Stakeholder Approaches to Risk Communication for the Understanding of NaTech Flooding Disasters

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Disclaimer: Participants and qualitative research

While efforts have been made to the utmost extent to eliminate pre-emptive and researcher biases, as well as to provide access to the researcher for the participants for comment, questions and further inclusion in the research process, there is very little ability within the framework of qualitative research to eliminate communication inconsistencies completely. These include misrepresentation or misinterpretation of ideas and concepts by both participants and researcher, as well as within the decoding and data analysis processes, as the stories and conversations of people and their experiences and perceptions are extensively dissected. As the researcher, I repeatedly requested and received informed consent and included high standards of ethical standards as per Iphofen and Tolich (2018), as well as research into vulnerable people per Gordon (2020). These have been discussed under Section 3: Methodology.

List of Abbreviations

BGD	People's Republic of Bangladesh
CC	Climate change
DOM	Dominican Republic
DRM	Disaster risk management
DRR	Disaster risk reduction
EC	European Council
EU	European Union
GIS	Geographic Information System
GLOF	Glacial lake outburst floods
HazMats	Hazardous materials
IFRC	International Federation of Red Cross and Red Crescent Societies
IOP	Internal Operation Plans
INGO	International non-governmental organisation
NASA	National Aeronautics and Space Administration
NaTech	Natural hazard triggering technological accident
NGO	Non-governmental organisation
NLD	Kingdom of the Netherlands
PAK	Islamic Republic of Pakistan
p-number	Participant number
RC	Risk communication
RP	Risk Perception
TTO	Republic of Trinidad and Tobago
UN	United Nations
UNDRR	UN Office for Disaster Risk Reduction
UNDRR AP-STAAG	UNDRR Asia-Pacific Scientific and Technical Academic Advisory Group
UNECE TEIA	UN Economic Commission for Europe Convention on the Transboundary Effects of Industrial Accidents
UNFCCC	United Nations Framework Convention on Climate Change
USA	United States of America
USA (HW)	United States of America (State of Hawaii)
VOC	Volatile Organic Compound
WASH	Water, sanitation and hygiene

Abstract

Flooding disasters are the most frequent disasters globally and have the most significant impact on livelihood, property and environment among all natural disasters. Increasing complexities in a multipolar world, risk factors intersect, and natural hazards can additionally cause secondary cascading disasters and technological accidents, classified as NaTech. Risks must be communicated diligently, especially where NaTech and stakeholders are diverse and numerous. Previous research highlighted the need for qualitative narratives to illustrate the risk communication needs of various stakeholders, along with understanding unique interactions through case studies. This research explores these interactions from the stakeholders' perspective in NaTech flooding events. The stakeholders represent the views of government agencies, research institutions and (I)NGOs. Eight stakeholders were interviewed via ~45-minute semi-structured conversations, where participants chose and navigated topics. Outcomes highlight gaps in policy, lack of implementation of risk communication guidelines, issues in the media's portrayal of risks, and understanding of stakeholder interactions in disaster events. Furthermore, stakeholders illustrated the importance of viewing the issues around risk communication in NaTech flooding incidents as issues with immediate relevance to and from climate change, socio-economic inequities, independence and abilities towards and within sectors of technological production, politics, and social and environmental resilience.

Keywords: *Flooding disasters, NaTech, Risk communication, Stakeholders.*

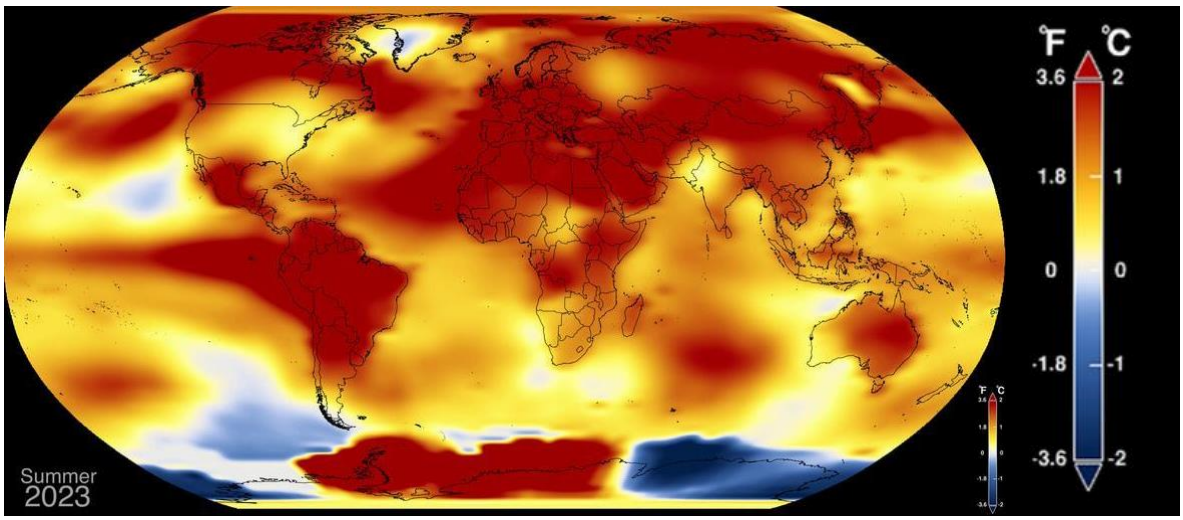
Table of Contents

1. Introduction

In 2023, our planet has seen the attributing effects of human-caused climate change (CC) on our environment to a new extent, leading to record extremes in daily average temperatures and sea surface temperatures (Calvin et al., 2023; NASA GISS, 2023). These fluctuations towards higher temperatures mean greater evaporation potential from bodies of water, which increases the likelihood of precipitation events and is directly linked to CC (Wang et al., 2017; Zhang et al., 2013). Fig.1 illustrates the overall impact in terms of temperature anomalies in August 2023. Here, most of the planet experiences temperatures above 1°Celcius anomalies respective to the baseline period of 1951-1980. Today, 3.2 to 3.6 billion[1] people live in conditions where they are vulnerable to the ever-increasing impacts of CC (Calvin et al., 2023).

Figure 1

Summer temperature anomaly measure of August 2023 concerning the baseline period 1951-1980 (Retrieved from NASA GISS, 2023).



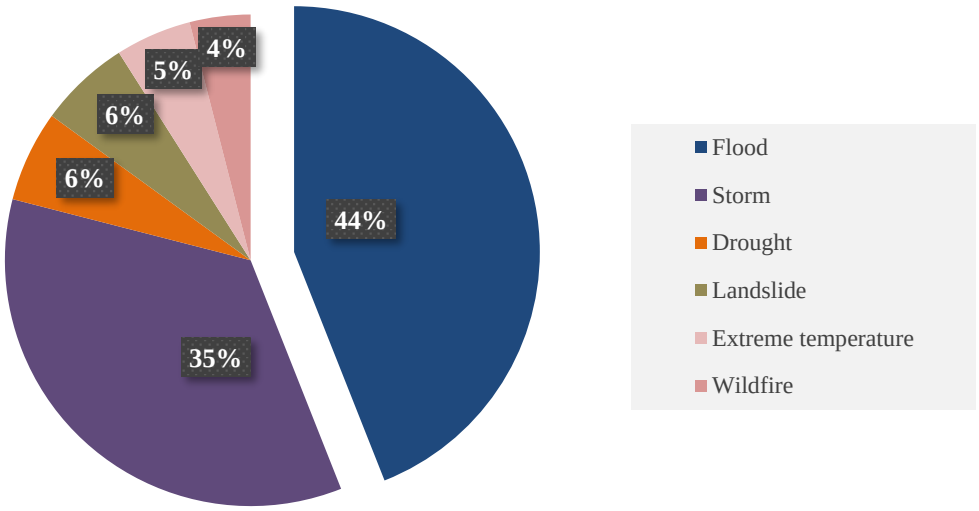
Whether due to consequences of CC, degradation of our environment and its ecological resilience, increasing industrialisation and hazard-prone urban development, increase of urban population growth and ineffective governance, climate disasters are deeply embedded in society today (Field et al., 2012; Suarez-Paba & Cruz, 2022). Highly urbanised communities are far more vulnerable due to high population density, where no other natural disaster has led to the same overall

[1]Current estimations (05/11/2023) from over 1,700 national censuses by the United Nations Population Division suggest a global population of 8,71 billion. Of these, between the low estimate of 3.2 billion or **36.7%** and a high estimate of 3.6 billion, about **41.3% of the total population** is currently impeded by anthropogenic climate change's effects.

catastrophic loss of people's lives, property and land as floodings (see Fig.2) (Calvin et al., 2023; Doswell, 2003; Douben, 2006; Taylor et al., 2023).

Figure 2

Distribution of weather-, climate- and water-related disasters reported between 1970 and 2019, by type in % (Retrieved from WMO, 2022).

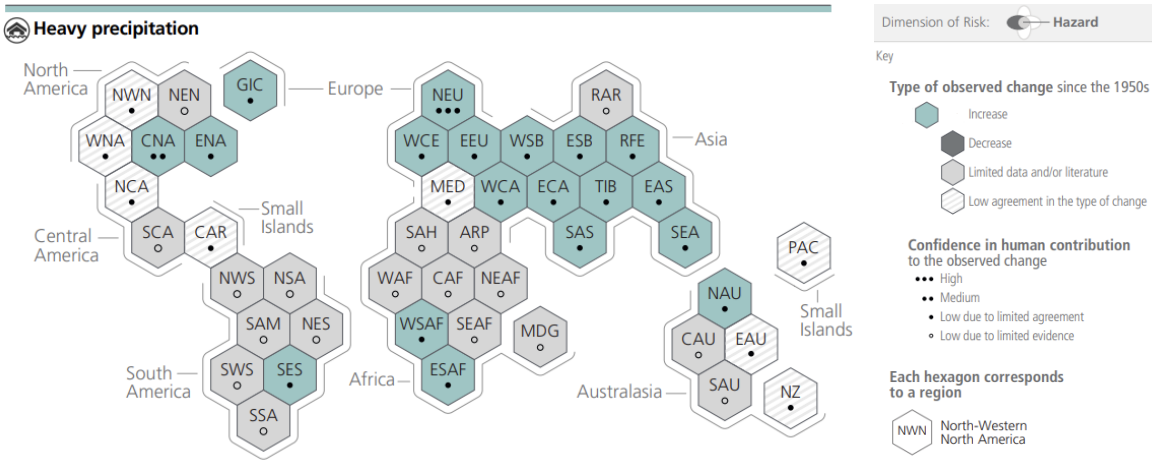


Flooding disaster events are defined by Doswell (2003) and Douben (2006) as usually dry land is flooded by water beyond typical confines, resulting from excessive precipitation. Heavy precipitation, storm surges, river- or flash floods, tropical storms (cyclones, hurricanes and typhoons) and glacial lake outburst floods (GLOF) are frequent causes of flooding (Calvin et al., 2023; Doswell, 2003; Douben, 2006; Taylor et al., 2023). In total, 1/3 of the attributed economic burden and half of all victims of worldwide natural disasters are related to flooding (Douben, 2006). Flooding occurs more frequently than all other climate-related disasters (see Fig.2; WMO, 2022). Many low-elevation rivers form part of landscapes called flood deltas, which flood seasonally and on occurrence of storm surges. Whilst not a very safe environment, deltas attract people seeking refuge and shelter, having ready access to potable water. 328 million people, or 97% of the people living in deltas worldwide, are part of developing or least-developed economies (Edmonds et al., 2020).

Flooding disasters are complex; often multiple causes and risks intersect, leading to further cascading risks to people, infrastructure and the environment (Piatyszek et al., 2017). Cascading risks describe the sequence of risks succeeding an initial disaster risk event (Pescaroli & Alexander, 2018).

Figure 3

Synthesis of assessment of observed change in heavy precipitation and confidence in human contribution to the observed changes in the world's regions (Amended from Figure 2.3a in Calvin et al., 2023).



