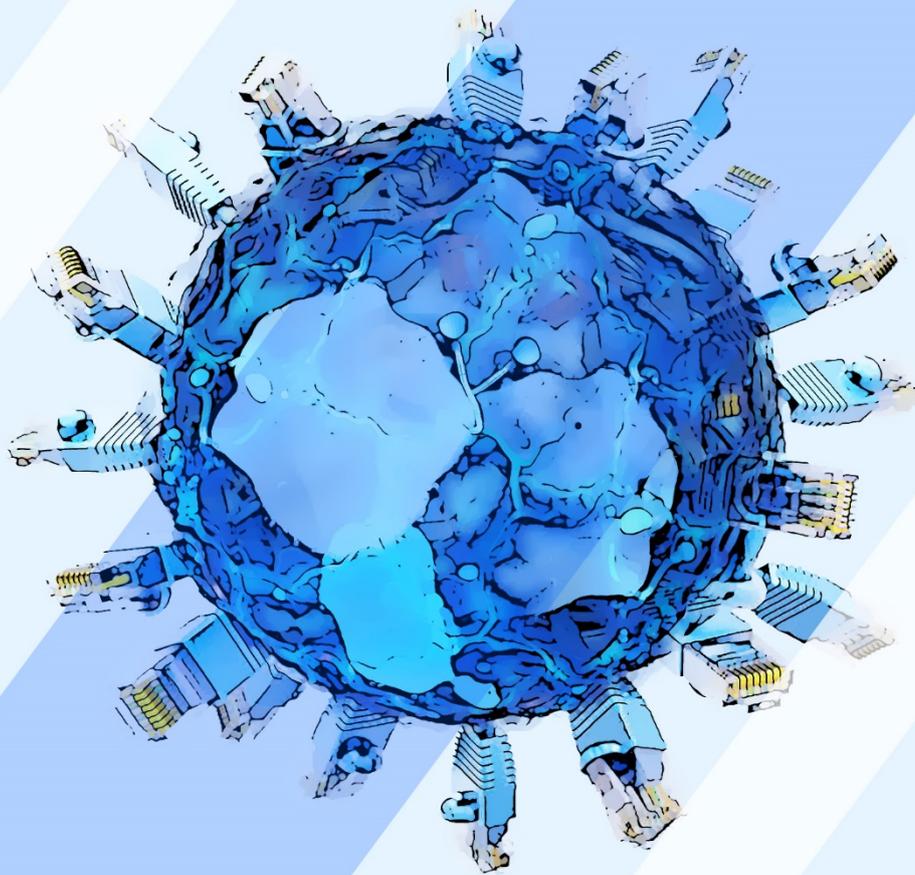# Conceptualizing a Framework for Successful Integration of Social Media into Flood Risk Management in Germany

Opening Channels for the Future

Stefan Gold
31th of July 2019

Master Thesis
Environmental and Infrastructural Planning | Double Degree Water & Coastal Management
Faculty of Spatial Sciences – Rijksuniversiteit Groningen | Carl von Ossietzky Universität Oldenburg
Student number Groningen: S3836878 | Oldenburg: 5037437
Supervisor: Dr. Inês Boavida-Portugal
Second supervisor: Steven Forrest

Contact: Stefan@ConceptArt.at

university of groningen

CARL VON OSSIETZKY universität OLDENBURG

I. Abstract

Communication is a central point in the German flood risk management strategy. This thesis focuses on how to integrate social media into flood risk communication, in order to engage with those unreached by common mass media and to establish a viable information source for stakeholders and administratives alike. Research has shown that while the scientific discourse surrounding flood risk management and social media focuses on a spectating role, harvesting existing information out of social networks, the active initiation and administration might yield additional benefits such as the prevention of misinformation. In this context, communication models are linked with theoretical concepts such as Public Value Management, Transition Theory and Path Dependency in the face of Complexity, in order to provide a theoretical basis for the study. From there on, an online survey was carried out in connection with the collection of social media statistics via an application programming interface, to reveal practical indicators for successful social media management and the current state of social media integration and flood risk perception. While the current state of integration showed to be very poor, as survey respondents identified it as an unviable information source with at best complementary function, respondents also showed a low level of education in flood risk related issues. The analysis and discussion of the data further indicates that reach and engagement rates of social media content, as vital indicators for successful social media management, are greatly dependent on the type of content, at which time of the day it is posted and how it is targeted at specific audiences. Additionally, social media is identified as a tool for more effective stakeholder engagement in order to minimize the gap between factual and perceived flood risks by offering the possibility for direct feedback between all parties. Further research is needed to identify more precise implications on how to execute the integration of social media into German flood risk management as the information available does not yet allow for the crafting of a comprehensive action plan.

II. Acknowledgements

I would first like to thank my thesis supervisor Dr. Inês Boavida-Portugal of the Rijksuniversiteit Groningen, as the meetings and other communication greatly helped me in executing my work and handling all related issues in time. While emphasizing that this was my work and giving me the most possible freedom on how to develop it, she offered valuable feedback and allowed me to ask questions whenever I needed to while asking me critical questions that helped me to reassess and evaluate my own work.

I would also like to thank all participants of my survey as their time spent to answer the questions truthfully is invaluable to this research and enabled it as a whole.

Furthermore, I would like to sincerely thank Steven Forrest of the Rijksuniversiteit Groningen as the second reader of this thesis for expressing his interest and taking his time to study my work.

Finally, my profound gratitude is expressed towards all of my friends and family who supported me during the rough patches and empowered me to always keep going. A special thank you also goes out to Tim Pissarczyk for reading the whole thesis and providing me with feedback on it.

Author
Stefan Gold

Table of Contents

III. List of Figures

IV.   List of Abbreviations

NINA	Notfall-Informations- und Nachrichten-App
UGC	User Generated Content
SARF	Social Amplification of Risk Framework
PVM	Public Value Management
GIS	Geo Information Systems
HWRM-RL	Hochwasserrisikomanagement-Richtlinie
API	Application Programming Interface
MG	Moderatum Generalizations

1. Introduction

Time and time again, people get surprised by high tides, heavy precipitation events and storm surges, leading to not only financial damages but also physical harm to the affected individuals. Those surprised by these rare weather conditions are often residents, visitors or tourists who are not familiar with the foreshadowing warning factors unique to every location and do not use the common forecasting information channels for early warning such as local radio stations or television news for that purpose. In a similar manner, high precipitation events often catch citizens off guard as they are difficult to forecast precisely and often include a high margin of uncertainty within their probabilistic models. Furthermore, there is a linear relation between the amount of uncertainty in modelling and the magnitude of weather events, making extremes more difficult to forecast (Damrath et al. 2000). In addition to the increasing uncertainty linked to extreme weather events, citizens' understanding of those forecasts is often limited as the probabilistic models and graphics are often misinterpreted or fail to express urgency (Murphy et al. 1980; Travis and Riebsame 1979). All of these factors call for improvements in flood risk communication that aims to convey the needed urgency to act, is able to cope with misinterpretation and establish feedback mechanisms between senders and recipients to monitor and adapt and tailor the communication process to their respective target groups. Social media poses as a possibly viable alternative to the current approach as a new information channel with new opportunities to take. In order to research these possibilities, a case study on Germany is employed to reveal the status quo and develop a framework for the successful integration of social media into the German flood risk management sector.

1.1.   Societal Relevance

Current and future generations of inhabitants use the standard information channels mentioned above less frequently and source the majority of their daily information from the internet (van Dijk and Hacker 2003). Flood and storm surge warning is all about reach and effectiveness, meaning that -when executed optimally- the entirety of people in danger to be present in the period of time where flooding is likely to occur is warned in a way that alerts them to a degree which is appropriate for the incoming event. This difference between usage of media to provide information and usage of media to consume leaves a gap which is likely to increase as information technology evolves and new generations emerge, increasing the urge to act and making research for solutions important. Social media is a relevant communication tool for flood risk management and offers potential benefits for all involved stakeholders (Haer et al. 2016). While social media is a medium widely consumed by the current new generation it is currently not integrated into the German flood risk management strategy. Social media is capable of reaching extensive amounts of people in short amounts of time while being able to transport different forms of data, as in text, pictures, videos etc. and would thus be able to serve as an effective digital information spreading mechanism for flood risk management. The German government introduced a weather warning app called "NINA", which -when translated- stands for "Emergency Information and News

App" for both Android and iOS in 2017 , which is not linkable to social media accounts, not advertised publicly and has limited functionality when it comes to sharing information to third party apps and websites (BBK 2019). It focused on the vast availability of smart phones but fails to connect individual users to a bigger network, making intervention and effective communication difficult. Furthermore, the "Meine Pegel" app, which was developed as a cooperation among all German federal states, is intended to give information about high water levels all across Germany and is also not connected to social media or the NINA app but works as an isolated tool mainly used by inland shipping and private individuals for recreational activities (Hochwasser Zentrale Deutschland 2016).

1.2.   Scientific Relevance

The disconnectedness of available data and infrastructure from frequently used information channels and widespread media networks makes for inefficient and strictly top-down communication, blocking potential synergetic feedback loops between public and private (Wehn et al. 2015). Past events have shown that individuals organize themselves and create natural warning systems through social media (Kammerbauer and Minnery 2018), but the intervention in, or initiation of such networks in the context of flood risk management are not combined and coherently approached by the scientific community. This shift from viewing social media as a self-organizing but isolated data source towards interrelated proactive communication and integration calls for additional research and thus proposes a knowledge gap which this study will focus on. Other sectors such as the news, music or sales industry already use social media to a great extend as a communication tool and could thus act as potential lesson donors to initiate, analyze and moderate effective networks for flood risk communication. Such social media-based approaches have a variety of pros and cons to be taken into account as touched upon Rollason et al. 2018 and exist in a highly dynamic virtual landscape with limited predictability. Furthermore, the fragmented manner of those self-organized groups, as there are often multiple smaller ones with overlapping regional interest and comparably small amounts of active users, would make governmental intervention in the administration and involvement a difficult and work-intensive task. Initiating such social media groups with clear regional coverage as well as the possibility to quickly receive, understand and share information and warnings about local flood risk via corresponding apps could make for effective and up to date flood risk management tools for planners and governmental organs. Another drawback of social media groups is the potential for misinformation, as information flow from individuals are often expressed via open messaging and posts without extensive factual proofing (Del Vicario et al. 2016; Mintz 2012). Filtering and preventing this misinformation from manipulating factual truths is of significant importance to ensure the quality of information and thus potential of the tool for effective and successful management. This intervention in self organization forms an approach combining the conventional paradigm of technical rationale and it's communicative counterpart, two concepts that will be further elaborated on in 2.3, to a hybrid, taking advantages of both. How the initiation, moderation, cooperation and maintenance of such social media-based information hubs could be approached is a central point of this research. A working communication system is vital for effective disaster management and communication. It helps to raise risk awareness, communicate

future plans and how society can shape or re-shape them, as well as posing as a powerful tool to reach out to a big share of stakeholders without using extensive physical or financial resources (Houston et al. 2015). Furthermore, the virtual nature of social media makes for a data system which limits additional data preparation for analyzing user statistics. While literature focuses mostly on self-organized networks or general disaster management, this research elaborates on purposely initiated social media communication. This can open up possibilities for multi-channel information and education exchange, specifically in flood risk management strategies, eliminating misinformation and fostering transparency as well as visibility. The conceptualized framework is aimed at helping politicians and planners alike to understand in which context social media might be an alternative virtual solution to physically existing problems. It furthermore can act as a guideline or recommendation on how an initiated social media network might be more beneficial than analyzing and trying to engage with existing ones and will point out lessons to learn from the industrial sector in this regard.

1.3. Research Questions

The search for solutions always begins with asking the right questions, guiding towards suitable answers.

For this research, the following main research question was formulated:

What are the potential benefits and challenges of successful social media integration in flood risk management?

The following complementary sub-questions help to answer this main research question as they try to unravel specific elements that help to understand the problem.

- *How is social media currently utilized amongst the general public in German flood risk management?*

- *How can social media strategies potentially improve flood risk management?*

- *What are the potential benefits and challenges for an initiated communication compared to analysing existing networks?*

- *What are key success factors for social media-based communication networks in commercial sectors and what lessons could one draw from those?*

- *What are the future implications of social media-based communication for flood risk management?*

3

These research questions are furthermore designed to provide a backbone structure to this work and will be answered sequentially.

1.4. Thesis Structure

This research is structured into several chapters, each with their own focus point as a guide throughout the document.

While chapter 2 presents the overarching theoretical background as a web of concepts as well as definitions and understandings to provide a foundation upon which the later chapters are constructed. Following the theoretical framework, chapter 3 establishes the methodology used to execute the data collection and analyses, as well as elaborating on the dimensional scopes and boundary conditions that frame the case studies. Chapter 4 concentrates on the findings and results related to the case studies and presents them including their analysis. Here, the findings are used in connection with the methods discussed in chapter 3 to form outcomes of quantitative and qualitative nature. In the following chapter 5, the analysed findings form the foundation for a discussion in the face of the theoretical framework in order to draw conclusions in chapter 6. These conclusions will aim to answer the pre-stated research questions and to give implications for further research, while critically reflecting on the theory and methodology used to come to them.

2. Theoretical Framework

In order to succeed in answering the research questions developed, multiple concepts and applicable theory has to be included to understand the dynamics of the issues as well as to conceptualize solutions derived from these theoretical dispositions. It is important to perceive the chosen theory as interrelated in an open system of knowledge creation within the scientific community, not as isolated aspects that create the sum of the problem, but as parts of an equation with a multitude of variables which can be of deterministic and factual nature or inherent high amounts of uncertainty, increasing the difficulty to solve it eventually, if at all.
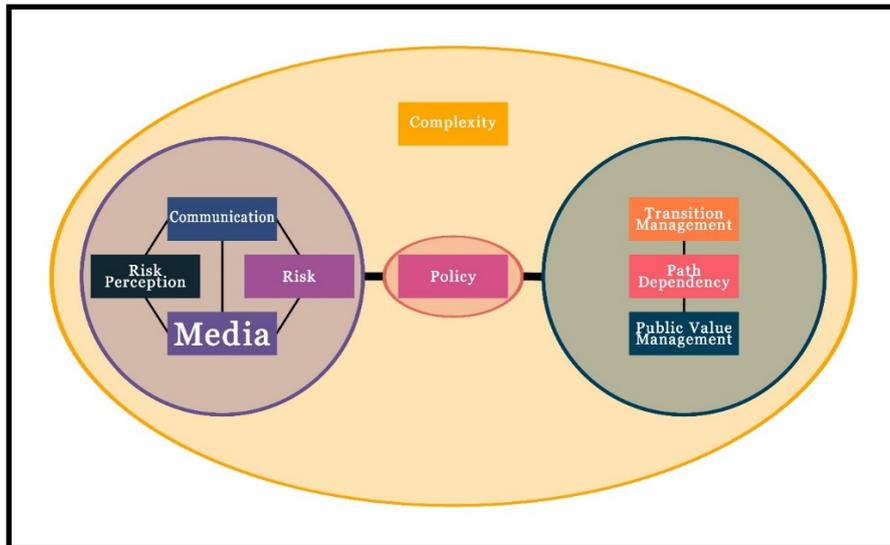
Figure 1: Theory Framework

The framework sketched in Figure 1 shows how the concepts and keywords discussed in this chapter relate to each other. The links established show the influences and connections between the different clusters. Furthermore, the framework does not reflect a closed system, nodes have external influences and connections can seize to exist or be reconnected when the system the nodes are embedded in changes.

2.1.   Media and Communication

With social media being the central aspect of this work, it is important to look at what media is in general, what its functions are and how it is currently utilized in flood risk management. Communication is the basis for any medium and is described in the Oxford Dictionary 2019 as the imparting or exchanging of information by speaking, writing, or using some other medium. In order to understand how information is conveyed in communication this work focusses on the model developed by Willbur Lang Schramm 1954. Communication is described as a circular process that starts with a message embedded in its context from a sender to a recipient who interprets the message within his own field of experience as shown in Figure 2.
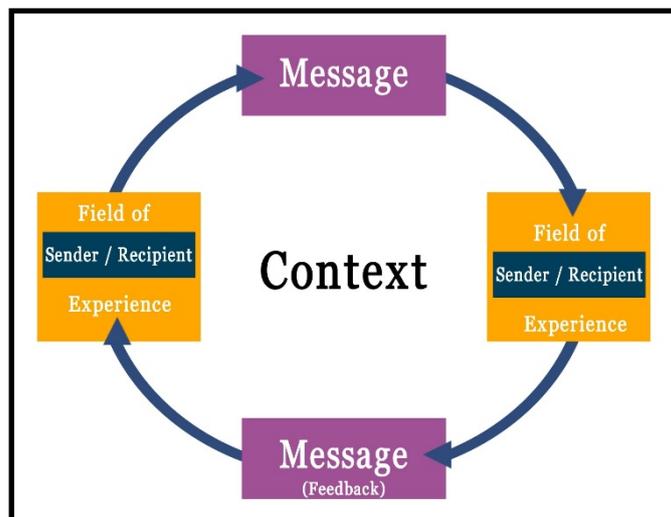
Figure 2: Communication Model

This model hence introduces a new dimension to the sender and recipient concept by adding interpretation and understanding of a message to the dynamic. This interpretation and understanding may distort the initial intention and meaning of the message which will be followed up by mismatching feedback which is again prone to be interpreted differently. This is a potential source of misinformation through misinterpretation (Mintz 2012).

The tool through which communication takes place is a medium, strongly linking the two key nodes presented in Figure 1 to each other (Figure 3).
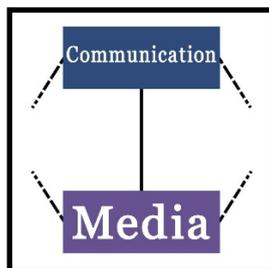
Figure 3: Media and Communication

Media in general can be described as channels through which individuals send and receive information. Social media as a sub-form of media inherits very specific characteristics that distinguish it from other media channels such as mass media like television or public radio transmission. Mass media is a form of media which is designed to reach masses of recipients of from a single sender, so "one to many" communication, as shown in Figure 4 (APFM 2015).
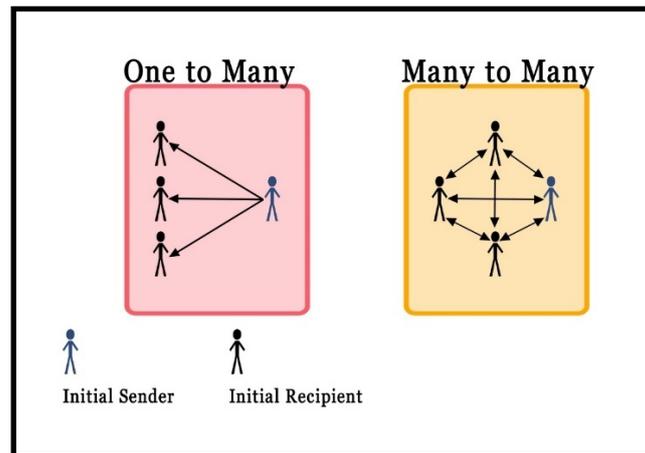
Figure 4: Types of Communication

Social media on the other hand is designed as networks, which, while also being designed to reach masses of recipients, allows for equal masses of senders, so "many to many" communication (Kaplan and Haenlein 2010; Obar and Wildman 2015). Another important characteristic for social media, which sunders it from physical forms of communication is the foundation in the world wide web. This foundation is specifically in Web 2.0 (Obar and Wildman 2015), meaning the internet environment that utilizes Adobe Flash (a widespread animation, interactivity and audio/video streaming plug-in for webpages), RSS (Really Simple Syndication, a type of web feed formats for publishing frequently updating content) and AJAX (Asynchronous JavaScript, a protocol for the communication between servers and users to update content without interfering with the webpage's display and behaviour for the user) (Kaplan and Haenlein 2010). This foundation enables another core function of social media, user generated content (UGC). UGC is the ways and means to use social media and consists of the various forms of media contents that is created by individual end-users. There are three basic conditions for media to be described as UGC according to Vickery and Wunsch-Vincent 2007:

1. UGC is published either on a publicly available website or on a social networking site accessible to a selected group of people.
2. UGC needs to show a certain amount of creative effort and uniqueness.
3. UGC needs to be created outside of professional routines and practices.

