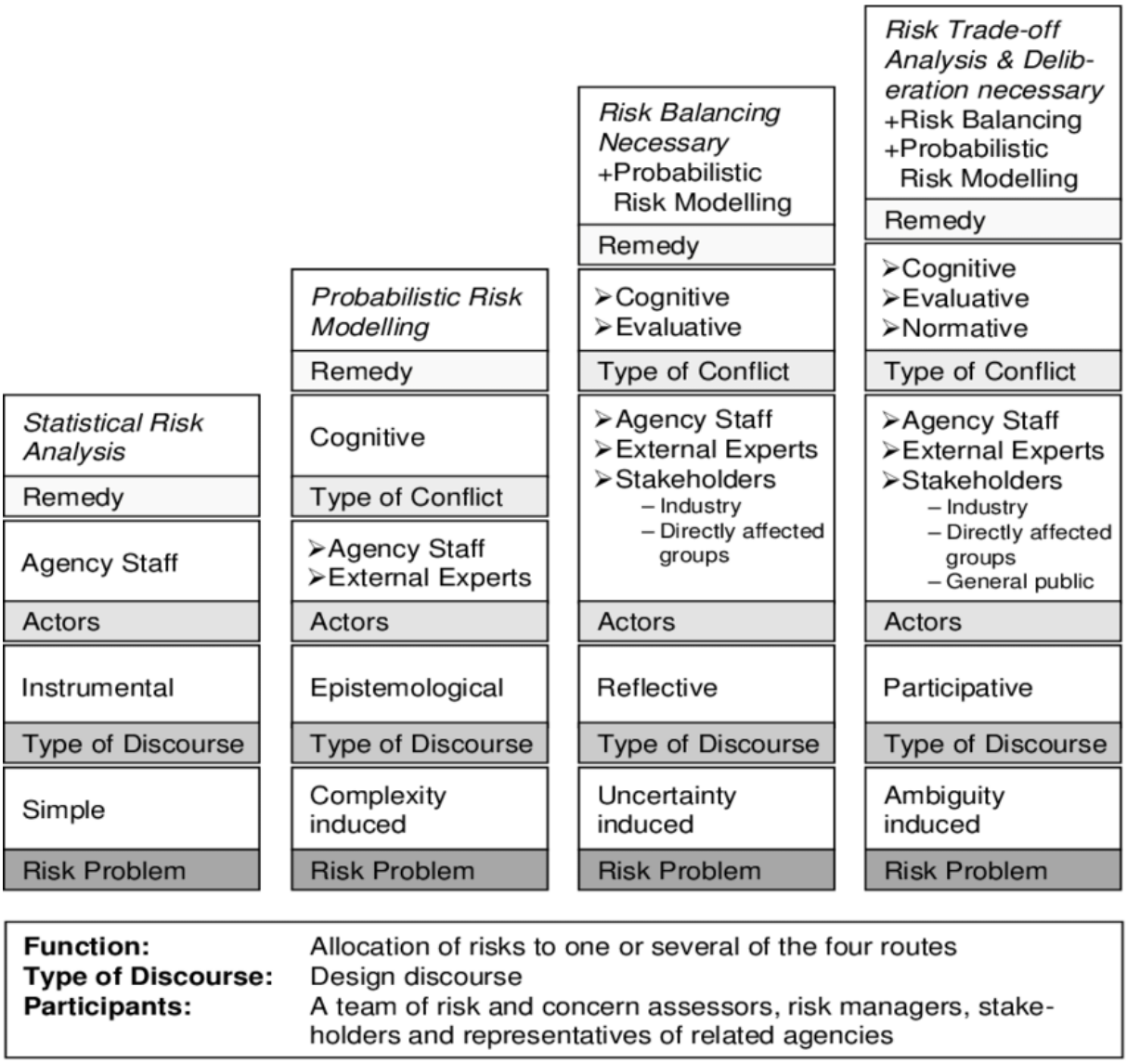

Figure 5. The risk management escalator and stakeholder involvement (Renn, 2008, p. 280)

Figure 5 illustrates how complex, uncertainty and ambiguity induced risk problems require a lot more resources on several levels. The more complex and ambiguity the risk problem is, the more resources and actors need to be involved. These are important facts that need to be included in the risk communication. It is not only information about the risk, but also about the solution that needs to be presented.

3.2 Berlo`s model of communication

The purpose of this subchapter is to present Berlo model of communication, which will be used as a foundation in the discussion chapter to understand how communication works and to analyze how the authorities have utilized several different channels in order to inform the receiver about climate-related hazard risks in Longyearbyen such as snow avalanche, flooding, debris flow and rockfall.

Communication is a vital part of risk communication, and there needs to be a clear understanding of what communication is before we move over to risk communication. Therefore, I will present Berlo (1960) models and theory of communication, as it creates a foundation to understand communication, which is essential in order to understand risk communication.

Berlo presents a straightforward model of how communication is linear process. This linear process consist of (1) a source in the form of a sender, (2) a message which the sender encodes, (3) different channels available for both the sender and receiver and lastly (4) a receiver who decodes the message sent from the sender (Berlo, 1960).

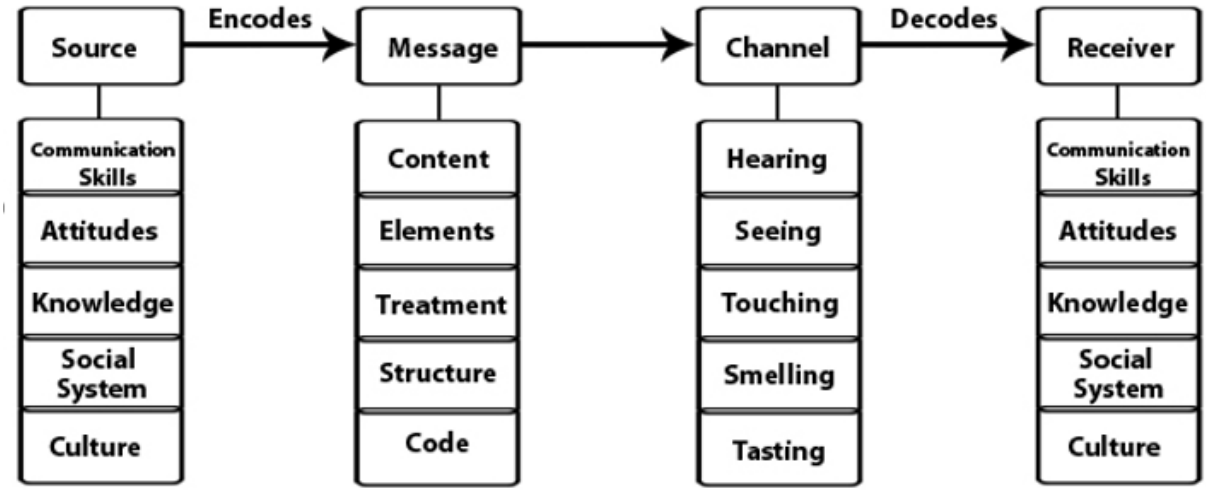

Figure 6 Berlo`s SMCR Model of communication (Berlo, 1960)

There are a multitude of factors which can affect the source and receivers' ability to communicate. These are communication skills such as ability to read, write and speak the same language. Furthermore, different attitudes, knowledge and culture can also affect the source encoding and the receivers decoding. The message`s content, formulation, structure are things that can make the message either easier or harder to decode. Furthermore, some channels may

not be as suited for the message (Berlo, 1960). These are some of the factors which can affect communication and will be used.

There are however some prerequisites which this model is based on (Berlo, 1960):

- The source (sender) and the receiver must be on the same level of understanding
- The receiver must devote time to decode and understand the message
- The medium must be appropriate for the message

The prerequisite for this model is therefore that the source and receiver is on the same level of understanding, so that they may communicate efficiently. Berlo`s model of communication gives the impression that because it is a linear model, that it is one-way communication. Because of the prerequisite, it is not a one way but a two-way communication (Berlo, 1960). Communication is therefore about "the construction of meaning, sharing some interpretation or consensual understanding between senders/receivers, audiences, publics, stakeholders or communities" (Sellnow & Seeger, 2013).

3.3 McQuail Pyramid of communication networks

The purpose of this subchapter is to present relevant theory regarding communication and how communication channel differs depending on the receiver's knowledge foundation. This will be utilized in the discussion chapter to explain how the availability of information decides one's information source.

McQuail theory regarding communication networks as a pyramid is of interest to this thesis, as it identifies different levels in a communication process. These different levels involve different means of communication, from intrapersonal to intergroup and lastly to society-wide networks (McQuail, 2010). The basis of the theory is that readily available information will be gathered through lower levels of communication while less readily available information has to be gathered through higher levels of communication. Figure 7 below presents McQuail theory of pyramid communication networks:

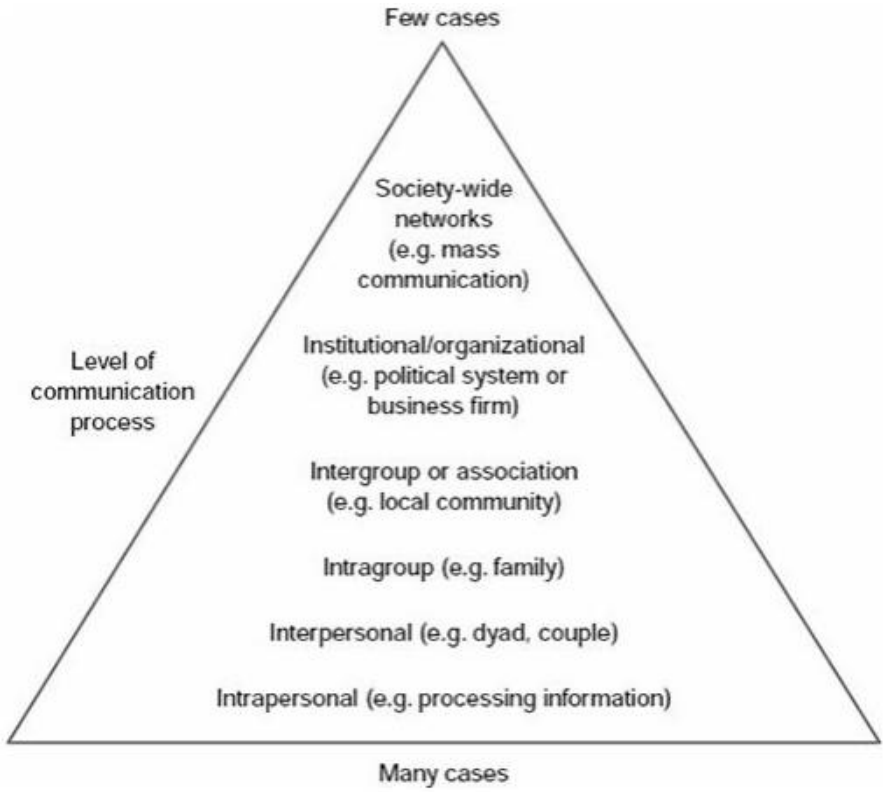

Figure 7. pyramid of communication networks (McQuail, 2010, p. 25)

The definition which McQuail use for communication is quite broad, defining communication as something which is "a process of information transmission, giving or taking of meaning, sharing of information, ideas, impressions or emotions "(McQuail, 2010, p. 22). This definition is similar to the definition which Berlo utilizes in his model of communication (Berlo, 1960).

In the case where information is readily available through the representation of many cases, it is enough to use intrapersonal level of communication. When information is less readily available the level of communication increases to interpersonal, including another person to assist you. It that is insufficient, an intragroup level of communication might be sufficient, such as utilizing your family, friends, or coworkers. If information is not readily available one might need to go to intergroup/association level of communication, which involves the local community. At last, if information is not available at all, institutional/organizational or society-wide network level of communication is the last two levels of communication in the communication network which is available. The last level of communication in the communication network, society-wide network, is especially interesting as it combines both public and private means of communication and allow communication to be shared beyond the shared space or personal acquaintance (McQuail, 2010, p. 24).

3.4 Risk communication

The purpose of this subchapter is to present relevant theory regarding risk communication. This will be utilized in the discussion chapter to identify how the authorities have done their short-term and long-term risk communication regarding climate-related hazard risks such as snow avalanche, flooding, debris flow and rockfall.

Risk communication can be divided into two dimensions (Renn, 2008, p. 202):

(1) *Internal risk communication:*
(2) *External risk communication*

Internal risk communication ensures that "those who are central to its risk framing, risk appraisal or risk management understands what is happening, how they are involved, and, where appropriate and what their responsibilities are" (Renn, 2008, p. 202). External risk communication is about ensuring that "others outside the immediate risk appraisal or risk management process are informed and engaged" (Renn, 2008, p. 202). As mentioned in the limitation subchapter, this thesis has its focus on external risk communication.

There are several descriptions of risk communication. The OECD perceive risk communication as a tool to "assist stakeholders in understanding the rationale of risk assessment results and risk management decisions, and to help them arrive at a balanced judgement" (OECD, 2002). While DeFluer and Ball-Rokeach perceive risk communication as "purposefull exchange of information between actors in society, based on shared meanings" (1982). A third perception is the US National Research Council, whom define risk communication as:

> "… 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 concern, opinions or reactions to risk messages or to legal and institutional arrangements for risk management" (NCR, 1982, p. 21)

For this master thesis, the objective of risk communication can be divided into four general functions (Renn, 2008, p. 207):

(1) *Ensure that all receivers of message are able to understand its content and enhance their knowledge about the risk in question*
(2) *Establish a trustful relationship between the sender and the receiver of risk communication*

(3) Persuade the receivers of the message to change their attitude or their behavior with respect to a specific cause or class of risk that

(4) Provide the conditions for an effective stakeholder involvement on risk issues so that all affected parties can take part in a conflict-resolution process

These functions each require different forms of risk communication. In general, one has four different forms of communication which can be used for risk communication (Chess et al, 1989; Lundgren, 1994; Renn, 2006c):

(1) *Documentation:* The purpose of documentation is to show that no information is being withheld. It can also be utilized by the public, but one could question if the public has the prerequisite knowledge required to properly understand the documents.

(2) *Information:* Information serves to enlighten its communication partner. The difference between information and documentation is that information implies that the target group can grasp, realize and comprehend the meaning of the information.

(3) *Two-way communication or mutual dialogue:* This form of communication is used to exchange arguments, experience, impressions and judgements.

(4) *Mutual decision-making and involvement:* The goal of this kind of communication is to ensure that the interests and values of future generation is preserved. It involves local stakeholders and actors in its communication.

These forms of communication are then utilized by the major actors of risk communication. Se figure 8 below

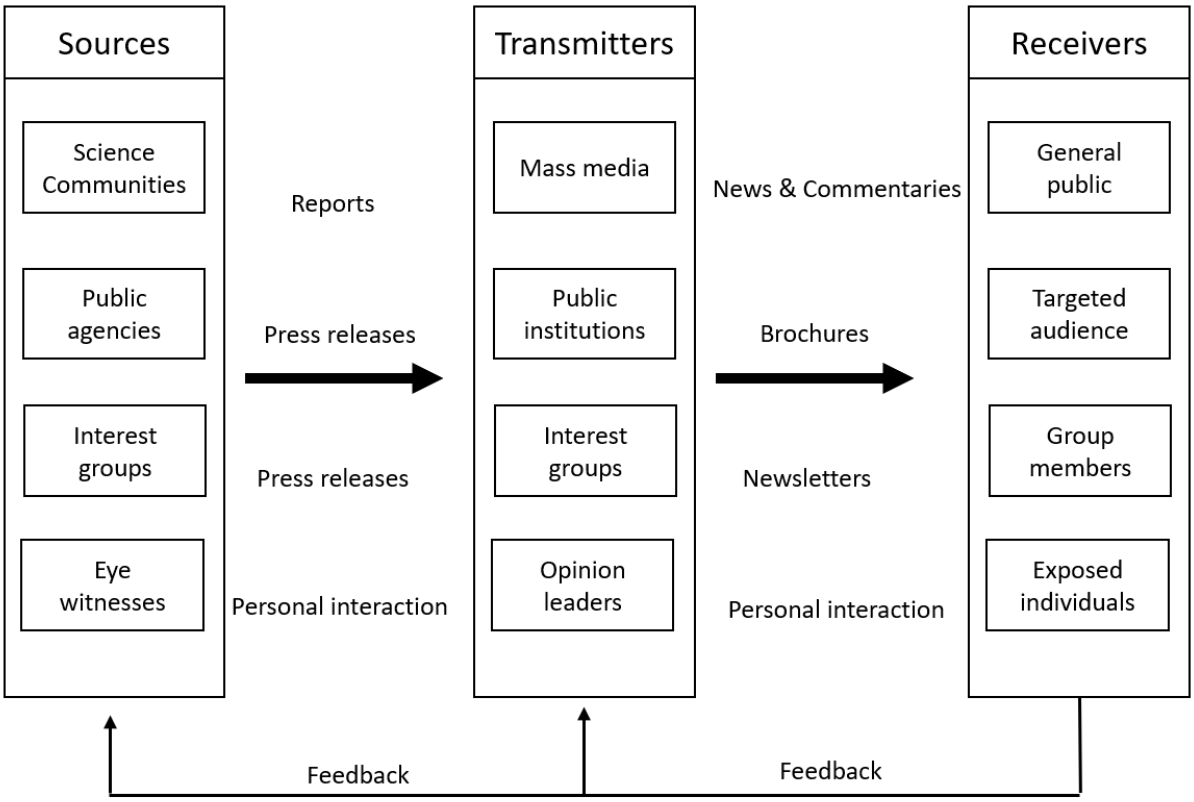

Figure 8. Organizational structure of risk communication (Renn, 2008, p 210)

Figure 8 above illustrates how the major actors of risk communication are the scientific institutions, public agencies, interest groups and eyewitnesses. An effective risk communication would include all four forms of communication, and inhabitants would preferably get their risk-information from all four major actors of risk communication (Renn, 2008, p. 208).

There are however three problems which the authorities need to be aware of when it comes to communicating risk to the population (Drottz-Sjöberg, 2003). The first problem is the problem of the populations trust and confidence in the authorities which are doing the risk communication. In a situation where the signals of dangers are prevalent, people are forced to change their routines through a conscious adaption. If the authorities have the populations trust, the population will trust the information and therefore act quickly upon the information which is given. This reduces the cognitive load, as the population does not require to process all relevant information as they can choose to follow the instructions of the authorities (Sjöberg, 2003, p. 12). A lack of such trust would mean that the population would either not respond to instructions or process the information and create their own solution as to which they follow. Which in turn could create a worse outcome for the part of population that does not follow the authorities' instructions.

The second problem relates to the use of numerical expression and probabilities embedded in the risk communication. Studies show that the utilization of statistical information in the risk communication creates difficulty for the receiver to understand the content of the risk communication. Statistical information can be replaced by words such as "rare", "unlikely", "frequent" and "probable". The use of these words is however problematic, as they are varying and non-precise (Theil, 2002). Therefore, risk communication should be done with great attention in order to ensure that the risk message is adequately interpreted in a language that can be understood 8Drottz-Sjöberg, 2003, p. 15).

The third and last problem is the misinterpretation of expert's information. The formulation of the risk communication is important, as there a multitude of different factors which can create obstacles in communication across different groups, such as scientists, authorities, and the general population. Some of these factors are language, background knowledge and experience (Drottz-Sjöberg, 2001). It is therefore important to be aware of such things when communication risk related information to the public or other groups which does not have the same background knowledge.

3.5 Social media in risk communication

The purpose of this subchapter is to present relevant theory regarding the use of social media as a medium for risk communication. This will be utilized in the discussion to identify how the authorities have utilized Facebook, and whether they have followed some of the good practices which has been identified in this subchapter.

The Organization for Economic Co-operation and Development (OECD) released a preliminary scientific paper (Wendling et al, 2013). This preliminary scientific paper contains the preliminary findings of the utilization of social media in risk and crisis communication. In total, the paper presents twelve good practices for the use of social media in risk and crisis communication. The purpose of this subchapter is to present the good practices which may be relevant for the thesis.

