The effect of shock events on collaboration and framing in cross-border flood risk management

A case study of the effects of the 2021 floods on collaboration between the Netherlands, Belgium and Germany

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Summary

In recent years, the frequency and intensity of extreme weather events have increased globally. Shock events will appear more frequently as a consequence of the anthropogenic influences on the climate. The aftermath of such events often exposes vulnerabilities in existing cross-border management frameworks and highlights the necessity for adaptive strategies. By examining the case of the 2021 floods in the Netherlands, Germany and Belgium. This study aims to shed light on how shock events influence collaboration in cross-border flood risk management and to identify factors that either facilitated or hindered effective collaboration and how the event influenced flood discourses. Lessons learned from this case study contribute insights to the broader discourse on adaptive governance, framing and resilience. To do this, the main research question was created: To what extent did the 2021 floods influence the collaboration between the Netherlands, Germany and Belgium in flood risk management and influence the flood risk management discourse? To conduct this research, qualitative methods were used. Methods such as semi-structured in-depth interviews, media analysis and content analysis. The internal validity of this research is in the fact that multiple interviews are conducted with experts from different organisations and backgrounds. The external validity of this research is also in the use of triangulation in the data collection.

The collaboration between the Netherlands, Germany and Belgium in committees such as the Meuse Commission and EMRIC proved to be insufficiently prepared for a cross-border crisis during the flood. Communication problems and national response dominated despite existing structures. The Netherlands considered the flood as a natural disaster and evaluated it thoroughly. Germany politicised the incident, while Belgium saw it as a government failure. Evaluations emphasised the need for better risk communication, warning systems and spatial adaptation. Nevertheless, cross-border cooperation remained limited, partly due to legislation. The EU region Meuse-Rhine advocates a stronger role for EMRIC. Reforms mainly took place nationally, which did not directly promote cross-border cooperation, especially in Belgium, where internal reforms were prioritised.

To answer the research question, the 2021 floods accelerated a shift in thinking about flood management: complete prevention is impossible, and living with water becomes central. Although cooperation between the Netherlands, Germany and Belgium increased, legislative obstacles and limited resources in Belgium hampered further cross-border collaboration in practice.

Limitations of this study include language barriers, limited time, limited sample size, and limited regional distribution in interviews. This may lead to bias. It is recommended that further research be conducted after the completion of currently ongoing projects. In other parts of the world, on citizen participation and the possibility of a cross-border crisis mandate.

Keywords: collaboration, framing, discourse, flood risk management, shock events.

Table of Contents

List of figures and tables

Chapter 1. Introduction

In this chapter, the research is introduced. Firstly, the context of the research will be described. Secondly, the problem statement will be discussed. Thirdly, the research aims, and research questions will be determined on the basis of the research problem. Lastly, the scientific and societal relevance of this research will be discussed.

1.1 Research context

In recent years the frequency and intensity of extreme weather events have increased globally. Such as the flooding of northwestern Europe in 2021, the extreme weather events in central Europe in 2024 and the floods in Valencia in 2024. Shock events will appear more frequently as a consequence of the anthropogenic influences on the climate (Bronstert, 2003). Shock events, characterised by their sudden onset and widespread consequences, can serve as pivotal moments that can either strengthen or strain collaborative mechanisms. The aftermath of such events often exposes vulnerabilities in existing cross-border management frameworks and highlights the necessity for adaptive strategies (Carter et al., 2021). The cross-border nature of many river systems requires effective collaboration among neighbouring countries for comprehensive flood risk management to be effective (Wiering et al., 2010).

The Netherlands, Belgium, and Germany, share a history of collaborative initiatives aimed at mitigating flood risks. The 2021 floods that took place in northwestern Europe, resulting in damage and several hundred victims in the countries of Belgium, Germany, France and the Netherlands (NOS, 2021a). Nuisance and damage has occurred in the flooded areas in the Netherlands, Belgium and Germany. Hundreds of thousands of residents have been affected, over 200 fatalities have been confirmed, and there are tens of billions of euros in damages (Expertise Netwerk Waterveiligheid, 2021). However, the 2021 floods, marked by their severity and impact, present an opportunity to assess the resilience and effectiveness of existing cross-border collaboration mechanisms. Understanding the dynamics of collaboration during and after such shock events enhances future preparedness and response strategies, potentially decreasing fatalities and damages (Williams et al., 2017).

1.2 Problem statement

The 2021 flood caused great financial losses. A damage expert has estimated that 433 million euros in damage occurred as a result of the 2021 floods in the Netherlands: 200 million euros in material damage and 200 million euros in business damage due to lost income (Deltares, 2023). In Germany, around 800 people have been injured and some are still missing. Thousands of inhabitants lost their homes. The total damage caused by the floods in the two states (North Rhine-Westphalia and Rhineland-Palatinate) is estimated at 30 billion euros (Duitsland Instituut, 2022). In Belgium, the damage from last summer's flood disaster is estimated to be 2.164 billion euros, spread over more than 70,000 damage cases (Vrtnws, 2021).