With the foundation described it is easier to come to a comprehensible understanding of social media: *"Social Media is a group of Internet-based applications that build on the ideological and technological foundations of Web 2.0, and that allow the creation and exchange of User Generated Content"* (Kaplan and Haenlein 2010). An important aspect to understand how social media functions, especially in flood risk management, is to asses to which degree social media has influence on its users and further enlighten the social aspect of the medium. Social presence, as discussed in Short et al. 1976, is the degree to which acoustic, visual and physical contact can be achieved between communication partners. Factors for the degree of social presence are the intimacy, so whether the communication is inter-personal or mediated externally and immediacy, so whether the communication is synchronous or asynchronous. Social media thus has a very high degree of social presence as it contains all possible

combinations of these factors and is thus a medium through which senders and recipients are influencing each other strongly in their social behavior. The factors restraining social media in terms of its social presence are latency (delay of information decreasing synchronization) and terms of service which moderate the nature of communication (censorship of certain communication topics). A different approach is the concept of media richness, a term to describe the capability of a medium to transport large amounts of information within a specific time (Daft and Lengel 1986). It proposes that the goal of any communication is to resolve ambiguity and increase certainty, with the ability to do that being directly related to the amount of information conveyable per time interval. Social media is thus to be described as a very rich medium as the amount of data transferable is extremely high compared to other forms of media and only limited by technological restraints such as availability of accessible bandwidth. It is important to notice that both social presence and media richness, while addressing the issue of the effectiveness of communication within the medium, misinterpretation and unconstructive communication, distorting this effectiveness, are not accounted for.

This aspect though, as part of the communication model presented in Figure 2, is an essential factor in human communication (Del Vicario et al. 2016) and especially important in the flood risk management context. Current flood risk communication consists largely of dissemination, as in the delivery of a message to the audience (Jim Davidson, M. C. Wong 2005), more specifically "one to many" communication through mass media channels is used. This lack of feedback mechanisms in flood risk communication is problematic, as it is impossible to verify if all recipients interpret and understand the messages conveyed correctly (Moe 2008). This verification can yield vital information on risk perception and the overall state of awareness among recipients and, in the case of apparent misunderstanding, trigger the call for new approaches in the ways and means used for this type of communication. The "many to many" nature of social media allows this verification to take place in synchronous, immediate and asynchronous, delayed manners dependent on which type of interaction method is chosen. Another aspect which strengthens the position of social media as a viable alternative to conventional mass media usage is that the technology used to utilize these communication channels, namely television and radio broadcasting, are becoming obsolete. A trend towards internet-based media can be observed, pushing television and radio out of their leading positions as news channels. This trend is likely to carry through the following decades as it materializes in young generations and is thus believed to be persistent as concluded by numerous studies and researchers (Chan-Olmsted et al. 2013; Gottfried and Shearer 2017; Liebowitz and Zentner 2012). This shift in media usage reveals a need to address recipients who are beyond the reach of conventional communication channels as they do not engage with its content. In order to do that, it is important to identify and characterize the target audience for communication to tailor the sent information in a way that it is reached and likely to engage with it, which is elaborated on further in 3.3.2.

2.2.　　Flood Risk and Risk Perception

Media and communication are sourced by issues and problems, as their aim is to solve them (Daft and Lengel 1986). In the context of flood risk management, the issue is flooding and the consequences of it,

emphasizing the linkage between media, communication, risk and risk perception and forming a cluster (Figure 5).
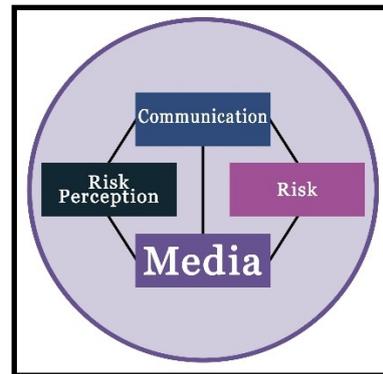
Figure 5: Media, Risk, Communication and Risk Perception

Thus the risk for the occurrence of it is at the very core of every flood risk management strategy (Kammerbauer and Minnery 2018). The term risk already implies the biggest challenge when it comes to the appropriate and exact analysis and study of risk, inevitable uncertainty. The probabilistic nature of risk is sourced by the complexity of nature processes together with the ever-growing complexity of society, as it is a prediction of unknowns. Hence, complexity as a concept has to be integrated into the thought process when assessing risk, developing related policy and into the communication of both. These notions are therefore embedded into the theoretical concept of complexity, which will be further elaborated later in this chapter. Risk itself is often referred to as the product of threat, vulnerability and consequence within the scientific community. A threat is further described as a situation, process or material object that may cause damage in any nature. Vulnerability means the boundary conditions which amplify the threat and finally consequence, expressed as the living and non-living entities involved (Lapham 2015; Cox 2008; Alfieri et al. 2016; Meyer et al. 2009; Wang et al. 2015; International Strategy for Diaster Reduction and United Nations 2004). Risk perception thus derives from how these factors are perceived among stakeholders. This perception is greatly influenced by information flow, often leaving a factorial gap between risk and perceived risk (Slovic 1987), while the ideal factor between them is exactly 1, as in the perceived risk among stakeholders equals the factual risk at hand, to the extends which its inherent complexity allows us to understand.

The Social Amplification of Risk Framework (SARF)

Developed by Slovic throughout his works, the SARF combines both technocratic risk assessment as in the quantitative factors together with risk management, and the qualitative factors based on communicative assessment (Slovic et al. 2002). The need for combination emerged after history repeatedly showed that purely technocratic approaches to risk failed in achieving the pre-calculated outcomes, not addressing the gap between risk and perceived risk. This perceived risk has great effects on stakeholders ability and willingness to act and acceptability towards decision- and policy-making (Slovic et al. 2002). Furthermore, these indirect impacts are often connected in a non-linear way to their original source as impacts spread through different social dimensions and their individual distortion.

In the SARF, Slovic (1987) defines risk perception as the intuitive risk judgments of individuals and social groups in the context of limited and uncertain information. The SARF begins with the hypothesis that, through feedback and ripple effects, the factual risk or risk event is translated into a perceived risk that is either less, equally or more severe, as shown in Figure 6. This is based on the assumption that, based on communication (Figure 2) and through the respective medium, risk events are transported to the public and thus undergo an inevitable chain of forwarding through several stages, each distorting the initial message. Through the distortion of risk into perceived risk, the impacts change too (Slovic et al. 2002). As an example for flood risk management, this means that even though a storm surge poses as an immediate threat to a region, the means and measures of communicating this risk and how the recipients interpret these warnings directly shapes how the potential flood might impact the region.
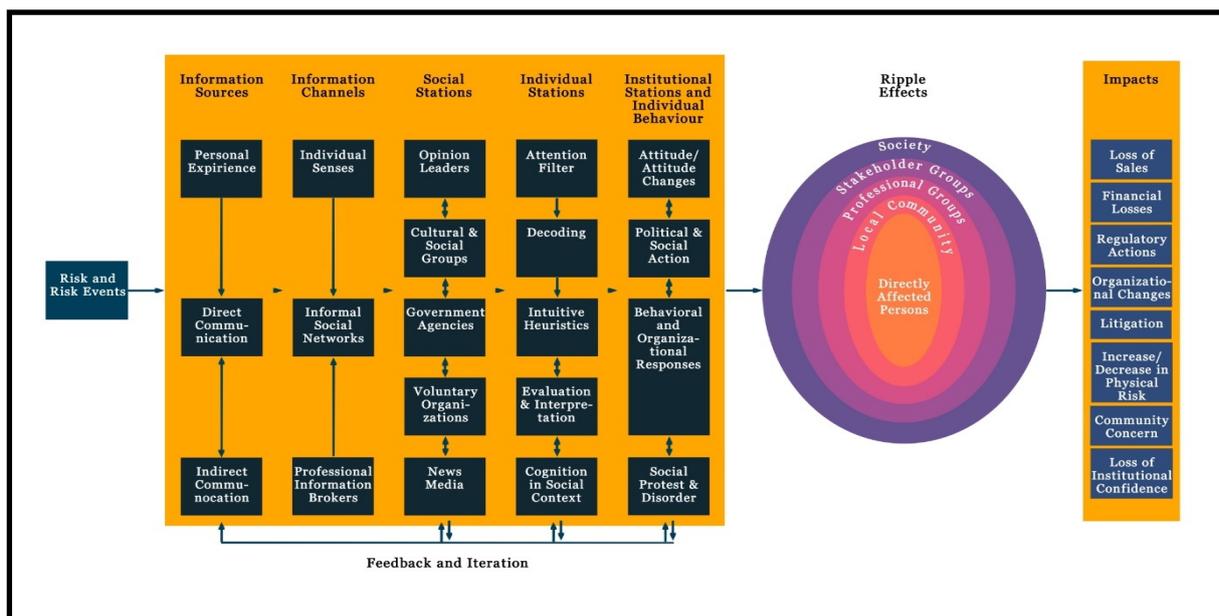
Figure 6: SARF after Slovic (2000)

As pictured in Figure 6, the initial ignition of the social amplification process is triggered by a potential threat, which is then distorted by individual interpretation and then transferred to others via media (Renn 2011). Through this process, directly affected persons are the first stage of recipients of this interpreted message and thus develop a perceived risk, positively amplifying or attenuating it. As further exemplified for flood risk management, APFM (2015) categorizes the following impacts as follows:

- Enduring mental perceptions, images, and attitudes
- Local impacts on business sales, residential property values, and economic activity
- Political and social pressure
- Changes in the physical nature of the risk (for example, feedback mechanisms that enlarge or lower the risk) and in risk monitoring and regulation
- Changes in training, education, or professional requirements
- Social disorder
- Increased liability and insurance costs
- Repercussions on social institutions and other technologies

These secondary effects are then also impacting other levels of society and groups of individuals, triggering ripple effects as the directly affected persons transfer their risk perception, through another additional interpretation by those new recipients. These ripple effects can affect the geographical and institutional areas of effect as well as their temporal extension (Slovic 2000). Social media as a medium with pro- and reactive communication capacities can thus reduce the distortion of interpretation by utilizing and initializing feedback channels to re-introduce undistorted messages at different stages. These mechanisms could allow to narrow down the gap between risk and perceived risk, enhancing the effectiveness flood risk communication. It is important to mention though, that the subsequent increase of information flow within the communication system could also catalyze distortion if misinformation is spread, legit content not understood or misinterpreted, or information is unrelatable as in not context-tailored to a degree at which recipients feel triggered to act at all. As referred to in chapter 1, this again calls for a certain amount of monitoring and control over these social media based solutions and a mixture of the communicative and conventional command and control paradigms. Understanding how risk is transferred through communication chains into its perceived form allows to change decision-making in order to cope with the identified challenges to reduce negative impacts of distortion. Furthermore, understanding the initial risk and its factual dimensions better will likewise improve communication, as more concrete information leaves less room for interpretation if transported appropriately. The less an information is open to interpretation, as in its amount of content provides enough insight without overloading the recipient and is tailored to be relatable and understandable, the better the quality of communication, again narrowing down the gap between risk and perceived risk. Quality of communication can thus be understood as the level to which it is tailored by the sender to invoke the exact intend of the message sent. With its multitude of media forms available to use within its technical limitations, social media can provide the needed messaging capacities and allow messages to be tailored into different formats such as texts, pictures, animations or videos to allow for the best message-format combination necessary to maximize compatibility to recipients and control the amount of information sent, as well as fostering understandability (Netten and van Someren 2011).

2.3.   Policy and Decision-making

Policy, as in the set of actions adopted or proposed by an organization or individual, is in essence about decision-making. The questions of who, what, when, where and why that shape policy are answered by internal or external agreements of different nature. To elaborate how communication influences decision-making, the two approaches at the extremes of the spectrum, as pictured in Figure 7, will be elaborated briefly in the following section. This model was developed over several publications as explained and summarized in Roo (2018) and explains the relationships between different kinds of decision-making, their dimensions and their position within the model. For the sake of simplicity and avoidance of disconnected theory, for this work the model was streamlined and acts as a frame of reference for the discussed theory.

Figure 7: The Spectrum of Decision-making.

For the purpose of this work, they will act as boundaries between which other hybridized solutions can be placed. The explanations and references focus on the aspects relevant for flood risk management.

2.3.1. Communicative Rationale

As developed and pioneered by Healey (1996), the communicative rationale has the premise, that through extensive communication between all involved stakeholders, an agreed consensus can be achieved from where a respective solution for any problem can be constructed. It respects and equalizes different sources of knowledge, for example local, international and scientific, to have a share in decision-making. Furthermore, it strives for horizontal power integration as it tries to decrease corporate and political leverage against individual citizens. The communicative rationale thus includes values and meaning and levels then with scientific facts to be included and considered. Through this communication process and exchange of knowledge and opinions, and agreed consensus is formed to serve as the final truth. This final truth is then seen as ultimate, as it has the highest achievable legitimacy among all stakeholders, making re-evaluation of it unnecessary. In her later studies, Healey (2000) identifies drawbacks of this approach which are of high relevance to this work, as the proposed extensive communication processes are very time consuming and thus have very limited capacity to react to problems of urgency. Furthermore, not everyone wants to be a part of this communication, making the gathering of all stakeholder opinions practically impossible. The final decision at the end of consensus is hence skewed by these factors, limiting the process' applicability to flood risk management.

2.3.2. Technical Rationale

Decision-making in the technocratic approach as discussed by Webster et al. (2000) is to be positioned on the other end of the spectrum and has also the premise, that there is one single solution. This truth is however based solely on scientific understanding and facts, as well as the rational behavior of all individuals and parties involved. It can thus deal better with high amounts of urgency since time-consuming decision-reshaping in communicative processes is ruled out, but also fails to implement temporal changes. Furthermore, streamlined decision-making processes like this have limited legitimacy among involved stakeholders as values and opinions outside the scientific factual environment are not accounted for. These drawbacks also limit the direct applicability of the technical rationale to flood risk management, again calling for hybrid approaches positioned between the two extremes.

This understanding of the involvement of communication into decision-making and thus policy closely connects the two nodes together.
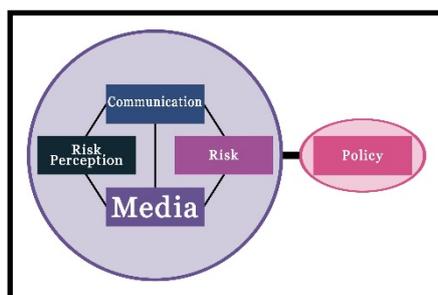
Figure 8: Connecting Policy

As visible in Figure 8, the involvement of communication to translate risk into policy is a different path than translating it directly as in the technocratic way of thinking, opening up two possible and parallel mechanisms of translation each with their own benefits and draw-backs.

2.1.   Complexity

The theoretical concept of complexity, developed in the field of complexity theory, is in essence about unpredictability and coevolution (Byrne 2002; Clemens 2013). Both of these notions refer to change and how change takes place, its causes and effects. The disconnectedness of cause and effect due the ungraspable multitude of factors that influence how, when and to which extend change happens, breaks up the conventional way of linear thinking. Linear here relates to a direct link between what caused a certain effect, expressible by facts, figures and formulas (Byrne 2002). Rational thinking, as elaborated on in the previous chapter 2.3, says that no matter how complicated the issue, a thorough analysis of it will reveal one final solution. Complexity theory on the other hand defines these issues of "wicked nature", as described in Rittel and Webber (1973), as inherently unsolvable. This insolvability results in inevitable uncertainty, calling for more adaptive approaches that leave room for a change of conditions and can react to them (Clemens 2013).
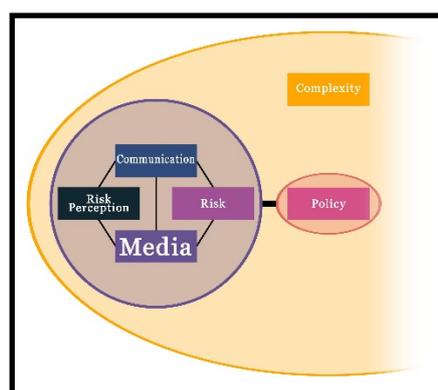
Figure 9: Complexity in the Theoretical Framework

As this research is conducted within scientific fields that deal with large groups of different stakeholders and natural processes, of which both greatly enhance complexity as their behavior can be described as unpredictable to a certain degree, complexity becomes an embedding notion that influences all processes and has to be taken into account at all times, as shown in Figure 9.

2.2. Path Dependency

The implications of this work to hybridize and form new approaches will inevitable change how flood risk communication is done and integrated into flood risk management itself. These changes steer away from the conventional way of operation, as in which media is used to communicate, how those contents are formatted, who is generating content, how it is expressed and how feedback is integrated. This change of the path of operation is difficult, as the informal and formal rules in place create a web of hinderance that is to be overcome in order to establish all necessary boundary conditions for the successful integration of social media into flood risk management. The communication approach in place right now, as discussed earlier in this chapter, does not incorporate feedback from recipients to the sender, meaning that the sender has no means to verify or falsify whether the communication is successful or heavily distorted. The lack of monitoring and evaluation in the approach hinders change, as operational pathways are identified as working if not proven otherwise (Sorensen 2015; Coombs and Hull 1998). Additionally, the organizational structure within competent institutions responsible for flood risk management is adapted to this operational pathway and the individuals executing it trained accordingly, hindering change as new approaches require appropriately trained staff. The concept of path dependency is, that institutions, as in the informal and formal rules present in the respective context, become increasingly difficult to change the more established they are over time. The core idea is derived from historical institutional analysis and is meant to forecast paths of operation on the basis of historical knowledge, developed within social sciences and economics by Arthur (1994) and David (1985). It describes that specific circumstances and moments, called critical junctures, enable change to these otherwise rigid pathways (Sorensen 2015). In the context of flood risk management, a major flood event, new technology, ground-breaking scientific insight, significant political change or a change in legal jurisdiction can be such a critical juncture, marking an important point in the timeline where change and innovation have a chance to grow and open up new paths (Garrelts and Lange 2011). The scientific community surrounding the concept of path dependency agree on its temporal sensitivity as in that these critical junctures are to be seen as opportunities that have to be taken to have an impact (Peters et al. 2005). Arguably, the window of opportunity for social media has long been existent as the technology has matured but its highly dynamic nature, limited demographical spread and technological as well as societal complexity have hindered the engagement with it. It has to be pointed out, that the trends discussed earlier in this chapter about the usage of social media will cause this window to stay open, presenting opportunities to be taken. With a widening window of opportunity to change, the question what keeps the sector from making advantage of it has to be asked and the answer can be explained with an important mechanism identified in path dependency research. The term lock-in is widely used and describes a state where a situation is locked into a specific path by the surrounding formal and informal rules which creates the need for a significant critical juncture that pierces through this cemented veil of established institutions to enable change (Booth 2011). Flood risk management in Germany is arguably is such a lock-in situation as it is highly regulated and technocratically approached. Recent developments show though, that more communicative and feedback-driven approaches are taken within small communities which is enabled by the very decentralized organization within the country, making local municipalities able to act within margins of regulation, but at their own demand.

A further explanation about how the governmental structures of Germany are organized is given later in chapter 3. The technocratically locked in path of operation, especially in the coastal defense sector, causes mechanisms that do not de- but increase risk, closely linking their cluster together with policy, as the policy is what is keeping the lock-in as rigid as it is (Figure 10).
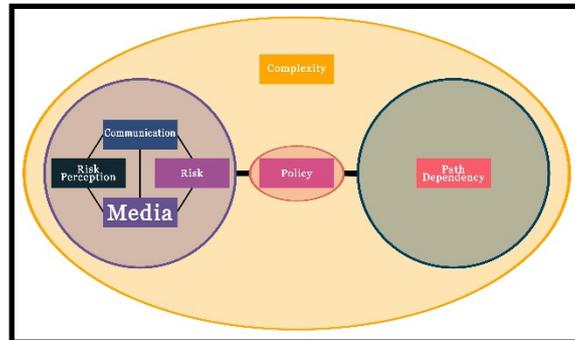
Figure 10: The Theoretical Framework Including Path Dependency

One of those mechanisms is called the "levee paradox". It describes the ironical relationship between risk and prevention strategies occurring in technocratic flood risk management as it identifies that the more advanced the flood prevention technology itself and the more extensive its implementation, as in dikes flood, gates, dams and their kind, the more development happens in the respective protected areas. This increase in development causes vulnerability to increase, as more organic and material entities are potentially exposed to flooding in the area, subsequently leading to an increase in risk according to the formula mentioned earlier in this chapter (Liao 2014). This emphasizes how the "levee paradox" interrelates with lock-ins as described by path dependency, and thus logically with risk, calling for a change in how risk is communicated, perceived and approached for solutions.

2.3.   Public Value Management

When approaching flood risk communication from a new angle that involves interactive and feedback-driven media as a central point in its strategy, communicative decision-making becomes increasingly important. Whilst the communicative rationale in its purest form as described earlier in this chapter poses several drawbacks, as many its technical counterpart, its benefits are not to be easily discharged.