Flooding extensively impairs and damages communities lacking socioeconomic means and resources, especially coastal regions (Dube et al., 2022; Hallegatte et al., 2013). This can be seen in many countries of the global south, with examples throughout 2023 and early 2024 in Brazil, Libya, Madagascar, Mauritius, Pakistan, and South Africa (Dube et al., 2022; Yeung, 2023). Ever the same, communities in the global north, including Germany in 2021, Japan in 2022 and catastrophic flooding events of 2023 in Greece, Hong Kong, and Türkiye, prove that communities and states of greater socioeconomic means are not exempt from the havoc caused by flooding disasters (idem). The 2011 Daiichi Fukushima Disaster remains a prominent example in recent history, where Japanese coastal communities were affected by the failure of critical infrastructure, flooding and exposure to dangerous materials, cascading risks caused by the Tōhoku earthquake and tsunami (Kwesell & Jung, 2019). Problems were further exacerbated by societal interactions with risk perceptions (RPs), causing lasting stigma, abandonment and exclusion from government action and greater society, repercussions enhanced by parallels drawn from previous experiences of the atomic bomb attacks in 1945 (idem.).

Observed in Fig.3 above, a significant proportion of regions are observing increasing trends in heavy precipitation, where regions such as NEU[2] (Northwestern Europe) see heavy anthropogenic influence (Calvin et al., 2023). When natural hazards, such as flooding, trigger technological

[2] Full graphic found in Appendix 5, including the decoding of other regional abbreviations.

accidents, they are known as NaTechs (Chen et al., 2020; Cozzani et al., 2014; Suarez-Paba & Cruz, 2022). They often occur in conjunction with activities in the chemical and process industries, potentially leading to multiple and simultaneous hazardous materials (HazMat[3]) spills and further tertiary risks to stakeholders (Chen et al., 2020; Krausmann & Mushtaq, 2008). These include radiation poisoning, non-potable water, chemical injury (idem). There are two ways in which flooding causes direct interactions with HazMats: Via the floatation of a HazMat and subsequent uncontrollable dispersion, or by bombardment of HazMat containment installations via floated debris, such as shell breach or rigid sliding (Zeng et al., 2022). To give an example of the magnitude of HazMat spills resulting from natural disasters, in the United States of America (USA), they accounted for more than 16,000 events in 1990-2008, merely 3% of the total disasters recorded in the USA at the time[4] (Sengul et al., 2012).

They create more complex situations where emergency services and other stakeholders face new scenarios in disaster risk management (DRM) and disaster response. Flooding and heavy precipitation are the most frequent natural hazards that lead to NaTech disasters (UNDRR-APSTAAG, 2020; Zeng et al., 2022). Understanding the non-cohesiveness and spontaneity of events, leading from and to fire, explosion, and dispersion of toxic substances. NaTech disasters, for their similarities in event progression, multiple escalation vectors, and secondary and tertiary effects, can be described as non-linear, cascading, with an overlap to so-called ‘domino effect’ events and low probability high consequence events (Chen et al., 2020; Cozzani et al., 2014). The interchangeability of these terms is often representative for the lack of distinctive understanding (Sulfikkar Ahamed et al., 2023), hence will be looked at further in the literature review and the data collection from the research participants.

Representative for this category of disaster events, the 2011 Daiichi nuclear disaster and the namesake 1976 Serveso-incident. They have brought pressure on national and international legislative bodies and frameworks to include NaTech risks and disaster events in guidelines and official

[3] HazMats will be used as the umbrella term for all denominations of toxic materials, dangerous goods or hazardous materials, whether chemical, biological, radioactive and/or nuclear in manner unless otherwise specified.
[4] Likely by the National Oceanic and Atmospheric Administration’s Office of Response and Restoration

legislatures, such as the Serveso-I directive of 1982 (82/501/EEC), Serveso-II in 1996 (96/82/EC) and Serveso-III in 2012 (2012/18/EU) under the UNECE TEIA. These, among other frameworks such as the Hyogo Framework (2005-2015) and the Sendai Framework (2015-2030), lead to progress in DRM and some NaTech research, policy and understanding of how multidimensional these risks and events are (2007/60/EC; 2012/18/EU).

For disaster response and prevention, NaTech events harm emergency mitigation, reducing effectiveness and even null-and-voiding potential lifesaving precautions (Cozzani et al., 2010; Krausmann & Mushtaq, 2008). Further, it is vital to frame these disasters in the context they develop and occur in, especially to produce forward- and holistic systems-thinking understanding of NaTechs (Chen et al., 2020; Suarez-Paba & Cruz, 2022). NaTechs are more-than-ever a product of this multifaceted landscape, where 'Polycrisis' has emerged as a subject that embodies many coinciding issues and risks.

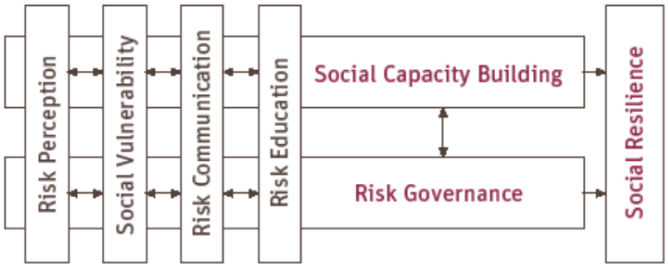
While it is difficult to establish who has a stake in risk, factors such as power, legitimacy, urgency, and proximity can play an essential role in discerning possible actors (Mitchell et al., 1997). The complex nature in which risks develop, their potential impacts and the relevant risk reduction strategies to decrease damages and loss are core topics behind the need for risk communication (RC).

Due to the complexity, ambiguity, and multifaceted nature of risks before, during and after natural disasters, sophisticated RC models allow better and more informed governance and management (Höppner et al., 2010). Risk communication is an intentional information transfer in response to concerns over specific risks related to realistic hazards, a social process of sharing knowledge and effectively communicating to the necessary audiences (idem).

As observed in Fig.4 below, RC improves DRM overall, influencing progress in both risk governance and social capacity building, affecting and is a 'crucial ingredient of resilient societies' (Höppner et al., 2010).

Figure 4

Concept interactions with risk communication (Retrieved from Höppner et al., 2010).



While risks are a common attribute of everyday human life, they are vital in driving human development in social and economic spheres (Baan & Klijn, 2004). Stakeholders, especially the public, act as 'social glue' when perceiving and interpreting natural disasters (Miles & Morse, 2007). In NaTech encounters with RC, they offer vital knowledge and understanding before, during and after such events. In framing a positive outlook, RC incorporating the stakeholders' experiences, ideas and purpose can play a valuable role in producing high-quality results in completing the targets of the United Nations Office on Disaster Risk Reduction's (UNDRR) Sendai framework.

By asking, "How do stakeholders play a role in NaTech flooding disaster RC?" this paper looks at the interaction of stakeholders' RC in NaTech flooding events, presenting current efforts in literature while interviewing selected stakeholders from multiple locations and sectors. Next, the methodology will be described, followed by the qualitative interview results and their discussion. The resulting information is discussed together with literature and utilised to highlight the nexus of stakeholder interactions, RC and communities to highlight improvement points. During this process, multiple limitations (below) were encountered which will be discussed further in Section 5: Discussion and Conclusion.

One of which is the small yet growing number of publications on the topic of NaTech, which required adapting tangential and adjacent literature to support the paper rather than relying on papers specific to the topic. In addition, terms and definitions, such as the aforementioned cascading, compound or interconnected risks, NaTech and others are not uniform and thus fragmented in literature, with some regions tending to use other vocabulary (Pescaroli & Alexander, 2018). While this paper aimed to illustrate the interactions of stakeholders in RC in NaTech flooding scenarios and

is privileged to illustrate a wide range of perspectives and case studies, it does not have as large of a group of participants, where around 10-12 participants were expected.

2. Literature review

The literature review will illustrate the current context of research in which my study takes place, highlighting the importance of various terms and the current gaps in the literature, such as the need for stakeholder interviews, implementing participatory action, lacking data and undefined metrics, and a need to study psychosocial effects of RC of NaTech flooding events.

Risk communication has changed drastically over the last decades, from being a one-way communication device for controlling the dissemination of information to the public in the discipline's inception in the 1970s to appreciating multi-stakeholder inclusion today (Fischhoff, 1995; Höppner et al., 2010). Today's Sendai framework, the UNDRR's strategy framework for 2015-2030, promotes novel learning in risk identification and management and a whole-of-society approach to disaster risk reduction (DRR) (Sulfikkar Ahamed et al., 2023). Multiple notions that have sub-/sequent interactions with RCs, some of which have already been illustrated in Figure 4. However, concepts such as risk drivers, risk perception and stakeholder identifiers are essential to understanding the ecosystem around participatory RC today.

According to the UNDRR, risks are 1- invisible at times, 2- unevenly distributed, and 3- exhibit complex nature due to their many interactions (Sulfikkar Ahamed et al., 2023). This vulnerability is underlined by the fact that these emergent risk patterns do not adhere to probability-based risk assessments, thus requiring more complex modelling to support their management.

Most of previous literature on post-disaster analysis finds RC to be inadequate (Sansom et al., 2021). There have been calls for different media devices, including increasing video clips of disaster events to improve RC (Sansom et al., 2021). Risks also have associated 'risk drivers', conditions increasing the likelihood and danger posed by risks. These are factors such as high levels of inequality, rapid urbanisation and ecosystem degeneration. On a broader spectrum, these also overlap with systemic risks found in critical infrastructure such as health, finance and banking, DRM and transportation sectors, to name a few (Sulfikkar Ahamed et al., 2023). A third class, named modifying factors, is used for even broader terms, looking into demography, CC, technology and socio-economic structures.

2.1. Risk perception

Risk perception is highly relevant for RC and can be described by how actors perceive the risks associated with their environment (Höppner et al., 2010). Thus, it should come as no surprise that RPs are distinct in every community and for every person; they do not match 'real risk' (Sansom et al., 2021). However, RP is one of many factors and associations, along with personal hazard experience, environmental cues, social cues, perceived self-efficacy and official warnings, that play a part in the possible success of RC (Sansom et al., 2021). This is the primary reason why that while there are broad ideas and concepts of frameworks being used, adaptations need to be made on an individual case-by-case basis, as RC efforts must be tailored to the perceptions and factors relevant in the intended communities (Sansom et al., 2021). In past experiences, Sansom and colleagues had found communities which suffer repeated losses, which lead to erosion of trust between these communities and pollution-intensive industries, as these are perceived as accountable for the additional NaTech incidents caused by flooding (Sansom et al., 2021). These communities often also struggle with poorer health outlooks due to the impacts of RP, chronic stress and more environmental hazards (Sansom et al., 2021). Such cumulative impacts only lead to the increase of systemic injustices and socioeconomic disadvantages, such as higher morbidity and mortality rates, along with health inequities (Sansom et al., 2021). Specific locations such as metropoles and megacities significantly overlap these risk drivers and factors.

As previously mentioned, while there is no universal way of establishing who has a stake in risk, our stakeholders are regarded as such due to having previous experiences of interacting with or being affected by RC and NaTech flooding incidents (Mitchell et al., 1997). In a case study of an applied simulation (i.e. serious gaming), comparative studies between South Korea and Japan reveal a lack of understanding and perception of NaTech risks, leading stakeholders and people to either over- or underestimate the severity of threats posed by potential NaTech disasters (Tzioutzios et al., 2022). This finding applied to the East Asian context and later was confirmed by real-life NaTech disaster cases in Japan and the USA, scenarios discussed in detail below.

2.2. Comparative case studies

In Deer Park, in Texas, USA, a 2019 NaTech, caused by a petrochemical fire at a chemical plant led to leakages of volatile organic compounds (VOCs) such as naphtha, toluene, xylene and benzene, where the plant, containment modules and the VOCs were damaged and/or subsequently caught fire (Sansom et al., 2021). This NaTech incident caused a 1200m-high smoke plume and a massive emergency service effort. Lacking transparency in RC to the public regarding the HazMat and VOC leakages, as well as in disaster response as the public was not informed in time of the extent of damage and even withheld HazMat spread (Sansom et al., 2021). Further, this incident also highlighted a lack of awareness regarding anthropogenic disaster risks (i.e. NaTech), and opt-in versus opt-out emergency communication[5]. It also demonstrated how repeated disasters can erode public trust in government and how stress caused in anticipation of these risks can lead to severe health concerns (Sansom et al., 2021).