After the 2021 floods, the governments of the Netherlands, Germany and Belgium all classified the flood as a national disaster. The governments individually established a special financial compensation scheme for damages resulting from the floods and heavy rainfall that occurred from 14 to 16 July 2021 and 24 July 2021 (Ministerie van Algemene Zaken, 2024; Etaamb.Openjustice.Be, 2021; Stern, 2021). Additionally, to the compensation scheme, the Belgium government agreed to a list of projects advised by an environmental impact study (Etaamb.Openjustice.Be, 2021). The Dutch government provided additional financial support for those affected by the flood who have insufficient financial resources to pay the necessary double housing costs, to repair their home or have incurred debt (Ministerie van Algemene Zaken, 2024). The German government has created a development fund endowed with up to 30 billion euros. The money is intended to benefit damaged private households, businesses and other institutions and to repair infrastructure. Reconstruction of federal infrastructure, such as federal highways, is separately funded by the federal government (Stern, 2021). The countries had a different approach to reacting to the shock event.

During the shock event, there was a lot of uncertainty. It wasn't really clear how collaboration was, who was doing what, how countries were coordinating and responding to this event. There was a lack of coordination between different activities at various levels of flood management undertaken by governments. Combined with a lack of guidelines for the victims on how to behave during such a situation and a lack of guidelines for first responders. The countries were not aligned in responding and coordinating the flood event. Different management styles used by the countries during the flood event combined with bureaucracy hindered fast joint responses (Nick et al., 2023). The countries had a separate way of framing this event. This framing impacted the discourses around flood prevention management. During and after the flood event the uncertainty created opportunity for fake news, false communication and false rumours to occur and influence the discourse around flood risk management. There was even some action against relief forces (Fekete & Sandholz, 2021). Thus, there is a lot of uncertainty around the collaboration between the involved countries during the flood event and with a lot of areas for improvement. It is unclear how the 2021 floods influenced collaboration between the Netherlands, Germany and Belgium in flood risk management.

1.3 Research aim and question

By examining the case of the 2021 floods in the Netherlands, Germany and Belgium. This study aims to shed light on how shock events influence collaboration in cross-border flood risk management. There was an uncertain way the countries reacted. By examining the interaction, the collaboration between the countries and the way the countries framed the event during the 2021 floods. The research aims to identify factors that either facilitated or hindered effective collaboration and how the event influenced flood discourses. Lessons learned from this case study contribute insights to the broader discourse on adaptive governance, framing and resilience.

In order to research this, a main research question was created:

> To what extent did the 2021 flood events in Limburg influence the collaboration between the Netherlands, Germany and Belgium in flood risk management and influence the flood risk management discourse?

To answer the main research question, the following sub-questions were created and will be used:

1. How did the Netherlands, Germany and Belgium collaborate before and act during the 2021 floods?

The first sub-question identifies the situation before and during the 2021 floods in the Netherlands, Germany and Belgium. This will create an overview of the situation before the flood and clarify the collaboration between the countries during the floods. This sub-question establishes a baseline for the research.

2. How did the Netherlands, Germany and Belgium frame the shock event?

The second sub-question identifies how the media in the Netherlands, Germany and Belgium each framed the situation. To see if there are differences and similarities in the framing of the floods between the media in the different countries. And to see if, in combination with the other research questions, the framing influenced the collaboration and actions undertaken by the involved countries.

3. What lessons were learned after the 2021 floods?

The third sub-question identifies the lessons learned by the Netherlands, Germany and Belgium as a result of the 2021 floods. The sub-question examines what legislation, policies and practices have been altered or created as a consequence of the 2021 floods. This sub-question functions as a basis for the fourth research question.

4. To what extent did the learned lessons translate to changes in collaboration?

The fourth sub-question identifies how much of the insights gained by the Netherlands, Germany and Belgium translated into actual changes in legislation, policies and practices. And in what aspects these insights were neglected or put aside, to see which part of the collaboration could be improved.

1.4 Societal & scientific relevance

The societal relevance of this research lies in the understanding of the effect that shock effects have on collaboration in cross-border flood risk management. Shock events are expected to occur more frequently due to climate change. Improved knowledge could help authorities act more adequately when a similar shock event occurs. Improved knowledge aids people living in flood-prone areas by giving them a better understanding of the situation and the aid they can expect from authorities. It helps authorities improve collaboration and helps prevent and decrease the consequences of flooding. Authorities from different flood-prone regions can learn from this casus, improving the collaboration in their region. Effective collaboration cuts down costs and thereby reduces spending tax money (Elston et al., 2018). A better understanding of the influence of the media on the flood risk management discourse could help prevent fake news, false communication and false rumours from spreading.