Figure 11: The Position of Public Value Management in the Spectrum of Decision-making

Public Value Management (PVM), as initially developed by Moore (1995), opts for a style of governance that embraces interaction and communication whilst keeping the focus on temporal efficiency, positioning it between the two extremes of rationale (Figure 11). As elaborated by Stoker (2006), PVM was developed with a focus on public service provision such as flood risk management in order to steer away from market-based and technocratic conventions. PVM proposes that the public sector and the

provision of its services is fundamentally different from the private, market-driven, sector as it cannot be characterized as a company that is buying and selling entities in a market environment. As a central notion of PVM, politics are integrated into different stages of the governing process to stimulate and coordinate social interaction (Stoker 2006). In democratic systems such as Germany, politics are designed to communicate the values and opinions of citizens through elected representatives to the respective instance of hierarchy where each issue is dealt with. Hence, the public sector is in its core concept developed to strive for public value in its decision-making process (Moore 1995), embracing and recognizing the experience and qualities of every citizen. Political decision-making is thus more flexible and adaptive as scientific decision-making, since discourse and valuing help to cope with the effects of uncertainty, ambiguity and unexpected change (Stoker 2006), which forms the links between PVM, policy and the left cluster (Figure 12). More adaptive and flexible policy subsequently clusters PVM together with path dependency.
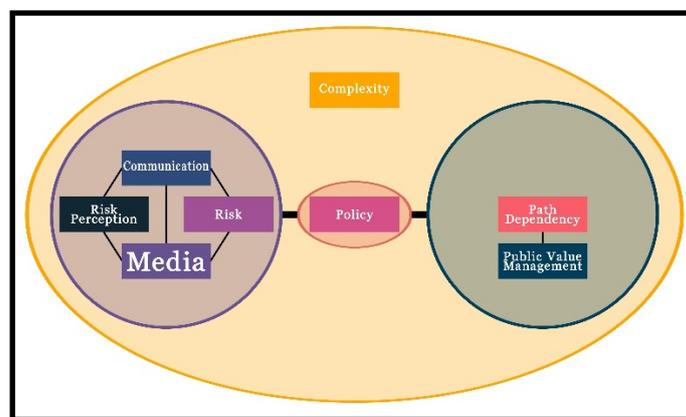
Figure 12: PVM in the linkage diagramm

Four propositions, as developed by Stoker (2006), help to further characterize PVM:

Proposition 1: *Public interventions are defined by the search for public value.*
While politics and public managers, such as planners, are meant to create public value, the definition of such and how it is perceived among recipients is at question. Answering it must happen through discussion and engagement with the relevant stakeholders to evaluate whether the decisions to be taken are creating public value, which would subsequently legitimize them in the face of citizens. This is similar to a cost-benefit analysis, where analyzing benefits entails an assessment of the created public value together with the resources spent to achieve it, balancing social and economic outcomes (See also Moore 1995).

Proposition 2: *There is a need to give more recognition to the legitimacy of a wide range of stakeholders.*
The elected state of a citizen's spokesman in the democratic system is insufficient to legitimize all actions taken and requires the inclusion of other stakeholders such as, but not exclusively, business partners, neighborhood leaders, those with knowledge about services as professionals or users and those in a position of oversight as auditors and regulators, to legitimize decision-making (See also Alford and O'Flynn 2009). PVM hence aims to strengthen the apparent disinterest and apathy

among the public by involving people in custom-tailored ways to ensure active involvement. Furthermore, Stoker (2006) identifies new information and communication technologies as tools for flexible, attractive and time-efficient interaction with people. Additionally, he states that these technologies are essential to achieve social and economic outcomes as it fosters public confidence in politics.

Proposition 3: *An open-minded relationship approach to the procurement of services is framed by a commitment to a public service ethos.*

Open-mindedness as to whom is supplying services through mechanisms such as user consultation, benchmarking and open competition is important to ensure the focus on results. Involving public, private and voluntary sectors contributes to the flexibility of service provision as each has its own strengths and weaknesses, making one of them the best fit for each task. This presets though, that all involved parties share the prescribed striving for public value to successfully provide public services (See also Bryson et al. 2014).

Proposition 4: *An adaptable and learning-based approach to the challenge of public service delivery is required.*

Learning means adaptation, increasing the flexibility of decision-making to ensure that the public system is maintained and improved. Public managers thus have to acknowledge that they play an active part in that system which makes them accountable for its performance and health. This embraces the challenges of change, aiming for constant improvement and re-evaluating past decisions (See also O'Flynn 2007).

These propositions align to a great extend with the characteristics and strengths of social media as identified in earlier chapters and propose a way of governance that fits the proposed need for hybridization as a foundation for new flood risk communication approaches. However, this approach also has its drawbacks. As Alford and Hughes (2008) argue in their work, PVM argues, even if context-dependent, for ultimate solutions, which is contradictory to its inherent aim to learn and adapt. Additionally, the implication of the public sector as fundamentally different from private sectors has to be re-addressed as it is in apparent conflict with the practice of lesson-drawing especially in regard to social media. Here, the private market might pose essential insight in how to best use this tool for the purpose of governance. This work proposes that learning and adaptation can be extended to all sectors in all fields when carefully executed.

2.4.   Transition Management

One of those concepts which utilizes an integrated form of lesson-drawing within its concept is Transition Management. A transition is defined in Rotmans et al. (2001) as gradual process of change in which society itself or a major subsystem of it structurally changes. Rotmans et al. (2001) further elaborates, that transitions are the outcome of the relationship between developments that sustain and empower each other and further explains that transitions are not caused by changing a single variable but through avalanching developments in various domains that gain momentum. This momentum gain, often understood as an acceleration of change (Loorbach 2002), makes change non-linear, as slow

change at the start of the transition is followed by rapid change which subsequently slows down again once it is completed. This gradual shift in the speed of change is described as an S-curve and broken down into four phases of transitioning, as visible in Figure 13 (Loorbach 2002; Loorbach and Rotmans 2010; Rotmans et al. 2001).
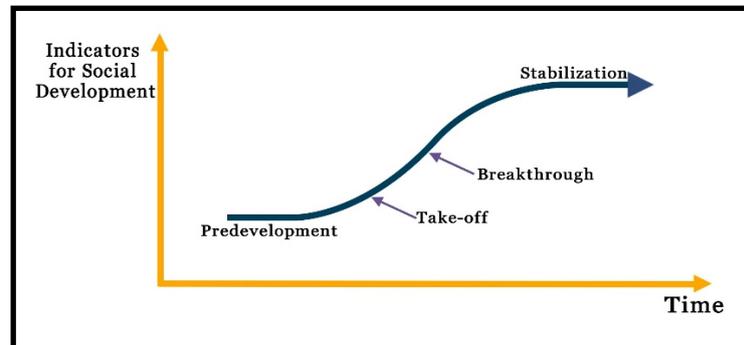
Figure 13: Four Phases of Transition (adapted from Rotmans et al. (2001))

Predevelopment describes the phase in which the visibility of societal change is low but there is a lot of experimentation.

The **Take-off** phase indicates change as the system begins to shift and the transition gains its momentum.

In the **Breakthrough** phase, structural change becomes visible through the accumulation of socio-cultural, economic, ecological and institutional changes which influence each other, triggering collective learning, diffusion and embedding processes.

Stabilization describes the phase in which the transition slows down as it reaches a new stable equilibrium (Loorbach 2002).

Analog to Path Dependency theory, Transition Management incorporates one-time events such as disasters and other impactful happenings into its core concept. These events do not trigger change, but can accelerate it (Loorbach and Rotmans 2010). For this work, that implicates that a transition in flood risk communication and media usage might already occur, but that it is not sufficiently accelerated by one-time events and empowering developments. Aligned with the previous research of this work such as the digital divide and evolution in social network technology, this assumption makes sense as societal factors are indeed already changing but are not impactful enough yet to reach the next transition phase. It is important to understand exactly how Transition Management is positioned in terms of decision-making, as its factual understanding and implicated rationality of management, as in the observation and control of events and timelines, under the use of preliminary expert knowledge, position it close to conventional governing and thus the technical rationale. In order to obtain the knowledge needed to understand the events and shifts that are happening, communication is integrated into the approach as an essential but complementary factor for decision-making. At the same time the concept acknowledges the notion of non-linearity and the multitude of inter-factorial influence as well as the temporal dimension of decision-making in terms of adaptability, giving it its unique position in the spectrum (Figure 14).
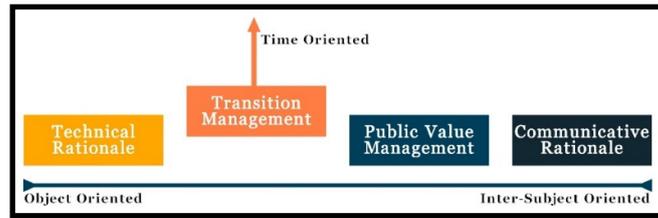
Figure 14: Transition Management in the Spectrum of Decision-making

As decision-making greatly influences how policy is developed, Transition Management poses as another hybridized approach that includes adaptability and lesson-drawing with the unique addition of the temporal dimension of decision-making as integral part of its approach. Developed by Loorbach (2010), Transition Management is expressed as a circular process that begins with structuring, envisioning and establishment of a transition arena as the strategic part of its cycle (Figure 15: The Transition Management Cycle After (Loorbach 2010)). A transition arena describes a setting in which a selected initial group of experts is joined by other innovative actors to conclude on the perception of the proposed problem, initializing the management cycle.

Figure 15: The Transition Management Cycle After (Loorbach 2010)

Secondly, developing coalitions, images and transition agendas as the tactical phase is meant to set goals and ambitions to create a long-term vision to strive for. In the third, operational phase, actors are mobilized and projects as well as experimental pilots are executed to establish a level of concreteness to the problem-solving process and improve visibility as well as awareness, while gaining important insights into the effectiveness and viability of available options. This knowledge is then used in the fourth phase to evaluate and monitor the ongoing cycle to learn from it as the reflexive ingredient of the management recipe, before beginning the next and improved loop. The cycle thus helps to cope with uncertainty and issues like path dependency in policy design, completing the final section of this research's theoretical framework is shown in Figure 16.
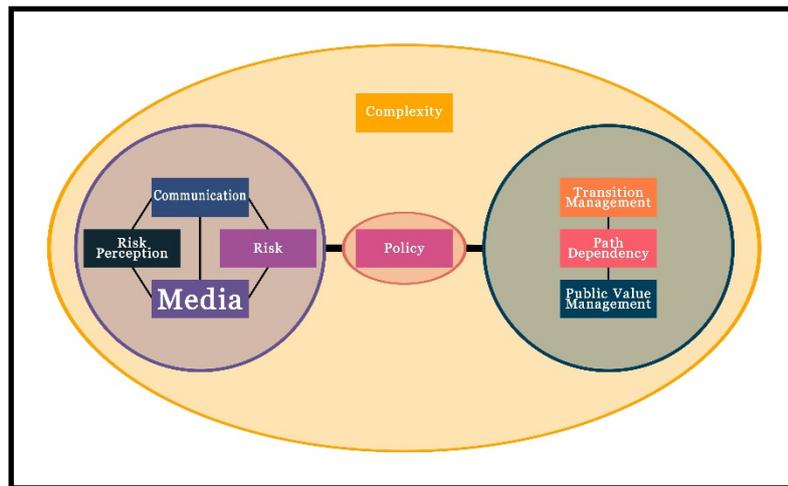
Figure 16: Theory Framework

But as every other concept, Transition Management has its own drawbacks. As identified in Voß and Bornemann (2011) and Loorbach and Rotmans (2010), further research on the concept has led the authors to conclude a number of challenges when implementing Transition Management into practice. The innovations and developments in small niches needed to start a transition are very difficult to identify and would require a lot of resources to do comprehensively. Additionally, niche developments are often short-lived and their worthiness for support and fostering are hard to assess. Another circumstance, which is often neglected by the scientific community surrounding Transition Management theory, is power and power relations between actors. All of these actor-related issues can be linked back to the notion of complexity, as power-related issues and identification of important innovative stakeholders are inter-actor related problems and hence point back at uncertainty and open systems. It is important to understand exactly what complexity theory implies for the management of transitions. The acknowledgement of non-linear relationships between causes and effects, expressed in the acceleration and deceleration within the transition cycle, connects to complexity theory as they describe the attempt to solve "wicked problems", as in ones that are complex and never fully comprehensible (Rittel and Webber 1973; Rotmans and Loorbach 2009). As it is not possible to decipher these problems completely with human efforts, high amounts of uncertainty become inevitable as actors and factors behave in unforeseeable ways. The complexity perspective on Transition Management hence implies, that through a process of investigation and adaption, these uncertainties can be coped with and properly reacted to. The underlying hypothesis of this perspective is that understanding the dynamics of complex, adaptive systems will translate into the identification of opportunities, limitations and conditions that enable intervention in these systems (Rotmans and Loorbach 2009). As further elaborated by Rotmans and Loorbach (2009), the Transition Management approach is meant to stimulate the relationship between actors to form new partnerships, coalitions and networks to establish new ways of thinking, that form a social movement to create continuous pressure on market and politics to overcome their inertia towards change. While Transition Management has its roots in the environmental domain, expanding it to cover others such as the communication sector, which in the case of this work strongly relates to environmental disasters as well, is seen to be a promising possibility (Rotmans and Loorbach 2009).

3. Methodology

This chapter aims at explaining and justifying the methods chosen to answer the research questions stated in chapter 1.3, as well as the overall qualitative and quantitative approaches that underpin this work.

3.1. Research Design

In this research a variety of tools and research techniques will be utilized. Quantitative data serves as the factual foundation for further analysis and is sourced from social media statistics of general anonymous usage insight data, specific case-bound statistics and comparison-tables. These facts and figures form the basis for qualitative data evaluation. Next to literature research, a survey will be carried out to gather qualitative data. Based on the quantitative data collected, lessons to be learned from the cross-sectorial research will be identified in order to develop suitable solutions for the flood risk management sector.

3.2. Data Collection Methods

Different methods for data collection and evaluation will be used in this study: literature research, online-survey, Geo Information Systems (GIS), and social media statistics.

3.2.1. Online-Survey

An online survey with the title of "Social Media Integration in German Flood Risk Management" will be executed in order to provide insight into the fundamental understanding of flood risk related issues among the respondents. Each question aims at further categorizing the participant and gathering a specific information. To ensure equal and thus comparable quality of the answers given, the questions will be closed and either answerable as binary "Yes"-"No" questions, or be designed as single-answer multiple choice questions. One questions will also have an option for indecisiveness as it is part of a cascading question that requires a previous one to be answered affirmatively in order to hold any value in its responses. It is important to note, that all questions are required to be filled out before successful submission to avoid incomplete answering schemes. This set of questions may rule out participants as incompatible to the research for geological reasons as in their remoteness to flood prone areas or lack of information and knowledge about the topic. The latest though will also act as an indicator for the education-level of participants regarding information relevant to this research. The survey focuses on a particular area identified by the "Hochwasserrisikomanagement-Richtlinie" (HWRM-RL) as prescribed by the Directive 2007/60/EC of the European Parliament and of the Council of the 23rd of October 2007 on the assessment and management of flood risks (Council directive 2007/60/EG). The directive, as transcribed into German law, deals with the rating of flood risk areas into three categories (Bundesanstalt für Gewässerkunde 12/31/2015):

- HQ20: The area of most frequent severe flood risk. As indicated within its abbreviation, it covers the areas of Germany which are on statistically flooded once every 20 years by a severe flooding event. "Q" here indicates how severe such an event is, as it is the outflow ratio indicator used to express that it is the highest amount of outflow (beyond the natural and manmade borders of the waterbodies) of water recorded within 20 years, and thus an average value.
- HQ100: Analog to HQ20, this covers the area in which "Century Floods" have direct and severe impacts.
- > HQ200: Similar to the ones previously mentioned, >HQ200 represents the area in which such a flood event is unlikely to occur more frequently than once every 200 years.

This study focuses on the HQ20 area as it identifies the region where the highest amount of awareness and effectiveness of communication is needed, providing an ideal primer for new solutions and approaches. In order to ensure productive communication with respondents, the survey will be available in both German and English for it to be answerable for the majority of the population. In the following only the English versions will be discussed, while their German counterparts are attached in the appendix.

The questions asked within the online survey are as follows (In their English version):

1. *Are you living or working in Germany or are you visiting it occasionally?*

    Yes (1)

    No (2)

Question 1 is set up as a simple binary question to exclude respondents who got access to the survey but are not situated in the case study area. As all data is tracked for each respondent individually, the disqualified answering schemes can be tracked and subtracted from the following questions' answers.

2. *Is your area, as in your city, village or travelling route prone to flooding?*

    Yes, definitely. (1)

    No, flooding is not a concern in this area. (2)

    I am unsure. (3)

This research greatly emphasizes the importance of risk awareness as a reoccurring theme throughout theory and practice. Question 2 tries to identify respondents which are aware of their flood risk, do not consider their area to be prone to flooding at all or are unsure about the circumstances. This helps to find relations between the need for communication and the current status of information flow, on which the following questions focus.

3. *How often do you check weather forecasts?*

    Never (1)

    Only on special occasions (2)

    Regularly (3)

Every day   *(4)*

Weather forecasting is an essential source of risk information for citizens which is widely available in practically every household. Question 3 identifies how intensely weather forecasting is followed by individuals by asking how often they use that source of information. The frequency at which they are checked by the respondent can indicate their interest and engagement with weather related issues.

4.   *Are you particularly interested in more specific information concerning extreme weather events such as heavy rainfall or storm surges in your area?*

      Yes, I am actively seeking information to be prepared for the situation.   *(1)*
      Yes, I schedule to catch broadcasted news.   *(2)*
      If I get informed, I am interested but I do not put effort into seeking out for information.   *(3)*
      No, I am not particularly interested.   *(4)*

To further specify what type of information the respondents seek in weather forecasting and general meteorological information, question 4 assesses if extreme weather events pose as particularly interesting pieces of information that respondents value over general weather forecasting. The question further gives insight about the level of proactiveness at which the respondent engages with the information by distinguishing between active and passive information retrieval. Additionally, it gives an indication about responsibility as passive information retrieval requires external individuals or organizations to actively carry that information to the recipient.

5.   *If you replied affirmatively to question 4., to what extent do you utilize social media (such as, but not exclusively, Facebook, Twitter, Instagram or Snapchat) to receive information?*

      I do not use social media at all.   *(1)*
      I do not use social media to receive information.   *(2)*
      I use social media occasionally and in combination with other sources.   *(3)*
      I use social media as my main source of information but check back with other sources.   *(4)*
      I exclusively use social media as my source of information.   *(5)*

Cascading on question 4, question 5 further zooms in on the role social media plays within weather forecasting and information flow. It reveals if respondents utilize social media at all and if so, how much they use it in respect to receiving news related to extreme weather events. Question 5 further gives information about how social media is seen in terms of its viability and reliability as an information source as it distinguishes between exclusive and complementary information gathering.

6.   *Are you actively spreading information about extreme weather events on social media?*

      I do not spread that kind of information on social media at all.   *(1)*
      I use social media to spread this kind of information on special occasions only.   *(2)*
      I use social media to spread this kind of information on a regular basis.   *(3)*
      I use social media to spread this kind of information daily.   *(4)*

Social media is, as elaborated in 2.1, built on the premise of UGC and thus requires a certain fraction of users to actively engage with the medium as content creators. Question 6 aims at gathering information about how often respondents generate or share content within their networks to assess their state of engagement, as user activity of greatly influences the speed at which information travels through social networks.

7. *Have you heard about the emergency information app of the German ministry of civil protection called "NINA"? If so, do you use it?*

I have never heard of the app. (1)

I have heard of the app but do not use it. (2)

I use the app occasionally or when other information channels trigger me to do so. (3)

I use the app extensively to stay informed. (4)

To analyze how current approaches that go beyond conventional communication channels work within flood risk communication, the "NINA" app is taken as an example to research how well it is integrated among respondents. It gathers information about how successful the app is in playing a relevant role within German flood risk communication.

These seven questions aim at getting a better understanding on how flooding is perceived and dealt with in terms of communication in flood prone areas in Germany. Trust in the technology in place, insufficient quality or availability of information and lack of motivation and incentive to proactively self-educate about the topic are critical indicators for how stakeholder management is to be approached and can contribute to reshape the perception and engagement of the potentially affected public with flood risk management. Furthermore, this survey will help to answer the question whether social media is already playing a significant role in flood risk communication and information flow and may identify the current state of integration and quality of the information available already, as well as give implications on how to successfully integrate social media into the sector.