In Soja city, in Okayama prefecture, Japan, a 2018 NaTech caused by the flooding of the Oda River embankments led to the explosion of an aluminium recycling plant affecting 120 households in the surrounding area, causing an evacuation of around 300 residents (Araki et al., 2020). Notably, residents had already requested stricter environmental controls for the plant and had observed a lack of emergency drills when based in proximity to the plant (idem). Regarding the incident, non-transparent communication from the factory to the emergency services, who also had to wait on authorisation from city council officials, postponed a complete response by multiple hours. In the meantime, local civil disaster management volunteer teams responded, investigated, and then swiftly evacuated nearby areas. Other NaTechs, such as the March 2011 Great East Japan earthquake and tsunami along the Japanese coastline, led to the emergence of a third of 39 affected industrial plants observed damage to internal emergency procedures before NaTechs were even reported in the first place (Piatyszek et al., 2017).

[5] Opt-in communication refers to communication where the receiver must overcome a barrier of entry, such as replying to a request for future contact during emergencies. Opt-out automatically approves and only requires the receiver to overcome a barrier of entry when attempting to step out of the communication method, i.e. deny future contact. For emergency contact, opt-out is often automatically assumed to prioritise lifesaving.

In many cases, stakeholders of mention are persons in vulnerable groups, such as children, people with disabilities and older persons, and local volunteer organisations (Ohtsu et al., 2021). In the case of the previously mentioned 2011 Natech, 16.1% of recorded deaths were people in the category of vulnerable people, where local volunteer disaster response groups made a strong effort to compile a vulnerable people registry to account for their specific rescue and recovery (Ohtsu et al., 2021). The described on-site procedures which are meant to counteract traditional understanding of technical accidents without interaction by natural hazards, are known as internal operation plans (IOPs). IOPs aim to limit the impacts of NaTechs and associated decontainment of HazMats from impacting people, property and the environment (Piatyszek et al., 2017). IOPs also prescribe communication protocols with authorities and the public (idem).

Not including media, such as videos and images, and governments' lack of zoning regulations make the impacts more severe in the event of a flooding NaTech (Sansom et al., 2021). Affecting decision-making is the result of RC, while adding a person's obligations, knowledge and perceptions, deciding to take active (i.e. evacuate) or passive actions (i.e. shelter in place) (Sansom et al., 2021; Omura et al., 2022).

Further, these studies show that information is difficult to access without efforts for accessibility (cultural norms, social contexts, age or language) and dissemination (targeted marketing campaigns, public outreach and individual/group relevance) (Sansom et al., 2021). Hence, RC falters (idem). Improving the understanding of how the roles of technology, social media, misinformation, and issues surrounding personal and communal power play is needed for the necessary and adequate response to acute hazards (idem). Additionally, we need to understand the needs, communication requirements and precautions for vulnerable groups such as older people (>65 yrs.), people with disabilities and children (idem). Previous studies conclude; direct communication with residents of affected populations is most effective in having people evacuate (Ohtsu et al., 2021). Ultimately, building, managing, and maintaining consequential relationships with stakeholders is needed for any organisation to fulfil its potential (Liu et al., 2020).

2.3. Gaps in the literature

This research identified four major research gaps in NaTech literature, including a lack of in-depth interviews with affected communities and other stakeholders, lacking implementation of participatory action, missing data and metrics, and needing more studies into the psychosocial elements of NaTechs. Scholars have repeatedly mentioned the lack of literature on this topic in recent years (Yu et al., 2017; Girgin et al., 2019; Liu & Viens, 2020).

1. Stakeholder interviews: There needs to be more qualitative research, stakeholder interviews are vital in providing understanding, depth, and insights into the priorities and topics of concern to stakeholders (Liu & Viens, 2020). Further, much research has been done from 'the outside looking in'; thus, it remains ever so important to hear the thoughts, opinions and ideas of those we claim to know so much about (idem).
2. Implementation of participatory action: In NaTech RC, especially in high-stress environments and growing complexities of a post-covid world, where expedited mental health issues and reduced resilience and capacities have become more prevalent, the implementation of participation in RC by stakeholders and communities remains vital and underachieved by many standards (Höppner et al., 2010; Piatyszek et al., 2017).
3. Missing data and metrics: Data on NaTech and research on niches within NaTech make it even more difficult to find credible information or long-term records, and thus there is little awareness and understanding by the public of what NaTech is and represents (Krausmann & Mushtaq, 2008). The lack of (inter-)government-publications heavily influences information availability. The lack of discussion of NaTech in latest UNDRR literature serves an example (UNDRR, 2022, 2023).
4. Psychosocial research on NaTech is rare[6]; topics such as neuroplastic and neuropsychological components are yet to be published in this field (Kwesell et al., 2023). Psychological and psychosocial risks and complexities in NaTech RC need to become more user-friendly and sustainable. Opinions and statements lacking knowledge

[6] Comparative understanding taken from Kim (2017), Kwesell and Jung (2019)

can spread rapidly, creating dangerous situations of sensationalism and panic-buying rather than informing the public about what responsible actions can be taken.

2.4. Research question

As the field and framing of NaTech is relatively new, especially outside the EU, USA and Asian contexts, literature is very sparse. Highlights of previous research state the need for insights into stakeholder interactions and the field of RC in crucial times, such as during NaTechs. Given the above questions, I formulated the following research question: “How do stakeholders approach RC to improve the understanding of the interdependencies and complex problems of NaTech in flooding disasters?”

3. Methodology

As an extension of my previous research with Professor Akihiro Tokai[7], this capstone thesis investigates unexplored avenues. The aim is to improve the understanding of stakeholder interactions in DRM and RC, by expanding on an identified research gap (point 1: Stakeholder interviews) via semi-structured interviews with experts. In addition, I highlighted the importance of quantitative knowledge in RC of (NaTech) flooding disasters, hoping to build stronger relationships between the stakeholders' views and current published research. Individuals with one-time or, preferably, even multiple or daily interactions with the topic of flooding and RC were sought.

I focussed on recruiting research participants through connections via university research staff or private connections made at academic conferences. Here, the social media platform LinkedIn was very effective at providing contact information and linking my contacts together for added reliability. The advertisement for the study was posted and shared through LinkedIn and the weekly faculty-wide newsletter of Campus Fryslân from early June 2023 to late July 2023.

Around 25 persons were contacted, and eventually, eight interviews were held. Each of the participants were recruited or snowballed via LinkedIn or academic contacts, after which email conversations were perused to clear up any questions, and to elaborate on the purpose and themes of the semi-structured questions to provide a rough guide but leave sufficient room for addition or changes to the questions when relevant to the study. The structure of the interview and questions allowed the participants to expand to their liking.

Interviews were held after meeting times had been arranged, time zones and contact mediums (i.e., Zoom, Google Meet, Microsoft Teams) had been established. After explicit ethical consent was explained, requested and given, the interviews proceeded in a semi-structured narrative, guided by the researcher but ultimately decided by the participant. This narrative method was chosen in the argumentation that participant-focused research should indeed mirror its purpose (Galletta, 2013). The calculated duration mean was 47 minutes[8].

[7] ‘Tokai Laboratory’, Department of Sustainable and Environmental Engineering of Osaka University, Japan

[8] Interview lengths in time included with each participant outline in Appendix 4.

Galletta describes the importance of this qualitative interview technique in its ability to give room to the ideas and thoughts of the participant and draw data in terms of a participant's real-life experience (idem). As cleared by the ethics checklist, no participants explicitly belonged to a vulnerable group, nor was this intended. However, the topic of disasters does raise themes of loss of lives and injury, livelihoods and belongings, and thus, this concern was explicitly raised repeatedly in the interview briefing; as an investigator I took the utmost care to cautiously frame questions and let participants extrapolate at their behest (Gordon, 2020).

The Research question can further be dissected, where derivatives could take the form of the following:

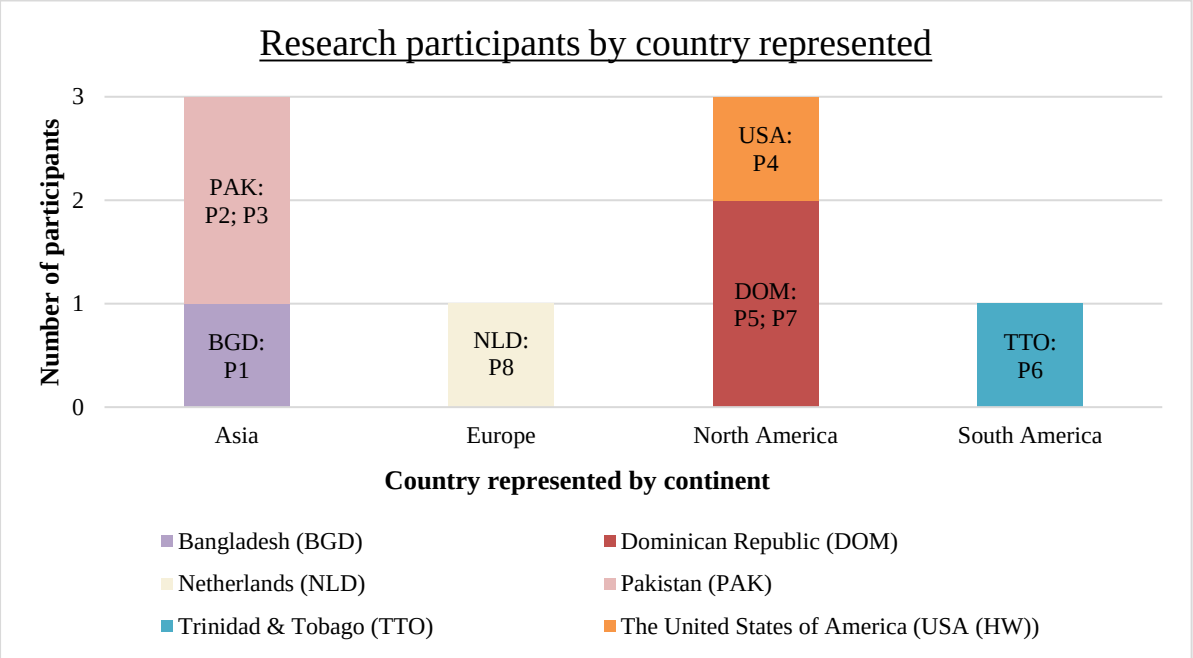
i. What role do you play as a stakeholder in NaTech flooding events?
ii. How do you perceive RC in such scenarios?
iii. Which channels and platforms do you observe RC?

These questions then became the basis for my semi-structured interview questions, as seen in Appendix 3. Of the eight interview participants, seven identified as men and one as women. They engaged in diverse occupations, industries, and topics such as media and communication specialists, water, sanitation and hygiene (WASH) specialists, professors and researchers, mentors, consultants, risk managers, lawyers, partnership officers, youth and environmental activists, working in think tanks, government agencies, non-governmental organisations (NGOs), research universities, petrochemical, power and utilities industries.

Fig.5 below portrays the continental and country of origin of interview participants on the x-axis. These are correlated with the number of participants on the y-axis, where a participant number (p-number) has been associated with each participant (e.g. p3). This p-number will be used to subsequently cite the participants (e.g. [p3]), and a short yet anonymised summary of their demographics is shared in Appendix 4.

Figure 5

Stacked bar graph illustrating the number of interviewed stakeholders per continent. Represented countries include Bangladesh, the Dominican Republic, the Netherlands, Pakistan, Trinidad & Tobago and the United States of America.



4. Results

"Unless these different models of 'good' risk communication are acknowledged and understood, efforts to identify best practice for flood risk management are likely to produce inconsistent, if not contradictory, recommendations" (p. 313, Demeritt & Nobert, 2014). Good RC and stakeholder inclusion experiences are vital in disasters. However, each stakeholder plays a distinct role, with one or more priorities, while representing a group of people or organisations. Given the presented literature and its current gaps, interviewing the participants allows us to inspect the intersection of stakeholder perspectives and practised RC in the unique contexts they presented themselves in.

Here, I observed a high level of interaction, where many of the interviews with the participants went beyond the expected 35 minutes planned, sharing personal experiences and insights from the get-go, with barely any hesitancy. They highlighted the vast interconnection of systems, peoples and organisations among stakeholders. They illustrated the importance of these insights, each having a specific role in the overall narrative. By this, the study is fortunate to have significant depth, little repetition in the topics observed and ideas collected, and observed new contexts and values through each conversation. Better insights into the respective participants' and their stakeholders' identity RP and RC were observed, highlighting various tools and strategies while exemplifying their use in flooding scenarios and subsequent NaTechs. Drivers and stakeholders such as technology and social media, news and reporting, the future generation principle and politics, as well as the private sector, vulnerable populations, people and communities, cultural contexts, and indigenous knowledge were explicitly relevant to understanding the role of RC of stakeholders in NaTech flooding.