The scientific relevance of this research lies in studying the impact of shock events on collaboration in cross-border flood risk management. Literature suggests that shock events could increase resilience by adapting dominant existing strategies or accelerating diversification of strategies (Kaufmann et al., 2016). This research checks if that was the case during the 2021 floods that occurred in the Netherlands, Germany and Belgium. It is uncertain what factors have hindered effective collaboration, during and after the flood, between the involved countries. This research aims to help identify those factors. During the shock event, different discourses were framed around the event by the countries. There is no clarity on how this difference enables or disables collaboration. Thus, there is uncertainty about how this different media framing influenced coordination, discourses and collaboration between the involved countries. The findings of this research provide more insights for refining collaborative strategies, fostering regional resilience, increasing knowledge on the influence of media framing and building a more adaptive framework for addressing the growing concern of floods across national boundaries.

1.5 Layout

The first chapter of this research introduces the problem context, the problem statement, the research aim, the research questions and the societal and scientific relevance. In the second chapter, relevant literature will be discussed in the literature review. The relevant theories will be discussed in the theoretical framework. The conceptual model will be discussed and operationalised. The third chapter explains the research strategy, research methods, data collection, data analysis, reliability and validity. The fourth chapter contains the results acquired from the data collection and analysis in connection with the research questions. The fifth chapter discusses the results found in chapter four. The sixth chapter concludes the research.

Chapter 2. Theoretical framework

In this chapter, the literature review and theoretical framework of this research will be discussed. The literature review consists of the three concepts: shock events, collaboration in flood risk management and framing. The theoretical framework will be discussed as well as the conceptual model.

2.1 Literature review

The literature review studies three concepts. The first concept is shock event, which consists of explaining what shock events are and more specific information about the 2021 shock event. The second concept is collaboration in flood risk management, which consists of what is understood by collaboration in flood risk management and a review of the paradigm change within flood risk management in Europe. The third concept is framing, which consists of the influence of framing during a shock event.

2.1.1 Shock events

According to Bonn and Rundle-Thiele (2007), the term shock event refers to an unexpected and sudden event that could cause considerable stress in an organisation. That could seriously affect and threaten the functioning and existence of the organisation. Opposed to decision-making during stable times, the decision-making process during shock events considers fewer in-depth analyses and a lower number of strategic alternatives (Bonn & Rundle-Thiele, 2007). Shock events sometimes open a window of opportunity that can allow different actors to introduce their innovative ideas. Therefore, shock events can be a starter for a significant transformational change. However, shock events can also strengthen the status quo (Kaufmann et al., 2016).

The decision-making during shock events is significantly influenced by the perceived level of uncertainty, combined with the narrowing options available and the urgency to act. The urgency to act during or after a shock event often causes an unlikelihood for the whole management structure to be involved in the decision-making process. The most common reaction, during or after a shock event, is to centralise the authority. Due to the time being a strictly limiting factor. The consensus-driven decision-making processes require too much time in such a scenario (Christensen & Kohls, 2003). The differences between decision-making processes in stable times versus during or after a shock event are displayed in Table 1. A shock event could increase resilience by an adaptation of dominant existing strategies or accelerating a diversification of strategies (Kaufmann et al., 2016).

Decision-making processes under different conditions

	In a stable environment	Following a shock event
Use of analysis	In-depth analysis of data, broad range of alternatives considered	Little analysis of data, small number of alternatives considered
Use of intuition	Limited use of intuition	Greater use of intuition and "gut feel"
Management involvement	CEO and senior management team	CEO and selected members of senior management team
Board involvement	Predominantly strategy approval, limited involvement in setting strategy	Heavily involved in setting strategy, responsible for strategy approval
Decision-making approach	Consultation	Limited consultation
Decision-making process	Comprehensive	Simplified
Speed of decision-making	Slow	Fast
Role of regulations	Major drawback	Can be quickly overcome

Table 1: Differences in decision making processes. Source: Bonn & Rundle-Thiele (2007)

The shock event that is focused on in this research is the flood that took place in Europe in July 2021. The flood took place in the northwestern interior of Central Europe, resulting in extensive damage and several hundred victims in the countries of Belgium, Germany, France, Italy, Luxembourg, the Netherlands, Austria, the United Kingdom and Switzerland. The floods were the result of persistent rain showers, which in turn were caused by a low-pressure area. Which remained in place for days.

Several rivers and streams flooded. The Belgian province of Liège and the German states of North Rhine-Westphalia and Rhineland-Palatinate were particularly hard hit (NOS, 2021a).