In order to draw conclusions from a survey it is important to assess whether the collected data poses as a valid source for generalization, as in how the respondents represent the target group. In order for a survey to fulfil this criterion, the total number of valid responses have to cross a threshold at which the conclusions drawn can be expressed with specific certainty. This threshold of significance is commonly referred to as the needed population size in stochastics literature (Georgii 2015). The formula used to determine the needed minimum number of respondents in order to fulfil the significance criterion contains several factors:

- Margin of Error (e) is expressed as a percentage that describes how much the result from the sample of respondents is likely to differ from the result of the total population. This means that the smaller the margin of error, the more closely the surveys' results match the total population's. A small margin of error thus enhances the significance of the study.

- Population Size (**N/n**) can be understood in two ways. Either it is comprised of the total number of entities that represent the survey's target group (**N**), as the whole population, or it is the sample size, as in the number of respondents to the survey (**n**).
- Confidence Level (**z**) refers to how reliable the results lie within the margins of error. When calculating **N** and *e* this reliability, which is commonly expressed as a percentage value, is translated into **z**-values that represent the corresponding percentages as decimal numbers which stand for the number of standard deviations the given proportion is away from the mean.
- Percentage Value (**p**) refers to the percentage at which the answers given by respondents are likely to repeat in following studies of the same kind. When a congruent binary question was asked in a previous study with the same target group and answered affirmatively by a certain percentage of respondents, this percentage would then translate into the new **p** value to reduce the needed sample size. In surveys that are carried out as pilot studies, the percentage value corresponds to 50%.

Taking all these factors into account, the corresponding formula is as pictured in Figure 17 (Georgii 2015).

$$\frac{\frac{z^2 \times p(1-p)}{e^2}}{1+(\frac{z^2 \times p(1-p)}{e^2 N})} = n$$

Figure 17: Survey calculation formula

In order to determine the needed sample size **n**, *e*, **z**, **N**, and **p** must be set first.

This research bridges the spatial and social science domains. According to the common values used in these fields of research (Kish 1968; Cochran 2007; Kalton 1983) *e* will be determined as sufficient if it is <10% to provide a profound basis for analysis and conclusions. Furthermore, the confidence level of 95% is chosen as it is a common value used in both fields, which translates into a **z**-value of 1.96. Given that this is a pilot survey, p is determined to be 50%. According to the data acquired through the Bundesanstalt für Gewässerkunde (12/31/2015), the total population size of people in the HQ20 zone is 216169 as of their last measurement. This number is of course changing every day as population numbers fluctuate but is the most recent data available. When inserted into the formula presented in Figure 17, the number of respondents necessary to reach the threshold of significance is 96. It is of course very much desirable to exceed that threshold by a fair margin as certain answering schemes will disqualify for further analysis as described earlier in this chapter.

3.2.2. Geographical Information Systems (GIS)

The emergence of network societies and its implications for the use of computer-based technology has significantly altered the common ways of communication, perception of our surroundings, and decision-making. As elaborated in Fazal (2008), data that represents our physical, meta-physical and virtual world can be saved and processed in an abstract form of binary data to be represented and shared in their simplified form as data files for specific needs. A lot of our decisions are directly dependent on

the specific attributes and locations in our world to account for contextual dimensions and thus require extensive knowledge about them. This type of information is called geographical as it enables us to distinguish between different locations and translate that into adaptive decision-making. This helps us to formulate and apply generalized principles to specific factors and boundary conditions that are bound to these locations and track their change over time, which makes geographical information an essential tool for decision-making in planning and other disciplines. GIS use geographical data in their digital form to create and analyze spatial datasets, which also enables it to analyze their temporal dimension and extrapolate those, expressing trends and forecasting changes. It is important to note at this point that the quality of such GIS-based data, analysis and forecasting depends highly on its accuracy, which in digital form is expressed as resolution. It is technically impossible to create maps that represent the real world in all its details as it would require an infinite amount of resolution and thus storage. GIS can therefore only ever act as a complementary tool of approximation. In this research GIS play such a complementary role as it will be used solely for the purpose of demonstration, visualization and as a data-source for the numerical foundation of population calculations. This is done with the commonly used GIS software "ArcGIS" in its version 10.5.1 and will provide a highly simplified and abstract map of the case study in which relevant data is projected and visualized.

3.2.3. Social Media Statistics

The virtual nature of social media yields its benefits when it comes to data collection. The individual social media networks each store and gather user data in order to function as intended and for other internal and external uses such as customized advertisements for users, back up data storage and spread of server load (Bloch 2006). In order to do this, these websites contain an Application Programming Interface (API) which is a piece of intermediate software that enables two other applications to exchange data with each other. As further elaborated in Bloch (2006), it acts as a foundation for most complex websites of the WEB 2.0. These APIs allow for programmers and researchers to access a pre-specified portion of the user data collected within the social media software for outside use. In this research, The API of the social media network "Facebook" (www.Facebook.com) is used to extract usage data about its users in order to reveal behavioral patterns in respect to reach and engagement as those are essential factors of successful social media integration as identified in 3.3.2.

3.2.4. Literature Study

For the sake of revealing the theoretical and practical discourse behind the notions and research fields discussed in this thesis, scientific literature serves as the foundation of knowledge and understanding which frames both information, argumentation and conclusion drawing. It furthermore gives implications about a multitude of different opinions and points of view to take into account in order to critically reflect on the results and work done in this thesis, as well as to balance the argumentation for benefits and drawbacks or certain approaches and tools. In order to find literature that is suitable for this research, sets of keywords were identified that contained the title of their respective chapter or sub chapter, flood risk management and complementary/specifying search terms such as commonly coined phenomena and understandings such as "levee paradox", "wicked problems" or "digital divide" to name a few. Occasionally, grey literature is used for visualization or complementary reinforcement of

arguments while all factual statements and essential knowledge is sourced in the works of the scientific communities.

3.3. Methods of Data Analysis

The data collected from the previously mentioned sources using their respective methods will be analyzed in order to obtain knowledge and insights that can be discussed and concluded from.

3.3.1. Survey Analysis

The survey conducted in this research produces a mix of qualitative and quantitative data as the defined set of possible answers limit the respondent's expression to a pre-set phrasing but is aimed at capturing opinions and values. The aim of the survey data is to provide a foundation for generalized statements from which to draw conclusions, as that is both inevitable and necessary for policy action and for claims about what the wider social world is like (May 2002). May (2002) introduces the concept of Moderatum Generalizations (MG), a concept developed around the interpretation of such mixed data types and specifically tailored for surveys in social sciences. MG builds on the concept of significance as elaborated in 3.2.1 and uses it as the basis condition that makes generalization through interpretation possible. The author greatly emphasizes that the interpretation of mixed data is to be seen probabilistic, as also elaborated on in 3.2.1, as it aims to represent a greater population than practically asked, leaving every individual within the target audience that was not questioned as an unknown variable. In the context of this research, the connection to the theoretical concept of complexity as introduced throughout chapter 2 becomes visible again. The concept of MG responds to this uncertainty by categorizing respondents where possible or necessary to reveal commonly grouped values and opinions as a set of feature characteristics that reveal the relationship between the sum of questions and individual responses (May 2002). As further concluded in May (2002), MG describes its statements not as facts but as theoretical interferences, which are overlaps with existing theory and phenomena as well as characterizations. As soon as one characterizes respondents, clustering them together in abstract pools of notions and relations, a certain degree of technical rationale thinking is inevitable, as is presupposes a certain amount of consistency among society and directly connect describable traits with reasoning. It is important to say further, that this has to be paired with interpretative, communicative ways of reasoning to make sense in the societal context as individuals are just that, individual (May 2002). MG has the aim to deliver interpretations with an ideographic character, painting a bigger picture that may have "blurred edges, but also sharp features" (May 2002).

3.3.2. Lesson-Drawing

The concept of lesson-drawing, as outlined by Rose (1991), is the process of transferring a set of ideas and actions from one context (the donor) to one that is spatially and/or temporally different (the receiver). This difference in context makes it necessary to adapt and transform ideas and actions during the process to increase compatibility. This compatibility is a crucial factor for success (James and Lodge 2003; Rose 2002; Mamadouh et al. 2002). The process is hence sourced in already existing knowledge, as it is enabled by dissatisfaction with present and searches for successful solutions to the same or

similar problems other contextual environments have faced in the past or are currently dealing with (Rose 1991). It is thus apparent, that a profound understanding of the existing problem is another critical success factor as understanding it acts as a foundation from which to look out for solutions. Furthermore, lesson-drawing focuses on contingencies, as in the interplay of factors and conditions that made the donor's solution successful and how those are contingent with the boundary conditions in the receiver's context (Mamadouh et al. 2002). In the context of this work, the lesson-drawing will be approached on a cross-sectoral level, specifically from the economic sector as a donor to the public sector as a receiver. As exemplified in James and Lodge (2003), the question why lesson-drawing is often preferred over other forms of decision-making has to be asked, as it is an analytical, rationality-focused concept which only later during its process advances towards a more adaptive approach. The media usage trends outline in earlier chapters, implications of the challenges that come with climate change and the disconnectedness of flood risk communication and local knowledge all call for solution with a certain urgency. Lesson-drawing as a concept tries to tailor existing knowledge rather than "reinventing the wheel" and thus can help to deliver successful solutions more quickly than purely innovative approaches. In the context of social media and flood risk communication it is important to understand that donor sectors have been implementing, reshaping and maturing the technology of social media to a great extend already and can help to transform the disadvantage of time into an opportunity to draw from their experience. It has to be said though, that an extensive amount of tailoring and adaptation may end up in a solution that is of such little resemblance to the original donor's, that the aim of lesson-drawing is diffused by the increasing use of financial and temporal resources used to realize it, questioning the concept and its success (James and Lodge 2003). James and Lodge (2003) further emphasizes that not all problems are fit for the approach as either the issue itself or its specific circumstance might differ from any other to a degree that calls for a different, more innovative approach. Nevertheless, determining how successful the implementation of transferred knowledge is, is a vital component of the evaluation process, potentially identifying the need for re-adaptation and reshaping or different donor-concepts after all. In the realm of social media research, success is often quantified in the concept of reach and qualified in engagement (Scott and Scott 2011). Reach is accounting for the amount of people reached within the target specific timespan, as reach of obsolete content is of no worth to sender or receiver. Engagement describes how the reached users interact with the content ranging from passively noticing it to actively engaging with it by providing feedback (Lipsman et al. 2012; Scott and Scott 2011). This provides a combination of qualitative and quantitative factors to determine the success of lesson-drawing in this works context. This focus on facts and numbers in combination with qualitative evaluation in a process of adaptation and transformation fits into the context of new public management, but also into other approaches which focus on similar concepts.

3.4.   Units of Research

The case of this research is determined by its spatial boundary, theoretical scope, and the timeframe of analysis (Ridder and Yin 2012). With social media being an internet-based technology and flood risk

management posing a global thread to society, focusing down to Germany as a case study to limit the complexity of the issue without narrowing it down to the micro-level, at which the bigger picture might get blurred by over-specific boundary conditions, is a logical step to take to increase the efficiency of research and compatibility of approaches and solutions with the local context. Additionally, parts of the world which have deliberately shut themselves off from common social media in general and have established their own solutions (Namely Russia and China) will be excluded in this work even as cross-sectorial references since the access from outside is prohibited and their function and form differs from more globally connected social media networks. In order to narrow the spatial scope of Germany, the HQ20 area as specified in 3.2.1 will serve as an area of focus as here the conditions form an optimal foundation for research. With the relative youth of the research topic, historical data about social media is non-existent but analogies from physical networks may still be applicable and through adaptation and transformation turned into valuable lessons to draw for future approaches. Furthermore, the analyzed quantitative data during the cross-sectorial information gathering will be limited to a certain timeframe to allow for confidence in relatively stable boundary conditions and the state of sector and thus reliability of the data gathered.

3.4.1. Case Study

Case studies are a common method to evaluate and develop theory while focusing on practical issues. This helps to incorporate the contextual boundary conditions the research is embedded in and thus provides insight into the processes and phenomena at hand (Yin and Davis 2007). As identified by Ridder and Yin (2012), case studies are especially useful to analyze group behavior, as it is on the basis of evidence, rather than simulation as in other common methods. In order to acquire the knowledge needed to form this evidence, using multiple methods to do so as a mix of quantitative and qualitative ones is highly beneficial (Onghena et al. 2018). It is thus of great importance that the required data to gather about the issue is available and accessible, making the case selection essential. As further elaborated in Yin (2017), cases have to fulfil requirements to be elected as a good fit for the research. These factors range from the evaluation of theoretic propositions, over the uniqueness and typicality of a case, to its function as a revelatory case, as in one that is observable for the first time, or longitudinal, as in observable within a temporal dimension. This research uses Germany, or more specifically the designated HQ20 zone in it, as its primary case study and a social media music site related to the music industry as its secondary case study. Germany as a developed country in western Europe has accessible internet connections for 93% of its inhabitants (Bär 2016; Eurostat 2019).
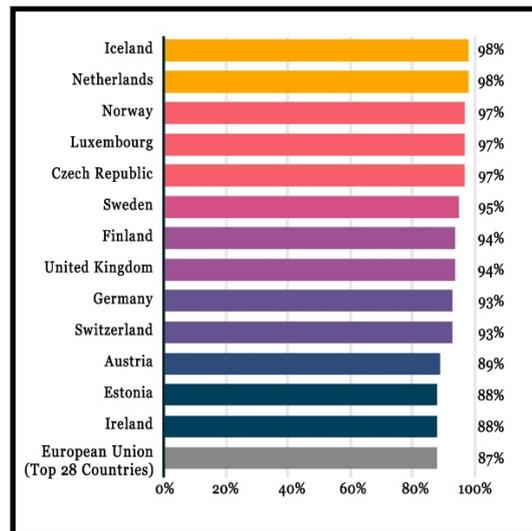
Figure 18: Level of internet Access in European Households (Eurostat 2019)

As visible in Figure 18, this status of integration is common in western Europe (Ngini et al. 2002; Scholz et al. 2017; Eurostat 2019), making Germany a typical case for this research. Furthermore, country-specific data is often stored locally and composed in the respective native language. For me as a researcher with German as my native language, the opportunity to capitalize on that by being able to assess data without translation processes, which would otherwise make the data prone to misinterpretation through mistranslation, poses another argument for the choice. Hence, Germany will be the focus area for this paper as it will be the area for which the research outcomes are designed for, while the music industry in its complementary, secondary function serves as a reservoir of knowledge to draw lessons from. Both case studies will follow their corresponding protocol to organize and structure data collection processes as laid out in this chapter. Both cases are to be individually addressed before any comparison, lesson-drawing or concluding can happen as the context they are embedded in is very different, as well as their geographical and jurisdictional boundaries, one being an area within a country while the other one is the social media related virtual webspace of an industrial sector. Thus they are embedded single-case studies, or as defined by Yin (2017), type 2 case studies. Data collection for such studies, as described by the authors, consists or the following essential factors for such scientific data collection:

- Use multiple sources

  The use of multiple information sources by applying different kind of research methods, aims to being able to triangulate between them. This is referred to as "construct validity", establishing correct operational measures for the concepts being studied.

- Create a case study database

A case study database acts as a reliability foundation and makes the reader to be able to back-track the conclusions made in the case study back to their original source and raw data, as well as to third party sources such as literature or interview-transcripts.

- Establish a chain of evidence

As important as the database is to track information sources, as it is to understand how the information is connected and intertwined, leading to the final conclusions in the research. Every step in decision-making and conclusion crafting is explained and traceable throughout the research by constant referencing and explanation.

These three factors enable decisive and transparent analysis and conclusion on the gathered data.

The HQ20 Area in Germany

The primary case study of this work is the HQ20 Area in Germany. As described in 3.2.1, this high risk zone for flooding events in Germany is an area where the urgency for a change in flood risk communication is the most apparent, as substantial flooding events are frequent in this area. Even though it only covers a small area of the country, as shown in Figure 19, the area spreads across every part of the country, making it a nation-wide need and ideally sized pilot study area.
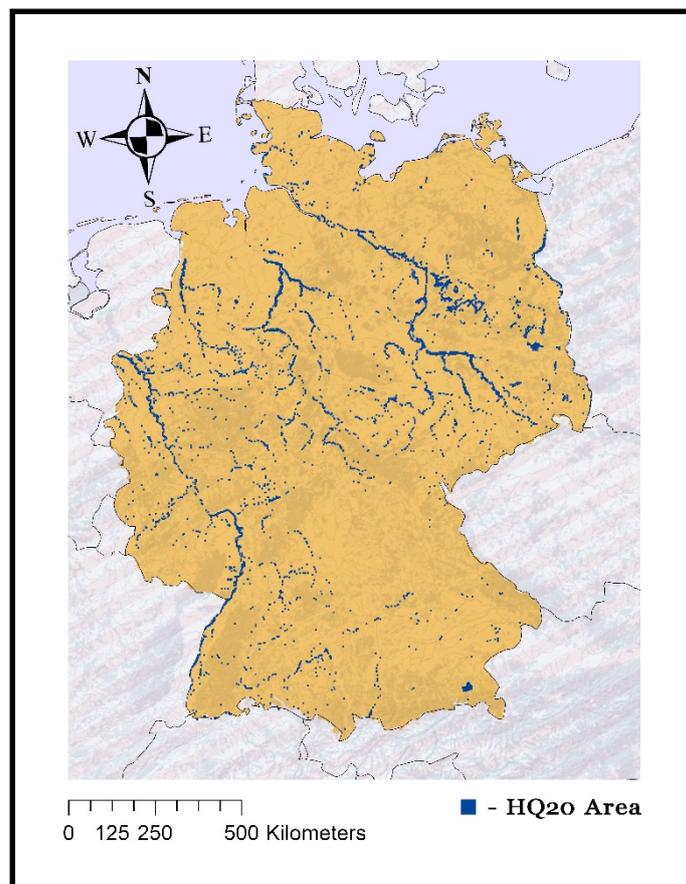
Figure 19: The HQ20 Area of Germany

The HQ20 area is composed of both sea- and land-based flooding hazard sources in a sense that it accounts for coastal, river and pluvial flooding. Waterbodies outside German jurisdiction are taken into account during cross-border research and their resulting impact zones displayed accordingly (Bundesanstalt für Gewässerkunde 12/31/2015).

Cross Sector Analysis: The Music Industry

Due to the partial inaccessibility of data due to privacy law and site-specific API restrictions as described in 3.2.3, a holistic approach to the music industry sector as an information source for social media statistics is not feasible. Thus, a specific site which I am granted administrative access to is chosen to represent this sector. The site "Concept Art" (www.facebook.com/conceptartmusic) is a typical artist site that is active in the creation of content of various types on an almost daily basis which makes a close-netted analysis of behavior within timelines possible. The administrative access level permits this research to access all data accessible through the site's API and will grant access to the behavioral data of more than ten thousand (10.480 on 23.05.2019) individuals at the state of this research.

4. Results and Analysis

In this chapter, the data gathered from the survey and social media statistics is presented and analyzed using the methods described in the previous chapter. The analysis aims at revealing a set of findings that can be used to answer the research questions stated in 1.3.

4.1. Analysis of the Survey Data

Since the survey aims to provide insight into the fundamental understanding of flood risk related issues among the respondents and thus reveal the current status of integration of social media in German flood risk management, it is important to filter the respondents.
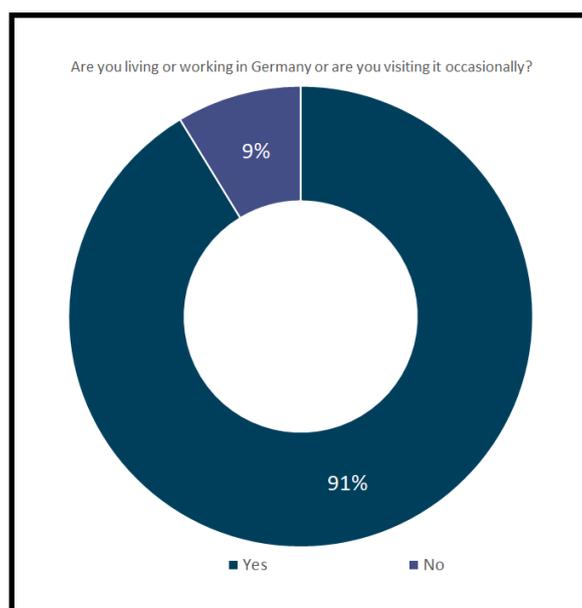
Figure 20: Survey Question 1

The results of question 1 show that 9% (14 in total) of respondents are not in one way or another situated in Germany, which disqualifies their answers for the sake of this research (Figure 20). These responses will be excluded from all further questions and their respective diagrams, effectively nullifying all answers given. As this lowers the total amount of respondents from 161 to 147, the calculated margin of error (e) after the formula elaborated in 3.2.1 is going to increase, mathematically amplifying uncertainty in the further results. As the elimination process effectively increases the fit of the respondents to the aims of the survey though, uncertainty arguably decreases as the results hold more value due to their respondent's characterization being closer to the ideal type as the principle of MG explains in 3.3.1. The resulting sample size (n) of 147 translates into an e of ±8.08% at the given z-factor of 1.96, or 95% confidence level respectively. According to the criteria set up in 3.2.1, this survey is of sufficient significance for this research.