The fist relevant practice is that social media can be utilized to raise public awareness about risks and crises. This is highlighted through the example of the CDC "Hurricane tip of the

week" initiate as well as the "Get prepared" portal of Public Safety Canada (Wendling et al, 2013). The recommendation is that social media, prior to crises can be utilized as an awareness raising strategy. It is the case that tweets, or Facebook pages become recognized authority for the information prior to the event. This allows emergency services and the authority to increase access to audience of different types, especially younger audiences which rely less on traditional media then digital ones (Wendling et al, 2013, p. 19).

The second relevant practice is that social media can be used to improve preparedness. In relations to natural disaster cases, social media has been used to raise awareness of the risks related to the geographical areas of the followers. Social media therefore diversification the type of posture emergency services and authority can take (Wendling et al, 2013). The third relevant practice is that social media can provide information and warning, both real time alert/warning in addition to provide information and instructions (Wendling et al, 2013, p. 21).

The fourth and last relevant practice is that social media could improve the crisis response through mobilizing volunteers. Social media can empower the and connect large numbers of volunteer through sharing who is willing to assist in the event of an emergency. Information can also be spread to request specific kind of volunteers (Wendling et al, 2013, p. 22).

3.6 Risk perception

The purpose of this subchapter is to present relevant theory regarding risk perception which will be utilized in the last research question to explain the inhabitants irks perception of snow avalanche, flooding, debris flow and rockfall in Longyearbyen.

Risk perception is the creation of risk constructs and images, which, depending on how these risk construction and images are, will affect individual judgement in whether to do certain actions. These risk construction and images are called perceptions, and risk perception are utilized when deciding whether a risk should be taken (Renn, 2008, p. 93).
Risk perception is a vital part of risk communication, and two of four functions of risk communication rely on the receiver's risk perception being changed.

(1) *Ensure that all receivers of message are able to understand its content and enhance their knowledge about the risk in question*

(2) Persuade the receivers of the message to change their attitude or their behavior with respect to a specific cause or class of risk that

Whether changes will arise in the receiver's behavior is mostly reliant on *qualitative evaluation characteristics* (Slovic, 1992). These characteristics describe properties of risk which either increase or decrease the receivers risk tolerance (Renn, 2008, p. 109).

Table 2. List of important qualitative risk characteristics (Slovic, 1992)

Qualitative characteristics	**Direction of influence**
Personal control	Increase risk tolerance
Insitutional control	Depends upon the confidence in institutional performance
Voluntariness	Increases risk tolerance
Familiarity	Increase risk tolerance
Dread	Decreases risk tolerance
Inequitable distributions of risk and benefit	Depends upon the individual utility; strong social incentive for rejecting risk
Artificiality of risk source	Amplifies attention to risk; often decreases risk tolerance

Furthermore, individual`s risk perception can also be affected by heuristics (Fischoff et al, 1978). Heuristics are mental shortcuts that can facilitate problem solving and probability judgement (TheDecisionlab, 2022). There are especially two heuristics that affect the individuals risk perception, namely the information about benefit to a risk as well as information about a risk (Slovie & Peters, 2006). The illustration below presents how an increase in the awareness of either benefits of risks or information about risks affect one's perception of the risk.

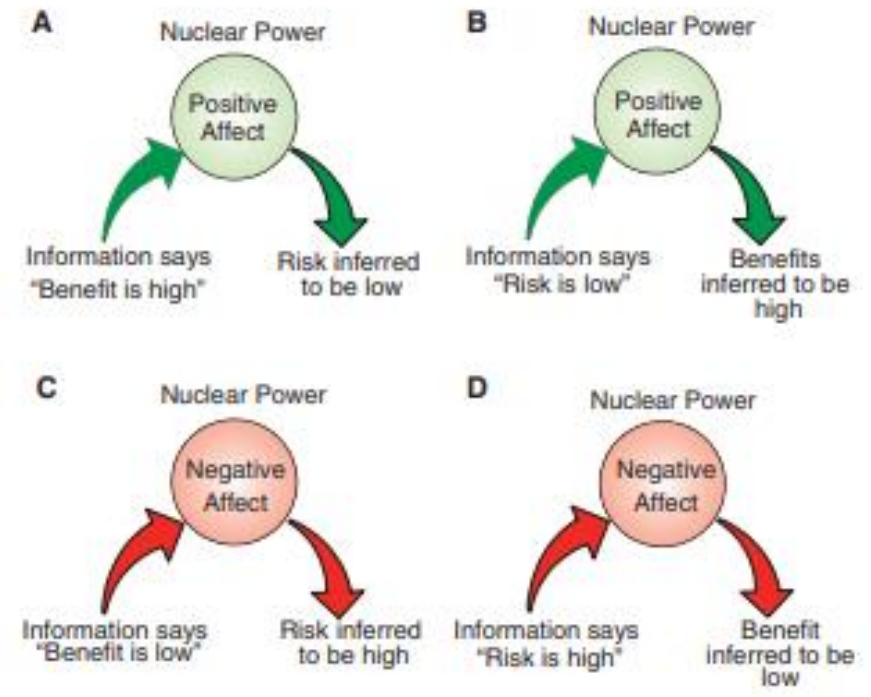

Figure 9. Individuals' awareness of benefits of risks or information about risk in and its correlation to risk perception (Slovie & peters, 2006)

4. Method

In this chapter of method, I will present the (1) research design, (2) research strategy, (3) data collection, (4) Data reduction, (5) Assessment of methods and (6) ethical reflections, in each of their own subchapters. This will enable the reader to both understand the foundation for the empirical findings which will be presented in chapter 5 and enable others to be able to recreate the method used in this master thesis.

4.1 Research design

This master thesis is designed as a case study, interested in identifying how the authorities in Longyearbyen are communicating climate-related hazard risks to its inhabitants. Case studies are usually utilized when the research questions are related to how and why questions (Yin, 2018, p. 9). A case study can be defined as an empirical method which "investigates a contemporary phenomenon in depth and within its real-world context" (Yin, 2018, p. 15). Using this definition, the phenomena which I intend to study in depth is climate-related risk communication, and its real-world context of the phenomena which is Longyearbyen.

There exist different types of case studies. The case study which I will use in this master thesis is an embedded single-case design. An embedded single-case design is a case study focusing on several units of analysis. The counterpart to an embedded single case-design is the holistic single-case design (Yin, 2018, p. 47). A holistic single-case design will utilize only one unit of analysis. In the case of my master thesis, I intend to utilize two units of analysis, both the authority's climate-related risk communication towards the inhabitants as well as the inhabitants risk perception of such climate-related risk communication. These units of analysis will be expanded upon in subchapter 4.3 *data collection*.

4.2 Research strategy

The research strategy utilized in this master thesis is one of an explorative abductive approach. Abductive logic of inquiry main purpose is to understand social life in terms of social actors meaning and motives (Blaikie & Priest, 2019, p. 93). In this master thesis the purpose is to understand the climate-related risk communication between different social actors, namely between the authorities in Longyearbyen and the residence. The ontological assumption used in this master thesis is one of idealist, ascertaining that social reality is made up of shared

interpretations that social actors produce and reproduce (Blaikie & Priest, 2019, pp. 12-24). The epistemological assumption used in this master thesis is one of constructionism, which emphasizes the discovery of social reality through the "inside" through the language of the participants. It furthers attribute social scientific knowledge to the outcome of social scientists' mediation between everyday social language and technical social scientific language (Blaikie & Priest, 2019, p. 104). The ontological and epistemological assumptions are chosen due to their compatibility with the master thesis.

The start of an abductive logic of inquiry starts with a discover of everyday lay concepts, meanings, and motives, and ends at a development of theory which it elaborates on (Blaikie & Priest, 2019, p. 104). Due to this thesis being an explorative abductive, whose purpose is to understand the climate-related risk communication between the authorities in Longyearbyen and the inhabitants, it diverts slightly from a typical abductive approach. Theory regarding risk communication has already been developed and elaborated and is the theoretical foundation which this master thesis stands on. In that sense, I utilize a theoretical lens when I try to understand the risk communication between the authorities and the inhabitants. In that sense, it has similarities with a deductive approach (Blaikie & Priest, 2019, p. 104). The difference is that I don't test a hypothesis, which one would do if they did a deductive approach.

The choice of research strategy is also affected by my background as a researcher. Through different courses connected to my master's degree in societal safety at both University of Stavanger (UIS) as well as The University Centre in Svalbard, I have been schooled about risk and risk communication. After the first year of the master's degree I moved to Longyearbyen, where in the third semester I was able to attend three courses at UNIS, whose duration lasted the whole semester. After that I applied to extend my stay in Longyearbyen through UNIS so that I could write a master thesis about Longyearbyen. All of this has led me to choosing an explorative abductive approach. My role as a researcher and how it has affected the data collection will be further elaborated in subchapter 4.3 *data collection*.

4.3 Data collection

The data collection utilized in this master thesis is one of methodological triangulation. Triangulations in research is the utilization of multiple datasets and methods in order to address a research problem and its research questions. A methodological triangulation is when different

methodologies are utilizes to approach the same topic (Bhandari, 2022). The different methodologies used in this master thesis are (1) Fieldwork, (2) quantitative survey, (3) qualitative interviews and (4) document study. These different methodologies will be utilized in order to collect data on both the both the authority's climate-related risk communication towards the inhabitants as well as the inhabitants risk perception of such climate-related risk communication.

The data collection has two phases. The first phase is based on the information gathered in the fieldwork. By utilizing the information from the fieldwork, a survey has been made. The purpose of such survey is to identify trends in the climate-related risk communication between the inhabitants and the local authorities. The second phase is then commenced and intend to use both interviews and document study to see if previous identified trends in the survey correlate with the answers given in the qualitative interviews of the inhabitants. This method of data collection is based on a quantitative foundation, where qualitative methods are used to penetrate deeper into the material then what a survey could do (Grønmo, 1996). The data collection then ensures that potential trends are identified and then proven right or wrong using qualitative interviews, which in addition secures a more in-depth answer as to why the trends are right or wrong.

4.3.1 Fieldwork

Throughout my time in Longyearbyen, I have been able to do participatory field observations, in addition to having a multitude of field conversations. Participatory field observations are characterized as fieldwork where the scientist can both participate and observe the phenomena which the scientist is studying (Fossåskaret, 2015, p. 33). A field conversation can be described as a non-scheduled interview similar to the day-to-day talk which occur in the daily life of any individual (Fossåskaret, 2015, p. 33). In this instance, I am both a recipient of risk communication as well as an observant to the authority's risk communication with the inhabitant, where field conversations are the day-to-day conversations which I have with the inhabitants of Longyearbyen.

These conversations and observations started when I first arrived in Longyearbyen on the 5th of August 2021. As a newly arrived Student at The University Centre in Svalbard, I was formally introduced to both Sysselmesteren and Longyearbyen Lokalstyre through the three different courses I had at UNIS: AS-302 *Safety Management in the Arctic*, AS-303 *Emergency*

preparedness and Response in the Arctic and AS-304 *Risk, Technology and Human Performance in the Arctic*. In addition to these formal introductions, information regarding avalanche warning system, short-term risk communication and other relevant topics were introduced to us, both as a result of the classes I took, as well as my status as a student at The University Centre in Svalbard.

I became an active participant in the field observations due to (1) receiving short-term and long-term risk communication about different climate-related hazard risks in Longyearbyen, and (2) participating in the public meetings held by Lokalstyre.

As stated in the beginning, I became a part of the system which I intended to analyze. In addition, I knowingly and unknowingly participated in, and started, field conversations with both colleagues and other inhabitants in Longyearbyen. Researchers who stay in an area for a certain amount of time gets most of their information through non-scheduled talks where the scientist is in his "local status". There are both formal and informal statuses, such as the status of a student or a teacher, and informal statues like being an inhabitant of Longyearbyen.

It is through these field conversations, both as a student, researcher, and an inhabitant of Longyearbyen (I am officially registered as an inhabitant of Longyearbyen), that I managed to accumulate local knowledge about Longyearbyen and its inhabitants. I can mention two field conversations, one with personnel from Sysselmesteren and one from Longyearbyen Lokalstyre, which really the thesis. Both conversations happened after a public meeting, where I introduce myself, what I was writing about, and asked them a few questions. Both were informal, cordial and were happy to chat me about some of my question in addition to some other loose talk. The one from Lokalstyre happily talked about data collection, which mediums they were using and where I could go to find such information. This made the data collection process considerable easier. This was an especial important field conversation, since at this point in time I had only been in Longyearbyen for a month or two. Therefor I did not completely understand how Longyearbyen Lokalstyre worked, and where they posted their information. The one from Sysselmesteren talked about risks in Longyearbyen, the focus on snow avalanche measures and how things are done in a special way up here in Svalbard. This also helped with my perception and understanding of how the authorities worked up here in Longyearbyen, then compared to a regular police and municipality in mainland Norway.

The field conversations have however as mentioned above contributed to my overall knowledge about Longyearbyen and its inhabitant, which has then been utilized in the creation of both the survey and the interview questions.

4.3.2 Survey

The purpose of this survey is to identify possible trends in the climate-related risk communication between the inhabitants and the authorities in Longyearbyen. The targeted demography of the survey are all inhabitants which have lived in Longyearbyen for a month and longer. The criterion for taking the survey is therefore also the same, that the individual has lived in Longyearbyen for more than a month, and not be a student.

The survey is structured into seven categories of questions in relations to: (1) the inhabitants perception of the risks, (2) the information which the inhabitants have received about these risks **when** moving to Longyearbyen, (3) the information which the inhabitants have received about these risks **after** having moved to Longyearbyen, (4) the information which inhabitants have received about long-term strategies and measures to deal with these risks, (5) inhabitants capacity to travel in the vicinity of Longyearbyen, (6) inhabitants overall perception of the risk communication between themselves and the authorities and (7) the expectations which the inhabitants have towards themselves and the authorities. The survey questions can be found in attachment *A - Survey* Questions.

The survey is structured so that the inhabitants taking the survey can answer in both a systematic and non-systematic way. This means that certain questions must be answered with a set predefined answer, while some questions can be answered through a textbox (Halvorsen, 2008, p. 142). The survey has also been created in accordance with best practice of how surveys should be structured and formulated (Halvorsen, 2008, pp. 144-145). This includes (1) easy sentence structure, (2) avoid leading questions, (3) explaining the transitions from each category of questions, (4) inserting control questions and (5) ask clear and precise questions in order to achieve the most precise results (Wenstøp, 1991).

The survey was pretested several times both through myself and my other work colleagues as to ascertain that the survey was working. The pretest results were then deleted, and the survey was shared. The survey was shared through my own personal account on the Ros & Info Longyearbyen Facebook page.

In total, 23 inhabitants answered the entire survey.

4.3.3 Interviews

The purpose of the interviews is to interview the inhabitants of Longyearbyen in order to gain insight in how they have both received and perceived the information which they have got in relation to the aforementioned climate-related hazard risks. The interview questions are structured in the same way as the survey, with some follow up questions to gain a deeper knowledge about why the informants have answered as they have. The Interview questions can be found in attachment *B – Interview* Questions.

The criteria for becoming an informant and being interviewed are the same as the criteria for answering the survey. One must have lived in Longyearbyen for around a month and longer, and not be a student.

The interview request was published in four different mediums (1) Ros & Info Longyearbyen, (2) Svalbardposten, (3) through emails to companies & organizations and (4) through personal visits to organizations and companies. On the Facebook group Ros & Info Longyearbyen, the interview request was first published through my own personal account. A couple of days later, it was published through The University Centre in Svalbard's official Facebook account, and lastly it was published through Arctic Safety Centre in Svalbard`s official Facebook account. A reader post was published in Svalbardposten, the local newspaper, in an attempt to get inhabitants to be interviewed (Svalbardposten, 2022). Lastly, around 40-45 mails were sent out to different companies and organizations, with a request for them to be interviewed. Information of my master thesis and the topic of the interview was also shared with them. If respondents had not replied in a two-week timeframe, they were called through phone.

In total, 3 inhabitants were willing to be interviewed.

4.3.4 ArctRisk Interviews

During my master thesis I have been able to be involved in the ArctRisk-project. The ArctRisk project is a research project focused on identifying transitional values which mainland Norway can utilize in Longyearbyen`s hazard mapping and risk handling of climate-related risks. A part

of that projects includes analyzing how risk communication works in Longyearbyen. That is where I have been able to connect my thesis to this project.

The involvement has enabled me to access certain interviews of previous and current employees of Sysselmesteren. The interviews have been performed by other members of the project, while I have gained access to certain interviews which they have deemed relevant for my thesis.

In total, I have gained access to 3 different interviews with Sysselmesteren, where the questions have in some degree been relevant to my thesis.

4.3.5 Document study

In order to be able to answer both the research problem and the research questions, an analysis of different documents and mediums are necessary.

To answer the first research question, an analysis had to be done to identify the different climate-related hazard risks which Longyearbyen were facing. For this, both Sysselmesteren Risk-and Vulnerability report from 2016[1], and reports in Longyearbyen Lokalstyre webpage were analyzed (Longyearbyen Lokalstyre, 2022a). These documents were the basis for answering the first research question.

To answer the second research question regarding how the authority's communication with the inhabitants, a multitude of mediums were analyzed. Both Sysselmesteren and Longyearbyen Lokalstyre webpage analyzed for information regarding these climate-related hazard threats. Their Facebook page was also analyzed, where all posts from 2015-2021 were analyzed related to the communication of climate-related hazard risks in Longyearbyen. In table 4 below are all the webpages and documents utilized in the document study.

[1] The Risk- and Vulnerability report from 2016 are no longer available at Sysselmesteren webpage. The document were previously downloaded before the report was removed.

Table 3. Documents and webpages utilized in the document study

Name	**Relevance**	**Source**
Longyearbyen Lokalstyre Facebook	Medium for risk communication	(Longyearbyen Lokalstyre, 2022b)
Sysselmesteren Facebook	Medium for risk communication	(Sysselmesteren, 2022a)
Longyearbyen Lokalstyre – Societal safety & preparedness section	Webpage for risk information	(Longyearbyen Lokalstyre, 2022c)
Longyearbyen Lokalstyre – Avalanche measures	Webpage for risk information	(Longyearbyen Lokalstyre, 2022d)
Longyearbyen Lokalstyre – preparedness plan	Webpage for risk information	(Longyearbyen Lokalstyre, 2022e)
Varsom - Avalanche warning	Webpage for risk information	(Varsom, 2022)
Longyearbyen Lokalstyre – Fire and rescue	Webpage for risk information	(Longyearbyen Lokalstyre, 2022f)
Longyearbyen Lokalstyre – news archive	Webpage for risk information	(Longyearbyen Lokalstyre, 2022g)
Longyearbyen Lokalstyre – Reports	Webpage for risk information through official reports	(Longyearbyen Lokalstyre, 2022a)
Sysselmesteren – Societal safety and preparedness	Webpage for risk information	(Sysselmesteren, 2022b)
Sysselmesteren – preparedness against acute contamination	Webpage for risk information	(Sysselmesteren, 2022c)
Sysselmesteren – Local avalanche forecast for inhabitants in Longyearbyen	Webpage for risk information	(Sysselmesteren, 2022d)
Sysselmesteren – Risk- and vulnerability analysis	Webpage for risk information	(Sysselmesteren, 2022e)
Sysselmesteren – preparedness council on Svalbard	Webpage for risk information	(Sysselmesteren, 2022f)
Sysselmesteren – news section	Webpage for risk communication	(Sysselmesteren, 2022g)
Longyearbyen – Elvesletta. Vassdragstekniske vurderinger	Report about risk of flooding to Elvesletta	(Hoseth & Daae, 1996)
Flomberegning for Longyearelva	Report about flood calculation for Longyear river	(Stenius, 2016)

Tiltaksplan – Flom- og erosjonssikringstiltak I Longyearelva	Report about flood measures for Longyear river	(Hoseth, 2017)
Skredfarekartlegging I utvalgte områder på Svalbard	Report about hazard mapping in specific areas on Svalbard	(NVE, 2016)
Sukkertoppen Svalbard – avalanche incidents	Report about avalanche incidents on Sukkertoppen	(NGI, 2017)
Skredulykken I Longyearbyen 19. Desember 2015	Report about the 2015 snow avalanche event in Longyearbyen	(DSB, 2015)
Gjennomgang og evaluering av skredhendelsen I Longyearbyen 21.02.2017	Report about the 2017 snow avalanche event in Longyearbyen	(NVE, 2017)
Longyearbyen Lokalstyre – press message about SMS warning system in longyearbyen	Website for risk communication	(Longyearbyen Lokalstyre, 2021)

4.4 Data Analysis

This subchapter will focus on how the collected data has been analyzed. It will go through how the survey, interviews, ArctRisk interviews and document study has been analyzed

The survey has both been created and analyzed using the software SurveyXact. have gained access to this software through my home university, the university of Stavanger (UiS). The survey automatically creates an overview chart of the different questions, and which options had been selected. This made it easy to identify possible trends. Through data reduction, a certain number of clear trends were chosen to be highlighted in the empirical chapter as findings. While some minor trends were not included in the empirical chapter, all empirical data has been utilized in the empirical chapter.