4.1. Participant engagement

To a great degree, the research participants were aware of the plurality of contexts and perspectives they acted within and towards people they represented in a local or larger, regional, national, or international context. All participants had experiences travelling and understanding different contexts, in terms of what the size and place they described meant to them, also in a comparative sense. Many of the participants [p3, p5, p6, p8] identified themselves in roles of multiple stakeholders, exemplified by "I'm a practitioner, and I am an academic. And then I also […] belong to

the indigenous tribe" [p3]. Others saw limitations and subgroupings, ranging from being non-operational/non-practical [p8] to others voicing their belonging to vulnerable [p4; p5] or indigenous populations [p2] or by their proximity to hazards such as living in coastal communities [p5].

Self-awareness was also illustrated by the depth and variety of subjects breached in these relatively short sessions, such as highlighting the lack of representation at various levels perceived by participants, necessary to understand and access knowledge relevant to RC to all stakeholders, be it indigenous people, people of colour, women, youth, diverse and non-global north perspectives. This was seen as especially relevant in producing outcomes to support the communities they were there to "serve" [p5].

The participating stakeholders also shared a willingness to provide solutions and engage them with fervour, "impatience" for non-action and encouraging interactions yielding assured results, some even acting as negotiators in climate advocacy at high-level conferences [p1, p5, p7] while also playing a significant role on the ground, in local RC and DRR.

Overall, the participants gave a good perspective of interactions they would have within their paid and unpaid/voluntary work positions, whether in government, as public servants, the public, individuals, lawyers, NGOs, private sector companies, or lobby and interest groups. For more NaTech relevant stakeholders, the military and emergency services, critical infrastructure such as power and other utilities, hazmat transportation and provider firms, storage facilities and occupational health and safety were mentioned. Adjacent are schools and day-care facilities for youth, local governance, local authorities and leadership, whether tribal leadership, elders, business leaders or local/municipal representatives. Additionally, international stakeholders such as the United Nations, along with their sanctioned organisations and subcommittees, the World Meteorological Organisation, UNDRR, International Federation of Red Cross and Red Crescent Societies (IFRC) and UN Office for the Coordination of Humanitarian Affairs were mentioned. In addition, the European Union (EU) regulations, and state governing bodies that interacted with the EU or multilateral spheres on topics such as NaTech, DRR, or CC were brought up [p7; p4]. The size and resources of each agency and organisation within and among each stakeholder entity varies and requires awareness of their capabilities and of each affiliated organisation [p4]. Some seemed worried about certain stakeholder

groups' ability to continue their services in their current conditions, lacking financing, support or agency. The following participant said: "I'm extremely concerned about our partners' ability to keep the economy running in the rainy season" [p6]. In summary, Stakeholders illustrated troubling conditions to their financing, support or agency to continue their work, and the importance of the interconnected web of local, national and international systems, actors and factors involved in RC in NaTech flooding scenarios.

4.2. Risk communication and risk perception

To begin with, these are the RC mediums mentioned by participants, where one participant said it best "communicating, it shouldn't be that hard" [p7]. Here, participants mention the media utilised by themselves or another stakeholder in RC interactions. For RC to succeed, stakeholders need to understand the importance of these methods to sufficiently deliver catered information to targeted segments in the population to improve reaction and response in such crucial moments.

Event briefs [p4]; PowerPoints [p4]; crisis mapping [p4]; social media [p4]; Facebook [p4]; Twitter [p4]; island-wide alerting sirens [p4]; emergency phone alerts [p4]; television, radio, and press media [p5]; condensed information via text [p5]; climate atlases [p8]; flood risk maps [p8]; internet-based hazard maps [p8]; conferences [p8]; student groups [p8]; master programmes and PhD students [p8]; blog posts [p8].

Multiple participants mentioned the high barrier of education/academic knowledge needed to understand the technical details of NaTech disasters and associated hazards. The information lacked methods or mediums that people felt "compelled to act" in the first place [p7]. Such forms should be interactive and condense some insights "into kind of an engaging format" [p8]. One such format could be Storytelling. A "Story is very powerful", said one participant [p1], everywhere "there is a living story" [p2] there are lessons to be learnt. The participant continued to explain that the "rich tradition of storytelling in the Caribbean" [p6] plays a vital role, for "when you tell stories around a particular issue, and people tend to care, they tend to see themselves in the story. So, I think we need to tell stories about flooding, interview people who would have [gone] through flooding, let them share what their decision-making was" [p6]. In this way, connecting RC to linguistic tools such as storytelling

can have a positive impact on connecting people with the experiences of others, asking them to question “what do you wish you would have done better?” in such times where disaster affected them.

All stakeholders also reasoned their many facets in instances of RC in NaTech flooding, where some highlighted the use of partnerships with other stakeholders such as the IFRC, which was helpful for “translating a million things”, which is essential in building effective RC [p6]. An underlying theme was distrust in funding, available resources and opportunities provided by the government when participants expected them to, “I’m not sure I could rely on the government systems to help” in NaTech scenarios [p6].

Language barriers reportedly have an enormous impact on RC, with all stakeholders referring to suitable language as key to RC. The main mistake mentioned by the government and other communication organisations is the “tone and communications style that they use”, including that “most of the time people don’t have the technical knowledge or capacity to understand” the events [p7]. Inclusive language means language and, therefore, RC that is freely accessible and, on a cognitive level, easily understood.

Participants also raised the idea that RC is very much about the audience, in addition to the respective groups of vulnerability. Some stakeholders felt that they, too, are driven by the ideas and motivations of their environment and, as such, felt motivated to enter the petrochemical sector or the oil and gas industry, “I’m pretty oil and gas generation, right?” [p6]. This is an example of how RC also needs to cater to the environment it operates within, the generations it speaks to, and the understanding of risks that change throughout different experiences, especially when hazards and circumstances conflict, as they do in TTO. Here, another participant also mentioned how much “impatience” they felt with all their perceived inaction on flooding and risk reduction, wanting to get the work done [p7]. This correlates to what another participant states, observing this shift: “Collective understanding of the risk on [us], the generation after us is pretty pissed off. I know they’re very upset, because of the way things are going” [p6].

Participant Eight identified RP as a vital component of the dynamics of RC, as well as the associated terms such as risk appraisal and comparisons to environmental psychology [p8]. It stands

to reason that there is a need for people and stakeholders to understand their interactions with risks, why they prioritise one risk over another and where NaTech risks rank within this system. As such, these questions lead to understanding RC implications, attributed resources and funding [p8].

4.3. Technology & social media

Technology provided a significant comment base by participants, mostly encompassing the significant contribution social media sites have made to RC efforts, either by grass-roots informational efforts or by large national or regional organisations warning hundreds of thousands of impending hazards and possible threats awareness [p4]. X.com, previously the social media giant named Twitter, has been "very important for that" and essential for getting "data to people quickly" [p4]. The reliance on social media and other tech giants such as Google, Alphabet, Instagram, Facebook, WhatsApp, Messenger, and TikTok, among others, has brought up questions to these stakeholders on open data, data biases and coverage and reliance on singular platforms [p4].

One participant highlighted how crucial instant social media platforms can be, where current world events intersect with social media and RC, leading them to recognise they saw "in real-time […] that was an actual war", in respect to "what people were tweeting from Libya" during the Arab Spring [p4]. Also, when looking towards the future, the participant was sure that "AI is going to be part of disasters" similarly to how it has already infiltrated social media such as TikTok and everyday email distribution [p4]. In the meantime, we need to be aware that we do not forget mobile data networks have not been covered everywhere yet, and technology and RC efforts, especially in the nexus of acute hazards around floods, HazMats and NaTechs, be inclusive and accessible to all [p7]. This is vital in incident reporting and receiving modern emergency broadcast messages.

The value of RC is becoming more apparent with more widespread and multifaceted hazards being faced by people, such as the covid pandemic, before which "risk communications was always an afterthought, but then the scale of impacts, and the differences of reporting became especially apparent [p4].

4.4. News and reporting

News, media and reporting play a significant role in RC, especially when information is scarce and complex processes are in motion away from the public eye. The participants describe

media as an industry like a two-sided sword; when wielded correctly, it is an effective tool to support RC and has a vastly beneficial role in reaching an audience. However, when the opposite turns out to be accurate, it can become a significant hindrance, spreading disinformation and may prevent the reactions required under the circumstances. Media and their reporting methodology were also often heavily criticised for their lack of "sensitisation" to disaster-related issues, with even "perverse incentives, […] disincentives for truth" when views and interactions with content count more than safeguarding the dignity of the stakeholders and victims involved [p2; p4]. In the same breath, many also acknowledged the fact that media personnel were ill-trained on topics of such significance and sensitivity, where they do not "have the proper skills" or "they don't have the proper well-trained human resources" [p2]. Further, the people behind the source, intent, communication strategies and contextual understanding are often either not well understood or misaligned to the extent where "you're going to have malign actors" [p4] or "the communication strategies that we use are not culturally safe" [p6].

When NaTech specifically was mentioned and brought into these scenarios by the participants, one participant [p8] mentioned how, due to the increased contextual complexity because of interactions between the hazards, there needs to be greater education of journalists as well as the public regarding pre- and post-disaster RC. However, by continuous observations by one participant, comparing the media response in 2011-2012 to more recent flooding disasters in 2022, some improvements were seen [p2]. The participant remarked that these improvements were twofold: the "media has to some extent played a slightly positive role, through their sensitisation, that some communities in the nearby areas were shifted" and that "they highlighted the issue in a better way and timely […] time matters" [p2]. Nevertheless, they still noted that the initial issue of media sensitisation was not improved, as "they try to create panic again, but there was a message with it […] that people can reduce their losses if they leave or evacuate from these areas in time" [p2].

4.5. Private sector

While sparsely mentioned, the private sector came up regarding growing interests in AI and technology in risk mapping and insurance business [p4]. This is also a benefactor of improved RC as the profitability of these funds can increase, and claims can be understood better before they come

into effect [p4]. Other sectors outside insurance mentioned were the agricultural, petrochemical, oil and gas sectors [p6]. It was commented that they played a significant role, especially in secure hazmat transportation and storage facilitation, while also being "always invited" to important stakeholder meetings and large high-level conferences, such as United Nations Framework Convention on Climate Change (UNFCCC) Conferences of the Parties (COPs) [p7]. In the end, they have the most to lose, "balancing risks" in the wake of CC, as well as "reputational risk" when things go wrong in the event of a flooding NaTech, and precautions "weren't taken" [p8]. While the private sector has an equally important role to play, leveraging its monetary or information advantages to gain an advantage others do not enjoy or cannot afford, continually perpetuates trends to suppress and spread injustice.

4.6. People

Participants describe people and their communities as vulnerable groups, victims of their environment or circumstance. However, some candidates clarified that these communities have become more resilient in times of disaster, observing improvements to their knowledge and information base to previous flooding iterations [p3]. One explained the general expectation of the erosion of social bonds in disasters, resulting in looting and anti-social behaviour. Yet studies repeatedly show the tendency is very much in the direction of "pro-social behaviour" [p8]. Studies in Japan by Kumasaki and King (2020) and Kwesell and Jung (2019) describe such outcomes.

4.7. Vulnerable People

The vulnerable groups mentioned have multiple subgroups, in addition to the fact that stakeholders can belong to multiple, such as being a frequently flood-impacted community, while also belonging to a group of indigenous people. One participant mentioned that we must view RC to people through the "Lens of human rights", where their right to access to information includes access to good RC [p7]. Often mentioned was the complexity and barrier-stricken language and means of RC. These become even more prevalent and heightened when RC interacts with disasters and people of vulnerable circumstances [p5]. "Why make it so complicated? […] It shouldn't be that way, especially in information that can save lives!", exclaimed participant number seven.

People with disabilities, especially children, were pointed out as frequently being among the deceased in flooding disasters. They are "very, very vulnerable to climate disasters" [p1; p5]. Amongst this vulnerable group also mentioned were hard of hearing/had auditory challenges [p4; p5] and required sign language translation of RC media, notedly being a "huge community that's underserved" [p5]. Further, a lack of agency lead them to being "very unprotected" [p5].