Continuing with the adjusted sample size, question 2 delivered the following results among respondents as visualized in Figure 21.
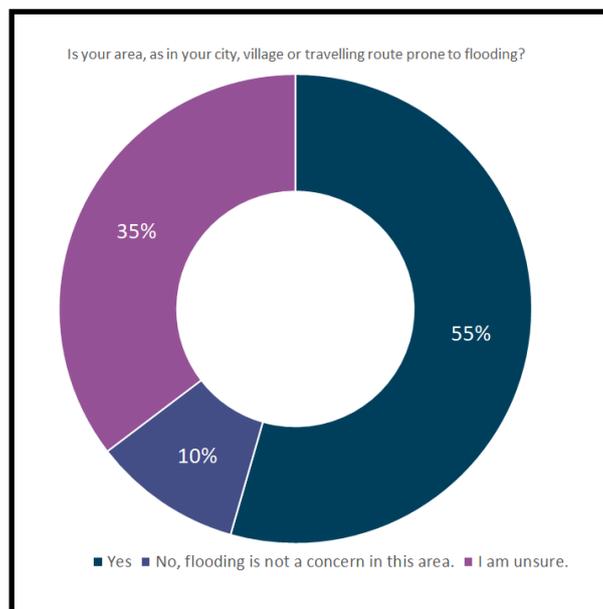
Figure 21: Survey Question 2

Even though the majority answered affirmatively to the question, the number of unsure respondents shows how difficult such a perceptive question is and how limited the state of information seems to be. As uncertainty can in this case be seen as a lack of education and awareness, it becomes evident that flood risk communication in its function to inform is flawed. Awareness of risk is important in both ways, as in the awareness of it being low of high is equally important to ensure that vulnerable areas respond accordingly, and not vulnerable areas do not respond to threats that would not impact them. For example, if too many people respond to a flooding event, the infrastructure's capability to handle evacuations may be negatively impacted, causing panic situations and amplifying the flood event's impacts beyond estimations. Furthermore, question 2 was designed to be simple-worded and not too specific to allow for respondents that are not as educated in the field to respond with certainty. It is plausible that if the question was formulated more precisely, as in asking for the respondent's location

within the HQ20 zone as identified in Figure 19, the amount of unsure responses would have increased. Additionally, respondents who negated the question might simply not know that they are indeed situated in a flood prone area but, due to the lack of education and recent happening of flooding events, are unaware of the possibility.

Question 3 is designed to gather information about the use of current media channels for weather forecasts (Figure 22). Specifically, it asks for the relative frequency in which weather forecasts are checked. The option "Only on special occasions" furthermore indicates a reasoning behind the intention to check these forecasts.
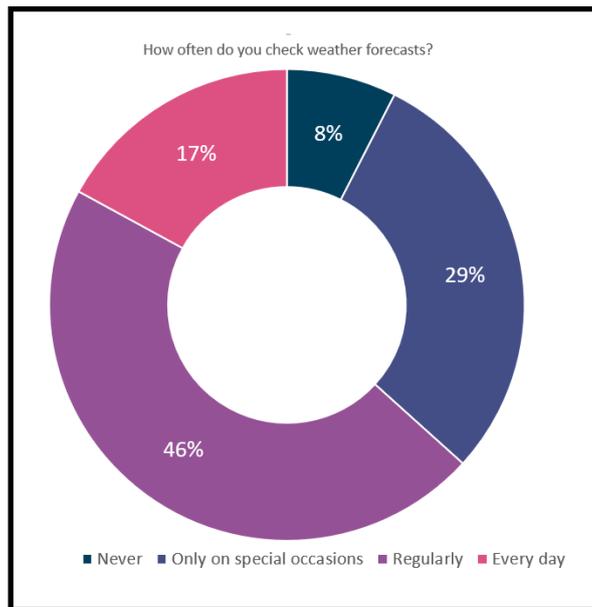
Figure 22: Survey Question 3

While 17% of respondents check weather forecasts every day and 46% at least on a regular basis, 8% stated that they never check weather forecasts. The 29% of respondents that check weather forecasts only on special occasions show a certain kind of awareness, for example noticing untypical weather patterns that could lead up to an extreme weather events, triggering the perceived need to check back with forecasts in order to understand the situation and act accordingly. The fact that extreme weather events do not always correlate with warning signs that are early enough to react to accordingly, are obvious enough to individuals to be noticed consistently or are sourced in far away geographical locations that their spill-over surprises locals is important to notice here. This circumstance entails that an individual subjectively triggered interest in insufficient for effective flood risk communication. With a total of 37% of respondents falling into the category of lacklustre information behaviour, the need for improved flood risk communication becomes even more apparent. It is important to note, that 7 out of the 11 responses for "Never" are respondents who answered question 2 with "Yes", so that they are indeed situated in flood prone areas, while only 2 out of the 11 respondents negated question 2. Equally, only 3 out of the 43 responses for "Only on special occasions" are people who negated question 2, while 29 out of those 43 answered it with "Yes". This means that the majority of respondents that do not check weather forecasts at all or in an occasion-based manner are individuals situated in flood prone areas.

Question 4 addresses the interest of respondents in extreme weather events and reveals interesting characteristics among respondents as visualized in Figure 23.

Are you particularly interested in more specific information concerning extreme weather events such as heavy rainfall or storm surges in your area?

1%
7%
23%
69%

- Yes, I am actively seeking information to be prepared for the situation
- Yes, I schedule to catch broadcasted news.
- If I get informed, I am interested but I do not put effort into seeking out for information.
- No, I am not particularly interested.

Figure 23: Survey Question 4

The vast majority of respondents claim to be interested if they get informed, but do not put effort into seeking out for information themselves. Together with the 23% of answers that are also taking a passive stance in information gathering, as they schedule to catch broadcasted news but do not actively seek out for additional information, 92% of respondents seem to perceive flood risk communication as a duty outside their own responsibility. The interest seems to be there with 99% of all answers, but only a small fraction (7%) are actively gathering information to prepare for possible flood events. To foster the characterization of respondents, an interesting connection between question 3 and 4 can be found as in that the majority (63 out of 102) of respondents which claim to only be interested when informed can be linked back to respondents that check weather forecasts on a daily or regular basis, which indicates that the respondents who are checking forecasts as a habit are already interested in weather in general, limiting the peak in interest when it comes to extreme weather events. This means that information which particularly targets extreme weather events will still reach those individuals.

The next step in the survey, question 5, targets the use of social media in the respondents' information gathering process, which led to the results visualized in Figure 24. As it is designed as a cascading question, the option "NO ANSWER" was not actively chosen but refers to the percentage of respondents who answered with "No, [...]" in question 4. 50% of respondents chose the option that describes occasional and more importantly complementary use of social media in the information gathering process. Added are the 16% of respondents that use social media more extensively but check back with other sources. These respondents do seem to take advantage of social media as an information source but also treat it as an insufficient source.
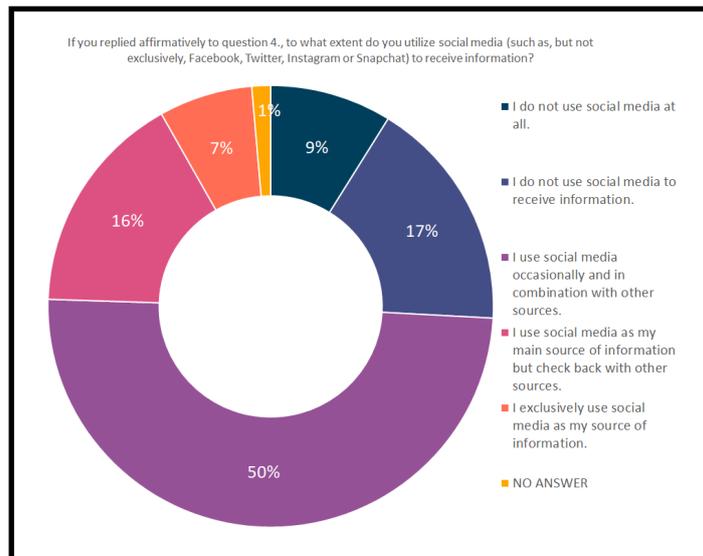
Figure 24: Survey Question 5

This insufficiency might be rooted in the lack of available content, its incomprehensiveness, incompleteness or insufficient trustworthiness, all tracing back to the need for legitimate and widely available information. It is plausible that once those sources are verified among individuals who currently do not use social media to receive information or as a complementary source, consumption of it will increase. It is noteworthy, that 8 out of the 13 respondents who answered to not use social media at all do check weather forecasts regularly, thus confirming the use of existing mass media-based information channels. When addressing social media, UGC, as discussed in 2.1, is the foundation of a healthy social network. It is important to assess whether content is generated by administrative users of a group within the network or also by non-administrative users.

Question 6 shows, as visualized in Figure 25, that none of the respondents share or generate weather event-related content daily, which indicates three scenarios.
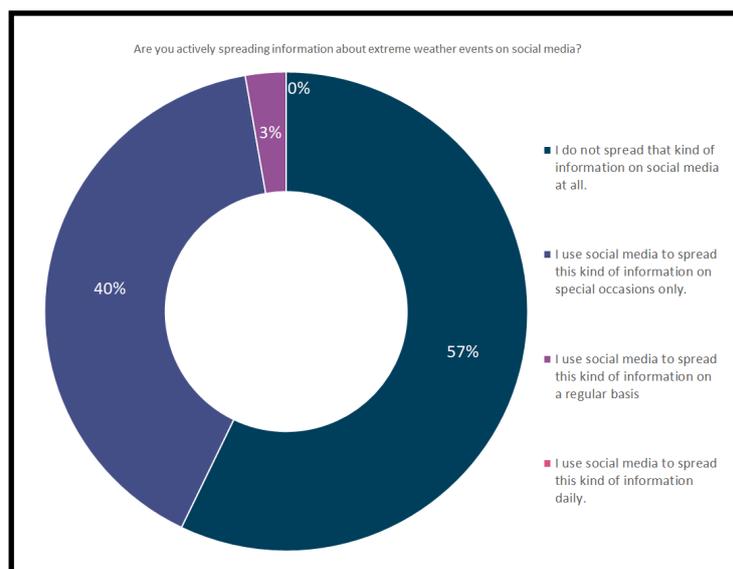
Figure 25: Survey Question 6

Firstly, the respondents are not interested enough in the topic to put in the extra effort to generate or share the existing content. Secondly, there is no existing content or network to generate or share in. Lastly, it is also possible that there is a lack in information to share, as in that it does not reach these respondents, or that the events occurring are not impactful enough to trigger a more engaging behaviour. It is furthermore important to say that naturally all respondents who, according to question 5, do not use social media at all subsequently answered question 6 with "I do not spread this kind of information on social media at all". All respondents who chose this answer are affected by one or multiple scenarios of the ones mentioned above. On the other hand, 40% of respondents do spread weather event-related content on special occasions, which means that while information is steadily available to them, they only engage in a spreading manner when the events are interesting enough and thus trigger this behaviour. The 3% of respondents who spread information on a regular basis seem to not be triggered by extreme events but developed a habit of spreading content, regardless of the events' potential impacts. These four respondents all answered question 4 in a manner that does not express highly specialized interest in extreme weather events, confirming the previous statement.

As the final question of the survey, question 7 focuses of the NINA app and poses as an example of existing information and communication technology. As mentioned in 1.1 and elaborated in 3.2.1, the NINA app seems to be disconnected from social media users as well as mass media users at first glance. Whether that is indeed the fact is assessed by asking about how the state of knowledge and, if applicable, usage of the app is among respondents.
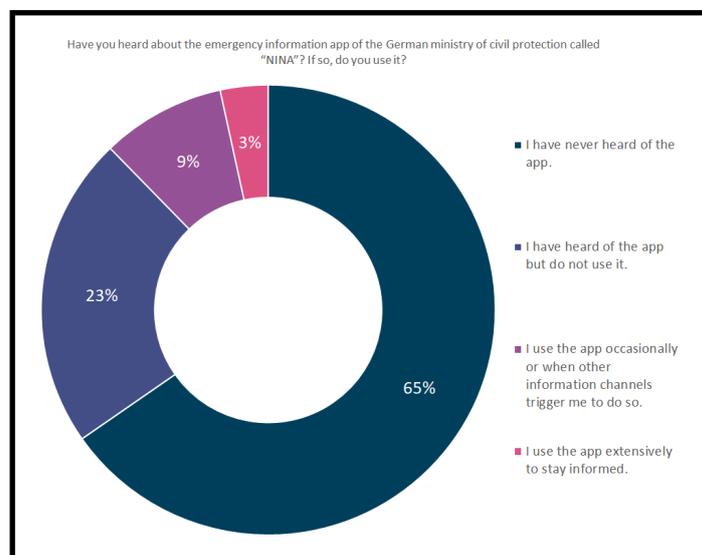
Figure 26: Survey Question 7

Confirming the initial perception, the majority of respondents, as in 65%, have never heard of the app and thus seem to not have been reached by advertisement campaigns, which are arguably part of flood risk communication. It is important to state at this point, that the 96 respondents denying any knowledge of the NINA app cannot be connected to a certain respondent profile or group but are widespread in regard to their preceding answering scheme. This though can be seen as characterization itself as the widespreadness signalizes that the majority of the general public lacks knowledge about the

app, not only a specific target group that was missed by the advertisement campaigns. Advancing in the analysis, 23% of the respondents confirm to know the app but claim to not be using it at all. This hints towards the disconnectedness of the app, as its lack of integration into the existing end user's behavior invokes inconvenience. Furthermore, it raises the question whether the apps overall functionality may be flawed. The 9634 reviews written by users in the Google Playstore and Apple Appstore at the point of this research show mediocre user ratings, complaining on the lack of functionality, compatibility, missing warnings and multiple warnings to single events (Apple inc. 2019; Google inc. 2019). It is notable, that out of the mere 5 respondents that answered to use the app extensively, 3 confirmed to live in a flood prone area and 4 check weather forecasts regularly or every day, signaling an elevated interest, while also re-confirming the paradox outlined in the analysis of question 4 as 4 out of 5 respondents here responded to take a passive stance in information-seeking for extreme weather events. The app thus seems to pose as a viable information technology to reach users that want to be informed, for example by warnings directly on their screens, rather than inform themselves actively.

4.2.   Analysis of the Social Media Data

While the analysis of the survey data unveiled issues and shortcomings of the current flood risk communication approach, the social media data gathered will help to understand how users are reached by and engage with content on social media platforms, as elaborated in 2.1, in order to solve these issues.

The first set of data gathered through the API compares different types of content, as in videos, statuses, text accompanied by or calling to follow certain hyperlinks and photos. The content is further linked to its average reach and engagement in absolute end-user numbers as visualized in Figure 27. It is important to say that the reach displayed is purely organic reach, which means that no paid ad-hoc advertisement was carried out on the platform to enhance them artificially beyond the site's own user selection algorithm.
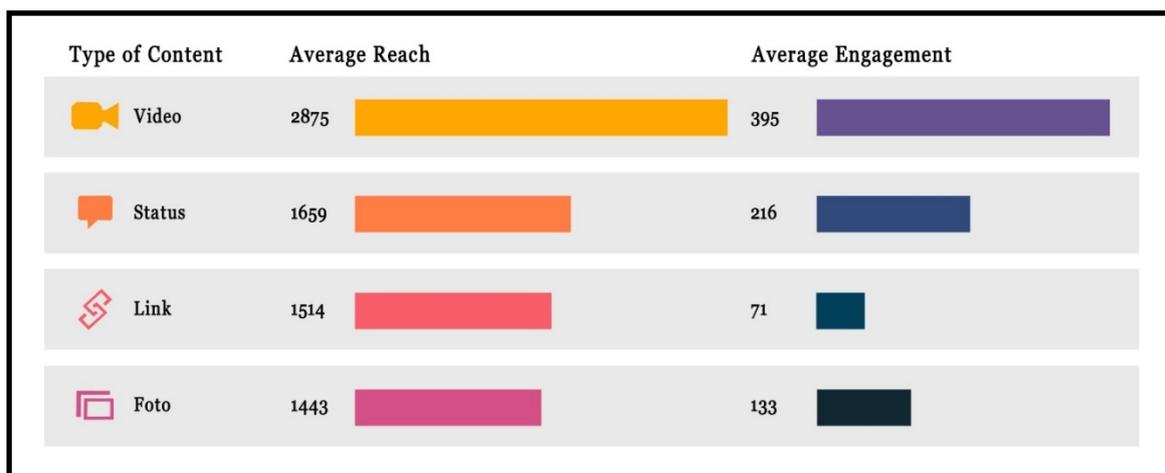
Figure 27: Reach and Engagement of Content

The data revealed that there is a significant advantage of videos when it comes to reach when compared to all other forms of content, nearly doubling their average performances. When it comes to the engagement rate though, as in the ratio between total users reached and engaging users, video content has an engagement rate of 13.7%, only slightly higher than the 13.0% of normal text statuses. When analysing the purpose of these videos and statuses though, it became clear that status messages were often very short and consisted more of questions rather than the often more announcing video content. Questions generate more engagement, as the end user is asked for his own opinion, enriching the status with its own content further invoking reactions from other users. Videos on the other side were often used to announce new music content and therefore aimed at as much reach as possible, offering more engagement opportunities in terms of direct video reactions -such as "likes"- by displaying enjoyable content. So, while the engagement rate is only slightly higher, the social media site's selection algorithms seems to favour video content over statuses, granting more reach on average. Hyperlinks have by far the lowest engagement rate with 5%, making it apparent that if the content leads out of the social media environment, it becomes inconvenient and thus unattractive to engage with among end users. It is important to note, that photos only count as such if they are not accompanied by text, which turns them automatically into a status, explaining their lower average reach and engagement rate of 9.2%.

By gathering data about the online activity over time of end users, as visualized in Figure 28, it was possible to identify how the temporal factor of content can influence reach and engagement.
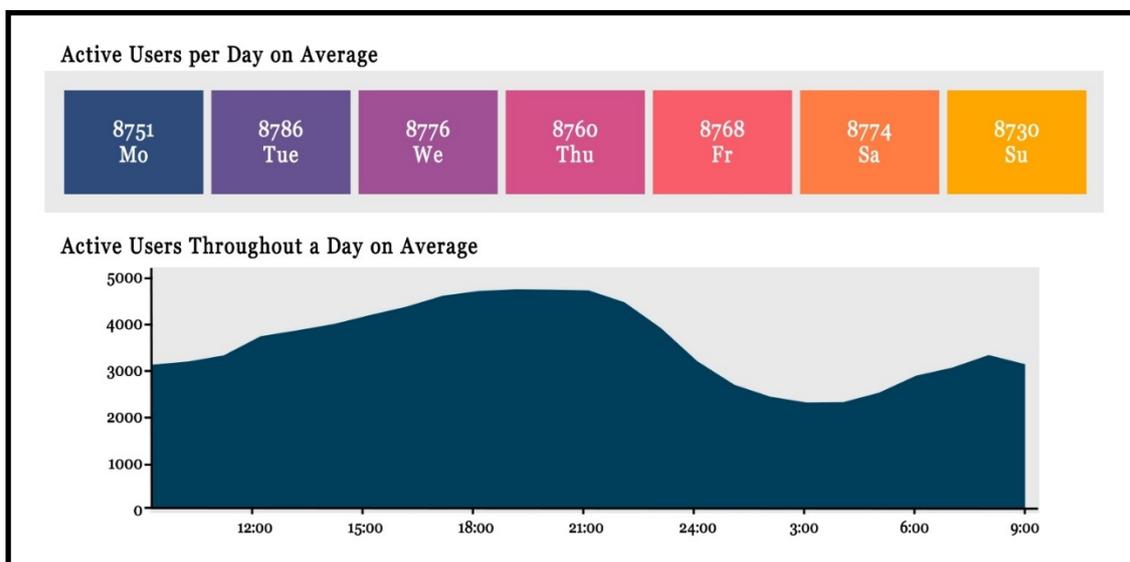
Figure 28: User Activity

The active users per day on average stayed roughly the same throughout the weekly cycle. Even though there is no such data available via the API, it is logical to assume that the weekly average over a month is equally consistent. During a single day though, average user activity fluctuates significantly. The majority of the end users linked to the analysed page share the time zone of Germany, where all timestamps in Figure 28 where converted to. The second biggest time zone group in terms of its share regarding the total users linked to the page are the Americas, especially western regions. The two peaks

in user activity are thus connected to the German time zone between 18:00 and 21:00 and the western parts of the Americas between 7:00 and 9:00, matching the difference between both time zones and lining them up to equal local times. These peak hours of user activity thus are optimal window to post content with maximum reach.