The interviews done with inhabitants were recorded in the format of an audio file. These audio files were then written down in a transcription document. An overview of what the different informants answered was created, so that the answers could be compared to each other, and identify if any trends were present. These were then written down into the empirical chapter.

When it comes to the ArctRisk Interviews, a conversation was first started with my work colleagues in regard to what I was looking for in the interviews, and which interviews could

possibly be relevant. Interviews identified as relevant was therefore given to me, in the form of an audio file which I had to write down in a transcription document. These interviews were mostly relevant in regard to how Sysselmesteren dealt with short-term risk communication of snow avalanche, and the snow avalanche warning system. Not all questions were relevant for my thesis, and therefore I had to do a data reduction and eliminate irrelevant questions. This all resulted in a small but valuable document where all relevant information from the interviews was written down and later added to the empirical chapter.

Lastly, we have data reduction of the document studies. Data reduction is the process of transforming raw data into a form which they can be analyzed. In relations to the first research questions, a lot of reports from Longyearbyen Lokalstyre (Longyearbyen Lokalstyre, 2022a) had to be disregarded as they were not relevant. The only relevant reports were those which contained information about snow avalanche, flooding, debris flow or rockfall in Longyearbyen. These were utilized in the empirical chapter, while the other report was disregarded. When it comes to the Risk- and Vulnerability report from 2016 by Sysselmesteren, large sections of the report were not relevant, as they did not contain information about climate-related hazard risks in Longyearbyen. In the section which did contain information about these hazard risks, a limitation had to be done. A decision was then made to limit the scope of the thesis and only focus on a couple of climate-related hazard risks.

In relations to the second research question, a multitude of mediums which have been utilized by both Sysselmesteren and Longyearbyen Lokalstyre were analyzed. This includes both their webpage and their Facebook page. The first stage of the analysis was to identify the timeframe which I would analyze. I choose to review all information posted from 2015-2021. After the 2015 and 2017 snow avalanche in Longyearbyen, much attention has been focused on the risk information of both snow avalanche and other risks. Such a time frame would enable the analysis to both pick up on more frequent short-term risk communication, as well as less frequent long-term risk communication. This timeframe was not always possible, as not all posts had been uploaded, especially those from 2015. Therefore, some mediums have a shorter timeframe. This has been commented on and highlighted in the empirical chapters.

The second stage is to analyze the different mediums. In the start I theorized about utilizing a software to analyze the different webpages and Facebook posts. This however posted both a challenge in regard to which software to use, and in addition that software would have to use

keywords or search words, which could create gaps which important information/posts could slip through. It was therefore decided to do a manual datamining of the different mediums. In the case of the webpages, I would go through each of the different page and subsection that was relevant to the different climate-related hazard risks. I was able to have an overview of what was relevant in the different webpage due to the extensive fieldwork and field conversations with colleague and other inhabitants. If relevant information were present, it would be noted down. Both in regard to which risks it is about, but also in regard to if it can be classified as short-term or long-term risk communication.

In the case of Facebook pages, I had to manually scroll down to the start of 2015 and then go through each post. In each post I quickly but effectively decided if it was relevant for any of the climate-related hazard risks. If they weren't, I would skip over them. If they were relevant, I would click on the post in order to identify if the content it was communicating could be classified as short-term risk communication or long-term risk communication. It would then be put into an excel sheet so that it was categorized and could be used later in tables. If posts were unclear, I would put them into the category which seemed logical. For this decision, I used my local knowledge about Longyearbyen as well as the theoretical knowledge I have about risk and risk communication.

4.5 Assessment of methods

This subchapter will reflect on both the validity and reliability of the different methodologies used in this master thesis. It will highlight what has been done to ensure the highest validity and reliability, as well as a reflection on what could have been done differently.

When it comes to judging the quality of research design in case studies, there exist four test to use on a case study (Gibbert et al, 2008): (1) *construct validity*, (2) *internal validity*, (3) *external validity* and (4) *reliability*.

Construct validity relates to the correct identification of operational measures for the concepts being studied. One of the tactics used in case study to improve the construct validity is to ensure multiple sources of evidence for the case study. Through the use of methodological triangulation, both fieldwork, survey, interviews and document study has been done to ensure a sound construct validity of this thesis, ensuring in both a multitude of evidence through

different sources, as well as a insight in both inhabitants and authorities point of view in relations to climate-related risk communication.

Internal validity are not usually utilized in explorative studies, as they don't specifically seek to establish causal relationship (Gibbert et al, 2008). Despite this, I feel compelled to include this as internal validity is gained through pattern matching, explanation building, addressing rival explanations and logic models. It is precisely this kind of pattern matching and explanation building that some of the empirical trends in the empirical chapter will present. I therefore find it relevant to describe both the strengths and potential challenges with this process.

The pattern matching is using the survey as a foundation. Depending on what trend/pattern is identified, the document study and especially interviews are used to further verify the patterns, and provide a explanation to why these patterns exist. There is a case to be made that the explanation building deriving from the interviews are not the most solid, due to the limited sample size. As presented in subchapter 4.3 *data collection*, a multitude of approaches have been done in order to get the largest number of informants for the interviews. That all this effort led to only 3 informants in total, is a weakness for the internal validity of this thesis.

However, in the case of the survey, the trends are clearly identified, and verified in the interviews. While there is a certainty that additional informants would have strengthened the internal validity, I do not think it weakens the overall conclusion of the trends which is presented in the empirical chapter. If the trends from the survey was less conclusive, the lack of informants in the interviews would most certainly have a larger impact on the thesis internal validity then what it does at this current moment.

External validity ascertains whether a case studies findings can be generalized. External validity is produced through application of theory in single-case studies (Yin, 2018, p. 43). This thesis utilizes theory regarding both communication and risk communication. The findings identified in this thesis regarding how authorities communicate complex risk problems such as climate-related risk problems to the inhabitants, and the utilization of society-wide networks and its formulation in communicating information and not just documentation has the potential for external validity due to their relevance. These findings are not unique for Svalbard, as cities, communities and individuals are exposed to climate-related natural hazards in other parts of the

world beyond the arctic region. The utilization of social media as a medium for risk communication is also not something which is unique to the arctic context.

Lastly, we have the reliability of the thesis which looks at the repeatability of the study with the same result, with the goal of minimizing the errors and biases in a study (Yin, 2018, p. 43). The research design and the chapter of method has documented the procedures and multitude of methods utilized in this case study, which in theory would enable other scientists to recreate this exact case study. There are however two issues of reliability for other scientist to take into account if they want to recreate this case study. The first iss ue is that they are not affiliated with the ArctRisk-project, and therefore does not have access to the interviews done with Sysselmesteren. This can be counteracted by creating their own interview guide and interview Sysselmesteren. This is however easier said than done, as Sysselmesteren are busy and therefore hard to get interviews with, especially if one is not affiliated with a project that is already in cooperation with the authorities. The second issue is that the researcher does not have access to the Risk- and vulnerability report from 2016 by Sysselmesteren. This document can however be requested, any reasoning for denying such a request would be, illogical at best, due to the nature of the document, which contain no sensitive information which is not already known in the local community.

4.6 Ethical reflections

There are two ethical topics which I have reflected upon during my master thesis. The first one is in regard to the data analysis and how it can be affected by my own bias, while the second one is about the informants and my prior contact with them.

When it comes to the analysis of data, I am both affected by my theoretical background as well as my status as one of the inhabitants in Longyearbyen. Both of these have the possibility to affect how I analyze the collected data. When I analyzed the empirical data, one of the things which I determined was whether something could be categorized as document or actual communication. This is an important distinction as it speaks to the ease of which an ordinary person could or could not understand what was communicated, either because it is too complex, or it includes terminology which require prerequisite knowledge. In an effort to reduce bias, I have gone through the analysis of the empirical findings several times and tried to double and triple check if what was communicated could really be understood by an individual just arriving

to Longyearbyen without any specific knowledge. This processed helped me realize my own bias and take that into account when analyzing.

In regard to the informants of the interviews, I have had prior contact with two out of the three informants which accepted to be interviewed. I was first introduced to them through the UNIS courses which I did in my 3rd semester. I would not characterize the prior contact with them as extensive. I talked with them a couple of times through the course, and I was a participant of the October 2021 AMRO exercise in Longyearbyen (Arctic Mass Rescue Operation). I interviewed one of the three participants in relations to an assignment which I had in one of my courses, and through that interview I was introduced to the second informant. A mail was sent to these informants asking for them to be interviewed, just as I had done with the other corporations and organizations in Longyearbyen.

4.7 Strengths & weaknesses

The last subchapter in the chapter of method will reflect on the largest weakness of this master thesis, as well as the process of making the weakness into one of the strongpoints of this master thesis.

Throughout my work on this master thesis, the most challenging task was getting access to data through interviews with the inhabitants. What I though would be an easy task, proved to be quite challenging, and required of me a great deal of work in order to increase the number of inhabitants that were interviewed. This were done, as mentioned in subchapter 4.3.3 *interviews*. The results were however not satisfactory, seeing as how the reader column, Facebook posts and mails had not resulted in additional inhabitants willing to be interviewed. The glaring weakness of my master thesis was therefore the lack of interviews done with the inhabitants. This initial weakness meant that additional time and resources needed to be focused on other aspects of the data collection process. This led me to focus on the triangulation method, where much attention was focused on the document study and survey. This resulted in an extension of different data sourced which would be utilized in the empirical chapter.
Although my perception still remains that an increase in the sample size of the inhabitants which has been interviewed would strengthen the master thesis, it would not prove to be a large weakness in the master thesis due to the multitude of other data sources which would be utilized to identify trends in the risk communication, as well as create a overall overview of the risk communication done between the inhabitants and the authorities relating to the chosen climate-

related hazard risks. I draw the parallel to different mediums in risk communication, some are good for documentation, some are good for information and some work as a two-way communication channel (Chess et al, 1989; Lundgren, 1994; Renn, 2006c). I would argue that the same can be applied for my data collection. Some data sources were more suited to identify trends, while some were suited to create an overview of the risk communication. Different data sources such as document study, survey and fieldwork have different strengths and weaknesses, and overall, they cover each other weaknesses and create a good foundation to answer the master thesis research problem and research question. The lack of interviews increased the vulnerability of the interview data source but was counteracted through focus on the other data sources. Therefore, I argue that the master thesis main weakness has been converted to one of its strengths, highlighting the importance of a diverse utilization of data sources.

I reflect on the possibility that if I would have utilized a less variety of data sources, the lack of interviews would create a large vulnerability in the master thesis. Especially the document studies have been crucial for counteracting the lack of interviews. The lack of interviews would then without a doubt create doubts and uncertainties ascertaining to the results in the empirical chapter.

5. Empirical findings

The empirical chapter is separated into three different subchapters. The first subchapters present the climate-related hazard risks which this thesis is all about. The second subchapters present and analyzes the different mediums which Sysselmesteren and Longyearbyen Lokalstyre have utilized. The third and last subchapters presents the survey, interviews done by myself as well as interviews through ArctRisk-project.

5.1 Climate-related hazard risks in Longyearbyen

The risk and vulnerability report from Sysselmesteren in 2016 highlights different risks to Longyearbyen and its inhabitants. These risks vary from large accident risks, acts of intentional harm to climate-related hazard risks. When it comes to the climate-related hazard risks, seven risks are presented (Sysselmesteren, 2022e). These are climate change and extreme weather, flooding, avalanches, infectious diseases, space weather, Vulcanic activity and earthquakes. The decision to only analyze snow avalanche, flooding, debris flow & rockfall were a result of the document study. Through the document study, these risks were highlighted as the most relevant climate-related hazard risks and were subsequently chosen. The purpose of this subchapter is therefore to shortly present how the risk of snow avalanche, flooding, debris flow & rockfall affects Longyearbyen.

The subchapters are categorized based on their geographical locations. First, the risk to Longyearbyen from Longyear river will be presented. Afterwards, the risk to Longyearbyen airport and main road will be presented. Then, the risk to Longyearbyen from both Platåfjellet and Sukkertoppen will be presented. Lastly, we close this empirical subchapter by presenting the risk to Longyearbyen from Vannledningsdalen.

5.1.1 Risk of flooding from Longyear river

The risk of flooding in Longyearbyen comes from Longyear river. Longyear river starts in both Larsbreen and Longyearbreen, two glaciers to the south of Longyearbyen. Four reports have been made regarding flooding of Longyearbyen. These are published on the webpage of Longyearbyen Lokalstyre (2022a). These reports look at the preliminary flood calculation of Longyearbyen (Hoseth & Daae, 1996; Senius, 2016), measures to deal with potential event of flooding in Longyearbyen (Hoseth, 2017) and lastly a risk assessment of flooding in the student housing in Elvesletta.

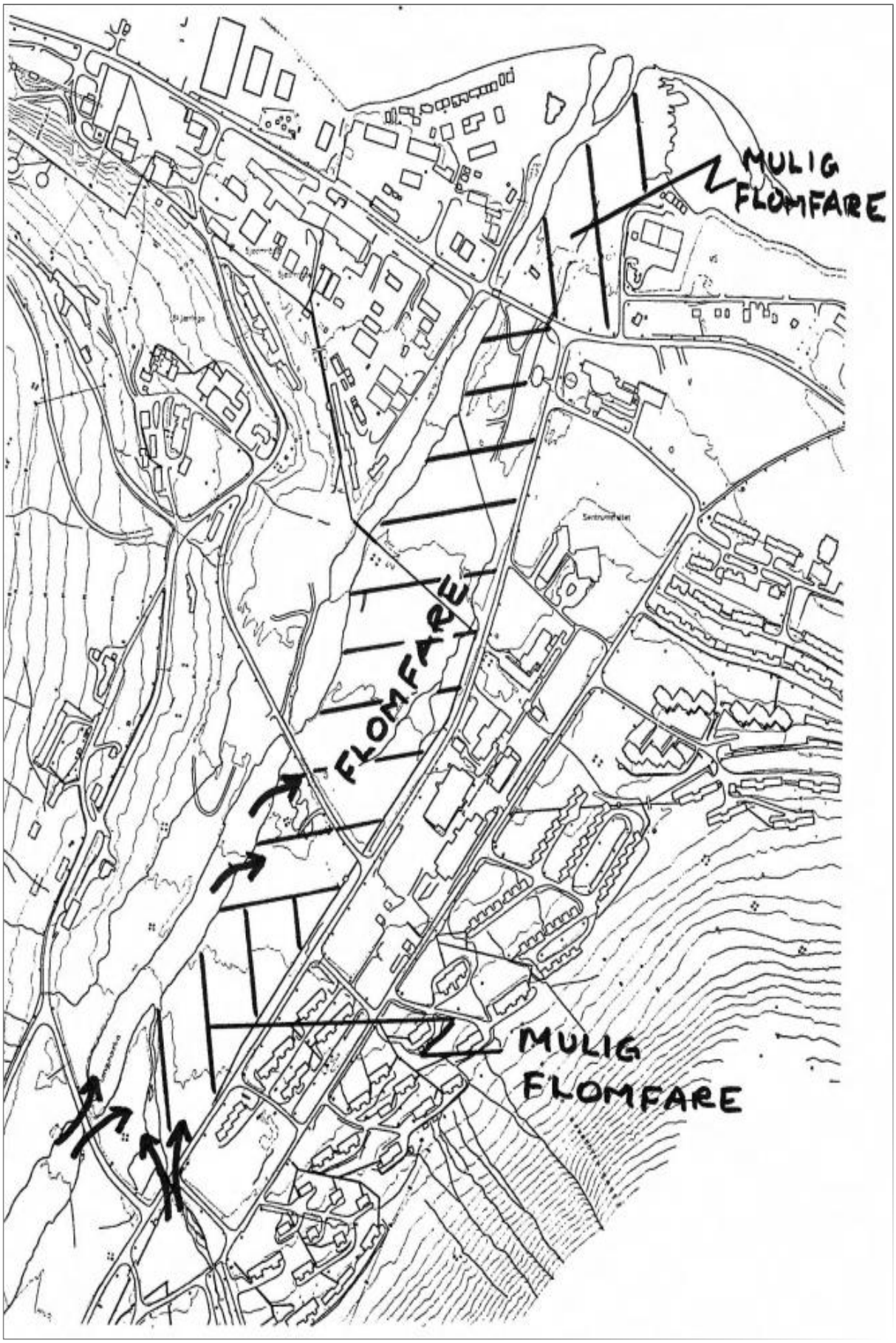

Figure 10. Probable risk of flooding without protective measures (Hoseth & Daae, 1996)

A geological survey done in 1996 mapped areas with a probable risk of flooding if protective measures were implemented. Due to an increase in precipitation and melting of ice, measures needed to be taken in order to avoid a sudden acute risk of flooding (Sysselmesteren, 2022e). In figure 10 above all the areas marked with black stripes is areas with a probable risk of flooding. "Flomfare" is translated to "risk of flooding" and "mulig flomfare" is translated to "possible risk of flooding"[2]. To mitigate the risk of flooding, several measures have been completed since the geological survey in 1996.

The first measure included bulldozing the river to clear it of sediments (Hoseth & Daae, 1996). The second measure were to create shoulders in the riverbeds, where each shoulder would decrease in height. In addition to this shoulder, the river would be expanded and then filled with rocks as to avoid button erosion of the river. The purpose was to control both sediment and water transport sediments (Hoseth & Daae, 1996). The third measure from 2018 includes a continuous monitoring of sediments water transportation and river erosion in Longyear river. This monitoring of Longyear river is a combined project between Longyearbyen Lokalstyre, The University Centre in Svalbard (UNIS), NGI, and NTNU (ResearchinSvalbard, 2022)

Figure 12. Second example of a river shoulder in Longyear river (Hoseth & Daae, 1996)

[2] To get a proper overview of the infrastructure and buildings in the area with probable risk of flooding, compare figure 10 and figure 3. This will allow you to see how many buildings and infrastructure have been constructed in the are with probable risk of flooding since 1996.

5.1.2 Risks to Longyearbyen airport & main road

Longyearbyen airport is located directly north-west of Longyearbyen. Due to its location, it is in the vicinity of Platåberget. As a result of this, the airport is exposed to both the risk of snow avalanche, debris flow & rockfall (NVE, 2016). When inhabitants and tourists arrive at Longyearbyen airport, they need to travel on the only main road in order to arrive at the city center of Longyearbyen, located 4 kilometers to the south-east (TopoSvalbard, 2022). The main road is primarily exposed to debris flow & rockfall (NVE, 2016).

A hazard map of both Longyearbyen airport and the main road will be presented. The purpose is to illustrate how the different climate-related hazard risks can affect the airport, the surrounding vicinity and the main road leading to Longyearbyen. Areas marked in red are areas where the risk of occurrence is 1/100 year. Areas marked in orange are areas where the risk of occurrence is 1/1000 year and areas marked in yellow are areas where the risk of occurrence is 1/5000 year. The different symbols are used for specific risks. Triangle is used for debris flow, circle is used for snow avalanche and square is used for rockfall (NVE, 2016).