Children face many difficulties, where even their optimised settings, schools and day-care facilities often do not facilitate age- and medium-appropriate RC. In the DOM, for example, these guidelines exist on the state level but simply are not carried out and implemented at schools to the necessary extent yet [p5].

In another example of the DOM mentioned, many Haitian immigrants are discriminated against by organisations and government agencies, opting to actively not consider their Creole as a language medium for RC [p5].

Women[9] are another group who are often more vulnerable in disasters, where women's health and rights, gender rights, sexual health and -rights, and mental health and -rights, are not explicitly cared for during NaTech responses. The nexus of which is known as intersectionality is the resulting movement against the threats against minority groups and vulnerable groups, which was a key phrase mentioned repeatedly by multiple participants [p5; p7]. These were often mentioned, especially surrounding RC in disasters, where one participant stated: "Inequalities that were existing before the disaster, they just heightened at the moment of the disaster" [p5]. These are heavily applied to these groups, as they are often not 'seen' enough to take timely precautions and adapt disaster RC to apply "gender-sensitive language", for example, or take precautions in shelters [p1; p2; p3; p5]. Especially women need to be in focus on RC, "We should be preparing communication protocols" catering to them to make DRM more effective [p7]. Women are essential to the social contexts in which RC and NaTechs intersect. Nevertheless, they often fall victim to circumstances in which they are not regarded enough in preplanning for and during response.

[9] Herewith are included menstruating persons, as well as people identifying themselves as women.

4.8. Communities

Particularly as communities were highlighted to be vital as recipients of RC, as well as safeguarding traditional knowledge on maintaining resilient environments, it is essential to understand that "if one person is [at] risk, that increases the risk of the whole community" [p5]. Floods quickly engorge large areas, and many people are also affected by the (potential) impacts of NaTech events. One large inhibiting sector is transportation and schooling, as especially in small island developing states, such as the DOM and TTO, where floods can bring everything to a stop. "It shuts down the economy" [p6].

The fragility of the relationship between RC, the population and its communities was frequently pointed out [p2; p7; p6], either by the ease of manipulation by media outlets and associated sources of information [p2; p3], lack of trust towards government action [p5; p6] or the rise of panic in situations where RC goes awry [p7]. Here, participants pointed out the benefits of "flexible, more localised response capacities" [p8] and more responsibility shifted towards industries associated with HazMats. Communities play an interdependent and essential role and relationship with their members in supporting people and providing the conditions to persevere NaTech flooding scenarios.

4.9. Future Generation

In 1992, the UN founded the UNFCC at the first COP in Rio de Janeiro. An Amazonian girl spoke to present leaders, "Don't do it for me, do it for the generations to come" [p7]. More and more, the future generation turns from a principle to represent an active stakeholder, personifying the duality of discourse. For one, it is an ethical and moralistic exercise before making impactful decisions, and two, it serves as a reminder that the politics at play now serve as the foundation of tomorrow's generations [p7]. This stakeholder should not be impeded, but rather should serve as a doorstop to building our sustainable future, as in any case, "our actions should align with the future generations to come" [p7]. The future generations principle is a powerful voice for stakeholders, calling companies, governments and institutions, to become accountable beyond the current day and offer positive outcomes for the people of yet-unborn generations.

4.10. Politics

Politics in RC was mentioned to play a role, especially in BGD, Pakistan, TTO, as well as the DOM, where participants perceived the (post-) disaster management to be a deciding phase for the potential re-election of a politician to government office [p1; p2; p3; p5; p6]. “None of the governments got a second chance to rule the people” [p3]. However, there was a sentiment that “there should be no politics in disasters” [p2]. Additionally, public sector jobs were commented to have a political side, and needing more human resources for the tools required for more advanced RC and scientific data-finding that should be required of them [p5]. Politics, similarly to media, offers advantages and disadvantages in motivating people and politicians to deliver and hold accountable the people who work in service to constituents, as well as pressures to motivate improvements to RC to improve staying in office post-disaster.

4.11. Recommendations for risk communication

Participants had many different perspectives and ideas of possible solutions to share, from local governance to international regulatory agreements such as those promised by the EU. Topics such as dependency were mentioned, where money plays a large role in disaster management and in expanding and building the technological capacities for RC. Many of the components for these products are imported and reliant on trade agreements, licensing, or purchasing power for the availability and ability to produce these products.

Construction policy needs reform, especially in large delta areas of overflowing sprawling cities, namely Dhaka, BGD, and Islamabad, Pakistan. This leads to slums being built in delta areas that can be “considered water passages” [p1; p2]. The participant also argued the responsibility was twofold, one by the government to secure better living areas and inform migrants and people forced to build a shelter in these outskirts to live elsewhere, and two, the responsibility of the people to understand that they cannot live in the areas threatened by storm surges or flooding in deltas [p2].

Due to personal stakeholder interactions, participant six elaborated on the lack of data-based building codes, adaptation for CC and climate-associated risks such as flooding [p1; p2; p6]. While tangential to RC, not understanding this risk on a more infrastructural and construction basis directly

leads to flooding-related incidents having a much worse effect than such considerations (Sansom et al., 2021).

On the other hand, the DOM's Ministry for Infrastructure building without considering environmental impact, thus not taking the same measures that they would endorse in their RC efforts [p7]. As such, all stakeholders agreed that policies should reflect more agency to the diversity of stakeholders, more representation of vulnerable people, and add effort to ensure consultation rights. Essentially, "let communities be part of the process, and engage with them, instead of telling them what to do" [p7].

There was much subliminal urgency of the participants to fight power disparities and allow minorities that previously struggled to have their voice be part of the discussion to be heard, working to prevent scenarios which one participant illustrates as walking into a room with only tall white men present [p4]. A few participants mentioned lobbying and, but then they stated that this was missing regulation [p3]. Another participant recalls interventionist approaches in the global south, calling for greater tri-lateral and south-south agreements to strengthen resilience in times of distress, including those of NaTech disasters, to reduce reliance on international aid from the global north or western organisations [p7]. Here, governments can do well to further their technical understanding and publish information on the impacts of hazards regarding HazMats and multi-hazard NaTech events [p7].

The participants from Europe made multiple comments on the "very detailed and very strict" EU regulations on hazardous goods and materials [p8]. They described the "balancing" of these around the latest expectations with hazards emerging from the climate, fine-tuning them as threats emerge [p8]. These regulations can be a "huge motivator of change", along with associated "carrot and stick" incentives, such as sanctions and licensing, being "quite powerful" [p8].

Another point mentioned needed more funding for RC initiatives and adjacent issues, such as disaster relief and reconstruction. Local and international crowdfunding efforts using videos, interviews and visual media, counteracted lacking rapid-deployment payments from the government and other aid providers [p1]. One sentiment that became clear for especially the case of BGD and Pakistan, as well as other countries of the 'global south', was the dependency on solidarity payments

and aid from the ‘global north’, as national agencies “are short with funds” [p2] as well as non-financial relief such as medicine and construction materials. This is due to being “hit by the inflation” as well as lacking the financial means to finance stressors such as repeated natural disasters increasing in frequency and severity [p2]. With this, this section can be summed to portray the importance of construction policy change, improved data for building codes, having the government take the environment into greater consideration when constructing new buildings, enforcing stricter HazMat and NaTech legislation as well as ensuring local sourcing of technology and infrastructure to support stakeholders in providing more resilience in NaTechs as well as benefitting from RC in the process.

4.12. Different cultural contexts

As communities play such a fundamental role in RC, it is essential to understand how cultural contexts affect them. Many participants mention comparisons to other cultural experiences to share their thoughts regarding their communities. In the DOM, difficulties mentioned include disorganisation in community-led organisations, lacking ongoing and independent drive and agency, and the amount of energy required to get them started in the first place [p5]. When compared to China, the DOM was referred to as “individualistic” and “very Americanised and more westernised” [p7]. China’s higher-level governing structures were also compared with the NLD, being much more top-down and vertical when compared to the Dutch’s horizontal and bottom-up governance style [p8].

In general, intercultural experiences were raised as lessons well learned, with anecdotes to share and reflections regarding their own actions and state of contexts, where one participant also mentioned the lack of cultural diversity in stakeholder meetings, where only tall white men were present [p4]. Another participant summarised this sentiment well, “we have to be observers of culture” to cater to RC better and make it as effective as it must be [p6].

Different cultural contexts were also raised when communities or cultures exhibited varied evidence of adapting to learned experiences and investigating the causes and origins of past failures. A participant offered insight: “Culture that doesn’t allow for reflection of failure or discourages identification of failure, where you have inadequate resourcing, you have very top-down governance mechanisms that do not allow for horizontal exchange between the agencies at the lower levels” [p8].

These interactions have an impact, reflecting on failure and investigating wrongdoing during RC is essential.

4.13. Indigenous knowledge

Indigenous knowledge has frequently been praised by the participants of this study, some noting how essential it is to understand why their ways helped the surrounding ecosystem stay stable. These "indigenous problem-solving tools" or so-called "local technology" [p3] have resulted from testing the limits of nature in the past and have become lessons learned for RC, sharing the solution to problems that had not been well understood. These have included using stories and myths to tell of risks from phenomena such as GLOFs [p4], overfishing [p3] and construction in proximity to bodies of water [p6]. Upon today's interactions with science, participants noted how relevant many of the ideas hidden in indigenous myths and stories were, with "strategic" and holistic insight into how these narratives interact with resilient environments. One example given was the protection of juvenile fish by not fishing in certain months on account of their youth and growing phases, fostering more resilient ecosystems, and improving conditions for coral reef and mangrove forest growth, which in turn provide more protection for future breeding grounds for fish and storm surge protection [p3]. The stakeholders saw a need to increase developments and projects with indigenous groups and their knowledge as a medium for RC, technology and training to provide resilience for communities [p3]. Indigenous knowledge remains a vital RC tool and method of knowledge and information traversing culture, communities and peoples.

Overall, the study resulted extensively portrayed diverse stakeholder groups, highlighting different factors and risk drivers affecting various stakeholders. The participants further expanded their experiences and thoughts based on the semi-structured questions, describing the inhibitors and disrupting factors, such as media, private companies and funding. They also gave insight into how improvements and recommendations should be realised to improve the setting for RC and tangential issues surrounding NaTech floodings.

5. Discussion and Conclusions

In this thesis, I aimed to study how stakeholders approach RC to understand NaTech flooding disasters better. More specifically, semi-structured interviews explored a variety of subtopics such as

how RC affected diverse groups of people, the barriers and openings to effective RC, improvements, and possible contextual solutions to furthering interactions between stakeholders and building social, economic and environmental resilience and sustainability.

5.1. Discussion

Overall, the participants had a wealth of insight to share, mainly on stakeholders, influencing factors in DRM and RC. Deriving from the results and the conversations with the study's participants, the interviewed stakeholders identified multiple gaps in the implementation of RC regarding NaTech flooding. They are as follows:

1. Interactions with indigenous knowledge – As discussed by participants, culture plays a vital role in RC knowledge transfer. Incorporating tools that combine indigenous knowledge, RC, and heritage would provide chances for better engagement. Storytelling can offer a form of sustainable knowledge transfer, harnessing cultural pride in the Caribbean context while providing generational longevity. As such, storytelling as a verbal media device and communal experience can contribute towards a positive learning environment and motivate information sharing (Höppner et al., 2010).
2. Expert communication – Environments, where experts cannot investigate wrongdoings or mishandling of situations, will disincentivise learning from failures and hence lack the mindset for continuous improvement. Further, in settings where "[experts] aren't speaking to one another" when there is "a lot of potential learning", not only do stakeholders lose out on knowledge building but, so does everyone else [p8].
3. Reinforce regulatory obligations of RCs of owners, providers, transportation and storage organisations of HazMats. Additionally, governments' access to NaTech knowledge should benefit society overall. Hence, they also have some obligations to meet to open the floor to discussions in the future and share their knowledge.
4. In-situ community knowledge centres – While libraries might have played a similar role in the past, frequent extremes in disasters have shown readiness is essential. Thus, a structure is needed that allows communities to build resilience, self-dependency, and self-deploy resources upon disaster, equipping them with emergency protocols, and materials while being

energy-self-sufficient and accessible around the clock for information, emergency protocols and guidelines.