When the type of content and timing of postings are out of the equation, what's left is the target audience. The demographic data gathered through the API identified users between 18 and 34 as the main target audience for the site as visualized in Figure 29. While music is in general often a topic closer connected to younger audiences, it regardless shows the importance to tailor the created content to be digestible for the target audience.
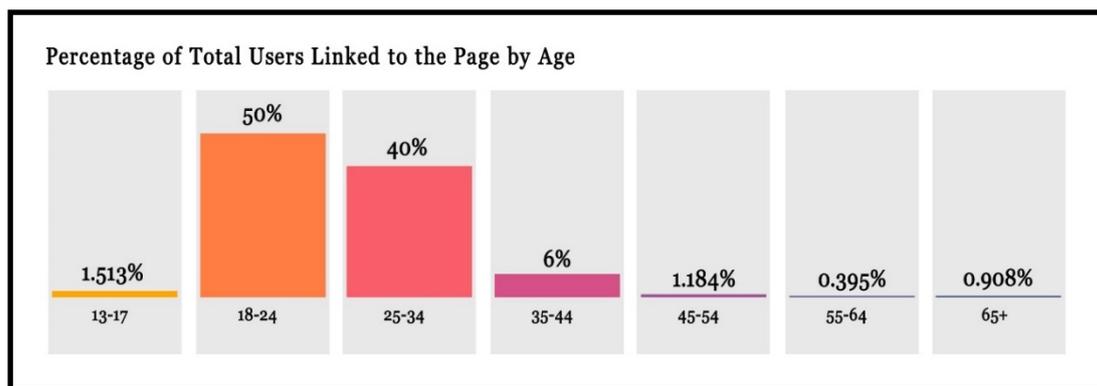
Figure 29: User Demography

Furthermore it exemplifies the phenomenon of the "Digital Divide" as elaborated on in 1.1 and 2.4, as the sudden decline in userbase shares among the age brackets beyond 34 years indicates the generation shift in the use of social media. The, at first glance, surprising lack of users between 13 and 17 years is logically linkable to the type of content and music the page is engaged with. All concerts and shows the music page is promoting are only allowed for adult (18+) audiences, excluding younger fans from the vast majority of content that is created on the page.

Another temporal dimension of content generation is the posting frequency. Oversaturating end users with too much content in a short time can be just as counter productive as not generating content for longer timespans. The keyword for successful social media management thus is continuity. As visualized in Figure 30, the userbase of the analysed social media page is growing constantly.
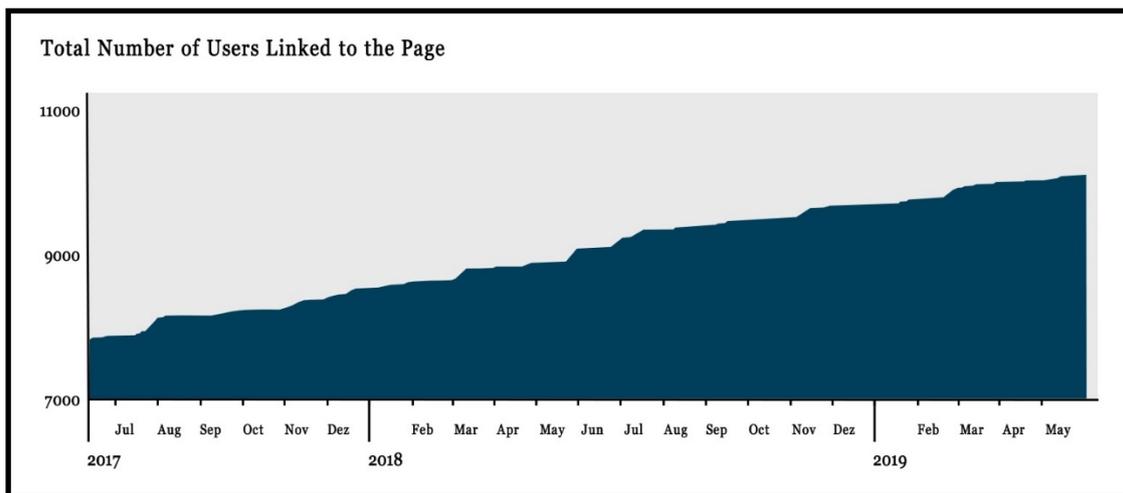
Figure 30: Content Continuity and Page Growth

A distinctive feature of this growth graph are the sudden increases over short timespans. These sudden periods of userbase growth directly correlate with major content postings. Major referring to the type of content (for example a video) and corresponding high reach and engagement rates. These major content postings are spread out to prevent oversaturation and are accompanied by smaller content postings between them to enhance continuity.

5. Discussion

To answer the main research question presented in 1.3, the sub-questions will serve as a backbone for the following discussion.

How is social media currently utilized amongst the general public in German flood risk management?

Drawing from the survey data and analysis, social media plays a complementary role at most when it comes to flood risk communication. This complementary function is sourced in an apparent incomprehensiveness, incompleteness, lack of availability, or insufficient trustworthiness of the consumable content. Only a small fraction of the social media userbase is creating or spreading flood risk related content, greatly limiting its reach and engagement. It can hence be said the current status of integration and the approaches to social media usage in flood risk management is insufficient. While the great majority of the general public is using social media, providing an existing widespread digital networking infrastructure, it's demographic reach concentrates on new generations. The picture painted by the gathered data shows a young technology in social media and niche developments in adjacent sectors that can help to integrate it into flood risk management. These small developments, as in self-organized social media groups, the NINA app, individuals sharing and engaging with related content and a constant yet small push of an environmental agenda within German politics could signalize the start of a transition. With societal change not yet being openly visible yet but lots of small experimentation by individuals, it seems to be in it's first phase, the predevelopment. Societal changes such as the "Digital Divide" though propose that the transition is already steering away from the current

path of mass media usage but does not seem to have set its new path towards social media just yet. The critical events needed to put the transition into its take-off phase and eventually accelerating changes to shape the new path for society towards social media-based flood risk communication will open windows for change and intervention. To properly capitalize on those chances and as proposed in the transition management cycle in Figure 15, after defining and structuring the problem, coalitions have to be made. Including social media experts, for example by collaborating with the music industry, could pose as a vital component to a successful management transition. *But is social media truly what the German flood risk communication needs?* The inherent uncertainty when working with highly connected social networks, its complex behaviour, pose as a big challenge to any kind of moderation or integration into existing systems. Numbers and facts can only tell so much about something as complex as social media, where every node is an individual actor that makes their own decisions. Furthermore, technology has developed extremely fast in the preceding decades and shows no sign to slow down. The effort put into a transition towards social media integration might end up investing in obsolete technology once it stabilizes. Then again, waiting until the next suitable technology emerges can not be a viable strategy, as it does not solve existing issues and would be just as unsure to invest into. A similar question to the ones just raised before could be: *But is it worth it?* That brings us to the second research sub-question.

How can social media strategies potentially improve flood risk management?

By using social media, the current German flood risk management approach would be enriched by a new communication tool. The advantages of the "Many to Many" communication type embedded in social media allows to improve how for example warnings, evacuation measures and polls can be wrapped into content that has reaches far into the target audience and is spread by users to accelerate response times. This also eases the pressure that lies on the flood risk management administration to inform every citizen directly, as the majority of the general public currently wants to be informed, rather than seeking out for information themselves. By spreading content within a social media network, even those who are not reached by the initial wave of information are likely to get informed by secondary information sources, as in the user-shared instance of content. Another potential of social media communication is its embeddedness in the internet, enabling the use of hyperlinks to offer further information beyond the generated content itself. The potential widespread reach and opportunity to provide additional information also take advantage in the possibility to design content specifically for certain target audiences. By spreading content within a social media network, the algorithms in place allow targeted content to reach their addressees with much less effort than for example sending a variety of different versions of physical messages out to individuals. Furthermore, mass media such as radio and television lack this feature entirely. While custom content increases reach, it also benefits how well the individuals reached by it are able to understand and interpret it, linking back to the concept of risk perception and helps to align perceived- and factual risk. All of these potential improvements make flood risk communication better for both parties, creating public value in a sense of convenience, effectiveness and transparency. Another dimension of communication added by social media is the possibility for easily accessible user-initiated communication. The importance and potential benefits gained by including the values, opinions and subsequently their generated content within the network

to more easily gain insight into contextual issues can improve local political decision-making and shape how policy evolves, recognizing the experience and qualities of every citizen in the face of public value. These changes again might be the accelerating events to foster the transition towards a more integrated approach to social media usage in flood risk management, creating a self-empowering system. This premise of "*more users = more content = more information to work with*" connects to the third sub question.

What are the potential benefits and challenges for an initiated communication compared to analysing existing networks?

As touched upon in 1.2, scientific research about social media integration widely focusses on analyzing existing networks and their content as well as userbase behavior to gather information. When integrating social media into flood risk communication as a core asset, relying on the independent formation and management of social media networks and analyzing them from outside cannot be sufficient. The first step would be to make interventions in these groups as an administrative user, overseeing what content is being created and how it is engaged with. The problems with that are that administrative capacities can only be granted by existing administrators, for whom there is no incentive to do so. Furthermore, this option still relies on existing networks and therefore has no use where no such group or content is available to take over. The next logical step is to initiate such groups, for example one for every spatial region. The survey showed that the majority of respondents check their weather forecasts regularly and generally take a more passive stance in information seeking, relying on information being carried to them by others. A network initiated for the sole purpose of flood risk communication and administrated in a way that could fulfill those needs by providing information about weather forecasts and potential flood hazards could serve these needs. Additionally, the regular posting of weather-related content would greatly enhance the reach of such a network as it increases content continuity and thus helps to attract new users. For example a social media page administrated by flood risk management officials that posts specific weather forecasts for a "Landkreis" (A level of German jurisdiction consisting of several postcode areas) could make conventional weather forecasting channels obsolete for its users, or attract ones who do not use these conventional channels at all. The moderation of these groups by official administrators also offers the opportunity to filter content and prevent misinformation by user UGC, as well as answer question and intervene in obvious misunderstandings, relating back to the SARF to re-engage in the flow of information once it strays too far from the intended message, ensuring that the gap between risk and perceived risk stays as small as possible. These groups would then require a definitive and transparent label as being official to prevent rogue groups from false impersonation and manipulation, as the reliability of the posted content is of great importance. The survey revealed that the trustworthiness of social media content is currently a factor why it is not commonly used as a main information source. If a group is initiated as being official and administrated to ensure that trustworthy information is available, this could enhance the credibility of the information and thus attract more users, as well as foster engagement rates. How such an administrative strategy could be laid out depends on numerous factors, connecting to the next sub question.

The social media API data analyzed for this researched was taken from a commercial music artist page and revealed a certain set of factors that could pose as valuable lessons and starting points to adapt them for flood risk communication. Reach and engagement analysis of the site's posted content, as elaborated in 3.3.2, showed that the best reaching type of content are videos. Also having the best engagement rate of all analyzed content types, videos hence pose as the most valuable content in the music industry. The resources spend to produce videos are significantly higher than posting a picture or plain text though, making it simply unfeasible to post such videos on a daily basis. Thus, videos mark highlights in the content timelines, accompanied by complementary picture and plain content posts between them to keep up continuity. For flood risk communication this translates into the recommendation, that video content should be posted about events and topics that demand for the highest possible reach and engagement such as urgent flood event warnings, while supplementing the content timeline with less demanding complementary posts in between. Furthermore, commercial pages such as the one analyzed time their content to go public during the peak times of online users to further foster reach and engagement rates of the posted content. This is only partly translatable as flood risk communication sometimes deals with urgent information that has to reach users as soon as possible. While Non time-sensitive content should be planned according to these activity peaks, waiting for them could have drastic consequences when dealing with flood event warnings or render them completely ineffective. While these factors deal with how content is created within the network, audience targeting poses as the most crucial factor for how it reaches the users. In commercial sectors, audience targeting is done by identifying which user groups, for example according to their region, age or social and financial status, are most likely to engage with their product. While flood risk communication is not trying to generate profit from products, targeting and managing their audience according to their region is of vital importance in issues with spatial dimensions such as flood events. Not only does it guarantee that the individuals which are likely to be affected by those events are informed, but it also prevents panic or unnecessary precautions for those that are not within the predicted impact zones. This helps to keep the gap between risk and perceived risk small. On the other hand, the more specific the audience targeting is, the less users will be reached by the content, limiting the organic spread within the network but not eliminating it completely. For flood risk communication that means that network overspill effects can still cause the content to reach users outside the target group and at the same time make it more difficult to actually reach all users in it. While this is a tradeoff accepted in commercial social media usage, urgent content such as flood risk warnings could be too important to accept those losses. Policy has to be developed in a way that allows flood risk communication administratives to assess how specific a piece of content is targeting an audience, while providing useful guidance on how to assess those situations. Transplanting these lessons from the commercial sector into public service provision has to be approached with caution and it is difficult to foresee how exactly content has to be created and how the network has to be set up, built and maintained. Here though, the biggest strength of social media, its interactive and communicative capacities, will help to shape a clearer picture of what is supposed too be done by whom, when and how. This leads us too the fourth and final sub question of this research.

What are the future implications of social media-based communication for flood risk management?

The survey and social media data collected helps to see the potential of social media-based flood risk communication and its advantages as well as drawbacks compared to conventional channels such as mass media. How significant each of these factors is in practice will have to be elaborated in field experiments, as the prediction of complex social systems and the detailed behavior of individuals is impossible. Best efforts and constant reassessment, learning by doing, will iteratively unravel the relations in place and help administratives and users alike to benefit from them. Relating back to transition theory and how it emphasizes this process in the transition management cycle, Figure 15, mobilizing actors and executing projects/experiments could be the most difficult piece in this puzzle, since social media networks are yet to be integrated into flood risk communication and will have to overcome the initial inertia of the system in place to change its path towards social media integration. While social media is arguably to most impactful communication technology of the 21st century and its userbases are constantly growing, it remains uncertain how long it will remain as significant as it is right now. The next big innovation might happen sooner than we would expect right now, an unknown unknown in complexity theory. Social media-based approaches could at the same time act as a steppingstone towards these new technologies and also teach us valuable lessons on how to deal with the integration of new technologies. Furthermore, the urge to act now as expressed in the earlier chapters of this research calls for the development of solutions that can face the challenges right now and not in a possibly distant future.

Drawing from all of these sub questions above, the center research question of this thesis can be answered.

What are the potential benefits and challenges of successful social media integration in flood risk management?

Closing the gap between risk and perceived risk, as well as ensuring that flood risk communication reaches everyone it needs too, while providing a platform for monitoring and evaluation are the key benefits of social media in the flood risk communication context. It could fundamentally alter the ways in which the public and their citizenship deal with flood risk by making it an integral part of the daily information cycle in their lives. Furthermore, the feedback- and content-driven communication style of social media allows for new insights in how to shape information to ensure a great compatibility between informer and informed, potentially elevating the overall level of education on both sides and therefore contribute to a better understanding of flood risk related issues. Additionally, it brings the public sector closer to its stakeholders, hence strengthening the relationship and establishing a virtual arena to express opinions and values. This can help to establish policy and decision-making legitimacy, reducing potential resistance and backlash.

The challenges to face are manifold, the main ones identified being the following. The initial inertia of alteration in the current information system surrounding flood risk management, due to the lack of

trigger events that would accelerate a change of pathways, is difficult to overcome. Triggers, as suggested by path dependency and transition theory, such as obvious miscommunication throughout flood events that would make the urgent need for change more apparent are not to wish for. Alternatively, this need for change has to be made apparent through other means such as advertisement and education campaigns or incentives for users to change their behavior. Another challenge is the lack of experience in the management of "many to many" information flows in flood risk communication. As proposed earlier, this could be solved by learning from other sectors as well as inviting social media experts into the discussion boards and, most importantly, creating adaptive working structures to iteratively tailor the strategies based on user behavior and feedback. Additionally, the allocation of resources needed to integrate social media into flood risk management is another big challenge. The suggested addition to staff such as social media managers, complemented by potential new offices and equipment are expenses to be made, but on who's account? The solutions to these challenges are yet to be fully developed as they are of very practical nature, making it ever so important to launch experiments and pilot project to test out possible solutions. It is thus important to design realistic but ambitious goals when facing these challenges to assess the success of the measures taken. A generalized definition of success in the integration of social media into flood risk management is of no use, as the complexity of the systems it is integrated into is in need for custom tailored and context-driven solutions, each with their own thresholds of success. Likewise, the exact plan of action is just as variant, emphasizing iterative learning in the process of development and management.

6. Concluding Remarks

The research carried out in this thesis tried to understand the factors for successful social media integration into the German flood risk management, in order to reveal the potential benefits and challenges one might encounter when approaching the issue in practice, in order to guide administratives and politicians as well as managers and planners in their decision-making. So far, the scientific discourse about social media sees it more as a complementary information source from which to gather data from the outside, rather than actively engaging with it in an administrative way. This blocks out a variety of potential benefits for communication that the technology enables. The survey which was carried out, as well as the data gathered from an existing social media page, delivered datasets which gave insight into the mindset and behavior of affected stakeholders, also revealing those potential challenges and benefits. Furthermore, by analyzing the data and discussing them with each other, possible solutions and limitations where identified, sharpening some of the many blurry edges that one encounters when dealing with this topic. The questions which were asked throughout the survey had to be kept extremely simple though, as the presumed state of low education regarding the topic of flood risk management would not allow for highly precise questions. As an example, one could have asked the respondents whether they live in the HQ20 zone or not. As the survey confirmed the apparent uncertainty among respondents even to the simplified version of this question, namely asking if they are living in a flood prone area or not, a more precise variant would not have yielded any additional value, or worse even increased uncertainty among respondents. Once the general public becomes increasingly aware of flood risk related issues, further research will be able to assess these topics more

effectively. Furthermore, the limitations of working with available social media data through an API are obvious, as the data is provided by the social media website and its company, making deeper analysis of the raw datasets impossible. A direct partnership that is allows to assess social media data in its purest form would certainly be of great benefit for the legitimacy of the gathered data in future research. Linking back to the preceding discussion, a set of new questions arose from the research that ask for solutions regarding practical issues, unanswerable by theory. As soon as more pilot projects and experiments are carried out, future research will likely be able to answer them.

Change is difficult, especially in a field of public service provision and with as much responsibility as flood risk management.

Lives and valuables are at stake, but the better we are prepared and understand when to act and how to react, the greater our strength to withstand the storms of the future.

7. Works Cited

Alfieri, Lorenzo; Feyen, Luc; Di Baldassarre, Giuliano (2016): Increasing flood risk under climate change: a pan-European assessment of the benefits of four adaptation strategies. In *Climatic Change* 136 (3), pp. 507–521. DOI: 10.1007/s10584-016-1641-1.

Alford, John; Hughes, Owen (2008): Public value pragmatism as the next phase of public management. In *The American review of public administration* 38 (2), pp. 130–148.

Alford, John; O'Flynn, Janine (2009): Making sense of public value: Concepts, critiques and emergent meanings. In *Intl Journal of Public Administration* 32 (3-4), pp. 171–191.

APFM (2015): The Role of Media in Flood Management. Integrated Flood Management Tools Series No.22 version 1.0. With assistance of Associated Programme on Flood Management, World Meteorological Organization, Global Water Partnership. World Meteorological Organization. Available online at https://www.floodmanagement.info/publications/tools/Tool_22_The_Role_of_the_Media_in_Flood_Management.pdf.

Apple inc. (2019): NINA. Available online at https://apps.apple.com/de/app/nina/id949360949, updated on 11/18/2018, checked on 6/24/2019.

Arthur, W. Brian (1994): Increasing Returns and Path Dependence in the Economy: University of Michigan Press. Available online at http://www.jstor.org/stable/10.3998/mpub.10029.

Bär, Dorothee (2016): Wie viel ist genug? Breitbandausbau in Deutschland. In *ifo Schnelldienst* 69 (20), pp. 3–28. Available online at https://www.econstor.eu/handle/10419/165823.