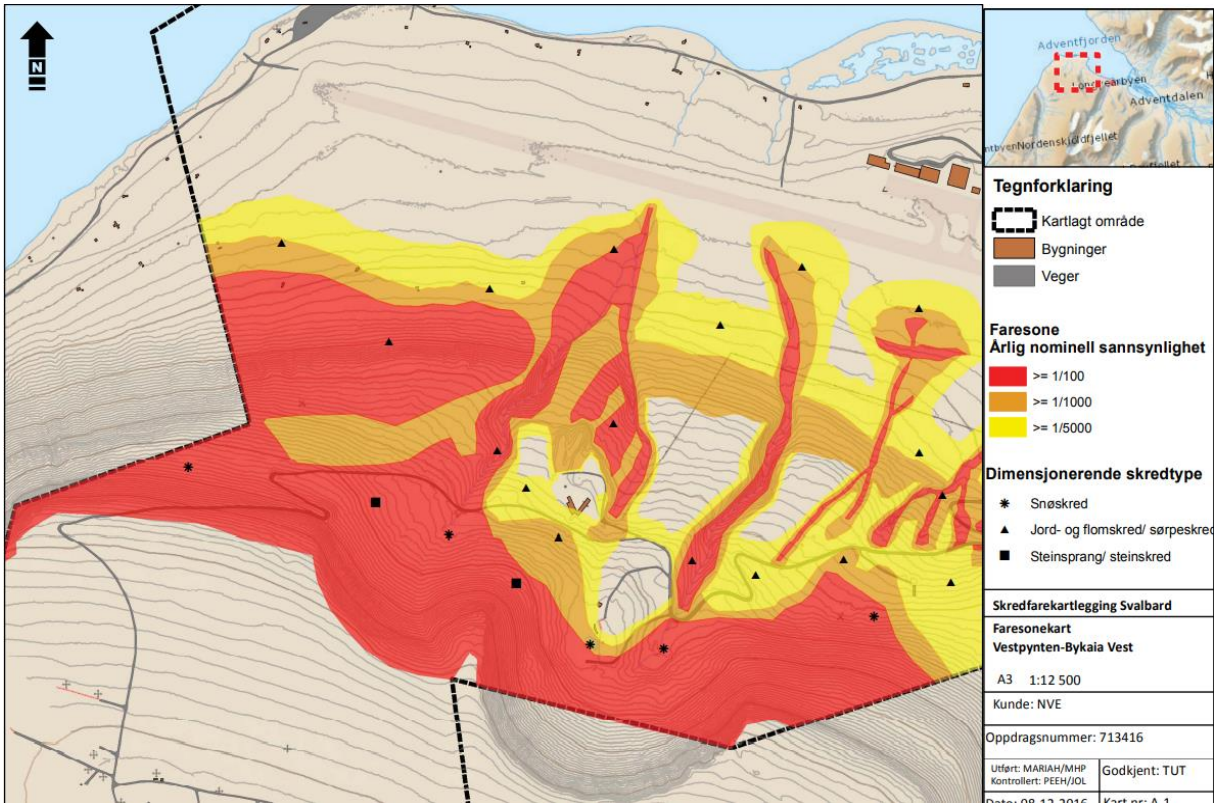

Figure 13. Hazard mapping of Longyearbyen airport (NVE, 2016)

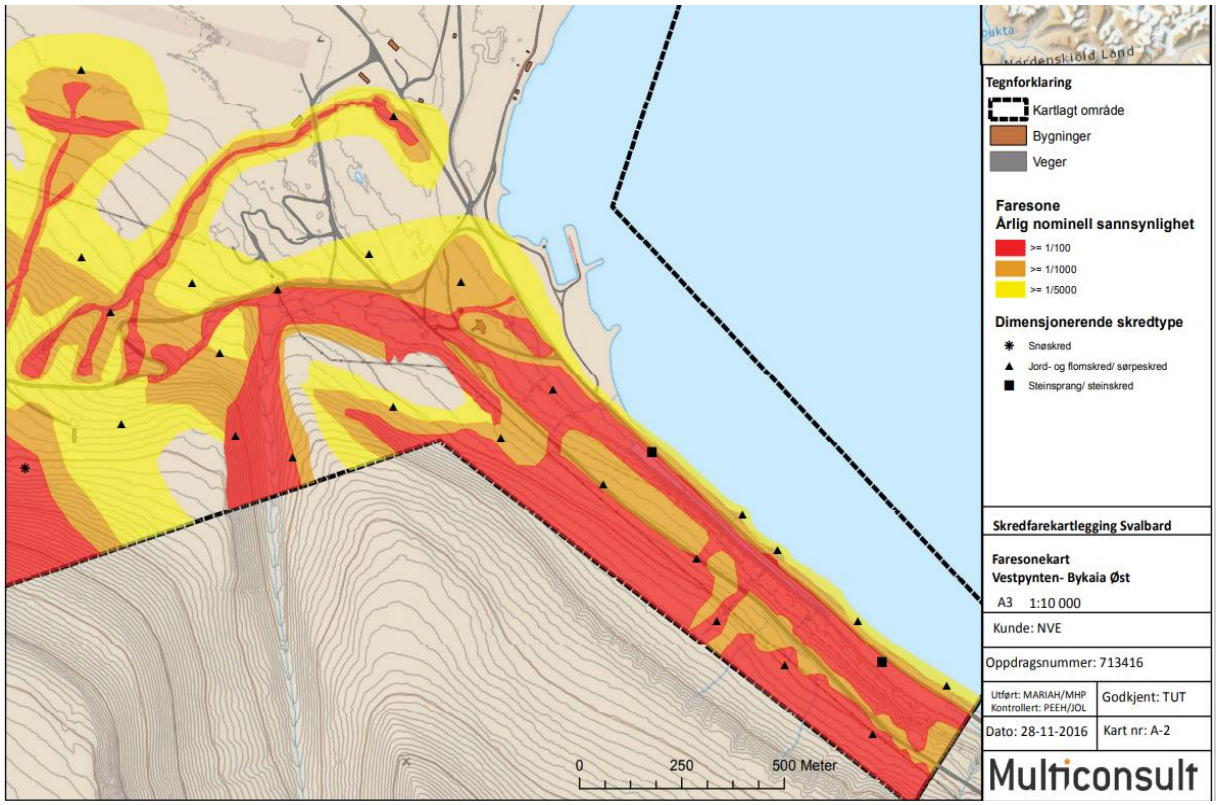

Figure 14. Hazard mapping of the main road (NVE, 2016)

5.1.3 The risk to Longyearbyen power plant from Platåfjellet

Platåfjellet is located directly to the west of Longyearbyen. The power plant is the town's only source of power, and due to its location close to Platåfjellet, is exposed to both snow avalanches and debris flow (NVE, 2016). Two hazard maps will be presented, one for the risk of snow avalanche, and one for debris flow[3].

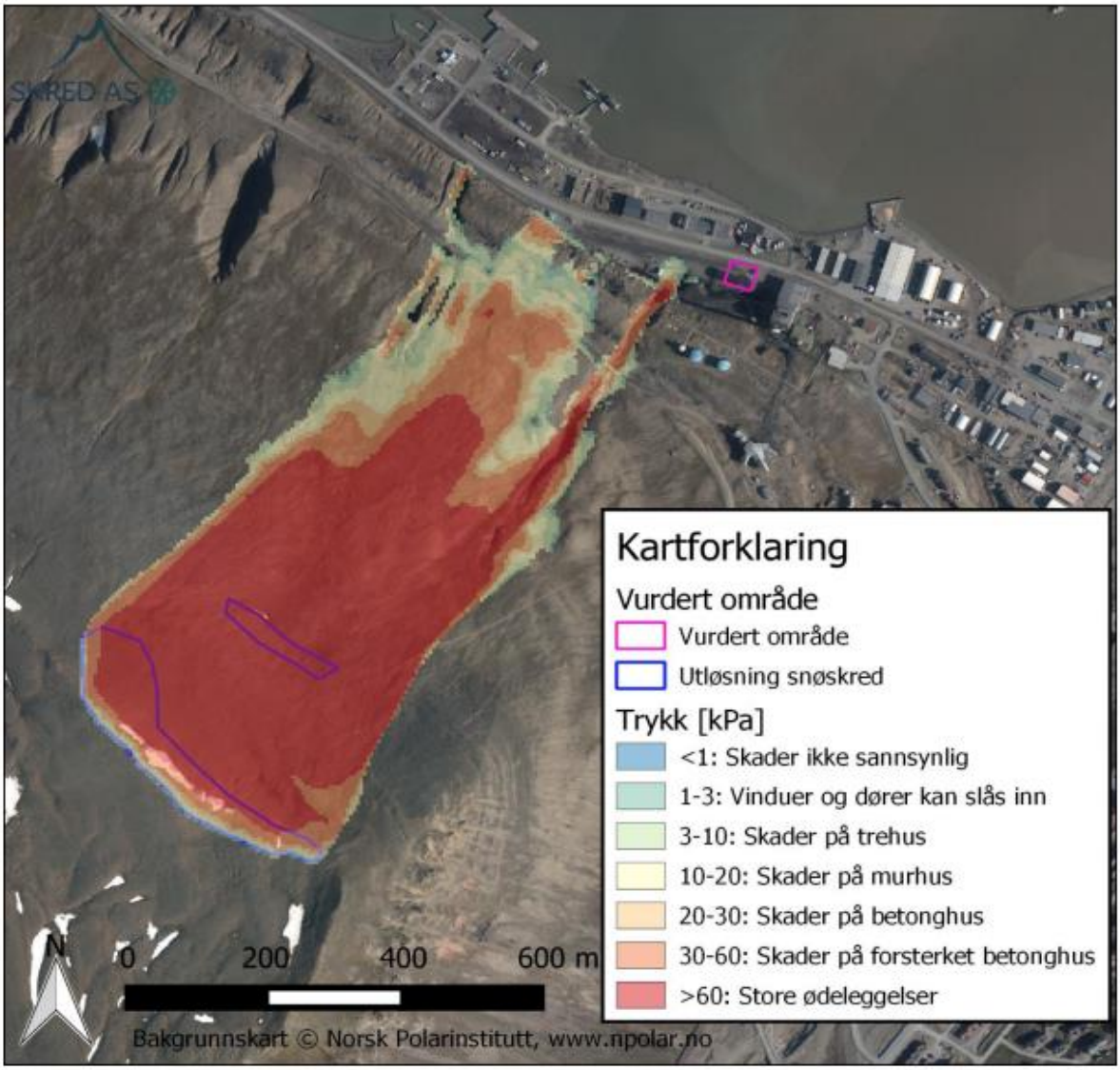

Figure 15. Snow hazard map of Longyearbyen power plant (NVE, 2016)

[3] Explanation for figure 15. The colored area indicates the area which is affected by the snow avalanche. The different colors indicate the different levels of pressure involved in. Areas with blue and green colors indicate less pressure, thus resulting in less potential damage to infrastructure The dark blue areas are the origin of the snow avalanche, and the purple box is where the power plant is located.

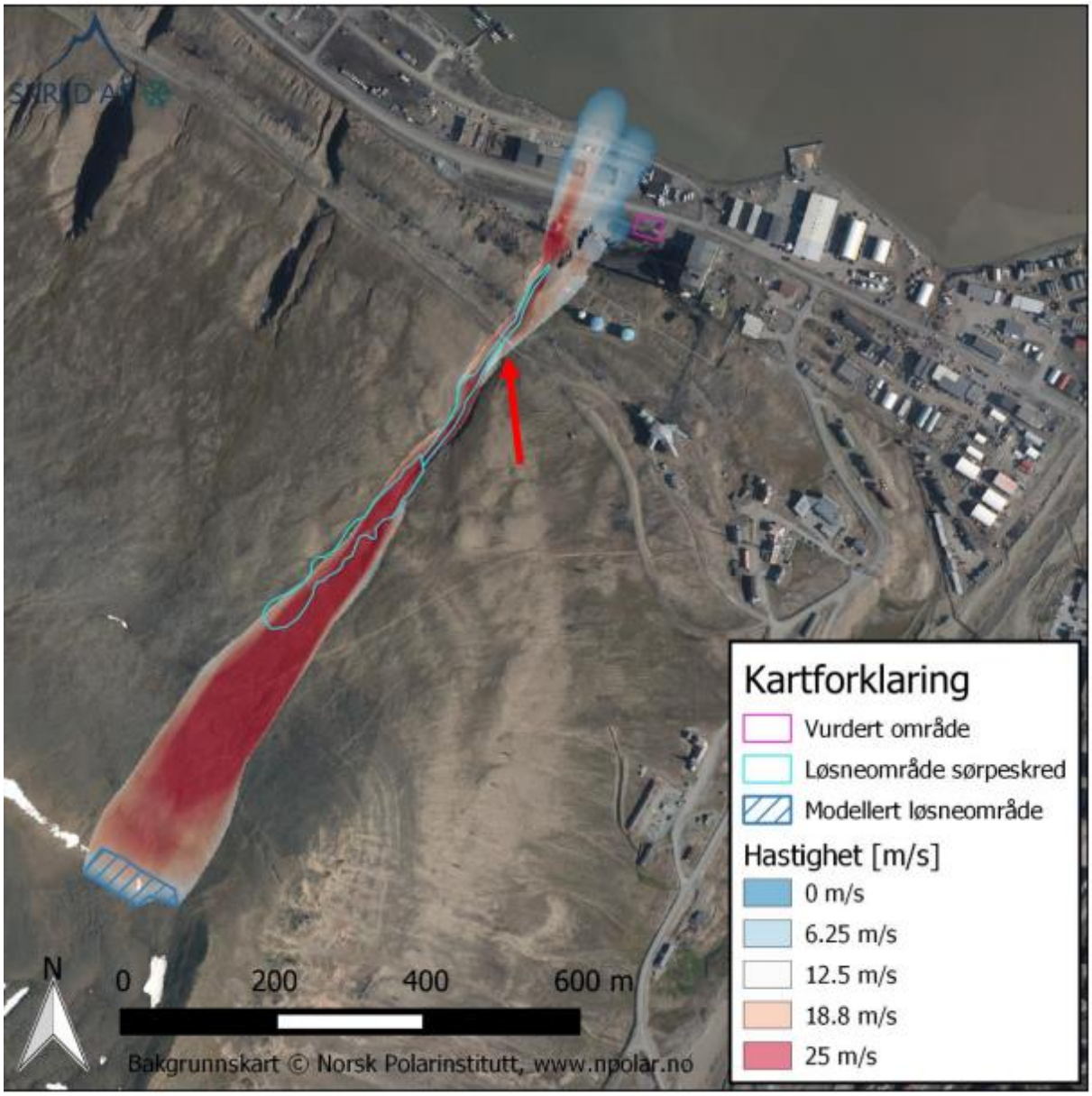

Figure 16. Debris flow hazard map of Longyearbyen power plant (NVE, 2016)

[4]

These two hazard maps illustrates how the risk of snow avalanche and debris flow affect the surrounding area in slightly different manner. Both the snow avalanches and debris flow hit the infrastructure which is located directly west of the power plant, no further than 100 meters away from the power plant facility.

[4] [4] Explanation for figure 16. Blue area are the areas where there is the highest probability of snow avalanche The different colors on map indicate the amount of force in the snow avalanche and the subsequent consequences on infrastructure

5.1.3 Risk to existing infrastructure near Sukkertoppen

Sukkertoppen is located directly to the south-east of Longyearbyen. From 1991 to 2010, at least five different snow avalanches has occurred (NGI, 2017).

On the 19th of December 2015 a snow avalanche occurred after heavy wind and snow the previous night. The snow avalanche impacted 11 different houses, where 2 were uninhabited at the time. In total, 25 people were directly affected by the snow avalanche, and who people died as a result (DSB, 2015).

On February the 21st 2017, another avalanche occurred directly south-west of the snow avalanche in 2015. In comparison to 2015, this snow avalanche only did material damage to buildings and led to no loss of life (NVE, 2017). These avalanches are illustrated in the figure 17 & 18 below, both illustrating the impact zone of the 2015 and 2017 snow avalanche[5], and the existing infrastructure in the surrounding area.

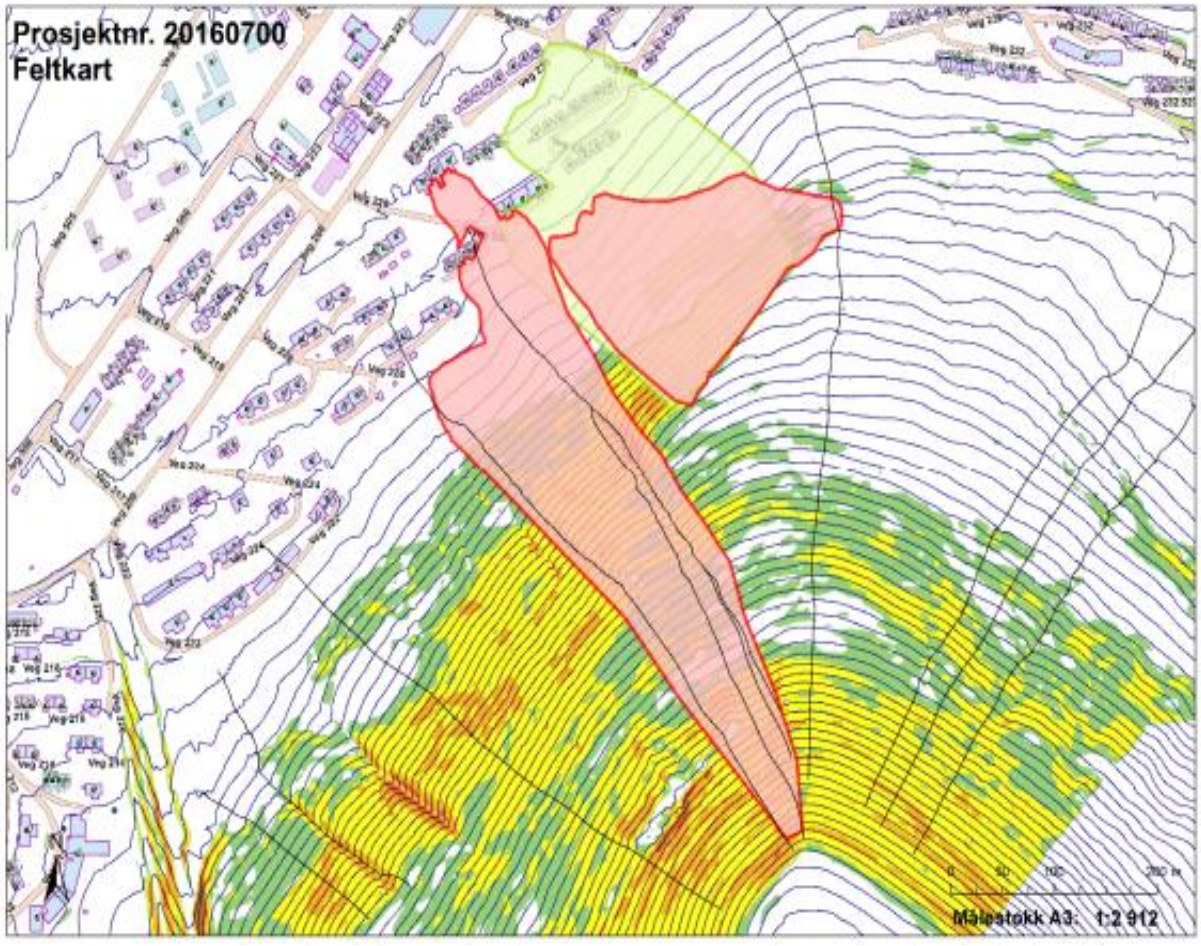

Figure 17. Hazard map of the 2015 and 2017 snow avalanche (NVE, 2017)

[5] The green area is the 2015 snow avalanche and the red areas is the 2017 snow avalanche