5. Implementation of inclusion criteria, whether in official delegations and negotiations for improved RC, or on a local scale where guidelines for RC need to be implemented in schools, education, workplaces and elsewhere. Setting compliance and control procedures should be essential to test the readiness and reliability of such information to target audiences. This includes integrated precautions and accessibility provided in preparation for various groups of vulnerable people while including their voices in preparation for providing these means.
6. Training and standards for responsible, non-sensationalist, and dignified reporting – Media did not in the past have the skills required to report on flooding disasters, nor knew how to broach the topic and communicate CC in a nuanced and non-alarmist manner [p2]. This was due to a lack of training of human resources, missing nuanced facets in communicating and reporting on crises and issues to build social, where in the past, most journalists and reporting agencies looked to improve their engagement and build hype, no matter the consequences [p2]. Desensitisation is dangerous, and thus, extended and frequent provision of images which are explicit, i.e. pictures and videos of dead bodies, can lead to reduced sympathetic response and psychological issues [p2] (Krahé et al., 2011). How to sensitise the communities to crisis without creating panic and building resilience is a question that must be answered and addressed through policy and training programmes for media professionals [p2]. Independent broadcasting complaints commissions should keep higher standards of due diligence and industry best practices in check. Additional allocations should be made for people of various vulnerable groups, communicating specifics to cater to their accessibility needs.

The relevance of NaTech being included in public knowledge is also highlighted by the complexity at which these events appear once they occur[10], which was frequently mentioned by participants. If broader spectra of people were sensitised to the occurrence and possible cascading risks of NaTech events, they would not appear as complex, or the complexity would have a lower

[10] see section 2.1: Risk communication and risk perception

burden of entry to being understood due to preexisting knowledge and understanding of similar events.

During the study, it emerged that participants focussed considerably on three central themes, which go together with RC in this field: Media and communication devices, CC and vulnerable groups. This may stem from questioning beneficial and counteractive means of RC in NaTech flooding events. However, they could have constructed their own narrative to answer these questions. How many participants reacted to actions of media organisations, whether more traditional or new age media, displayed serious trouble with the portrayal of events in the past. One participant [p2] saw an improvement in how media acted today, it was significant that people whom disasters have severely impacted saw media as a stakeholder to blame for lacking RC. The intersection with CC is deliberate and essential to acknowledge, especially as CC and more extreme and frequent disasters are linked (Calvin et al., 2023). The participants' their environments and cultures were different through their work, yet they have shown a distinct understanding of how changing climate affects them and can cause NaTech events. They chose to focus on ecosystem resilience and traditional knowledge to provide access and relevance for the need for RC.

This study benefited from the firsthand experiences the participants had of flooding and related risks and its RC while also accessing their wealth of stakeholder interactions in the field and international experiences that were proven to be excellent comparisons for the different cultural dynamics and environmental contexts at play. The conversations went to remarkable depths and allowed the participant to express their ideas and thoughts freely as they wished, with no restrictions for time or topic set by the researcher.

The advantage of interviewing persons with first-hand experiences and knowledge was that their accounts also included associations such as associated companies, organisations, communities, families and friends, allowing me to gather a network of information from their perspective. The interview results support a so-called 'trust of spheres' sentiment, where people are more willing to trust their social circle info (e.g. social media, friends and family, local organisations over national broadcasting) (Sansom et al., 2021). Further, the diversity and variety of localities represented in such

a small study, while reaching different communities, age groups and stakeholder identities, strengthens the papers' outcomes.

Some of the limitations include the low number of respondents to my requests for an interview, as this could have strengthened the selectivity the participants could have undergone. Additionally, qualitative interviews are affected by interactions between the interviewed participant and the researcher. Thus, various dynamics played a significant role in changing the outcome of how subjects were breached. These include, respective to the interviewee as well as the interviewer, gender, ethnicity, background, social values and cultural practices (Oakley, 1998; Broom et al., 2009). Interestingly, NaTech was seldom approached, despite being explicitly mentioned in the research call-out, email and message correspondence, defined and explained during the interview. While much of the information collected was highly relevant and viable even for NaTech research, this approach reiterates the need for common and shared knowledge among stakeholders interacting with and adjacent to NaTech risk-prone industries. This could be due to a small sample size or needing more niche outreach opportunities. The small number of research papers on the subject makes it likely that the field is yet to reach larger public appeal and scientific saturation.

Finally, due to personal circumstances, timelines were repeatedly extended. While beneficial for outreach to participants, it set issues in the arrangement of meetings and hindered cohesive progress towards completion of the study.

5.2. Future research

In the future, didactic interviews, like focus groups, where the interviewing researcher faces not one but rather two participants at a time, could prove insightful to circumvent potential biases, observe interactions between the participants and delve deeper into respective stakeholder assumptions of other active or passive stakeholder groups. These differ from the current format as the researcher faces not one participant, but two at a time, allowing for greater focus on the stakeholder roles. They also may offer more scenario-driven interaction, as in NaTech RC, and an opportunity for the stakeholders to discuss the questions among themselves. Nevertheless, this format would have been more difficult to implement in the current online setting, where struggles with audio and video

feeds already impacted on data transmission. Focus groups also collect more interaction data, which is needed for producing a system mapping of risk drivers, factors, and stakeholders.

5.3. Conclusion

To summarise, the study found that stakeholders saw RC as an essential yet underrepresented aspect of DRM, reviewing the lack of implementation and respective accessibility for vulnerable communities and diverse target groups. Understanding local case studies and transferring them to discuss and understand global issues highlights the value of participants' global experiences and their local experiences.

More research is needed on adjusting metrics and key performance indicators regarding measuring the relevance and success of RC in respective media. Experts on NaTech should communicate, engage and provide stakeholders with more fruitful encounters across the multiple dimensions of risk reduction and embrace structural and knowledge infrastructure pathways such as physical and digital knowledge centres, empowering communities with mobile internet access and emergency supplies while also encouraging open discussion on past failures and lessons learnt from flooding disasters. Resilience is the keystone combining risk factors, NaTech flooding and stakeholders of RC, where ways of communication representing the people should communicate holistic approaches regarding environmental and social resilience to, i.e. storytelling in the Caribbean and indigenous generational knowledge in South Asia. Approaches should incite respect for the strong interconnectivity of people and nature while understanding the devastating anthropogenic influences on our changing climate, the balance of ecosystems, and the ever-increasing threat of surpassing tipping points in our planetary boundaries. Critical infrastructure and policy implementation are tied to actions pre- and post-NaTech flooding events. As the need for RC increases, stakeholders will need to deliberate expansion into these converging topics.

6. References

Araki, Y., Hokugo, A., Pinheiro, A. T. K., Ohtsu, N., & Cruz, A. (2020). Explosion at an aluminum factory caused by the July 2018 Japan floods: Investigation of damages and evacuation activities. *Journal of Loss Prevention in the Process Industries*, *69*, 104352. https://doi.org/10.1016/j.jlp.2020.104352

Broom, A., Hand, K., & Tovey, P. (2009). The role of gender, environment and Individual biography in shaping qualitative interview data. *International Journal of Social Research Methodology*, *12*, 51–65. https://doi.org/10.1080/13645570701606028

Calvin, K., Dasgupta, D., Krinner, G., Mukherji, A., Thorne, P. W., Trisos, C., Romero, J., Aldunce, P., Barrett, K., Blanco, G., Cheung, W. W. L., Connors, S., Denton, F., Diongue-Niang, A., Dodman, D., Garschagen, M., Geden, O., Hayward, B., Jones, C., … Péan, C. (2023). *IPCC, 2023: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]*. *IPCC, Geneva, Switzerland.* (First). Intergovernmental Panel on Climate Change (IPCC). https://doi.org/10.59327/IPCC/AR6-9789291691647

Chen, C., Reniers, G., & Khakzad, N. (2020). A thorough classification and discussion of approaches for modeling and managing domino effects in the process industries. *Safety Science*, *125*, 104618. https://doi.org/10.1016/j.ssci.2020.104618

Cozzani, V., Antonioni, G., Landucci, G., Tugnoli, A., Bonvicini, S., & Spadoni, G. (2014). Quantitative assessment of domino and NaTech scenarios in complex industrial areas. *Journal of Loss Prevention in the Process Industries*, *28*, 10–22. https://doi.org/10.1016/j.jlp.2013.07.009

Directive 82/501/EEC of of the Council on 24 June 1982 on the major-accident hazards of certain industrial activities, CONSIL, 230 OJ L (1982). http://data.europa.eu/eli/dir/1982/501/oj/eng

Directive 96/82/EC of the Council on 9 December 1996 on the control of major-accident hazards involving dangerous substances, CONSIL, 010 OJ L (1996). http://data.europa.eu/eli/dir/1996/82/oj/eng

Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks, CONSIL, EP, 288 OJ L (2007). http://data.europa.eu/eli/dir/2007/60/oj/eng

Directive 2012/18/EU of the European Parliament and of the Council of 4 July 2012 on the control of major-accident hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EC, CONSIL, EP, 197 OJ L (2012). http://data.europa.eu/eli/dir/2012/18/oj/eng

Doswell, C. A. (2003). Flooding. In J. R. Holton (Ed.), *Encyclopedia of Atmospheric Sciences* (pp. 769–776). Academic Press. https://doi.org/10.1016/B0-12-227090-8/00151-2

Douben, K.-J. (2006). Characteristics of river floods and flooding: A global overview, 1985–2003. *Irrigation and Drainage*, *55*(S1), S9–S21. https://doi.org/10.1002/ird.239

Dube, K., Nhamo, G., & Chikodzi, D. (2022). Flooding trends and their impacts on coastal communities of Western Cape Province, South Africa. *GeoJournal*, *87*(4), 453–468. https://doi.org/10.1007/s10708-021-10460-z

Edmonds, D. A., Caldwell, R. L., Brondizio, E. S., & Siani, S. M. O. (2020). Coastal flooding will disproportionately impact people on river deltas. *Nature Communications*, *11*(1), 4741. https://doi.org/10.1038/s41467-020-18531-4

Field, C. B., Barros, V., Stocker, T. F., & Dahe, Q. (Eds.). (2012). *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation: Special Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press. https://doi.org/10.1017/CBO9781139177245

Fischhoff, B. (1995). Risk perception and communication unplugged: Twenty years of process. *Risk Analysis: An Official Publication of the Society for Risk Analysis*, *15*(2), 137–145. https://doi.org/10.1111/j.1539-6924.1995.tb00308.x

Galletta, A. (2013). *Mastering the Semi-Structured Interview and Beyond: From Research Design to Analysis and Publication*. NYU Press.