BBK (2019): Warn-App NINA. Bundesamt für Bevölkerungsschutz und Katastrophenhilfe. Available online at https://www.bbk.bund.de/DE/NINA/Warn-App_NINA.html, checked on 4/14/2019.

Bloch, Joshua (2006): How to design a good API and why it matters. In Peri Tarr, William R. Cook (Eds.): Companion to the 21st ACM SIGPLAN conference on Object-oriented programming systems, languages, and applications - OOPSLA '06. Companion to the 21st ACM SIGPLAN conference. Portland, Oregon, USA, 22/10/2006 - 26/10/2006. New York, New York, USA: ACM Press, p. 506.

Booth, Philip (2011): Culture, planning and path dependence: some reflections on the problems of comparison. In *Town Planning Review* 82 (1), pp. 13–28. DOI: 10.3828/tpr.2011.4.

Bryson, John M.; Crosby, Barbara C.; Bloomberg, Laura (2014): Public value governance: Moving beyond traditional public administration and the new public management. In *Public administration review* 74 (4), pp. 445–456.

Bundesanstalt für Gewässerkunde (12/31/2015): Berichtsdatenbestand zur HWRM-RL. RDir. Dr. Ralf Busskamp Referatsleiter M4 "Geoinformation, Fernerkundung und GRDC". E-Mail.

Byrne, David (2002): Complexity Theory and the Social Sciences : An Introduction. London, UNITED KINGDOM: Routledge. Available online at http://ebookcentral.proquest.com/lib/rug/detail.action?docID=165044.

Chan-Olmsted, Sylvia; Rim, Hyejoon; Zerba, Amy (2013): Mobile News Adoption among Young Adults. In *Journalism & Mass Communication Quarterly* 90 (1), pp. 126–147. DOI: 10.1177/1077699012468742.

Clemens, Walter C. (2013): Complexity Science and World Affairs. Albany: State University of New York Press. Available online at http://search.ebscohost.com.proxy-ub.rug.nl/login.aspx?direct=true&db=nlebk&AN=665690&site=ehost-live&scope=site.

Cochran, William G. (2007): Sampling techniques: John Wiley & Sons.

Coombs, Rod; Hull, Richard (1998): 'Knowledge management practices' and path-dependency in innovation. In *Research policy* 27 (3), pp. 239–256.

Council directive (2007/60/EG): Directive 2007/60/EG of the European Parliament and of Council of 23 October 2007 on the assessment and management of flood risks. Text with EEA relevance). In *Official Journal of the European Union* (288), pp. 27–34. Available online at https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32007L0060&from=EN, checked on 5/14/2019.

Cox, Louis Anthony Tony (2008): Some limitations of "Risk = Threat x Vulnerability x Consequence" for risk analysis of terrorist attacks. In *Risk analysis : an official publication of the Society for Risk Analysis* 28 (6), pp. 1749–1761. DOI: 10.1111/j.1539-6924.2008.01142.x.

Daft, Richard L.; Lengel, Robert H. (1986): Organizational Information Requirements, Media Richness and Structural Design. In *Management Science* 32 (5), pp. 554–571. DOI: 10.1287/mnsc.32.5.554.

Damrath, U.; Doms, G.; Frühwald, D.; Heise, E.; Richter, B.; Steppeler, J. (2000): Operational quantitative precipitation forecasting at the German Weather Service. In *Journal of Hydrology* 239 (1-4), pp. 260–285. DOI: 10.1016/S0022-1694(00)00353-X.

David, Paul A. (1985): Clio and the Economics of QWERTY. In *The American Economic Review* 75 (2), pp. 332–337. Available online at http://www.jstor.org/stable/1805621.

Del Vicario, Michela; Bessi, Alessandro; Zollo, Fabiana; Petroni, Fabio; Scala, Antonio; Caldarelli, Guido et al. (2016): The spreading of misinformation online. In *Proceedings of the National Academy of Sciences of the United States of America* 113 (3), pp. 554–559. DOI: 10.1073/pnas.1517441113.

Eurostat (2019): Households - level of internet access. Available online at http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=isoc_ci_in_h&lang=en, updated on 5/16/2019, checked on 5/17/2019.

Fazal, Shahab (2008): GIS Basics. New Delhi: New Age International. Available online at http://search.ebscohost.com.proxy-ub.rug.nl/login.aspx?direct=true&db=nlebk&AN=269101&site=ehost-live&scope=site.

Garrelts, Heiko; Lange, Hellmuth (2011): Path Dependencies and Path Change in Complex Fields of Action: Climate Adaptation Policies in Germany in the Realm of Flood Risk Management. In *AMBIO* 40 (2), pp. 200–209. DOI: 10.1007/s13280-010-0131-3.

Georgii, Hans-Otto (2015): Stochastik: Einführung in die Wahrscheinlichkeitstheorie und Statistik: Walter de Gruyter GmbH & Co KG.

Google inc. (2019): NINA - Die Warn-App des BBK. Available online at https://play.google.com/store/apps/details?id=de.materna.bbk.mobile.app&hl=de, updated on 6/15/2019, checked on 6/26/2019.

Gottfried, Jeffrey; Shearer, Elisa (2017): Americans' online news use is closing in on TV news use. In *Pew Research Center* 7.

Haer, Toon; Botzen, W. WouterJ.; Aerts, Jeroen C.J.H. (2016): The effectiveness of flood risk communication strategies and the influence of social networks—Insights from an agent-based model. In *Environmental Science & Policy* 60, pp. 44–52. DOI: 10.1016/j.envsci.2016.03.006.

Healey, Patsy (1996): The communicative turn in planning theory and its implications for spatial strategy formation. In *Environment and Planning B: Planning and design* 23 (2), pp. 217–234.

Healey, Patsy (2000): Planning Theory and Urban and Regional Dynamics: A Comment on Yiftachel and Huxley. In *International Journal of Urban and Regional Research* 24 (4), pp. 917–921. DOI: 10.1111/1468-2427.00288.

Hochwasser Zentrale Deutschland (2016): Meine Pegel. Hochwasser Zentrale Deutschland. Available online at http://www.hochwasserzentralen.info/meinepegel/, updated on 2016, checked on 4/14/2019.

Houston, J. Brian; Hawthorne, Joshua; Perreault, Mildred F.; Park, Eun Hae; Goldstein Hode, Marlo; Halliwell, Michael R. et al. (2015): Social media and disasters: a functional framework for social media use in disaster planning, response, and research. In *Disasters* 39 (1), pp. 1–22. DOI: 10.1111/disa.12092.

International Strategy for Diaster Reduction; United Nations (2004): Living with risk. A global review of disaster reduction initiatives / International Strategy for Disaster Reduction (ISDR). 2004 version. New York: United Nations.

James, Oliver; Lodge, Martin (2003): The Limitations of 'Policy Transfer' and 'Lesson Drawing' for Public Policy Research. In *Political Studies Review* 1 (2), pp. 179–193. DOI: 10.1111/1478-9299.t01-1-00003.

Jim Davidson, M. C. Wong (2005): Guidelines on Integrating Severe Weather Warnings into Disaster Risk Management. World Meteorological Organization. Geneva (PWS-13 WMO/TD, 1292). Available online at https://library.wmo.int/pmb_ged/wmo-td_1292.pdf.

Kalton, Graham (1983): Introduction to Survey Sampling. Thousand Oaks, California. Available online at https://methods.sagepub.com/book/introduction-to-survey-sampling.

Kammerbauer, Mark; Minnery, John (2018): Risk communication and risk perception: lessons from the 2011 floods in Brisbane, Australia. In *Disasters*. DOI: 10.1111/disa.12311.

Kaplan, Andreas M.; Haenlein, Michael (2010): Users of the world, unite! The challenges and opportunities of Social Media. In *Business Horizons* 53 (1), pp. 59–68. DOI: 10.1016/j.bushor.2009.09.003.

Kish, L. (1968): Survey Sampling. London: John Wiley & Sons, Inc (10) (1).

Lapham, Robert (2015): Risk Analysis and Security Countermeasure Selection: CRC Press.

Liao, Kuei-Hsien (2014): From flood control to flood adaptation: a case study on the Lower Green River Valley and the City of Kent in King County, Washington. In *Nat Hazards* 71 (1), pp. 723–750.

Liebowitz, Stan J.; Zentner, Alejandro (2012): CLASH OF THE TITANS: DOES INTERNET USE REDUCE TELEVISION VIEWING? In *The Review of Economics and Statistics* 94 (1), pp. 234–245. Available online at http://www.jstor.org/stable/41349172.

Lipsman, Andrew; Mudd, Graham; Rich, Mike; Bruich, Sean (2012): The Power of "Like". In *JAR* 52 (1), pp. 40–52. DOI: 10.2501/JAR-52-1-040-052.

Loorbach, Derk (2002): Transition Management: Governance for Sustainability.

Loorbach, Derk (2010): Transition Management for Sustainable Development: A Prescriptive, Complexity-Based Governance Framework. In *Governance* 23 (1), pp. 161–183. DOI: 10.1111/j.1468-0491.2009.01471.x.

Loorbach, Derk; Rotmans, Jan (2010): The practice of transition management: Examples and lessons from four distinct cases. In *Futures* 42 (3), pp. 237–246. DOI: 10.1016/j.futures.2009.11.009.

Mamadouh, Virginie; Jong, Martin de; Lalenis, Konstantinos (2002): An introduction to institutional transplantation. In : The theory and practice of institutional transplantation: Springer, pp. 1–16.

May, Tim (2002): Qualitative research in action. 1 online resource (402 pages) : illustrations. London: SAGE.

Meyer, Volker; Scheuer, Sebastian; Haase, Dagmar (2009): A multicriteria approach for flood risk mapping exemplified at the Mulde river, Germany. In *Nat Hazards* 48 (1), pp. 17–39. DOI: 10.1007/s11069-008-9244-4.

Mintz, Anne P. (2012): Web of deceit. Misinformation and manipulation in the age of social media / edited by Anne P. Mintz. Medford, N.J.: CyberAge Books. Available online at http://catdir.loc.gov/catdir/enhancements/fy1116/2011033116-b.html.

Moe, Hallvard (2008): Dissemination and dialogue in the public sphere: a case for public service media online. In *Media, Culture & Society* 30 (3), pp. 319–336. DOI: 10.1177/0163443708088790.

Moore, Mark Harrison (1995): Creating public value: Strategic management in government: Harvard university press.

Murphy, Allan H.; Lichtenstein, Sarah; Fischhoff, Baruch; Winkler, Robert L. (1980): Misinterpretations of Precipitation Probability Forecasts. In *Bull. Amer. Meteor. Soc.* 61 (7), pp. 695–701. DOI: 10.1175/1520-0477(1980)061<0695:MOPPF>2.0.CO;2.

Netten, Niels; van Someren, Maarten (2011): Improving Communication in Crisis Management by Evaluating the Relevance of Messages. In *Journal of Contingencies and Crisis Management* 19 (2), pp. 75–85. DOI: 10.1111/j.1468-5973.2011.00636.x.

Ngini, Chukwuma U.; Furnell, Steven M.; Ghita, Bogdan V. (2002): Assessing the global accessibility of the Internet. In *Internet Research* 12 (4), pp. 329–338. DOI: 10.1108/10662240210438399.

Obar, Jonathan A.; Wildman, Steven S. (2015): Social Media Definition and the Governance Challenge - An Introduction to the Special Issue. In *SSRN Journal*. DOI: 10.2139/ssrn.2663153.

O'Flynn, Janine (2007): From new public management to public value: Paradigmatic change and managerial implications. In *Australian journal of public administration* 66 (3), pp. 353–366.

Onghena, Patrick; Maes, Bea; Heyvaert, Mieke (2018): Mixed Methods Single Case Research: State of the Art and Future Directions. In *Journal of Mixed Methods Research*, 1558689818789530. DOI: 10.1177/1558689818789530.

Oxford Dictionary (2019): Communication. Oxford Dictionaries. Available online at https://en.oxforddictionaries.com/definition/communication, checked on 4/19/2019.

Peters, B. Guy; Pierre, Jon; King, Desmond S. (2005): The Politics of Path Dependency: Political Conflict in Historical Institutionalism. In *The Journal of Politics* 67 (4), pp. 1275–1300. DOI: 10.1111/j.1468-2508.2005.00360.x.

Renn, Ortwin (2011): The social amplification/attenuation of risk framework: application to climate change. In *WIREs Clim Change* 2 (2), pp. 154–169. DOI: 10.1002/wcc.99.

Ridder, Hans-Gerd; Yin, Robert K. (2012): Case Study Research. Design and Methods. In *Zeitschrift für Personalforschung / German Journal of Research in Human Resource Management* 26 (1), pp. 93–95. Available online at http://www.jstor.org/stable/23279888.

Rittel, Horst W. J.; Webber, Melvin M. (1973): Dilemmas in a general theory of planning. In *Policy sciences* 4 (2), pp. 155–169.

Rollason, E.; Bracken, L. J.; Hardy, R. J.; Large, A. R. G. (2018): Rethinking flood risk communication. In *Nat Hazards* 92 (3), pp. 1665–1686. DOI: 10.1007/s11069-018-3273-4.

Roo, Gert de (2018): Ordering Principles in a Dynamic World of Change – On social complexity, transformation and the conditions for balancing purposeful interventions and spontaneous change. In *Progress in Planning* 125, pp. 1–32. DOI: 10.1016/j.progress.2017.04.002.

Rose, Richard (1991): What is lesson-drawing? In *Journal of public policy* 11 (1), pp. 3–30.

Rose, Richard (2002): Ten steps in lesson-drawing: A guide to learning from abroad: European University Institute.

Rotmans, Jan; Kemp, René; van Asselt, Marjolein (2001): More evolution than revolution: transition management in public policy. In *Foresight* 3 (1), pp. 15–31. DOI: 10.1108/14636680110803003.

Rotmans, Jan; Loorbach, Derk (2009): Complexity and Transition Management. In *Journal of Industrial Ecology* 13 (2), pp. 184–196. DOI: 10.1111/j.1530-9290.2009.00116.x.

Scholz, Frederike; Yalcin, Betul; Priestley, Mark (2017): Internet access for disabled people: Understanding socio-relational factors in Europe. In *CP* 11 (1). DOI: 10.5817/CP2017-1-4.

Scott, David Meerman; Scott, David Meerman. New rules of marketing and PR (2011): The new rules of marketing & PR. How to use social media, online video, mobile applications, blogs, news releases, & viral marketing to reach buyers directly / David Meerman Scott. 3rd ed. Hoboken, N.J.: Wiley; Chichester : John Wiley [distributor].

Short, John; Williams, Ederyn; Christie, Bruce (1976): The social psychology of telecommunications. London: Wiley.

Slovic (1987): Percepotion of Risk. In *Science* (236), pp. 280–285. Available online at http://www.heatherlench.com/wp-content/uploads/2008/07/slovic.pdf.

Slovic, Paul (2000): The perception of risk. London: Earthscan Publications (Risk, society, and policy series).

Slovic, Paul; Finucane, Melissa; Peters, Ellen; MacGregor, Donald G. (2002): Rational actors or rational fools: implications of the affect heuristic for behavioral economics. In *The Journal of Socio-Economics* 31 (4), pp. 329–342. DOI: 10.1016/S1053-5357(02)00174-9.

Sorensen, Andre (2015): Taking path dependence seriously: an historical institutionalist research agenda in planning history. In *Planning Perspectives* 30 (1), pp. 17–38.

Stoker, Gerry (2006): Public value management: a new narrative for networked governance? In *The American review of public administration* 36 (1), pp. 41–57.

Travis, Richard W.; Riebsame, William E. (1979): Communicating environmental uncertainty: The nature of weather forecasts. In *Journal of Geography* 78 (5), pp. 168–172. DOI: 10.1080/00221347908979982.

van Dijk, Jan; Hacker, Kenneth (2003): The Digital Divide as a Complex and Dynamic Phenomenon. In *The Information Society* 19 (4), pp. 315–326. DOI: 10.1080/01972240309487.

Vickery, Graham; Wunsch-Vincent, Sacha (2007): Participative web and user-created content. Web 2.0, wikis and social networking / [Sacha Wunsch-Vincent, Graham Vickery]. Paris: Organisation for Economic Co-operation and Development.

Voß, Jan-Peter; Bornemann, Basil (2011): The Politics of Reflexive Governance. Challenges for Designing Adaptive Management and Transition Management. In *Ecology and Society* 16 (2). Available online at http://www.jstor.org/stable/26268901.

Wang, Zhaoli; Lai, Chengguang; Chen, Xiaohong; Yang, Bing; Zhao, Shiwei; Bai, Xiaoyan (2015): Flood hazard risk assessment model based on random forest. In *Journal of Hydrology* 527, pp. 1130–1141. DOI: 10.1016/j.jhydrol.2015.06.008.

Webster, Frank; Halcli, Abigail; Browning, Gary K. (2000): Understanding Contemporary Society : Theories of the Present. London: SAGE Publications Ltd. Available online at http://search.ebscohost.com.proxy-ub.rug.nl/login.aspx?direct=true&db=nlebk&AN=268605&site=ehost-live&scope=site.

Wehn, Uta; Rusca, Maria; Evers, Jaap; Lanfranchi, Vitavesca (2015): Participation in flood risk management and the potential of citizen observatories: A governance analysis. In *Environmental Science & Policy* 48, pp. 225–236. DOI: 10.1016/j.envsci.2014.12.017.

Willbur Lang Schramm (1954): The process and effects of mass communication. Urbana: University of Illinois Press.

Yin, Robert K. (2017): Case study research and applications. Design and methods / Robert K. Yin. Sixth edition. Los Angeles: SAGE.

Yin, Robert K.; Davis, Darnella (2007): Adding new dimensions to case study evaluations: The case of evaluating comprehensive reforms. In *New Directions for Evaluation* 2007 (113), pp. 75–93. DOI: 10.1002/ev.216.

Appendix

Number	Question1 Are you living or working in Germany or are you visiting it occasionally?	Question 2 Is your area, as in your city, village or travelling route prone to flooding?	Question 3 How often do you check weather forecasts?	Question 4 Are you particularly interested in more specific information concerning extreme weather events such as heavy rainfall or storm surges in your area?	Question 5 If you replied affirmatively to question 4., to what extent do you utilize social media (such as, but not exclusively, Facebook, Twitter, Instagram or Snapchat) to receive information?	Question 6 Are you actively spreading information about extreme weather events on social media?	Question 7 Have you heard about the emergency information app of the German ministry of civil protection called "NINA"? If so, do you use it?
1	No	Yes	Only on special occasions	Yes, I am actively seeking information to be prepared for the situation.	I do not use social media at all.	I do not spread that kind of information on social media at all.	I have never heard of the app.
2	No	I am unsure.	Regularly	No, I am not particularly interested.	NO ANSWER	I use social media to spread this kind of information on special occasions only.	I have never heard of the app.
3	No	No, flooding is not a concern in this area.	Only on special occasions	If I get informed, I am interested but I do not put effort into seeking out for information.	NO ANSWER	I use social media to spread this kind of information on special occasions only.	I have never heard of the app.
4	No	Yes	Regularly	No, I am not particularly interested.	NO ANSWER	I do not spread that kind of information on social media at all.	I have never heard of the app.
5	No	Yes	Every day	No, I am not particularly interested.	NO ANSWER	I use social media to spread this kind of information on special occasions only.	I have never heard of the app.
6	No	Yes	Regularly	No, I am not particularly interested.	NO ANSWER	I do not spread that kind of information on social media at all.	I have never heard of the app.
7	No	Yes	Only on special occasions	No, I am not particularly interested.	NO ANSWER	I do not spread that kind of information on social media at all.	I have heard of the app but do not use it.
8	No	I am unsure.	Regularly	Yes, I schedule to catch broadcasted news.	NO ANSWER	I use social media to spread this kind of information on special occasions only.	I have never heard of the app.
9	No	Yes	Every day	No, I am not particularly interested.	NO ANSWER	I do not spread that kind of information on social media at all.	I have never heard of the app.
10	No	No, flooding is not a concern in this area.	Every day	If I get informed, I am interested but I do not put effort into seeking out for information.	I exclusively use social media as my source of information.	I do not spread that kind of information on social media at all.	I have never heard of the app.
11	No	I am unsure.	Regularly	No, I am not particularly interested.	NO ANSWER	I do not spread that kind of information on social media at all.	I have never heard of the app.
12	No	Yes	Regularly	No, I am not particularly interested.	I do not use social media at all.	I do not spread that kind of information on social media at all.	I have never heard of the app.
13	No	I am unsure.	Every day	No, I am not particularly interested.	I use social media as my main source of information but check back with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.
14	No	Yes	Regularly	No, I am not particularly interested.	NO ANSWER	I use social media to spread this kind of information on special occasions only.	I have never heard of the app.
15	Yes	Yes	Never	Yes, I am actively seeking information to be prepared for the situation.	I do not use social media to receive information.	I do not spread that kind of information on social media at all.	I have never heard of the app.
16	Yes	I am unsure.	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I exclusively use social media as my source of information.	I do not spread that kind of information on social media at all.	I have never heard of the app.