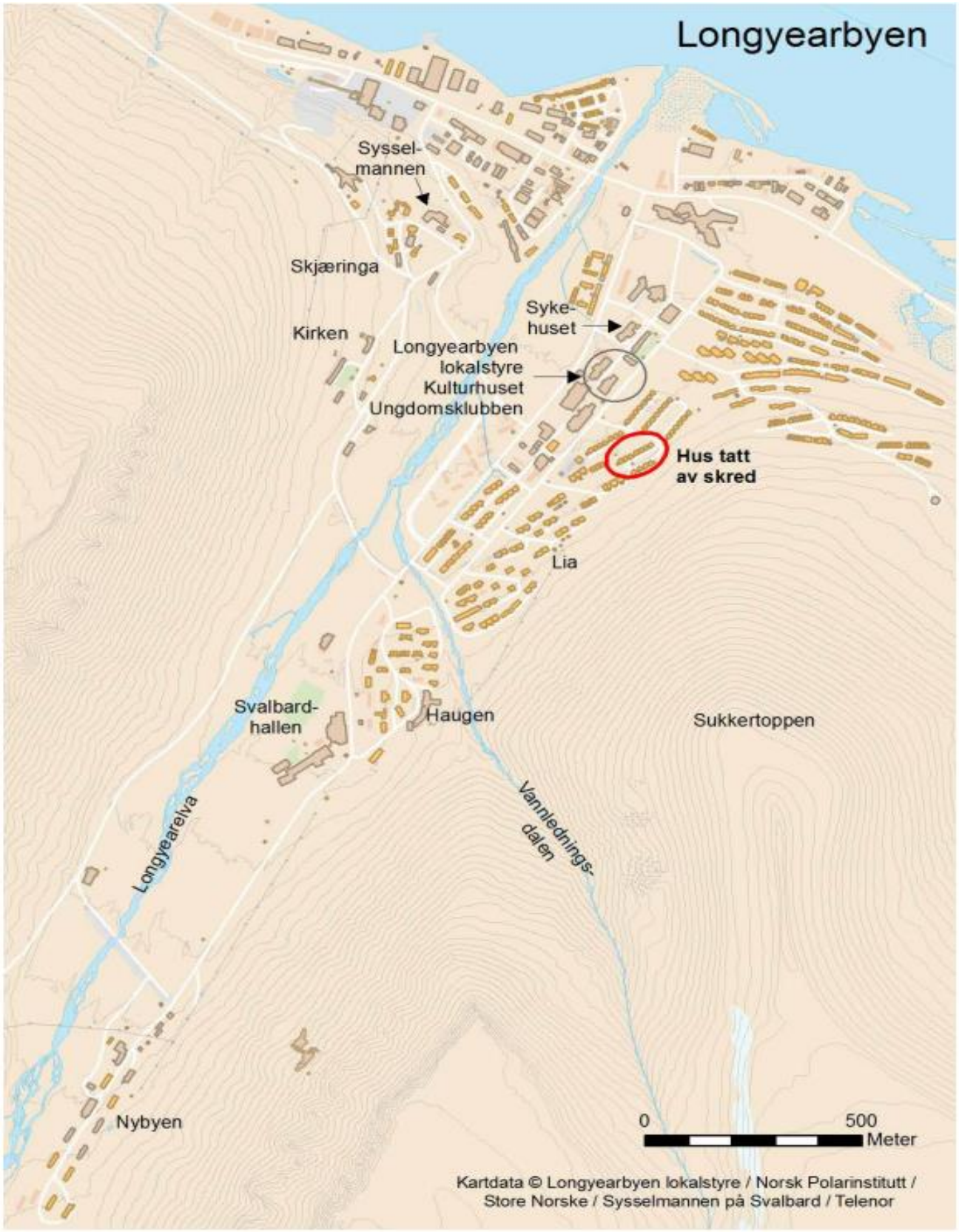

Figure 18. Area of impact of snow avalanche 2015 (NVE, 2017)

After these two snow avalanches, several measures have been put in place, such as (Longyearbyen Lokalstyre, 2020a):

(1) Creation of an assessment group for snow avalanche in Longyearbyen

(2) Snow-collection screens at Sukkertoppen and Gruvedalen

(3) Draining ditch close to Gruvedalen

(4) Stone barricade where the 2015 avalanche occurred to protect remaining infrastructure

5.1.4 Risks to existing infrastructure from Vannledningsdalen & Nybyen

Vannledningsdalen is a valley located directly south of Longyearbyen. Infrastructure which are located at the end of Vannledningsdalen are primarily exposed to debris flow. A measure which is still in its planning face, but has been approved, is the construction of a large net in Vannledningsdalen[6].

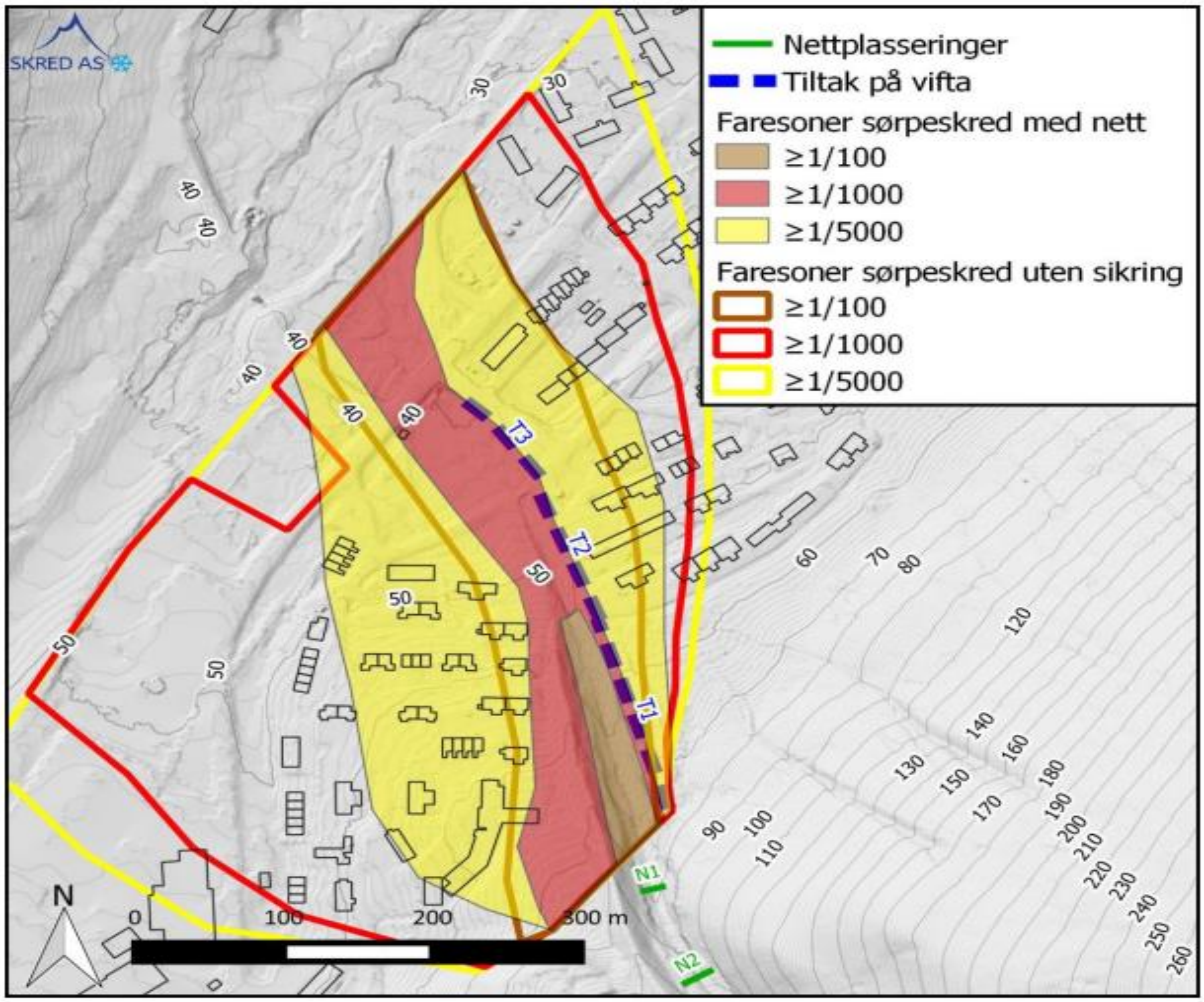

Figure 19. Hazard mapping of existing infrastructure at Vannledningsdalen, with and without measures (NVE, 2017)

[6] Figure 19 shows a reduction an affected areal if a debris flow were to occur. The fully colored areas are the area of impact with debris flow measures and the colored lines are the area which can be affected if measures are not taken.

Nybyen is located a couple of hundred meters south of Longyearbyen. It is still counted as a part of Longyearbyen, even though it is some distance away from the other infrastructure. Due to Nybyen being located close to Gruvefjellet, it is exposed to snow avalanches. Figure 20 below illustrates the risk of snow avalanches for the inhabitants who live in Nybyen. On the map, Nybyen is located at the end of the road in the south-west corner of the map.

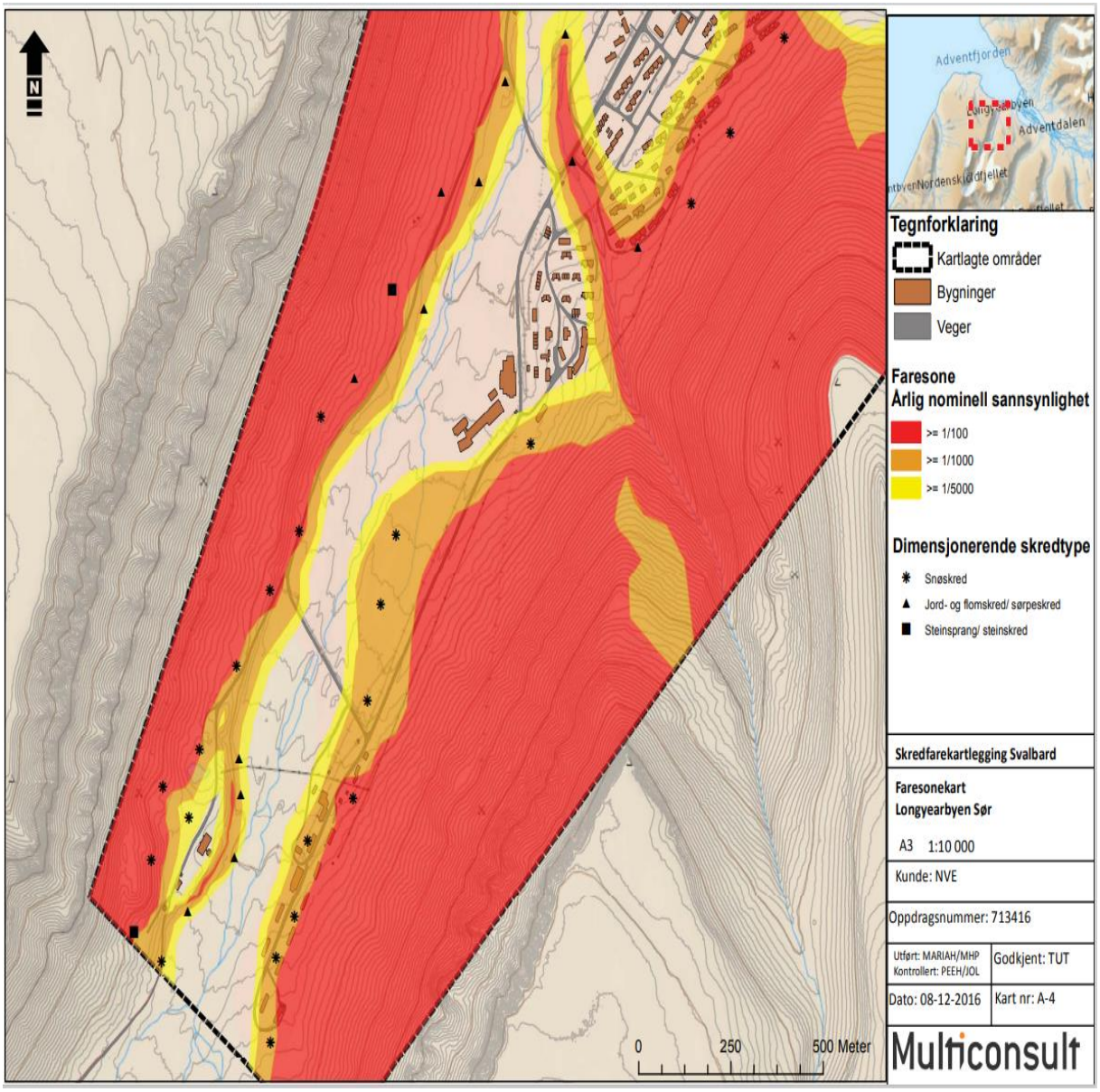

Figure 20. Hazard map of Nybyen (NVE, 2016)

5.2 What mediums are Longyearbyen`s decision-makers utilizing to communicate with its inhabitants?

This subchapter intends to present the different mediums which the authorities have used in their risk communication of climate-related hazard risks such as snow avalanche, flooding, debris flow & rockfall. Content related to the different mediums will also be presented. Content that is deemed particularly relevant will be described in depth, while other parts of the content will be described shortly. Those contents are still relevant, but not of major importance in the discussion chapter. The subchapter will start by presenting Sysselmesteren webpage and Facebook page, before moving out to Longyearbyen Lokalstyre webpage and Facebook page. We then move over to the public meetings and end this subchapter by presenting other smaller mediums which the authorities have utilized.

5.2.1 Sysselmesteren webpage

One of the mediums which Sysselmesteren is using to communicate information to its inhabitants is its own webpage (Sysselmesteren, 2022h). On the webpage you can find information about Sysselmesteren, laws, and other important information which inhabitants should be aware of. The webpage contains a section about societal safety and preparedness. In this section one gets information about (1) *preparedness against acute contamination of as a result of oil spill or maritime accidents*, (2) *risk and assessment analysis*, (3) *local snow avalanche warning for inhabitants of Longyearbyen* and (4) *preparedness council for Svalbard* (Sysselmesteren, 2022b). In addition to this, Sysselmesteren periodically releases information on their news section.

Information on both the risk and assessment analysis and the local snow avalanche warning for inhabitants will be presented, as they entail important information regarding the risk of snow avalanche, flooding and other types of avalanches. Then, an analysis of Sysselmesteren news section will be done, in order to get an overview of what information is given to the inhabitants that relates to snow avalanche, flooding and other types of avalanches.

The risk and assessment analysis is a document created in 2016, which presents the different hazard which Longyearbyen is facing. The document presents risks in different categories, ranging from natural events to large accidents, intended acts of violence and risks facing the critical infrastructure in Longyearbyen (Sysselmesteren, 2022e). When it comes to the natural events category, both flooding, snow avalanche, debris flow and rockfall are mentioned. The

risk and vulnerability report gives an overview of the different risks Longyearbyen is facing from flooding, snow avalanche, debris flow and rockfall, and what measures have been implemented or will be implemented in order to deal with these climate-related hazard risks.

The local snow avalanche warning for inhabitants is a system which is active from the 1st of November to 31st of May every year. The Norwegian Water Resources and Energy Directorate (NVE) alongside Skred AS and local observers from Longyearbyen produces daily snow avalanche reports describing the local conditions. The webpage details where inhabitants can get their information from, and how they will be warned if evacuation is in order due to high risk of snow avalanche (Sysselmesteren, 2022d).

The news feed is the section where all the posts made by Sysselmesteren is stored[7]. After reviewing the different posts in the news section, table 5 was created, giving an overview of different posts related to the relevant climate-related hazard risks.

Table 4. Overview of relevant posts regarding climate-related hazard risks on Sysselmesteren webpage from 2019 to 2021

	2019	2020	2021	Total
Snow avalanche - Short term	0	0	19	19
Snow avalanche - Long term	0	2	0	2
Flooding - Short term	0	0	0	0
Flooding - Long term	0	1	0	1
Debris flwo - short term	0	0	0	0
Debris flow - long term	0	1	0	1
Rockfall - short term	0	0	0	0
Rockfall - long term	0	0	0	0
Total	0	4	19	23

A reflection on the information provided on Sysselmesteren webpage is that the information is both superficial and does not provide the inhabitants with much in-depth information about these different climate-related hazard risks.

[7] Sysselmesteren systematically delete old posts. As such, any information which is before the 15.04.2019 are unavailable in the news feed.

5.2.2 Sysselmesteren Facebook

One of the mediums which sysselmestern is utilizing frequently to communicate with its own inhabitant is its own Facebook page. The Facebook page has been analyzed, where the goal is to identify how this medium has been utilized in both short-term and long-term risk communication of snow avalanche, flooding, debris flow & rockfall.

Table 5. Overview of relevant posts relating to climate-related hazard risks on Sysselmesteren Facebook page from 2015 to 2021

	2015	2016	2017	2018	2019	2020	2021	Total
Snow avalanche - Short term	35	37	109	16	21	3	23	244
Snow avalanche - Long term	1	13	3	7	0	2	4	30
Flooding - Short term	0	5	2	0	1	0	0	8
Flooding - Long term	0	2	1	0	0	0	1	4
Debris flwo - short term	0	7	0	5	2	0	0	14
Debris flow - long term	0	3	0	1	0	0	1	5
Rockfall - short term	0	0	0	0	2	0	1	3
Rockfall - long term	0	0	0	1	0	0	0	1
Total	36	67	115	30	26	5	30	309

Through an analysis of the different posts on Sysselmesteren Facebook page from 2015-2021, several trends are identified. First off, most of the communication which is done is categorized as short-term risk communication (87%), while the remaining is long-term risk communication (13%). The second trend which has been identified is the fact that snow avalanche related risk communication, both short-term and long-term, accounts for 89% of the total risk communication. This results in the remaining 11% of risk communication posts, both short-term and long-term, being shared between risks such as flooding and debris flow & rockfall.

A reflection on the risk communication done through sysselmestern Facebook page is that the communication is focused on snow avalanche related risk communication, at the cost of the other climate-related hazard risks such as flooding and debris flow & rockfall. Although the results are not discussed in depth here, it will be done in the discussion chapter.

5.2.3 Longyearbyen Lokalstyre Webpage

One of the main mediums which Longyearbyen Lokalstyre is utilizing to communicate with its inhabitants is its own webpage. The webpage is categorized into different fields, from school and energy to politics and societal safety & preparedness. The relevant sections which has been included in the document study is the societal safety & preparedness section, the news section, the welcome to Longyearbyen section and the report section. All of these will be presented chronologically.

Societal safety & preparedness section

The societal safety & preparedness section entails the different preparedness plans and measures taken in relations to different risks. These plans and measures are then categorized into six different topics ranging from (1) *corona measures*, (2) *fire and rescue*, (3) *avalanche warning*, (4) *preparedness plan*, (5) *avalanche measures* and (6) *self-preparedness* (Longyearbyen Lokalstyre, 2022b). Both avalanche warning, the preparedness plan and avalanche measures will be presented, as they entail important information regarding the risk of snow avalanche, flooding and other types of avalanches.

The avalanche warning section takes you directly to a snow avalanche webpage of Nordenskiöld, which is the area in and around Longyearbyen. On the webpage one can get information about the weather on current and previous days, as well as an avalanche warning description, ranking from low to high avalanche warning. The webpage gives advice about how to behave in avalanche terrain (Varsom, 2022). The webpage is in both Norwegian and English, however details on specific avalanche risk is in Norwegian. The webpage does inform its reader that one can utilize google translate, but most relevant data has been translated to English.

The preparedness plan is split into four parts. The first part looks at the overall preparedness plan. What risks are Longyearbyen facing, what scenarios might arise and who will do what in different emergency situations.

The second part is an overall risk and vulnerability assessment. This assessment presents the different kind of risk which Longyearbyen is facing. Some of those risks include both snow avalanche and other types of avalanches but does not include flooding. Maps of areas exposed to snow avalanche and other types of avalanches are shown, as well as a short description of the particular risk of snow avalanche, debris flow and rockfall.

The third part is a document regarding crisis-communication, and how Longyearbyen Lokalstyre will communicate with its citizens in a crisis situation. It entails both the principles which Longyearbyen Lokalstyre will adhere to, and how they will act in the first hour and first day of a crisis. They have a checklist which they need to perform, which include keeping the public and media up to date with the current situation. The last part contains information about a psychosocial emergency team which is a cooperation between Longyearbyen Lokalstyre, the local hospital and the local church.