Girgin, S., Necci, A., & Krausmann, E. (2019). Dealing with cascading multi-hazard risks in national risk assessment: The case of Natech accidents. *International Journal of Disaster Risk Reduction*, *35*, 101072. https://doi.org/10.1016/j.ijdrr.2019.101072

Gordon, B. G. (2020). Vulnerability in Research: Basic Ethical Concepts and General Approach to Review. *The Ochsner Journal*, *20*(1), 34–38. https://doi.org/10.31486/toj.19.0079

Hallegatte, S., Green, C., Nicholls, R. J., & Corfee-Morlot, J. (2013). Future flood losses in major coastal cities. *Nature Climate Change*, *3*(9), Article 9. https://doi.org/10.1038/nclimate1979

Höppner, C., Buchecker, M., & Bründl, M. (2010). *Risk Communication and Natural Hazards* (CapHaz-Net WP5). Swiss Federal Research Institute WSL. https://www.researchgate.net/profile/Matthias-Buchecker/publication/228451235_Risk_Communication_and_Natural_Hazards/links/02bfe50e2d4b6608ea000000/Risk-Communication-and-Natural-Hazards.pdf

Iphofen, R., & Tolich, M. (Eds.). (2018). *The Sage Handbook of Qualitative Research Ethics*. Sage. https://philpapers.org/rec/IPHTSH

Kim, Y. (2017, November 23). *Long-term Psychosocial impact of Natural Disasters on survivors in Japan*. WHO Center for Health Development. https://extranet.who.int/kobe_centre/en/news/Psycho-social_Impact_20171115

Krahé, B., Möller, I., Huesmann, L. R., Kirwil, L., Felber, J., & Berger, A. (2011). Desensitization to Media Violence: Links With Habitual Media Violence Exposure, Aggressive Cognitions, and Aggressive Behavior. *Journal of Personality and Social Psychology*, *100*(4), 630–646. https://doi.org/10.1037/a0021711

Krausmann, E., & Mushtaq, F. (2008). A qualitative Natech damage scale for the impact of floods on selected industrial facilities. *Natural Hazards*, *46*(2), 179–197. https://doi.org/10.1007/s11069-007-9203-5

Kumasaki, M., & King, M. (2020). Three cases in Japan occurred by natural hazards and lessons for Natech disaster management. *International Journal of Disaster Risk Reduction*, *51*, 101855. https://doi.org/10.1016/j.ijdrr.2020.101855

Kwesell, A., & Jung, J.-Y. (2019). A Multidimensional Analysis of Stigma: Findings from a Qualitative Study of Fukushima Residents Following Japan's 2011 Nuclear Disaster. *Journal of International Crisis and Risk Communication Research*, *2*, 233–258. https://doi.org/10.30658/jicrcr.2.2.4

Kwesell, A., Jung, J.-Y., & Mai, L. (2023). Long-term socio-psychological disaster impact after 8 years: Relationships between the persistent impact of the Fukushima disaster and individuals' media and community connectedness. *International Journal of Mass Emergencies & Disasters*, *41*(2–3), 279–295. https://doi.org/10.1177/02807270231214256

Liu, B. F., Seate, A. A., Iles, I., & Herovic, E. (2020). Eyes of the Storm: How Citizen Scientists Contribute to Government Forecasting and Risk Communication. *Weather, Climate, and Society*, *12*(2), 263–277. https://doi.org/10.1175/WCAS-D-19-0131.1

Liu, B. F., & Viens, J. (2020). Crisis and Risk Communication Scholarship of the Future: Reflections on Research Gaps. *Journal of International Crisis and Risk Communication Research*, *3*, 7–13. https://doi.org/10.30658/jicrcr.3.1.1

Mitchell, R. K., Agle, B. R., & Wood, D. J. (1997). Toward a Theory of Stakeholder Identification and Salience: Defining the Principle of Who and What Really Counts. *The Academy of Management Review*, *22*(4), 853–886. https://doi.org/10.2307/259247

NASA GISS. (2023, September 14). *NASA Scientific Visualization Studio | NASA Summer 2023 Temperature Media Resources*. NASA SVS. https://svs.gsfc.nasa.gov/14407

Oakley, A. (1998). Gender, Methodology and People's Ways of Knowing: Some Problems with Feminism and the Paradigm Debate in Social Science. *Sociology*, *32*(4), 707–731.

Ohtsu, N., Hokugo, A., Cruz, A. M., Sato, Y., Araki, Y., & Park, H. (2021). Evacuation of vulnerable people during a Natech: A case study of a flood and factory explosion in Japan. *International Journal of Disaster Resilience in the Built Environment*, *14*(1), 53–67. https://doi.org/10.1108/IJDRBE-04-2021-0043

Omura, T., Hokugo, A., Ohtsu, N., & Liao, J. (2022). *Analysis of Evacuyation Behavious Characteristics by Intergenerational Comparison During Heavy Rain Disasters*. https://www.jstage.jst.go.jp/article/aija/87/797/87_1407/_article/-char/ja/

Pescaroli, G., & Alexander, D. (2018). Understanding Compound, Interconnected, Interacting, and Cascading Risks: A Holistic Framework. *Risk Analysis*, *38*(11), 2245–2257. https://doi.org/10.1111/risa.13128

Piatyszek, E., Tardy, A., Lesbats, M., & Cruz, A. M. (2017). Natech Events Triggered by Floods: When Floods Cause Technological Accidents. In F. Vinet (Ed.), *Floods* (pp. 73–87). Elsevier. https://doi.org/10.1016/B978-1-78548-268-7.50005-5

Sansom, G. T., Aarvig, K., Sansom, L., Thompson, C., Fawkes, L., & Katare, A. (2021). Understanding Risk Communication and Willingness to Follow Emergency Recommendations Following Anthropogenic Disasters. *Environmental Justice*, *14*(2), 159–167. https://doi.org/10.1089/env.2020.0050

Sengul, H., Santella, N., Steinberg, L. J., & Cruz, A. M. (2012). Analysis of hazardous material releases due to natural hazards in the United States. *Disasters*, *36*(4), 723–743. https://doi.org/10.1111/j.1467-7717.2012.01272.x

Suarez-Paba, M. C., & Cruz, A. M. (2022). A paradigm shift in Natech risk management: Development of a rating system framework for evaluating the performance of industry. *Journal of Loss Prevention in the Process Industries*, *74*, 104615. https://doi.org/10.1016/j.jlp.2021.104615

Sulfikkar Ahamed, M., Sarmah, T., Dabral, A., Chatterjee, R., & Shaw, R. (2023). Unpacking systemic, cascading, and compound risks: A case based analysis of Asia Pacific. *Progress in Disaster Science*, *18*, 100285. https://doi.org/10.1016/j.pdisas.2023.100285

Taylor, C., Robinson, T. R., Dunning, S., Rachel Carr, J., & Westoby, M. (2023). Glacial lake outburst floods threaten millions globally. *Nature Communications*, *14*(1), Article 1. https://doi.org/10.1038/s41467-023-36033-x

Tzioutzios, D., Dandoulaki, M., & Cruz, A. M. (2022, October 1). Exploring how citizens communicate about Natech risk through a comparitive study and a serious game. *SafeThessaloniki*

2022. SafeThessaloniki 2022 – 9th International Conference on Civil Protection & New Technologies, Thessaloniki. https://safegreece.org/safethessaloniki2022/images/docs/safethessaloniki_proceedings.pdf

UNDRR. (2022). *GAR2022: Our World at Risk (GAR) | UNDRR*. https://www.undrr.org/gar/gar2022-our-world-risk-gar

UNDRR. (2023, July 11). *GAR Special Report 2023: Mapping resilience for the sustainable development goals | UNDRR*. http://www.undrr.org/gar/gar2023-special-report

UNDRR-APSTAAG. (2020). *Asia-Pacific Regional Framework for NATECH (Natural Hazards Triggering Technological Disasters) Risk Management*. http://www.undrr.org/publication/asia-pacific-regional-framework-natech-natural-hazards-triggering-technological

Wang, G., Wang, D., Trenberth, K. E., Erfanian, A., Yu, M., Bosilovich, M. G., & Parr, D. T. (2017). The peak structure and future changes of the relationships between extreme precipitation and temperature. *Nature Climate Change*, *7*(4), Article 4. https://doi.org/10.1038/nclimate3239

World Meteorological Organisation. (2022). *Distribution reported climate disaster worldwide by type*. Statista. https://www.statista.com/statistics/1269702/distribution-of-reported-climate-disaster-by-type/

Yeung, J. (2023, September 17). *Ten countries and territories saw severe flooding in just 12 days. Is this the future of climate change?* CNN. https://www.cnn.com/2023/09/16/world/global-rain-flooding-climate-crisis-intl-hnk/index.html

Yu, J., Cruz, A. M., & Hokugo, A. (2017). Households' Risk Perception and Behavioral Responses to Natech Accidents. *International Journal of Disaster Risk Science*, *8*(1), 1–15. https://doi.org/10.1007/s13753-017-0116-y

Zeng, T., Chen, G., & Genserik, R. (2022). Coping with flood Natech events: A safety framework to make chemical clusters more resilient. *Chemical Engineering Transactions*, *90*, 805–810. https://doi.org/10.3303/CET2290135

Zhang, Q., Li, J., Singh, V. P., & Xiao, M. (2013). Spatio-temporal relations between temperature and precipitation regimes: Implications for temperature-induced changes in the hydrological cycle. *Global and Planetary Change*, *111*, 57–76. https://doi.org/10.1016/j.gloplacha.2013.08.012

7. Appendices

Appendix 1:Outreach Faculty-wide Newsletter Campus Fryslân

"Participate in research on how commmunicationa nd results affects the stakeholders of NATECH flooding disasters!

Are you a person who has previously been impacted by flooding and its cascading risks? For their bachelor's thesis, a student is researching the impacts of risk communication in flooding events, specifically in observance of NATECH events: Natural hazard-triggered technological accidents. This research forms a vital component of their research question: How stakeholders approach risk communication to improve the understanding of the interdependencies and complex problems of NATECH disasters.

If you, or someone you know, have stories and thoughts to share, please refer and contact Joel Gräff at j.d.graff@student.rug.nl."

Appendix 2: Outreach Post LinkedIn

Joel Gräff • You
Piloting community leadership & creating adaptive solutions | BSc Global Re...
6mo •

Call for interviewing participants:
- Are you a person impacted by flooding?
- Are you experienced in flooding events and their associated risk communication?
- Have you experienced natural hazards such as oil spills, electrical failure, industrial disasters or any other technical accident related to flooding?

Then please let me know! I am researching the impacts of risk communication in flooding events, specifically in observance of NATECH events: Natural hazard-triggered technological accidents.

This research forms a vital component of my research question, for completion of my Bachelor's degree: How stakeholders approach risk communication to improve the understanding of interdependencies and complex problems of NATECH disasters.

These stakeholder interviews would add more depth, insights and comprehension to the topic from a practical point of view, making sure more perspectives and experiences are collected to help further policy recommendations.

Interviews are aimed to be conducted from early June to the end of July 2023, with an approximate duration of 35-40 minutes.

Sample interview session:
5 mins: Introductions
5 mins: Research explanation, objectives, disclaimers, agreements, questions, etc.
5 mins: Expansion on previous stakeholder interactions in NATECH scenarios
15 mins: Insight to risk communication practices and lessons learned
5 mins: Thank you and follow-up questions, contact

Results will be anonymised and safely recorded according to passed ethical procedures and data protection in the EU and the University of Groningen.

Looking forward to hearing from you, and let me know if you have some thoughts and ideas!

#research #natechevents #disasterresponse #riskcommunication

Appendix 3: Interview guide

Sample interview session (~35 mins):

5 mins: Introductions

5 mins: Research explanation, objectives, disclaimers, agreements, questions, etc.

5 mins: Expansion on previous stakeholder interactions in NATECH scenarios.

15 mins: Insight to risk communication practices and lessons learned.

5 mins: Thank you and follow-up questions, contact.

Semi-structured questions:

- are you a person impacted by flooding?
- are you experienced in flooding events and their associated risk communication?
- Have you experienced natural hazards intersecting with technical accidents such as oil spills, electrical failure, industrial disasters or any other technical flooding-related accident?

Interview guide

- Figure out the needs.
- Who is left behind?
- What is the stakeholder's agency?
- How do they respond to NATECH
- Resources
- Accountability

1. Introduction to participants and research
   - 1.1. Introduction (participant)
   - 1.2. Introduction (interviewer)
   - 1.3. Explain the session parameters again.
     - 1.3.1. Duration
     - 1.3.2. Conditions
     - 1.3.3. Privacy
     - 1.3.4. Awareness of psychological health
     - 1.3.5. Conduct

2. Questions
   - 2.1. What role do you play as a stakeholder in (NATECH) flooding events?
   - 2.2. How do you perceive risk communication in such times?
   - 2.3. What are the potential disruptors or inhibiting factors in such scenarios in risk communication?
   - 2.4. What improvements could you imagine having a positive impact on risk communication?
   - 2.5. How do local circumstances (which?) impact (NATECH) flooding scenarios?
   - 2.6. Which channels/platforms do you observe risk communication? Who does not have access?
   - 2.7. What issues surround crisis/disaster response in such scenarios?
   - 2.8. What advice do you have for other (or specific) stakeholders?

3. Follow up questions.
4. How participant feels about our conversation and improvement suggestions
5. Informal Ending: Thank you and goodbye, Research follow ups.

Appendix 4: Participant outlines

P1 (60 min)

Origin: Bangladesh

Age: 20+ yrs.

Work: Co-founder of a large multi-chapter youth organisation in Bangladesh focussing on delivering environmental education and activism for pro-environmental behaviour, NGO spokesperson

Schooling: Technical Diploma

Priorities: physical and local/communal support; climate advocacy; long-term support/self-sufficiency of flooding victims; enterprise development/resilience; vulnerable communities; sexual rights

Stakeholder interactions: Government officials, local population, aid organisations, government agencies (local level, regional, national and international/foreign governments)

P2 (48 min)

Origin: Pakistan

Aged: 50+

Work: Higher government official in media and broadcasting; engages heavily with risk communication and facilitation thereof

Schooling (max.): Master

Stakeholder interactions: Government officials. Media, party representatives for broadcasting of messages.