Number	Q1	Q2	Q3	Q4	Q5	Q6	Q7
17	Yes	I am unsure.	Every day	If I get informed, I am interested but I do not put effort into seeking out for information.	I do not use social media to receive information.	I use social media to spread this kind of information on special occasions only.	I have never heard of the app.
18	Yes	I am unsure.	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I do not use social media to receive information.	I do not spread that kind of information on social media at all.	I have never heard of the app.
19	Yes	I am unsure.	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I do not use social media at all.	I do not spread that kind of information on social media at all.	I have never heard of the app.
20	Yes	Yes	Only on special occasions	Yes, I schedule to catch broadcasted news.	I use social media as my main source of information but check back with other sources.	I do not spread that kind of information on social media at all.	I have heard of the app but do not use it.
21	Yes	Yes	Every day	Yes, I schedule to catch broadcasted news.	I use social media as my main source of information but check back with other sources.	I use social media to spread this kind of information on special occasions only.	I have heard of the app but do not use it.
22	Yes	I am unsure.	Every day	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I use social media to spread this kind of information on special occasions only.	I use the app occasionally or when other information channels trigger me to do so.
23	Yes	Yes	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I do not use social media at all.	I do not spread that kind of information on social media at all.	I have never heard of the app.
24	Yes	Yes	Never	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I use social media to spread this kind of information on special occasions only.	I have never heard of the app.
25	Yes	No, flooding is not a concern in this area.	Regularly	Yes, I schedule to catch broadcasted news.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.
26	Yes	Yes	Only on special occasions	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media as my main source of information but check back with other sources.	I use social media to spread this kind of information on special occasions only.	I have never heard of the app.
27	Yes	Yes	Regularly	Yes, I schedule to catch broadcasted news.	I use social media occasionally and in combination with other sources.	I use social media to spread this kind of information on special occasions only.	I use the app occasionally or when other information channels trigger me to do so.
28	Yes	Yes	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I exclusively use social media as my source of information.	I do not spread that kind of information on social media at all.	I have never heard of the app.
29	Yes	I am unsure.	Regularly	Yes, I schedule to catch broadcasted news.	I do not use social media at all.	I do not spread that kind of information on social media at all.	I have never heard of the app.
30	Yes	I am unsure.	Every day	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media as my main source of information but check back with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.
31	Yes	I am unsure.	Every day	Yes, I schedule to catch broadcasted news.	I use social media as my main source of information but check back with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.
32	Yes	Yes	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media as my main source of information but check back with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.
33	Yes	Yes	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.
34	Yes	Yes	Only on special occasions	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media as my main source of information but check back with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.

#							
35	Yes	No, flooding is not a concern in this area.	Every day	Yes, I schedule to catch broadcasted news.	I do not use social media to receive information.	I use social media to spread this kind of information on special occasions only.	I have never heard of the app.
36	Yes	I am unsure.	Regularly	If I get informed, I am interested but I do not put effort into seeking for information.	I do not use social media to receive information.	I do not spread that kind of information on social media at all.	I have heard of the app but do not use it.
37	Yes	I am unsure.	Regularly	If I get informed, I am interested but I do not put effort into seeking for information.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I have heard of the app but do not use it.
38	Yes	Yes	Only on special occasions	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I have heard of the app but do not use it.
39	Yes	I am unsure.	Regularly	Yes, I am actively seeking information to be prepared for the situation.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I have heard of the app but do not use it.
40	Yes	Yes	Only on special occasions	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I use social media to spread this kind of information on special occasions only.	I have never heard of the app.
41	Yes	I am unsure.	Only on special occasions	If I get informed, I am interested but I do not put effort into seeking out for information.	I do not use social media at all.	I use social media to spread this kind of information on special occasions only.	I have heard of the app but do not use it.
42	Yes	Yes	Only on special occasions	Yes, I schedule to catch broadcasted news.	I use social media as my main source of information but check back with other sources.	I use social media to spread this kind of information on special occasions only.	I have never heard of the app.
43	Yes	Yes	Every day	If I get informed, I am interested but I do not put effort into seeking out for information.	I do not use social media to receive information.	I use social media to spread this kind of information on special occasions only.	I have never heard of the app.
44	Yes	No, flooding is not a concern in this area.	Only on special occasions	Yes, I schedule to catch broadcasted news.	I use social media as my main source of information but check back with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.
45	Yes	Yes	Every day	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.
46	Yes	No, flooding is not a concern in this area.	Regularly	Yes, I schedule to catch broadcasted news.	I do not use social media at all.	I use social media to spread this kind of information on special occasions only.	I have heard of the app but do not use it.
47	Yes	I am unsure.	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I exclusively use social media as my source of information.	I use social media to spread this kind of information on special occasions only.	I use the app occasionally or when other information channels trigger me to do so.
48	Yes	Yes	Every day	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I have heard of the app but do not use it.
49	Yes	I am unsure.	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.
50	Yes	I am unsure.	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I use social media to spread this kind of information on special occasions only.	I have never heard of the app.
51	Yes	Yes	Never	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I use the app occasionally or when other information channels trigger me to do so.
52	Yes	No, flooding is not a concern in this area.	Only on special occasions	No, I am not particularly interested.	I use social media occasionally and in combination with other sources.	I use social media to spread this kind of information on special occasions only.	I have heard of the app but do not use it.

#							
53	Yes	Yes	Every day	Yes, I am actively seeking information to be prepared for the situation.	I do not use social media to receive information.	I use social media to spread this kind of information on special occasions only.	I have heard of the app but do not use it.
54	Yes	Yes	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media as my main source of information but check back with other sources.	I use social media to spread this kind of information on special occasions only.	I use the app occasionally or when other information channels trigger me to do so.
55	Yes	No, flooding is not a concern in this area.	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I do not use social media at all.	I do not spread that kind of information on social media at all.	I use the app extensively to stay informed.
56	Yes	I am unsure.	Regularly	Yes, I schedule to catch broadcasted news.	I do not use social media to receive information.	I use social media to spread this kind of information on special occasions only.	I have heard of the app but do not use it.
57	Yes	I am unsure.	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I exclusively use social media as my source of information.	I use social media to spread this kind of information on special occasions only.	I have never heard of the app.
58	Yes	Yes	Never	If I get informed, I am interested but I do not put effort into seeking out for information.	I do not use social media at all.	I use social media to spread this kind of information on special occasions only.	I have heard of the app but do not use it.
59	Yes	Yes	Only on special occasions	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media as my main source of information but check back with other sources.	I do not spread that kind of information on social media at all.	I have heard of the app but do not use it.
60	Yes	Yes	Only on special occasions	Yes, I am actively seeking information to be prepared for the situation.	I exclusively use social media as my source of information.	I do not spread that kind of information on social media at all.	I have never heard of the app.
61	Yes	Yes	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media as my main source of information but check back with other sources.	I use social media to spread this kind of information on special occasions only.	I use the app extensively to stay informed.
62	Yes	No, flooding is not a concern in this area.	Never	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.
63	Yes	I am unsure.	Every day	Yes, I schedule to catch broadcasted news.	I use social media as my main source of information but check back with other sources.	I do not spread that kind of information on social media at all.	I have heard of the app but do not use it.
64	Yes	I am unsure.	Every day	If I get informed, I am interested but I do not put effort into seeking out for information.	I do not use social media to receive information.	I do not spread that kind of information on social media at all.	I have never heard of the app.
65	Yes	Yes	Every day	Yes, I schedule to catch broadcasted news.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.
66	Yes	No, flooding is not a concern in this area.	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I have heard of the app but do not use it.
67	Yes	I am unsure.	Regularly	Yes, I schedule to catch broadcasted news.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I have heard of the app but do not use it.
68	Yes	No, flooding is not a concern in this area.	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I do not use social media to receive information.	I use social media to spread this kind of information on special occasions only.	I have never heard of the app.
69	Yes	Yes	Only on special occasions	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I use social media to spread this kind of information on special occasions only.	I have never heard of the app.
70	Yes	Yes	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I do not use social media at all.	I do not spread that kind of information on social media at all.	I have never heard of the app.

#							
71	Yes	Yes	Only on special occasions	No, I am not particularly interested.	I use social media as my main source of information but check back with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.
72	Yes	No, flooding is not a concern in this area.	Only on special occasions	Yes, I schedule to catch broadcasted news.	I do not use social media to receive information.	I do not spread that kind of information on social media at all.	I have never heard of the app.
73	Yes	No, flooding is not a concern in this area.	Regularly	Yes, I schedule to catch broadcasted news.	I use social media as my main source of information but check back with other sources.	I use social media to spread this kind of information on special occasions only.	I use the app occasionally or when other information channels trigger me to do so.
74	Yes	Yes	Only on special occasions	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I have heard of the app but do not use it.
75	Yes	Yes	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.
76	Yes	Yes	Only on special occasions	If I get informed, I am interested but I do not put effort into seeking out for information.	I do not use social media to receive information.	I do not spread that kind of information on social media at all.	I use the app occasionally or when other information channels trigger me to do so.
77	Yes	I am unsure.	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.
78	Yes	No, flooding is not a concern in this area.	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I use social media to spread this kind of information on special occasions only.	I have heard of the app but do not use it.
79	Yes	I am unsure	Only on special occasions	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I use social media to spread this kind of information on special occasions only.	I have never heard of the app.
80	Yes	Yes	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I use social media to spread this kind of information on special occasions only.	I have never heard of the app.
81	Yes	I am unsure.	Only on special occasions	Yes, I schedule to catch broadcasted news.	I do not use social media at all.	I use social media to spread this kind of information on a regular basis	I have never heard of the app.
82	Yes	I am unsure.	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I do not use social media at all.	I do not spread that kind of information on social media at all.	I have never heard of the app.
83	Yes	I am unsure.	Only on special occasions	If I get informed, I am interested but I do not put effort into seeking out for information.	I do not use social media to receive information.	I use social media to spread this kind of information on special occasions only.	I have never heard of the app.
84	Yes	I am unsure.	Regularly	Yes, I schedule to catch broadcasted news.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.
85	Yes	Yes	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I do not use social media to receive information.	I do not spread that kind of information on social media at all.	I have never heard of the app.
86	Yes	I am unsure.	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.
87	Yes	Yes	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I do not use social media at all.	I use social media to spread this kind of information on special occasions only.	I have never heard of the app.
88	Yes	I am unsure.	Every day	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.

#							
89	Yes	I am unsure.	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.
90	Yes	Yes	Only on special occasions	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I use social media to spread this kind of information on special occasions only.	I have never heard of the app.
91	Yes	Yes	Only on special occasions	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I use social media to spread this kind of information on special occasions only.	I use the app occasionally or when other information channels trigger me to do so.
92	Yes	I am unsure.	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I use social media to spread this kind of information on special occasions only.	I have heard of the app but do not use it.
93	Yes	Yes	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I do not use social media to receive information.	I do not spread that kind of information on social media at all.	I have heard of the app but do not use it.
94	Yes	Yes	Regularly	Yes, I schedule to catch broadcasted news.	I do not use social media to receive information.	I do not spread that kind of information on social media at all.	I have never heard of the app.
95	Yes	Yes	Only on special occasions	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I use social media to spread this kind of information on special occasions only.	I have never heard of the app.
96	Yes	Yes	Every day	Yes, I am actively seeking information to be prepared for the situation.	I do not use social media to receive information.	I do not spread that kind of information on social media at all.	I have heard of the app but do not use it.
97	Yes	Yes	Never	Yes, I schedule to catch broadcasted news.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.
98	Yes	I am unsure.	Only on special occasions	If I get informed, I am interested but I do not put effort into seeking out for information.	I do not use social media to receive information.	I do not spread that kind of information on social media at all.	I have never heard of the app.
99	Yes	I am unsure.	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.
100	Yes	I am unsure.	Regularly	Yes, I am actively seeking information to be prepared for the situation.	I do not use social media to receive information.	I use social media to spread this kind of information on special occasions only.	I have never heard of the app.
101	Yes	I am unsure.	Every day	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I use social media to spread this kind of information on a regular basis	I have never heard of the app.
102	Yes	I am unsure.	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I use social media to spread this kind of information on special occasions only.	I use the app occasionally or when other information channels trigger me to do so.
103	Yes	Yes	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	NO ANSWER	I do not spread that kind of information on social media at all.	I use the app extensively to stay informed.
104	Yes	Yes	Regularly	Yes, I schedule to catch broadcasted news.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.
105	Yes	Yes	Never	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media as my main source of information but check back with other sources.	I do not spread that kind of information on social media at all.	I have heard of the app but do not use it.
106	Yes	Yes	Never	Yes, I schedule to catch broadcasted news.	I use social media occasionally and in combination with other sources.	I use social media to spread this kind of information on special occasions only.	I have never heard of the app.

#							
107	Yes	Yes	Every day	Yes, I am actively seeking information to be prepared for the situation.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.
108	Yes	I am unsure.	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.
109	Yes	I am unsure.	Only on special occasions	Yes, I schedule to catch broadcasted news.	I use social media occasionally and in combination with other sources.	I use social media to spread this kind of information on special occasions only.	I have heard of the app but do not use it.
110	Yes	Yes	Regularly	Yes, I schedule to catch broadcasted news.	I exclusively use social media as my source of information.	I use social media to spread this kind of information on special occasions only.	I have never heard of the app.
111	Yes	Yes	Regularly	Yes, I schedule to catch broadcasted news.	I use social media occasionally and in combination with other sources.	I use social media to spread this kind of information on special occasions only.	I have never heard of the app.
112	Yes	I am unsure.	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I use social media to spread this kind of information on special occasions only.	I have never heard of the app.
113	Yes	Yes	Only on special occasions	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.
114	Yes	Yes	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I use social media to spread this kind of information on a regular basis	I have never heard of the app.
115	Yes	Yes	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.
116	Yes	I am unsure.	Only on special occasions	Yes, I schedule to catch broadcasted news.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.
117	Yes	Yes	Every day	Yes, I schedule to catch broadcasted news.	NO ANSWER	I use social media to spread this kind of information on special occasions only.	I have never heard of the app.
118	Yes	Yes	Only on special occasions	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I have heard of the app but do not use it.
119	Yes	Yes	Only on special occasions	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I use social media to spread this kind of information on a regular basis	I have never heard of the app.
120	Yes	I am unsure.	Only on special occasions	Yes, I schedule to catch broadcasted news.	I use social media occasionally and in combination with other sources.	I use social media to spread this kind of information on special occasions only.	I have never heard of the app.
121	Yes	I am unsure.	Every day	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.
122	Yes	Yes	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.
123	Yes	Yes	Only on special occasions	If I get informed, I am interested but I do not put effort into seeking out for information.	I do not use social media to receive information.	I do not spread that kind of information on social media at all.	I use the app extensively to stay informed.
124	Yes	No, flooding is not a concern in this area.	Never	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I use social media to spread this kind of information on special occasions only.	I have never heard of the app.

#							
125	Yes	No, flooding is not a concern in this area.	Every day	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I have heard of the app but do not use it.
126	Yes	Yes	Only on special occasions	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media as my main source of information but check back with other sources.	I do not spread that kind of information on social media at all.	I have heard of the app but do not use it.
127	Yes	Yes	Only on special occasions	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media as my main source of information but check back with other sources.	I use social media to spread this kind of information on special occasions only.	I have heard of the app but do not use it.
128	Yes	I am unsure.	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media as my main source of information but check back with other sources.	I do not spread that kind of information on social media at all.	I use the app occasionally or when other information channels trigger me to do so.
129	Yes	I am unsure.	Regularly	Yes, I schedule to catch broadcasted news.	I use social media as my main source of information but check back with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.
130	Yes	Yes	Regularly	Yes, I schedule to catch broadcasted news.	I use social media as my main source of information but check back with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.
131	Yes	Yes	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media as my main source of information but check back with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.
132	Yes	I am unsure.	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I exclusively use social media as my source of information.	I use social media to spread this kind of information on special occasions only.	I have never heard of the app.
133	Yes	I am unsure.	Never	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.
134	Yes	I am unsure.	Never	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I use social media to spread this kind of information on special occasions only.	I have never heard of the app.
135	Yes	Yes	Every day	If I get informed, I am interested but I do not put effort into seeking out for information.	I exclusively use social media as my source of information.	I do not spread that kind of information on social media at all.	I use the app occasionally or when other information channels trigger me to do so.
136	Yes	Yes	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.
137	Yes	Yes	Every day	If I get informed, I am interested but I do not put effort into seeking out for information.	I exclusively use social media as my source of information.	I use social media to spread this kind of information on special occasions only.	I have never heard of the app.
138	Yes	Yes	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.
139	Yes	Yes	Every day	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I use social media to spread this kind of information on special occasions only.	I have heard of the app but do not use it.
140	Yes	Yes	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I do not use social media to receive information.	I use social media to spread this kind of information on special occasions only.	I have never heard of the app.
141	Yes	No, flooding is not a concern in this area.	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I do not use social media to receive information.	I do not spread that kind of information on social media at all.	I have heard of the app but do not use it.
142	Yes	Yes	Only on special occasions	If I get informed, I am interested but I do not put effort into seeking out for information.	I do not use social media at all.	I do not spread that kind of information on social media at all.	I have never heard of the app.

#							
143	Yes	Yes	Regularly	Yes, I schedule to catch broadcasted news.	I use social media occasionally and in combination with other sources.	I use social media to spread this kind of information on special occasions only.	I use the app occasionally or when other information channels trigger me to do so.
144	Yes	I am unsure.	Every day	Yes, I schedule to catch broadcasted news.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I use the app extensively to stay informed.
145	Yes	Yes	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.
146	Yes	I am unsure.	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I use social media to spread this kind of information on special occasions only.	I have never heard of the app.
147	Yes	Yes	Only on special occasions	If I get informed, I am interested but I do not put effort into seeking out for information.	I do not use social media to receive information.	I use social media to spread this kind of information on special occasions only.	I have never heard of the app.
148	Yes	I am unsure.	Only on special occasions	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I use social media to spread this kind of information on special occasions only.	I have never heard of the app.
149	Yes	I am unsure.	Regularly	If I get informed, I am interested but I do not put effort into seeking out for information.	I do not use social media to receive information.	I use social media to spread this kind of information on special occasions only.	I use the app occasionally or when other information channels trigger me to do so.
150	Yes	I am unsure.	Only on special occasions	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media as my main source of information but check back with other sources.	I do not spread that kind of information on social media at all.	I have heard of the app but do not use it.
151	Yes	Yes	Only on special occasions	If I get informed, I am interested but I do not put effort into seeking out for information.	I do not use social media at all.	I use social media to spread this kind of information on special occasions only.	I have heard of the app but do not use it.
152	Yes	Yes	Regularly	Yes, I am actively seeking information to be prepared for the situation.	I do not use social media to receive information.	I do not spread that kind of information on social media at all.	I have never heard of the app.
153	Yes	Yes	Only on special occasions	If I get informed, I am interested but I do not put effort into seeking out for information.	I exclusively use social media as my source of information.	I use social media to spread this kind of information on special occasions only.	I have never heard of the app.
154	Yes	I am unsure.	Only on special occasions	Yes, I schedule to catch broadcasted news.	I use social media as my main source of information but check back with other sources.	I use social media to spread this kind of information on special occasions only.	I have heard of the app but do not use it.
155	Yes	Yes	Only on special occasions	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.
156	Yes	Yes	Regularly	Yes, I am actively seeking information to be prepared for the situation.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.
157	Yes	Yes	Only on special occasions	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.
158	Yes	Yes	Only on special occasions	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.
159	Yes	Yes	Regularly	Yes, I am actively seeking information to be prepared for the situation.	I use social media occasionally and in combination with other sources.	I use social media to spread this kind of information on special occasions only.	I have never heard of the app.
160	Yes	Yes	Only on special occasions	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I do not spread that kind of information on social media at all.	I have never heard of the app.

#							
161	Yes	Yes	Every day	If I get informed, I am interested but I do not put effort into seeking out for information.	I use social media occasionally and in combination with other sources.	I use social media to spread this kind of information on special occasions only.	I have never heard of the app.