The avalanche measures give an overview of different measures and strategies which has been and will be implemented in order to screen Longyearbyen from different avalanche danger. These measures and strategies are then divided into six different categories (Lokalstyre 2022X); (1) *overall plan for avalanche measures*, (2) *hazard zone mapping*, (3) *previous measures taken in 2018* , (4) *study of security solutions for Lia and Vannledningsdalen*, (5) *assessment of other measures* and (6) *ongoing measures in Longyearbyen*.

The overall plan for avalanche measures describe how the avalanche in 2015 and 2017 have resulted in development of a long-term strategy to deal with avalanches, both snow avalanche and other types. A timeline of events and measures are described, with links to collection of reports and documents detailing the different climate-related hazard risks. These documents give an insight in specific measures, strategies and how Lokalstyre with the assistance of NVE and Sysselmestern deal with snow avalanche (Longyearbyen Lokalstyre, 2022d).

The hazard zone mapping presents the different hazard zones which have been mapped from 2001 to present day. It explains chronologically the difference between the different hazard zone mappings, and goes into detail on the different findings, and how previous reports have a smaller hazard zone then the newer reports due to an increase in uncertainty, leading to a larger hazard zone mapping in the more recent hazard zones.

The previous measures taken in 2018 refers to several documents from 2017 regarding snow avalanche measures, which were put into motion January 2018. These measures were a direct response to the 2015 and 2017 avalanche, and these measures are the same as those mentioned in 5.1.5 Avalanche risk from Sukkertoppen. The reports and measures are introduced in a chronological order and provide easy access to relevant files regarding the different measures.

In the study of security solutions for Lia and Vannledningsdalen, measures and strategies for dealing with both the snow avalanche risk from Sukkertoppen and debris flow from Vannledningsdalen were presented alongside with maps of where the actual measures would be located. A chronological presentation of previous reports and projects were presented, including changes in the measures to protect Longyearbyen against debris flow from Vannledningsdalen (Longyearbyen Lokalstyre, 2022d).

Other measures in Longyearbyen which is of a smaller scale are presented in its own category. There, measures are presented ranging from the hazard mapping of Svalbard church to the avalanche risk assessment of one of Longyearbyen`s kindergartens. Lastly, the section regarding ongoing measures in Longyearbyen gives the inhabitants an update regarding the snow avalanche measures being constructed in 2021-23 (Longyearbyen Lokalstyre, 2022d).

A reflection on the information found in the societal & safety section is that it contains valuable information which could be utilized to create a strong foundation to understand the different risks which Longyearbyen are facing and the different measures which the authorities have done and are planning to do. The only issue which is identified is the structure and formulation in this section, which could make it hard for inhabitants to understand, as they would need to have some kind of prerequisite knowledge in order to read it. This will be commented on in the discussion chapter and will be a reoccurring reflection in the empirical chapter.

News section

If Longyearbyen Lokalstyre are not publishing something in their webpage section, it gets put in the news section. All the news is stored in an open-source archive, which has been utilized in the document study. Table 7 below presents the findings of the document study

Table 6. Overview of relevant posts relating to climate-related hazard risks on Longyearbyen Lokalstyre news section from 2015 to 2021.

	2015	2016	2017	2018	2019	2020	2021	Total
Snow avalanche - Short term	22	51	71	1	8	1	16	170
Snow avalanche - Long term	22	14	11	8	0	2	2	59
Flooding - Short term	0	2	1	2	0	0	0	5
Flooding - Long term	0	1	1	4	0	0	0	6
Debris flwo - short term	0	0	2	1	0	0	0	3
Debris flow - long term	0	0	0	0	0	0	0	0
Rockfall - short term	0	0	0	1	0	0	0	1
Rockfall - long term	0	0	0	0	0	0	0	0
Total	44	68	86	17	8	3	18	244

Through an analysis of the different posts on Longyearbyen Lokalstyre news section from 2015 to 2021 several trends have been identified and presented in table 7 above. These trends are almost the same as the trends identified in Sysselmesteren webpage and Facebook page. Short-term risk communication (87%) is more communicated then long-term risk communication (27%). Snow avalanche risk communication, both short-term and long-term, accounts for 94% of the total risk communication. This results in the remaining 6% of posts being distributed between informing the inhabitants of the risk of flooding and debris flow & rockfall.

Report section

The report section is where the authorities release all reports which have been made regarding the different projects. Amongst these are reports relating to snow avalanche measures, flooding measures and debris flow measures. The report section is not a place for inhabitants to find their risk information, as the information found can be described as documentation. This will be further addressed in the discussion chapter. Information regarding what reports were utilized in the document study can be found in the chapter of methods.

Information for new inhabitants

Longyearbyen Lokalstyre has their own web section on information which is useful for newcomers in Longyearbyen to be aware of, called "Welcome to Longyearbyen" (Longyearbyen, 2020). This webpage section provides no useful information about climate-related hazard risks but is of importance to the discussion. The information given out in this section related to important information which newer inhabitants needs to be aware of. If inhabitants ever need to visit the authority's webpage, they will go here due to the amount of information and links located in this section of Longyearbyen Lokalstyre webpage.

A reflection on the risk communication done through Longyearbyen Lokalstyre webpage is that there is an abundance of information relating to the different climate-related hazard risks. Both information through webpage, as well as information through news section, although the news section focusses on snow avalanche related information. There are several issues identified through the document study pertaining to this webpage, both its focus on snow avalanche as well as the lack of risk information on the welcome to Longyearbyen section. These issues are some of the foundations for the discussions which will be done in the chapter of discussion.

5.2.4 Longyearbyen Lokalstyre Facebook

Another medium which Longyearbyen Lokalstyre is utilizing frequently to communicate with its own inhabitant is its own Facebook page. The Facebook page has been analyzed, where the goal is to identify how this medium has been utilized in the short-term and long-term risk communication of climate-related hazard risks such as flooding, snow avalanche, debris flow and rockfall.

Table 7. Overview of relevant posts relating to climate-related hazard risks on Longyearbyen Lokalstyre Facebook page from 2015 to 2021.

	2015	2016	2017	2018	2019	2020	2021	Total
Snow avalanche - Short term	55	45	64	13	17	0	12	206
Snow avalanche - Long term	0	16	6	3	0	3	2	30
Flooding - Short term	0	1		1	0	0	0	2
Flooding - Long term	0	3		0	0	0	0	3
Debris flow - short term	0	0		0	0	1	0	1
Debris flow - long term	0	0		0	0	0	0	0
Rockfall - short term	0	0		0	0	0	0	0
Rockfall - long term	0	0	0	0	0	0	0	0
Total	55	65	70	17	17	4	14	242

The result of the analysis is presented in the table 8 above. The trends are almost the same as with the table 7 and table 6. Short term risk communication (87%) is communicated more than long-term risk communication (14%). Snow avalanche risk communication, both short-term and long-term, accounts for more than 97.5% of the total risk communication. Leaving a mere 2.5% of the remaining posts for flooding and debris flow. As with the reflection note in regard to table 7 & 6, the results clearly indicate a lack of risk communication on other climate-related hazard risk due to a focus on snow avalanche risk communication. Which as previously stated will be brought up for discussion.

5.2.5 Public meetings

Another medium which Longyearbyen Lokalstyre is utilizing to communicate with its own inhabitant is the public hearings, where Longyearbyen Lokalstyre and a variety of other actors participate in debates and discussions. The public meetings from 2015-2016[8] have been analyzed in regards to how it is being utilized to do long-term risk communication of climate-related hazard risks such as flooding, snow avalanche, debris flow and rockfall. The results of the public meeting analysis is not important, as they point out a already established empirical finding, namely the focus on snow avalanche related risk communication.

Table 8. Overview of relevant posts relating to climate-related hazard risks on public meetings from 2015 to 2021.

	2015	2016	2017	2018	2019	2020	2021	Total
Snow avalanche	0	1	2	1	0	2	0	6
Flooding	0	0	0	0	0	0	1	1
Debris flow	0	0	0	1	0	2	0	3
Rockfall	0	0	0	0	0	0	0	0
Total	0	1	2	2	0	4	1	10

5.2.6 Other mediums

One of the mediums which Longyearbyen Lokalstyre has implemented in the last year is an SMS-warning system designed to be able to send messages to everyone in the vicinity of Longyearbyen, inhabitants and tourists alike (Lokalstyre, 2021). This enables Longyearbyen Lokalstyre to quickly give out crucial information to its inhabitants and tourists in the area. This system is primarily going to be used in case of critical events such as natural hazards or polar bear being spotted in the vicinity of Longyearbyen.

Another medium which Longyearbyen Lokalstyre and Sysselmesteren can use it going door-to-door to inform citizens of an evacuation or any other problems. Longyearbyen Brannvesen (fire-department) have the ability to quickly gather its employees and start immediate door-to-door knocking to make sure that all whom resides in Longyearbyen or in a particular area of the town can be informed of critical events.

[8] Records from 2015 are not uploaded to the site. These public meetings in 2015 would contain information about snow avalanche, due to the 2015 snow avalanche in Longyearbyen, resulting in two being killed.

Another medium which Sysselmestern is utilizing to communicate with its inhabitants is a information screen between the main road in Longyearbyen and The University Centre in Svalbard (UNIS). The information screen is a result of a collaboration between Telenor, Arctic Safety Centre and Longyearbyen Lokalstyre, and has different function. The information screen gives out both weather related data and a testing site for avalanche beacons. The weather information relays information about the current weather conditions, the weather forecast, the temperature and the windspeed. It also calculates the total temperature which the person would be facing (base temperature & windchill). In addition, a detection system is placed in the information screen so that if you take out your avalanche beacon and take it close it will beep, enabling all whom wants to travel outside to test out if their avalanche beacon works or not.

The last medium which both Sysselmesteren and Longyearbyen Lokalstyre are utilizing is another Facebook group besides their own page called *Longyearbyen Ros & Info*[9]. The webpage was created with the intention to share important information with the inhabitants. Voicing opinions regarding different subjects is also one of the functions, although not one of its main functions according to the information page of the group. After analyzing the Facebook group, some interesting notions were noticed:

(1) Both Sysselmesteren and Longyearbyen Lokalstyre use this Facebook group frequently
(2) Posts on this group tend to easily be drowned out by newer posts. As the group is popular and active, a medium to large number of posts are posted every day. There is a risk of important information being drowned out
(3) The authority does not have the administration rights to pin important information to the Facebook group in a certain timeframe. In a sense, Sysselmesteren and Longyearbyen Lokalstyre are just two individuals in the Facebook group. Lack of ownership/vital administrative rights in a crucial Facebook group where nearly all of inhabitants are present as members.
(4) Information posts have both been drowned out by other posts in addition to there being additional noise in the channel from time to time. In the recent weeks a large number of posts have been deleted from the group due to its content. The content was in relations to the Norwegian-Russian relationship with Barentsburg (small Russian town located

[9] Another facebook group which citizens utilize to communicate short-term climate-related hazard risks is *Farer/fører/Vær/Snø/Vindhull/Elver/daler/Hytter/glede osv.* Neither Longyearbyen Lokalstyre or Sysselmesteren are active in this facebook group, but citizens use it often to communicate about climate-related hazard risk around Longyearbyen, out on specific trips etc. It's a platform for citizens to ask and consult with others about weather conditions and advice regarding trips/conditions/equipment etc.

southwest of Longyearbyen). This stirred quite a lot of controversy and creates a group environment which makes it impossible to relay precise information out to the inhabitants.

5.3 Result from survey & interviews with inhabitants

This subchapter will present the empirical findings from the survey which the inhabitants have answered, the interviews which were done with the inhabitants of Longyearbyen as well as the interviews through ArctRisk Project which provided some access to interviews done with Sysselmesteren.

5.3.1 Survey

A survey was created with the purpose of identifying how inhabitants were informed of different climate-related hazard risks, and how they perceive such risks. The survey can be categorized into seven different categories, due to the type of question asked. The survey was distributed through the Facebook group *Ros & Info Longyearbyen*, where the inhabitants had the opportunity to answer the survey. In table 9 which can be located below, is a summary of the different categories of questions which were asked. The entirety of the survey questions can be found in attachment A.

Table 9. Overview of the seven categories of questions in the survey

Categories	**Topic**
1	Inhabitants risk perception of snow avalanche, flooding and debris flow & rockfall
2	Inhabitants receival of information regarding the risks when[10] he/she moved to Longyearbyen
3	Inhabitants receival of information regarding the risks after[11] he/she moved to Longyearbyen
4	Inhabitants receival of information regarding measures & Long-term strategies to deal with the risks

[10] "When he/she moved to Longyearbyen" has been defined as the first month of the inhabitant's residence in Longyearbyen

[11] "After he/she moved to Longyearbyen" has been defined as the timeframe after the first month which the inhabitant has resided in Longyearbyen and to the day which the inhabitant answered the survey

5	Inhabitants' perception of the overall risk communication between themselves as inhabitants and the authorities
6	Inhabitants' capacity to travel in the vicinity of Longyearbyen with regards to the different risks
7	Inhabitants' expectations of risk communication from the authorities & inhabitants' expectation of themselves

The empirical findings from this survey will be presented in the next paragraphs, where each paragraph represent a category of questions starting chronologically with the fist category. Empirical findings which are important will be commented, as they will then be utilized in the discussion chapter.

The findings in the first category of questions relates to the inhabitant's risk perception. The inhabitants were asked to categorize the risk of snow avalanche, flooding and debris flow & rockfall into three risk categories. Low, moderate, or high-risk perception. When asked about their risk perception of snow avalanche in Longyearbyen, 87% perceived the risk of snow avalanche as high, while the remaining 13% perceived the risk of snow avalanche as high. When asked about their risk perception of flooding in Longyearbyen, 57% answered that they perceived the risk as low while the remaining inhabitants perceived the risk as high (43%). When asked about their risk perception of debris flow & rockfall in Longyearbyen, 30% perceived the risk as low, 52% perceived the risk as moderate and the remaining 17% perceived the risk as high. The findings of the first category of questions highlight how the inhabitants perceive the risk of flooding as the most dangerous risk compared to debris flow and especially snow avalanche. Which has caused fatalities in 2015 and resulted in huge loss of infrastructure in 2015 and some damage to infrastructure in 2017 (DSB, 2015). These findings will be of importance for the upcoming discussion in the discussion chapter.

The findings in the second category relates to the information which the inhabitants received when they first moved to Longyearbyen. Around half the inhabitants were informed about the risk of snow avalanche when they moved in. In comparison, nearly all inhabitants were not informed about the risk of flooding or debris flow & rockfall. These findings are also important and will be utilized in the chapter of discussion.

The findings in the third category of questions relates to the information which the inhabitants received about the risk of snow avalanche, flooding, debris flow & rockfall in Longyearbyen after they moved in. The result, in comparison to the empirical findings of the second category of question, reveal an improvement in the information which the inhabitants have received in regard to the risk of snow avalanche in Longyearbyen. ¾ of inhabitants have received information about the risk of snow avalanche in Longyearbyen, but there has been no improvement in the number of inhabitants which has received more information about the risk of flooding or debris flow & rockfall in Longyearbyen. These findings are also of interests, and will be utilized in the chapter of discussion.

The findings in the fourth category of questions relating to inhabitants having received information about measures and long-term strategies to deal with the risk of snow avalanche, flooding, debris flow &rockfall in Longyearbyen. The findings show that two-thirds of the inhabitants are aware of measures and long-term strategies pertaining to the risk of snow avalanche in Longyearbyen. The opposite is true for the risk of flooding, where two-thirds have not been informed about any measures or long-term strategies. In the case of debris flow & rockfall, half were informed about measures while the rest were not. These findings were also of interesting and are used to some degree in the chapter of discussion.

The findings in the fifth category of questions relates to the inhabitant's ability to travel in Longyearbyen and in the nearby vicinity. Two-thirds of the inhabitants respond that they are either good or very good prepared to travel in the vicinity of Longyearbyen, and that their ability to travel in and around Longyearbyen were attributed to either their previous experience or information from other inhabitants or from the authorities. These findings are not considered important, but was asked non-the-less in order to identify any possible correlations between the amount of risk information and the inhabitants ability to travel in the surrounding area.

The findings in the sixth category of question relates to the inhabitants' overall impression of the risk communication[12] between themselves as inhabitants and Sysselmesteren and Longyearbyen Lokalstyre. The findings are inconclusive, showing an overall balanced impression of the authority's risk communication, ranging from very bad to very good. These findings are therefore of no particular importance in the discussion chapter.

[12] Risk communication regarding the climate-related natural hazard: snow avalanche, flooding, debris flow and rockfall

The seventh and last category of questions relates to the inhabitants' expectations of the authority's risk communication, as well as the expectations which is placed on the inhabitants regarding collection of risk information. The inhabitants have expectations that the authorities will provide information regarding measures, strategies of the different risk which Longyearbyen are facing. The inhabitants also expect the authorities to highlight important information and make it easily accessible in mediums which are easy to discover. The inhabitants also agree that they themselves have a large responsibility for gathering their own information through the authorities. These findings are also of importance and will be mentioned in the chapter of discussion.

5.3.2 Interviews

The questions which were presented in the interview with the inhabitants are structured in the same way as the survey. The interview questions can be found in attachment A. These are the findings which has been identified through the interview:

The informants who participated in the interview were generally aware of the risk of snow avalanche in Longyearbyen, but not aware of the risk of flooding, debris flow & rockfall in Longyearbyen. When the informants first moved to Longyearbyen, they were generally not informed about the risk of snow avalanche, flooding, debris flow and rockfall. All the informants answered that they would have liked to be informed about this when they first moved in, and that in hindsight they expected to be informed. Most of the informant were not worried about the different risks facing Longyearbyen. One of them were slightly more worried about snow avalanche while another was more worried about the risk of flooding. The informants answered that they felt in good hands and that they trusted that Longyearbyen Lokalstyre and Sysselmesteren would ensure their safety

All the informants answered that they get their information from social media, citing *Ros & Info Longyearbyen* as their main source of information, while some checking Sysselmesteren and Longyearbyen Lokalstyre Facebook page. When asked how they would fare if they didn't have social media accounts, everyone answered that it would be quite difficult to get information. When asked about the effect of the received risk information from the authorities, the informants answered that the information given to them has not necessarily brought forth

direct changes in their behavior but has made them more aware of the different risks and thus lead to more awareness.

All informants answered that they are capable of traveling in Longyearbyen and in the nearby vicinity, and that their previous experience and help from other inhabitants has made them capable to travel in Longyearbyen and the nearby vicinity.

The informants have not checked out either of the authority's webpage or Facebook for any kind of risk information. However, the informants agreed that they themselves have a responsibility of actively searching for information, but when inside the area of Longyearbyen, the government are responsible for ensuring their safety and providing them with information. They also expect the authorities to publish information in a clear and concise manner, both on their Facebook page and on their webpage. To end it off, some of the informants have mentioned that they wanted a clearer structure on the webpage in regard to which risks are presented. A different section on snow avalanche, flooding, debris flow and rockfall which could be easily understood was wanted by the informants.

A reflecting note on the empirical findings from the interview is that while there were few informants, which is explained in further detail in the chapter of method, highlights the same findings as the survey did. While the interview in themselves is of a smaller quantity, they sever as an important part of the overall empirical evidence which is used in the chapter of discussion to discuss important trends identified in both the risk communication from the authorities as well as the inhabitants risk perception.

5.3.3 Interviews through ArctRisk-project

The ArctRisk-project has done a series of interview with different companies and governmental agencies in relation to their project. Interviews which is relevant to my thesis has therefore been given to me, which is comprised of three interviews done with current and former employees of Sysselmesteren. The findings from these interviews are mostly related to the risk of snow avalanche in Longyearbyen but provides both interesting and important aspects of risk communication. The findings are as follows.

The avalanche warning system has been reworked several times. Both as a result of the 2015 and 2017 snow avalanche. Resulting in outsourcing of the warning system to Skred AS.

Sysselmesteren have no snow avalanche competence and are therefore entirely reliant on the advice of Skred AS, with no possible way to ascertain if other local conditions merit a different response. In the communication between Skred AS and Sysselmesteren, Skred AS does not communicate uncertainty to Sysselmesteren regarding the snow avalanche warning. Furthermore, snow avalanche reports are simplified and reduced to a yes/no in regards if there needs to be an evacuation. As a result of this, Sysselmesteren simplifies the information given to the inhabitants, as information regarding the process and decisions tend to quickly get technical.