P3 (44 min)

Origin: Pakistan

Age: 50+

Work: WASH professional; Member of Pakistan's climate grouping (work group); Inclusion of cc and DRM in secondary and tertiary school systems in UK and Pakistan; Consultant for international aid organisations, UN, Government

Schooling (max.): PhD

Priorities: coastal regions; wash infrastructure; dry zones

Stakeholder interactions**:** INGOs, Government, communities, lay knowledge keepers in local communities.

P4 (57 min)

Origin: USA

Age: 50+

Work**:** Trained GIS professional, external work for a private research institution in DRM and GIS

Schooling (max.): Master

Priorities: Multi-stakeholder interactions,

Stakeholder interactions: Government officials, military officials (training exercises/simulations), researchers, UN and affiliated agencies

P5 (36 min)

Origin**:** Dominican Republic

Age: 30+

Work**:** WASH professional, works in INGO with focus on water and sanitation

Schooling (max.): Master

Priorities: WASH; vulnerable communities (disabilities; children; women)

Stakeholder interactions: Academia, government officials

P6 (45 min)

Origin: Trinidad & Tobago

Age: 30+

Work**:** OSHA professional

Schooling (max.): Master, MBA

Priorities: Flood resilience, emergency management, occupational health and safety

Stakeholder interactions: Utility (electricity), government, public and communities

P7 (45 min)

Origin**:** Dominican Republic

Age: 20+

Work**:** Lawyer for government environmental agency in the Dominican Republic

Schooling (max.): LLB

Priorities: Social equity and justice, Epistemic justice, Environmental rights

Stakeholder interactions**:** Communities, government agencies, international students

P8 (45 min)

Origin: Ireland

Age: 30+

Work: Assistant professor in disaster management and geography in the NLD

Schooling (max.): PhD

Priorities: Schooling, training and mentorship of knowledge associated with DRM and RC

Stakeholder interactions: Academia, international students, industry partners, research institutions

Appendix 5: Figures and Illustrations.

Figure 1: *Retrieved from NASA Scientific Visualisation Studio's Summer 2023 Temperature Media Resources by NASA GISS, 2023 on 20/01/2024.*

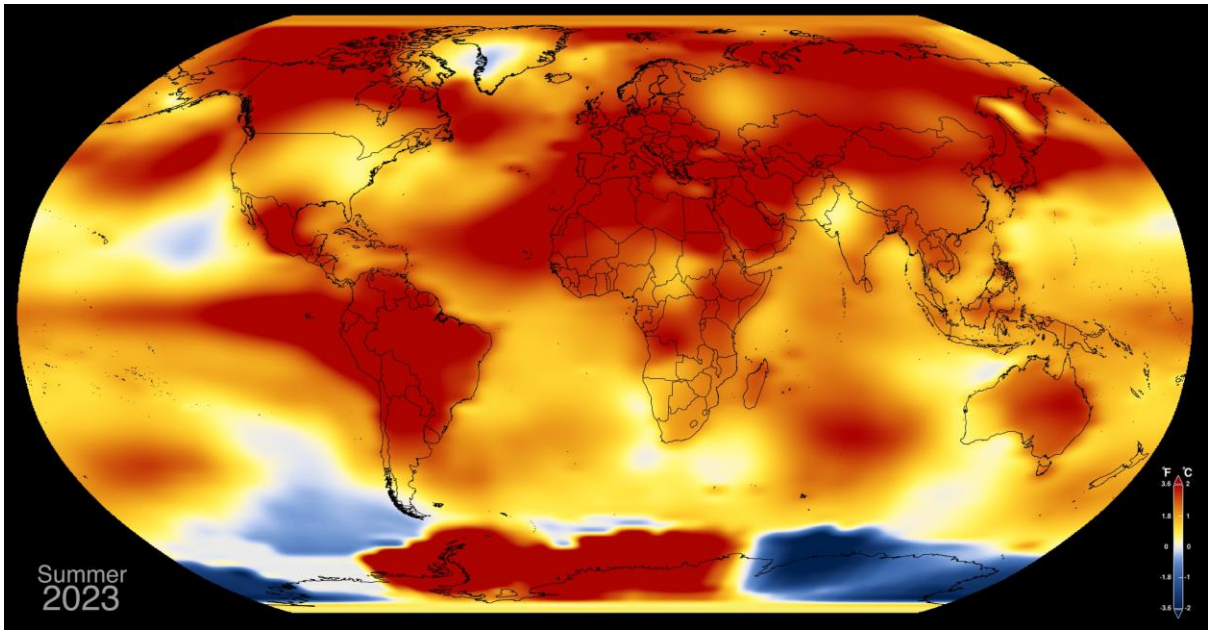


Figure 2: *Adapted from a Statista illustration on the Distribution of weather, climate, and water related disasters reported between 1970 and 2019, by type, by World Meteorological Organisation, 2022.*

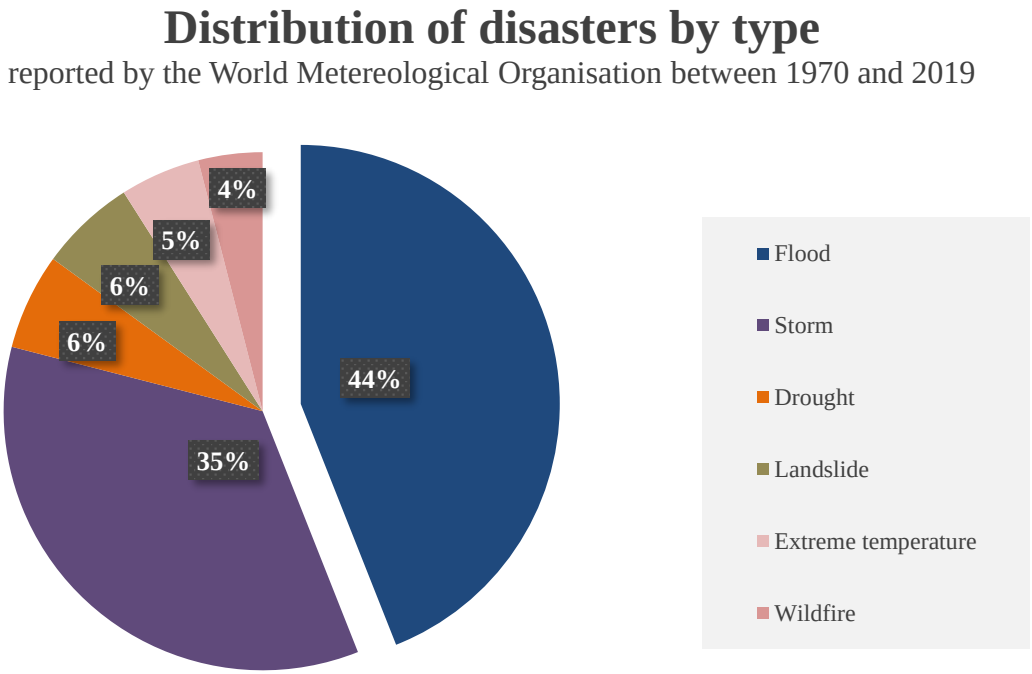


Figure 3: *Amended from Figure 2.3a on pg. 48 of IPCC Climate Change 2023: Synthesis Report by Calvin et al., 2023.*

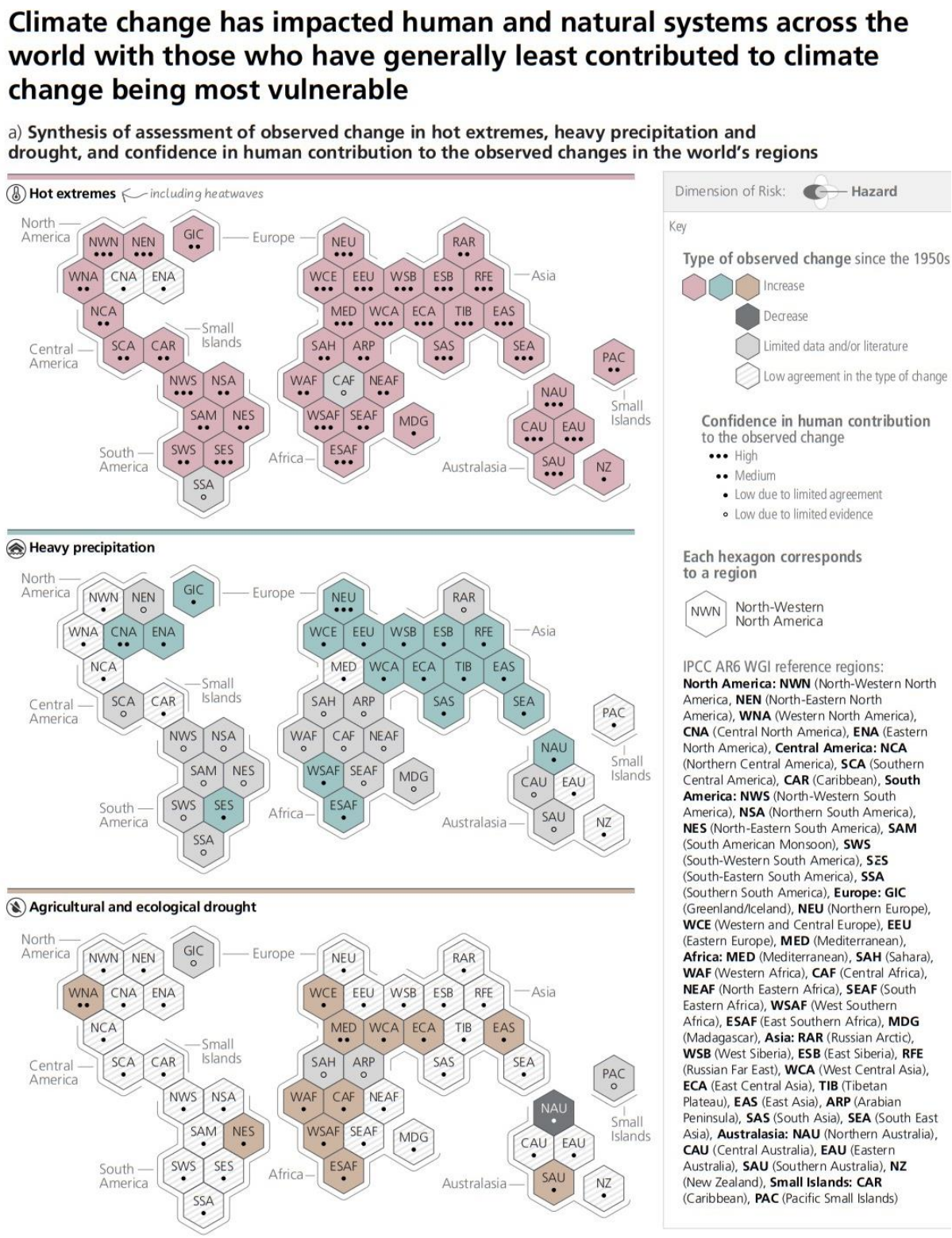


Figure 4: *Retrieved from pg. 3 of Risk Communication and Natural Hazards: CapHaz-Net WP5 by Höppner et al., 2010.*

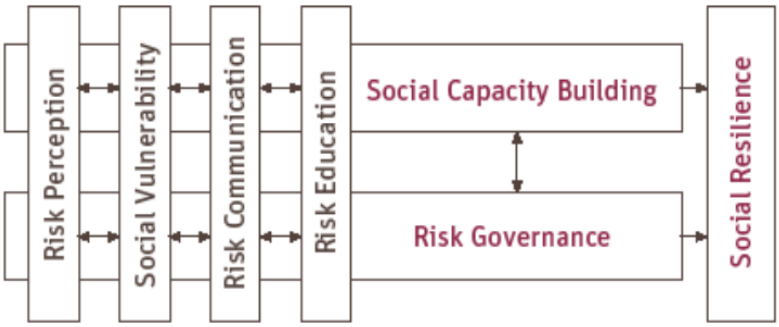


Figure 5: *Generated from research data of this Capstone thesis by Joel D. Gräff, 2024.*