Sysselmestern are also aware that most of the communication with the inhabitants happens on social media. Both from Sysselmesteren and Longyearbyen Lokalstyre Facebook page, but mainly from *Ros & Info Longyearbyen*. Sysselmesteren perceives that the inhabitants have confidence in Sysselmesteren and the work they do. Additionally, they perceive that there is a difference between what people are worried about and what they should truly be worried about.

6. Discussion

In this chapter of discussion, relevant findings in the empirical chapter will be discussed in relations to the theoretical framework which has been presented in the theoretical chapter. The discussion will be chronological and follow the same structure as the research questions. This chapter will therefore start off with a discussion regarding the challenges of communicating climate-related hazard risks in Longyearbyen, before moving over to a discussion regarding the focus on snow avalanche risk communication, and how it affects the overall risk communication. Thereafter a discussion will ensue debating if Facebook is a good platform for risk communication and try to explain why the authorities are sharing their news on a private owned Facebook group. The last discussion of this chapter tries to explain the inhabitant risk perception of snow avalanche, flooding, debris flow and rockfall.

6.1 What are the challenges of communicating climate-related hazard risks in Longyearbyen?

It has been established that snow avalanche, flooding, debris flow and rockfall are the most pressing climate-related natural hazard that Longyearbyen is facing. This subchapter intends to discuss the challenges of communicating such risks to the inhabitants in Longyearbyen. At least two challenges were identified through the fieldwork, survey, interviews and document study. The first challenge is related to the communication of a risk which can be categorized as a complex risk problem. The second challenge is to communicate risk related information to an everchanging demographic, as the population in Longyearbyen is constantly being switched out.

Complex risk problems are characterized by a major scientific dissent about the effect and measures in regard to a decrease in vulnerability (Renn, 2008, p. 188). As displayed in the document study, previous reports relating to the probability and consequence of both snow avalanche and debris flow have all been underestimated. In the newer reports, more up-to-date estimation of risk show an increase the in size of the hazard mapping. In addition, measures against snow avalanche, flooding, debris flow and rockfall all requires outside expertise. As shown in the risk management escalator and stakeholder involvement figure 5, complex induced risk problems require both agency staff and external experts in order to handle the risk problem (Renn, 2008, p. 280). The authorities in Longyearbyen have utilized external experts in order to deal with the different climate-related natural hazards, from the utilization of

different companies to come up with solutions for measures against flooding in Longyear river, debris flow measures in Vannledningsdalen and snow avalanche measures for Lia and the other areas in Sukkertoppen. This includes an outsourcing of the snow avalanche warning system to Skred AS.

These complex risk problems have led the authorities to outsource competence through external experts. This creates an issue, which can be connected to Berlo`s model of communication, where one of the prerequisites for communication is that the source (sender) and receiver must be on the same level of understanding (1960). Because the authorities do not have the in-house expertise, they themselves become the receiver of risk communication, before they themselves become the source which informs the inhabitants about these risks. As such, there are two stages to the risk communication of snow avalanche. Let's use the example of the snow avalanche warning system. Skred AS, which is the external experts, become the source which encodes a message about the snow avalanche forecast through their digital meetings where the authorities decode the message as the receivers. Then, based on the decoding, they utilize this information, and it becomes their source which they themselves encode in a message on several channels where the receivers, namely the inhabitants, decode that message.

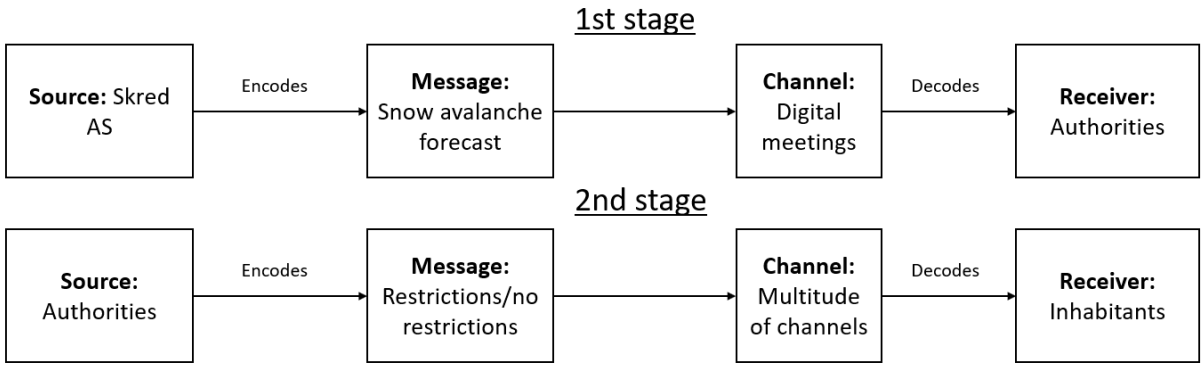

Figure 21. Two stages of snow avalanche risk communication (based on Berlo 1960 model of communication)

This results in a simplification of risk information. Between both Skred AS and the authorities, and the authorities and the inhabitants. One of the problems presented in the theory chapter about risk communication, is the use of statistical information and technical terms which creates difficulty for the receiver to understand the content of the risk information (Sjöberg, 2003, p. 15). Through this process of simplification, it is ensured that the source of the information, be it the authorities or Skred AS, are communication risk in a language that can be understood. This kind of risk communication with Skred AS would be categorized as short-term risk communication, where the inhabitants are informed through mediums most often utilized for short-term risk communication such as Facebook or SMS.

The demographic change in Longyearbyen creates a local community where there is a constant influx of people who choose to stay as inhabitants or who leaves Longyearbyen and moves to the mainland. There are two main issues relating to this change in demographic. The first issue is that the inhabitants who leave takes with them their local knowledge, and therefore a degree of local knowledge is lost in the community. McQuail presents a pyramid of communication networks, with different levels in the communication process (2010). When inhabitants leave Longyearbyen, a certain degree of local knowledge is lost. Due to the large and constant change in demographics, a degree of local knowledge is lost, which forces individuals to utilize higher levels in the communication process, such as institutional/organizational or society-wide networks (McQuail, 2010, p. 25). Communication levels such as interpersonal, intragroup and intergroup may not always be enough. This is shown in the survey and in the interviews, where the inhabitant's knowledge about flooding, debris flow and rockfall are lacking, especially in regard to the different measures and long-term strategies to deal with such risks. Because of this, inhabitants must utilize society-wider networks in order to be informed.

Reliance on society-wide networks is not necessarily negative, but the main sources of risk information then comes from webpages, Facebook, and other mass communication mediums. This reliance could be problematic, as the empirical findings show. First off, the risk communication through Facebook is mostly focused on snow avalanche, which I will go through in the next subchapter. Secondly, the webpages of the authorities are not formulated in a way which makes it easy to read for ordinary inhabitants who does not have particular knowledge about these risks. The information on the webpage can therefore be categorized as documentation, and not information (Renn, 2006c). This reliance on society-wide networks results in the inhabitants either receiving a one-sided risk communication regarding snow avalanche from Facebook or are stuck with documentation from different webpages where the inhabitant has no foundation to decode the message (Berlo, 19690). The only webpage which is not categorized as documentation is the "Welcome to Longyearbyen" subpage, which can be found on Longyearbyen Lokalstyre webpage (Longyearbyen Lokalstyre, 2022h). Unfortunately for newer inhabitant, no information regarding the different climate-related hazard risks is presented in this webpage. Thus, both current and future inhabitants of Longyearbyen have a limited ability to be informed about the climate-related hazard risks which the city they live in are facing.

6.2 What can explain the focus on snow avalanche risk communication, and how does this affect the overall risk communication?

Perhaps the most conclusive findings which has been highlighted in the empirical chapter is the authorities focus on snow avalanche related risk communication, both short-term and long-term.

To reiterate, risk communication is defined as "an interactive process of exchange of information and opinion among individuals, groups and institutions…" NCR, 1982, p. 21). Through document study, it has been identified that the authorities risk communication regarding climate-related hazard risks has mostly been focused on snow avalanche. In the case of Longyearbyen Lokalstyre and its Facebook page, almost its entirety of risk communication with the inhabitants were related to the risk of snow avalanche in Longyearbyen, where 97.5% were related to snow avalanche and the 2.5 % were related to other relevant climate-related hazard risks such as flooding, debris flow or rockfall. Its webpage news section showed the same trend, with 94% of its risk communication relating to the risk of snow avalanche in Longyearbyen. In the case of Sysselmesteren, the trend is the same, although slightly lower percentages. Their risk communication on their Facebook page consists of 82% snow avalanche related posts, while the remaining related to the risk of flooding, debris flow and rockfall. On their webpage, around 82% of the content is related to snow avalanche, while the remaining are related to the risk of flooding, debris flow and rockfall.

The explanation as to why the authorities have chosen to focus on snow avalanche risk communication, can be explained through both the authorities lack of institutional control over the risk, as well as the dread associated with snow avalanche events. The snow avalanche event of 2015 and 2017 proved that the authorities does not have enough institutional control over the snow avalanche risk in Longyearbyen. This could in turn decrease the inhabitants trust in the authorities (Renn, 2008, p. 109). Furthermore, the dread associated with the loss of life in the 2015 snow avalanche, as well as the potential loss of life which could have occurred in 2017 had the avalanche been stronger. These two qualitative valuation characteristics could explain as to why the authorities have focused on snow avalanche related risk communication. The authorities focus on snow avalanche related risk communication has resulted in a variety of consequences, both for the snow related risk communication as well as risk communication of other climate-related hazard risks such as flooding, debris flow and rockfall.

The first and foremost consequence of the authorities focus on snow avalanche risk communication in Longyearbyen is the creation of both routines and procedures in relations to communicating snow avalanche risk in Longyearbyen. As presented in the empirical chapter under the ArctRisk interviews, the focus on snow avalanche related risk communication has led the authorities to have good routines when it comes to relaying important information to the affected inhabitants. This includes maps of the exposed areas where in inhabitants must either evacuate, or not utilize, such as roads with high avalanche risk. In addition, they have a multitude of tools which they can use to inform the inhabitants, including both Facebook and SMS. By utilizing Berlo model of communication, the focus on snow avalanche risk communication has resulted in a standardization of how messages are both encoded and decoded (1960). The information given to the inhabitants are given in several formats, such as short information posts, links to long-term risk communication regarding snow avalanche, or posts about evacuation, risk of evacuation or travel limitations, which are followed up with a map of the affected area. Due to the frequency of snow avalanche related risk information, the source and receiver are able to be at the same level of understanding, which is one of the prerequisites in his model of communication (Berlo, 1960). This enables the source to encode the message in a way which can be easily decoded by the receiver, through communication channels which are frequently utilized for snow avalanche risk communication, thus enabling the source and receiver to communicate on different channels.

The second consequence of the authorities focus on snow avalanche risk communication in Longyearbyen is that inhabitants of Longyearbyen are less reliant on higher levels of communication in order to find available information about the risk of snow avalanche in Longyearbyen (McQuail, 2010). The frequency of avalanche related risk communication creates a foundation of information which the local community can utilize and spread amongst themselves. This enables inhabitants to utilize intragroup or intergroup level of communication in order to collect relevant information regarding the risk of snow avalanche in Longyearbyen. Inhabitants are therefore not overly reliant on society-wide networks in order to get their information about snow avalanche. The frequency of snow avalanche related risk communication therefore enables sharing of information inside the local community. Overall, the focus on snow avalanche risk communication enables the inhabitants collect information from both lower and higher levels of communication.

The third and last consequence of the authorities focus on snow avalanche risk communication in Longyearbyen is the lack of focus on the risk communication of flooding, debris flow and rockfall. The focus on snow avalanche related risks communication creates a lack of focus on other climate-related hazard threats. This lack of focus can be identified through the low frequency of posts related to the risk of flooding, debris flow and rockfall in Longyearbyen. The low frequency of posts then affects the amount of information, which is available for the inhabitants, which creates some issues.

The low frequency of posts related to other risks beyond snow avalanche means that it will have to fight with other posts in the different channels for attention (Berlo, 1960). As mentioned in the first consequence, the large frequency of posts related to snow avalanche meant that even if the inhabitant misses a post or two, it is not a problem, as more will be published. It is therefore not exposed to the same competition. This is not the case for risk communication pertaining to flooding, debris flow and rockfall, which does not have the same exposure to the inhabitants. If the inhabitant misses a post or two, it could take substantial longer time before another relevant post is published. Even then, it runs the risk of being overshadowed by other posts. The inhabitant is therefore reliant on timing in order to receive the information, unless the information is shared later through coworkers or other inhabitants. The survey addresses this, and the empirical findings show that inhabitants themselves are not able to rely on others in order to be informed about these climate-relate hazard risks.

In addition, the low frequency of posts results in a low availability of information regarding flooding, debris flow and rockfall (McQuail, 2010). This results in the inhabitants being reliant on higher levels of communication in order to find available information. The option of utilizing lower levels of communication is few and far between, due to the limited amount of information circulating. The issue with higher levels of communication such as society-wide networks, is that the information is available through the authority's webpage and Facebook page. In the case of the Facebook and webpage news section, the content is mostly about snow avalanche. Thus, the inhabitants need to utilize the webpages in order to collect information. The webpages are however structured and formulated in such a way that it can be categorized as documents, and not as actual information 8renn, 2008). Documentation requires certain knowledge in order to be understood, and is not meant for the common person, while information is meant to be read by everyone, without needing some kind of prerequisite knowledge (Renn, 2008). The issue with the webpage is that the encoding of the message is written in a way which can be

categorized as documentation, and it requires perquisite knowledge in order to understand and is therefore not suited for inhabitants (Renn, 2006c; Berlo, 1960). This is especially problematic for newer inhabitants, as they are not able collect information about any of the climate-related hazard risks in Longyearbyen except snow avalanche. Which is something which has been identified. Both the participants of the survey and the informants in the interview were not informed about any of the climate-related hazard risks except snow avalanche when they first came to Longyearbyen.

To sum it up, the focus on snow avalanche risk communication increases the vulnerabilities associated with using the authority's webpage and Facebook page, and these vulnerabilities are not counteracted.

For the inhabitants of Longyearbyen, this results in a reduced risk communication of every other risk except snow avalanche in Longyearbyen, both short-term and long-term. For newly arrived inhabitants of Longyearbyen however, the lack of risk communication in other risks beyond snow avalanche leaves them with a poor foundation to identify the risks which they are facing when living in Longyearbyen.

The more clear and concise result of an overfocus on snow avalanche risk communication, is that good routines and procedures are in place for when both short-term and long-term risk communication about snow avalanche needs to be communicated. Communication to the inhabitants can occur through several mediums, from door-to-door to SMS warning and Facebook posts. These are mediums which Sysselmesteren and Longyearbyen Lokalstyre have accumulated a lot of experience in utilizing. This in turn creates a good foundation for snow avalanche risk communication, both short-term and long-term. There are however some consequences as a result of this overfocus on snow avalanche risk communication which will be highlighted.

Two of these consequences which I have deemed important to discuss, is the lack of communication regarding the other climate-related hazard risks and how the subsequent lack of communication leads to a reliance on the authority's webpages for information regarding the other less communicated climate-related hazard risks. This however comes with its own sets of challenges which will be discussed.

The issue with an overfocus on snow avalanche risk communication, is that the other risks are not nearly as much exposed. In the empirical chapters, Sysselmesteren and Longyearbyen Lokalstyre Facebook pages consist of 89% and 97.5% risk communication, both short and long-term, about snow avalanche. In relations to the webpages news section of both Sysselmesteren and Longyearbyen Lokalstyre, the numbers are 95% and 94%. This in turns, translates to the fact that information about other risks beyond snow avalanche rarely are posted on the authority's webpages news section or Facebook pages. This affects the overall short-term and long-term risk communication, and it increases one of the large vulnerabilities of Facebook, the fact that posts can "drown" in between other unrelated posts. In Berlo (1960) model of communication, it is important to note that the source`s message needs to be encoded and transported to the receiver in a channel where the receiver will decode the message. If the receiver is on the same channel as the code, but new, unrelated messages are added, it creates the possibility of missing out of important messages. Taking into account the rarity of short-term and long-term risk communication about any other risks beyond snow avalanche, the chance of inhabitants simply missing out of the information is high. Which is something that is reflected in both the survey and interviews, where it is clear that risk communication about any other risks beyond snow avalanche are not communicated enough.

Thus, the inhabitants are forced to seek out the authorities' webpages, excluding their news section, where the absolute majority is about snow avalanche. Utilizing Berlo (1960) theory regarding communication, webpages have a more clearly defined structure. The risk of additional messages overshadowing the original message in the same channels is considerably less. One could therefore argue that the webpages of both Sysselmesteren and Longyearbyen Lokalstyre compensate for the one-dimensional risk communication on snow avalanche. The prerequisite for this though is that enough relevant information is present in the webpage, and that its content can easily be decoded by the receiver (Berlo, 1960). This is however not the case. As presented in the empirical chapter, the webpages of Sysselmesteren contain little relevant information, while Longyearbyen Lokalstyre webpage has a lot of very relevant information to all of the climate-related hazard risk which it is facing. The issue is that the encoding of the message is written in a way which can be categorized as documentation, and not as information. Meaning that it is both structured and written in a way which require perquisite knowledge in order to understand and is therefore not suited for inhabitants (Lundgren, 1994; Renn, 2006c, Berlo, 1960).

This is especially crucial for newer inhabitants. All new inhabitants of Longyearbyen are informed of a webpage section in Longyearbyen Lokalstyre webpage which goes in dept about moving to Longyearbyen, what one needs to be aware of etc. No kind of climate-related hazard risks are mentioned. As a result, newer inhabitants are not informed of these climate-related hazard risks. This is confirmed through both the survey and the interviews, where the majority of people were not informed about the risks when moving to Longyearbyen. In hindsight, the informants in the interview stated that they would have expected some kind of information about the different risks.

To sum it up, the overfocus on snow avalanche risk communication increase the vulnerabilities associated with using both Facebook and webpages. These vulnerabilities are not counteracted.

For the inhabitants of Longyearbyen, this results in a reduced risk communication of every other risk except snow avalanche in Longyearbyen, both short-term and long-term. It is seen as likely that inhabitants that have lived in Longyearbyen for a couple of years are aware of the risk associated with living in Longyearbyen.

For newly arrived inhabitants of Longyearbyen however, the lack of risk communication in other risks beyond snow avalanche leaves them with a poor foundation to identify the risks which they are facing when living in Longyearbyen.

6.3 How suitable is Facebook for risk communication, and how come the authorities are sharing their news on a private Facebook group?

Facebook is a social media platform. Social media can be defined as "computer-based technology that facilitates the sharing of ideas, thoughts, and information through the building of virtual networks and communities" (Dollarhide, 2021). Through the empirical chapter, it has been identified that Facebook is being utilized as a medium for risk communication, both through the authorities own Facebook page as well as sharing their post in a private Facebook group called Ros & Info Longyearbyen. This subchapter aims to discuss three things. Firstly, is Facebook suited as a channel for both short-term and long-term risk communication? Secondly, what challenges will the authority have to deal with due to their utilization of Facebook as a medium for risk communication. Last and thirdly, why are the authorities sharing their news on a private Facebook group?

The idea of sharing information through networks and communities is the foundation for risk communication. The definition of social media is quite similar to DeFluet and Ball-Rokeachm`s perception of risk communication, which is a process of "purposeful exchange of information between actors in society, based on shared meanings" (1982). Therefore, the idea of utilizing social media as a medium for risk communication seems viable. Especially considering the OECD preliminary findings on good practices relating to the use of social media as a tool for risk communication (Wendling, 2013).

In regard to the utilization of Facebook as a toll for short-term and long-term risk communication, an argument can be made for why the social media platform is suitable. The users of Facebook have the ability to follow specific groups and pages by pressing the "follow" button. This enables the user to be notified when new posts are published. In this sense, the ability to follow specific groups and pages enables the receiver, in this case the user of the Facebook account, to specifically be notified of certain messages in certain channels, or subchannels (Berlo, 1960). It therefore creates a clear line of communication between the source and the receiver.

If we are to utilize this description in the case study of Longyearbyen, the inhabitants as the receivers are able to be informed when the authorities release new information on their Facebook pages. The only issue is that if the user follows other pages and Facebook groups beyond the authorities Facebook pages, those notifications will also be highlighted with the same priority as the authorities Facebook pages. Thus, Facebook can be described as one huge channel with many subchannels attached to it. There is however a solution to this. In the settings of Facebook, one can prioritize certain groups/pages which one follows. The notification related to that specific group/page will be prioritized, even if the user is following other pages and groups. The only issue is that inhabitants would have to manually change these settings in order to counteract this issue. Thus, rendering the solution somewhat obsolete.

An additional argument which can be utilized in order to explain why Facebook could be viable for both short-term and long-term communication, is the ability for Facebook to releases both documentation and information (Renn, 2008). The authorities can release long-term risk information about risks either through posting directly about the risk, or sharing links to other webpages, such as the authorities' official webpages. Which is something which the authorities

have done in their use of Facebook for risk communication from 2015 to 2021. Facebook is not deemed suitable for either two-way communication or mutual dialogue, or any kind of mutual decision-making involvement. Inhabitants can not reach out directly to the authorities through Facebook, but thorough other means of communication. This eliminated the possibility of any two-way communication. The authorities are able to read through comments, but from my own observations through the document study, they rarely respond. It is also not the primary area for mutual decision-making and involvement. Local stakeholders and actors can be involved through public meetings or other kind of gatherings between the authorities and the inhabitants of Longyearbyen. It should however be mentioned that mutual decision-making and involvement have been available through long-term risk communication posts on their webpage, which has been advertised through the authorities Facebook pages.

To sum it up, Facebook is a social media platform which can both be utilized for both short-term and long-term risk communication. It allows the authorities to quickly spread-out vital information regarding short-term risk communication and can also be utilized to share links to the authority's webpage for long-term risk communication. Although Facebook does not in itself cover all the four types of communication (Renn, 2008), it is a good and suitable tool. This is reflected in the authorities use of Facebook as a medium for risk communication, and their utilization of the medium coincide with the good practices identified in the preliminary research paper from OECD (Wendling, 2013). This does not mean that their utilization does not have room for improvement, but that they have grasped the potential of society-wide networks as a tool for risk communication (McQuail, 2010).

In regard to the second discussion, several potential challenges have been identified in regard to the authorities use of Facebook as a platform for risk communication. These potential challenges relate to the inhabitants use of other social media platforms which the authorities are not on, the subsequent fading popularity of Facebook and the lack of marketing regarding the use of Facebook as a platform for risk communication.

It is not a given that the inhabitants of Longyearbyen are active on Facebook or for that sake have an account. This creates a problem for the authorities, as they will not be able to reach their target group, which is the inhabitants of Longyearbyen. They are therefore encoding a message on a channel with the possibility that the receivers are not on the same channel, thus creating a situation where the receivers are unable to identify the message and decode it

accordingly (Berlo, 1960). This is something which was asked about in the interviews. The informants were asked about the potential consequences to their ability to collect and receive risk information from the authorities if they did not have a Facebook account. All the informants answered that they believed that if they did not have a Facebook account

result from the interviews with the inhabitants, reveals that when the informants were asked about what effect it would have on their ability to collect risk information from the authorities if they did not have Facebook. The demographic of Longyearbyen is also characterized as diverse, containing more than 40 different nationalities (SSB, 2012). This opens up the possibility that individuals from other countries use other social media platforms, such as Whatsapp. It is therefore important that the authorities inform the inhabitants of the different channels utilized for risk communication. This in turn would counteract the issue and enable the inhabitants to be on the same channel as the authorities, thus enabling risk communication.

This is however not the case. When inhabitants first move to Longyearbyen, they need to go to Longyearbyen Lokalstyre webpage and look up the "Welcome to Longyearbyen" section (Longyearbyen Lokalstyre, 2022h). Here they have a collection of different subsections informing the newly arrived inhabitants about the different sources of information which the inhabitants must be aware of. These involve things such as the special Svalbard tax, hospital, environmental tax and polar bear danger. None of the subsections address the climate-related hazard risks which Longyearbyen are facing, and no information is given in regard to which channels the authorities utilize in order to communicate risk. This could however be counteracted by the fact that the local community of Longyearbyen are good at sharing important information with their work colleagues, creating a network of information. This may however not be enough to fully counteract the lack of advertisement or information about where to receive information about risks.

The third and last topic of discussion intends to briefly explain as to why the authorities are sharing their news in a private Facebook called Ros & Info Longyearbyen. At first glance it seems somewhat unique for authorities to share their news with a private Facebook group. On second look however, it makes sense and it shows that the authorities are willing to go the next step in order to reach out to the entirety of the inhabitants in Longyearbyen. The Facebook group describes its main function as a meeting place where inhabitants of Longyearbyen can ask questions, share information and give feedback. As a result of this, a large variety of local social actors are member of this particular private Facebook group. By putting the function of

this Facebook group in a theoretical context of risk communication, it then makes perfect sense for the authorities to share their news on this Private Facebook group.

In the theoretical field of risk communication, there exist four major actors of risk communication, namely the scientific communities, public agencies, interest groups and eyewitnesses (Renn, 2008, p. 208). The fascinating thing about Ros & Info Longyearbyen is that all our major actors of risk are present in the group. Their presence is not just related to risk communication, but to other things relevant for daily life. This creates a perfect gathering spot for information flow. In that sense, almost all the sender and receivers of both risk communication and other types of communication is gathered in the same channel (Berlo, 1960). It is thus a prime target for any kind of communication

This does however come with its own dilemmas. The fact that it is a private citizen who own this Facebook group results in the authorities having no administrative privileges in the group. If they would have had administrative privileges, they could "pin" important messages to the top of the group in a time duration which they themselves deem as reasonable to increase the chance that all inhabitants can identify, decode, and understand the message. On the other hand, it makes sense for the authorities to not increase their media responsibility, by administrating a private Facebook group. A solution could be of the owner of the group to highlight important messages which the authorities share in the group. This would however require some kind of dialogue and agreement and is not really optimal.

I will end this subchapter by reflecting on the potential of social media platforms as a medium for risk communication, despite its limitations and challenges. This subchapter, seen together with the empirical findings highlight the importance of Facebook as one of many tools which authorities could utilize in order to most effectively communicate risk to its inhabitants, and how it seems to have worked out quite effectively in the small community that is Longyearbyen.

6.4 What can explain the inhabitants risk perception?

Risk perception is the creation of risk constructs and images which affects individual judgement in whether to do certain actions (Renn, 2008, p. 93). The judgement of risk is affected by qualitative evaluation characteristics, which will either increase or decrease the receivers risk tolerance (Slovic, 1992). Additionally, the amount of information relating to either the benefit

of risk or the information of risk, will affect how individuals perceive risks (Renn, 2008; Slovie & Peters, 2006).

Through the survey and interviews, the inhabitants risk perception regarding the risk of snow avalanche, flooding, debris flow and rockfall in Longyearbyen have been identified. This subchapter aims to discuss possible reasonings as to why the inhabitants perceive the risks as they do. This subchapter will be structured in three different parts. The first part discusses the inhabitant's risk of snow avalanche in Longyearbyen, while the second part discusses their risk perception of flooding. The third and last part discusses their risk perception regarding debris flow and rockfall. At the end there will be a reflection note regarding this subchapter.

The inhabitants risk perception of snow avalanche in Longyearbyen was split between inhabitants who deemed the risk to be moderate (87%) and the remaining who deemed the risk to be high (13%). The majority of inhabitants therefore perceive the risk of snow avalanche as being moderate. This is especially interesting due to the fact that between the risk of snow avalanche, flooding and debris flow & rockfall, fewer inhabitants have perceived the risk of snow avalanche as high then in comparison to the risk of flooding or debris flow & rockfall in Longyearbyen.

An argument as to why the inhabitants risk perception should be higher than what it currently is, is the amount of damage snow avalanche has done to the community of Longyearbyen, counting both material and fatalities. Due to the snow avalanche events of 2015 and 2017, both the dread and lack of institutional control associated with snow avalanche are qualitative evaluation characteristics which should decrease the inhabitants risk tolerance 8Slovic, 1992; Renn, 2008). Based on this, one could question the inhabitants moderate risk perception.

A counter argument could however be made, that the authorities have both limited both the frequency and consequence of snow avalanche, in addition to bolstering the institutional control and providing sufficient information to the population about the risk of snow avalanche. For starter, the authorities after the 2015 and 2017 snow avalanche event bolstered the snow avalanche warning system, as well as implementing several measures meant to decrease the frequency and consequence of snow avalanche events. This could in turn increase the institutional control and thus increase the inhabitant's risk tolerance, especially since these measures were visible on the top of Sukkertoppen. Creating a visual channel where the

inhabitants can observe and decode the message, which could lead to addition bolstering of institutional control (Slovic, 1992; Renn, 2008). When the informants in the interviews were asked about their risk perception of snow avalanche, all inhabitants answered that they believe that the authorities are dealing with it, thus increasing their risk tolerance and decreasing their risk perception of snow avalanche. In addition, there has been a focus on communicating snow avalanche related information to the inhabitants, which has been documented through the document study. This focus on snow avalanche related risk communication could also be an explanation as to why the inhabitants risk perception is moderate instead of high. Individual risk perception can be affected by so called heuristics (Fischoff et al, 1978). These mental shortcuts can facilitate problem solving and probability judgement and can affect the individual risk perception based on the individual's degree of information about a risk (TheDecisionlab, 2020; Slovie & peters, 2006). Most of the inhabitants in Longyearbyen are aware of the risk of snow avalanche, and they have received information relating to this risk. One could therefore argue that the amount of information has created a positive effect on the inhabitant's risk perception of snow avalanche. It is therefore likely that the authority's response to the 2015 and 2017 snow avalanche has increased the risk tolerance of the inhabitants, which can be reflected in the inhabitant's current risk perception of snow avalanche.

Regarding the inhabitant's risk perception of flooding in Longyearbyen, it is split evenly between those that perceive it as low (57%) and those that perceives it as high (43%). It is interesting to identify that among the selected climate-related hazard risks, the inhabitants perceive the risk of flooding as the one with the highest risk. Especially when the risk of flooding is being compared to the risk of snow avalanche, which has caused fatalities and considerable material damage.

An argument could be that the inhabitant perceive that nothing has been done to deal with the risk of flooding in Longyearbyen. Which in turn would reduce inhabitants' perception of the authorities and their capability as an institution to control this risk (Slovic, 1992; Renn, 2008). As presented in the empirical chapter, the authorities have implemented measures to deal with the risk of flooding from Longyear river. Something which is important to take note of is the fact that this information can only be found through the reports section found in Longyearbyen Lokalstyre webpage (Longyearbyen Lokalstyre, 2022a). The information is therefore in a webpage which I have classified as documentation, and not information (Renn, 2008).

In addition, the measures which have been done are hard to spot. In comparison to the snow avalanche measures, the flooding measures are hard to visually identify. Inhabitants therefore lose the visual channel, resulting in their perception being reliant on information from other channels such as the webpages (Berlo, 1960). However, this reliance on webpage information does not decrease the inhabitants risk perception since it is documentation and not information (Renn, 2008).

Furthermore, the inhabitants have not received sufficient information about the risk of flooding in Longyearbyen. Through the document study, survey and interviews, it highlights how communication related to flooding is not prioritized. This has resulted in the inhabitant's lack of information regarding both the risk of flooding in Longyearbyen as well as the measures and strategy utilized to deal the risk of flooding in Longyearbyen. Which in turn works as a negative amplifier on the inhabitant's risk perception, reducing their risk tolerance (Slovie & Peters, 2006).

Therefore, one could argue that the lack of visualization of the measures, the inhabitants lack of knowledge and the authorities lack of has creates a weak foundation for risk perception. Which creates the potential for inhabitants to either underestimate or overestimate the risk. In this case, one could argue that the weak foundation for risk perception has resulted in a large overestimation of risk. Resulting in almost half of the inhabitants overestimating the risk associated with flooding from Longyear river. The inhabitant's weak foundation for risk perception would explain why they perceive the risk of snow avalanche as a lower risk then flooding in Longyearbyen, due to their extensive knowledge about the risk and measures, and the authorities routinely informing the inhabitants about the risk of snow avalanche in Longyearbyen.

Lastly, we look at the inhabitant's risk perception of debris flow & rockfall in Longyearbyen. The inhabitants risk perception is split into three. Around 30% perceive the risk as low, while 52% perceive the risk as moderate and the remaining 17% perceive the risk as high. In comparison to the inhabitant's risk perception of flooding, their risk perception of debris flow & rockfall are more balanced.

There exist several arguments as to why some inhabitants perceive the risk as high (17%) or moderate (52%). First off, measures regarding debris flow are still in the planning phase, and

at this time no measures regarding rockfall have been planned. Just like with the flooding measures, Inhabitants lose their visual channel, and are therefore reliant on information from other channels such as webpages (Berlo, 1960). At this point the inhabitants find themselves in the same position as the inhabitants did with the risk of flooding. Information about debris flow & rockfall are hard to find, not communicated enough, and written in a way which require prerequisite knowledge (Renn, 2008).

Secondly, the lack of information regarding the risk of debris flow & rockfall either increases or decreases the inhabitants risk perception (Slovie & Peters, 2006). In this case it looks like the lack of information amplify some inhabitant risk perception while decreasing it for others, resulting in both an increase and decrease in risk tolerance. This could explain why the overall risk perception of the inhabitants are balanced.

I will end this subchapter by reflecting on how the inhabitants risk perception is reliant on information from the authorities, and that the lack of communication from the authorities relating to flooding, debris flow & rockfall makes the inhabitant reliant on information from the authority's webpages, which in turn can be categorized as documentation. Which in turn creates a negative amplification of risk tolerance, which can be reflected in the survey, document study and interviews.

7. Conclusion

7.1 Main Conclusion

Throughout the thesis, the main purpose has been to answer how the authorities in Longyearbyen communicate climate-related hazard risks to its inhabitants. To answer this research problem, four research questions were formulated. The findings in each of the four research questions provide the basis to give a short summary of their risk communication with inhabitants, both highlighting strengths and weaknesses.

Overall, the authorities in Longyearbyen have a well working short-term risk communication with the inhabitants. They utilize a multitude of different tools which has their own weaknesses and strengths. This creates an overall good foundation for short-term risk communication. The question which remains to be seen is if they can utilize this foundation to create a more balanced short-term risk communication. When it comes to the authority's long-term risk communication, they have room for improvements. They have strong foundation for long-term risk communication, with the same multitude of tools as their short-term risk communication. The issue is the content related to the long-term risk communication. Both the lack of advertisement as well as the formulation of the content transforms the content from information to documentation. This becomes crucial as inhabitants are reliant on this content to be informed about the risk of flooding, debris flow & rockfall. Thus, creating a barrier for the inhabitants to overcome in order to be informed of other climate-related hazard risks beyond the risk of snow avalanche in Longyearbyen.

7.2 Recommendations

Throughout the thesis I have reflected on possible recommendations, and these are my recommendations:

(1) Create a section in the webpage "Welcome to Longyearbyen" detailing the relevant climate-related risks and provide URL links so that inhabitants can easily be brought forward to relevant information instead of having to navigate themselves.

(2) Restructure the "avalanche measure" subsection of the societal safety & preparedness section. Categorize subsections into the different climate-related hazard risks. The most important subsections would be snow avalanche, flooding and debris flow.

(3) After restructuring the "avalanche measure" subsection, reformulate the content in a way which makes it understandable for inhabitants. The purpose of the content should

be to inform inhabitants about the risk and measures, and then provide documentation. Not as it is currently, where the whole content is documentation and not meant for the inhabitant.

7.3 Further Research

This master thesis is primarily one of qualitative study, where the goal is not to be generalizable. There are however certain findings which revealed itself during the data collection phase, while not directly relevant to this master thesis research problem, can be of interest to other scientists.

A particular finding which has the possibility to be transferable is how the authority's communication both short-term and long-term risk communication with inhabitants who does not speak English. With a diverse population of over 40 different nationalities (SSB, 2012), Longyearbyen is an interesting case study of how authorities' communication short-term and long-term risk information to non-Norwegian speaking inhabitants and can be transferable to other parts of the world regarding how authorities communicate with those that does not speak the country language. This finding was identified through my own fieldwork, attending several public meetings, where I discovered that the inhabitants could ask questions at the end in English, but all the relevant materials which were presented were on Norwegian, which realistically hinders any possibilities for the non-Norwegian speaking inhabitants to ask question or give feedback.

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Attachments

Attachment A – Survey Questions

- How long have you lived in Longyearbyen
- What gender are you
- What is your risk perception of snow avalanche in Longyearbyen?
- What is your risk perception of flooding in Longyearbyen?
- What is your risk perception of debris flow & Rockfall in Longyearbyen?
- When you moved to Longyearbyen, where did you get your information about the risk of snow avalanche in Longyearbyen
- When you moved to Longyearbyen, where did you et your information about the risk of flooding in Longyearbyen?
- When you moved to Longyearbyen, where did you get your information about the risk of snow avalanche in Longyearbyen
- When you moved to Longyearbyen, where did you get your information about the risk of debris flow & rockfall
- After you moved to Longyearbyen, where did you get your information about the long risk of snow avalanche in Longyearbyen?
- After you moved to Longyearbyen, where did you get your information about the risk of flooding in Longyearbyen
- After you moved to Longyearbyen, where did you get your information about the risk of debris flow & rockfall
- After you moved to Longyearbyen, where did you get your information about strategies and measures for reducing the risk of snow avalanche in Longyearbyen?
- After you moved to Longyearbyen, where did you get your information about strategies and measures for reducing the risk of flooding in Longyearbyen?
- After you moved to Longyearbyen, where did you get your information about strategies and measures for reducing the risk of debris flow & rockfall?
- Do you feel that you have enough knowledge about natural hazards to travel safely in the vicinity of Longyearbyen? Such as Sukkertoppen, Sarkofagen, trollsteinen, Nordenskjoldfjellet and Vannledningsdalen
- What has enabled you to travel safely in the vicinity of Longyearbyen?

- What is the reason why you are not able to travel safely in the vicinity of Longyearbyen?
- How would you describe the communication between you as an inhabitant and Longyearbyen Lokalstyre and Sysselmesteren when in to snow avalanche, flooding, debris flow & rockfall in Longyearbyen?
- Is there a possibility to give feedback to Longyearbyen Lokalstyre and Sysselmesteren?
- What is your expectations towards Sysselmesteren and Longyearbyen Lokalstyre when it comes to communication of risks which the inhabitants in Longyearbyen are faced with?
- What responsibility does the inhabitant have in collecting information about the existing risks in Longyearbyen?
- Other commends relating to the climate-relate risk communication between the inhabitants and Longyearbyen Lokalstyre and Sysselmesteren?

Attachment B – Interview Questions

- How long have you lived in Longyearbyen
- When you moved to Longyearbyen, were you aware of the phenomena snow avalanche, flooding and debris flow & rockfall?
- Were you aware that these risks exists in Longyearbyen?
- When you move to Longyearbyen how were you informed about the risk of snow avalanche, flooding, debris flow & rockfall in Longyearbyen
    - In hindsight, what do you think about the fact that you weren't informed about these risks?
- After you moved to Longyearbyen, how were you informed about the risk of snow avalanche, flooding, debris flow & rockfall in Longyearbyen?
- How did this information change your behavior?
- How do you perceive the risk of snow avalanche, flooding and debris flow & rockfall in Longyearbyen?
- Do you feel that you have had use for this information?
- Do you feel that you have enough knowledge about the different risks, enabling you to travel in and around the vicinity of Longyearbyen?
- How do you perceive the communication between yourself as inhabitant and Sysselmesteren and Longyearbyen Lokalstyre

- Are you able to have oversight of the different risk in Longyearbyen?
- Any expectations towards Sysselmesteren and Longyearbyen Lokalstyre when it comes to risk communication?
- What responsibilities does the inhabitant have towards collecting risk information from the authorities?
- Is it easy to be kept under the loop in regards to new information towards these risks?
- Any other comments?