In the tributaries of the Meuse in Belgium and the Rhine in Germany, extremely enormous amounts of precipitation fell in a brief period. The rain fell in hilly areas and almost immediately became surface runoff water and was collected in the rivers via the shortest route. The riverside villages, laid at the bottom of the slopes, in the narrow river valleys of the Vesdre, Ahr and Sauer have been significantly damaged or destroyed. Major damage was also caused to the infrastructure. Hundreds of thousands of residents have been affected, more than 200 fatalities have been confirmed, and there are tens of billions of euros in damages. The damage is greatest in Belgium and Germany. These countries also had the highest number of fatalities. The situation in Belgium and Germany was more catastrophic than in the Netherlands, partly due to the larger amounts of precipitation, steeper terrain and faster-flowing rivers compared to the Netherlands (Expertise Netwerk Waterveiligheid, 2021).

2.1.2 Collaboration in flood risk management

Collaborative research can be used as a tool for multi-actor collaboration. The collaborative research could provide a more informal environment to discuss solutions, problems, perceptions, ambitions, and facts between groups of stakeholders in a legitimate and neutral setting (Van Herk et al., 2011). Collaborative research is achievable if stakeholders are willing to act and think beyond the boundaries of legislation and organisations. The collaborative attitude combined with personal and collaborative capacity is significant for successful collaborative research (Van Popering-Verkerk & Van Buuren, 2017). There are three levels of collaborative capacity: individual, organisational and network. The individual collaborative capacity is the person's collaborative attitude and motivation. The organisational capacity concerns the access to resources between collaborating partners and incentives for participants to contribute and collaborate. Network collaborative capacity establishes connections between actors outside the current network (Van Popering-Verkerk & Van Buuren, 2017). For a more detailed description of the collaborative capacities, see Table 2.

Collaborating with stakeholders is not the only necessity required for successful collaboration. Necessary resources such as (local) knowledge, sufficient time and budget and legitimacy need to be accessible to all collaborating stakeholders. Also, the organisational capacity is important. Organisational capacity is the ability to provision existing arrangements and procedures. This implies the development of new rules or the adjustment of already existing rules (Van Popering-Verkerk & Van Buuren, 2017).

Collaborative capacity at individual, organizational and network level.

Level	Collaborative capacity	Operationalization
Individual	People's capacity to think and act beyond boundaries	• People's capacity to acknowledge the relevance of other problem definitions • People's capacity to reflect upon the limitations of their own boundary judgments
	Collaborative attitude and motivation	• People's capacity to recognize the existence of mutual dependencies and the necessity of collaboration • People's capacity to motivate themselves and others to collaborate
	Connective leadership	• Leaders' capacity to manage a collaborative process • Leaders' capacity to combine individual interests in a collective ambition
Organizational	Access to resources between collaborating partners	• Access to financial and production resources and possibilities to put them together • Organizational provisions that facilitate access to knowledge • Organizational provisions that facilitate access to decision makers
	Incentives for collaboration	• Obligations for collaboration in procedures and arrangements • Rewarding incentives for collaboration in procedures and arrangements
Network	Constructive dialogues and mutual adjustment	• Provisions for actors to achieve open and enduring dialogues • Actors' capacity to achieve mutual adjustment of actions
	Mutual understanding and trust	• Mutual understanding between actors involved • Mutual trust between actors involved
	Establish connections with actors outside the network	• Opportunities for actors outside the network to become involved • Provisions to connect the process and outcomes of the pilot to relevant developments outside the pilot

Table 2 Collaborative capacity at individual, organisational and network level. Source: (Van popering-Verkerk & Van Buuren, 2017)

Evidence shows that the inclusion of stakeholders increases the shared understanding of a problem and its possible solutions, builds trust between the different stakeholders and enhances the legitimacy of the decisions made. Therefore, collaborative processes facilitate adaptive management through mutual learning and capacity building among and between stakeholders and scientists (Söderholm et al., 2017). Collaborative decision-making and social learning processes could play a significant role in increasing coping capacity and preparedness in sustainable flood risk management due to the various actors and stakeholders being involved (Evers et al., 2016).

Stakeholder participation does not come without hindrances and challenges. There is potential for difficulties with stakeholders' interest to participate, limitation of financial resources, limitation on the duration of the project and the stakeholders' spatial distribution (Almoradie et al., 2013). Hurlbert and Gupta (2015) have also identified flood preparation projects as a policy issue with a high agreement on the scientific level but with high disagreement on norms and values. A high level of participation for reaching consensus and so-called self-management could be required for success and to permit social learning processes in flood risk management (Evers et al., 2016).

In Europe, there is currently a paradigm shift taking place in the flood issues and flood risk governance discourses. This shift is characterised by moving away from flood protection and moving towards flood risk management. An explanation for this shift is the increase in floods and the increase in flood damage in recent decades. As a consequence of this shift, the EU Floods Directive was adopted. The EU Flood Directive requires EU members to assess a flood risk management plan, to start involving interested parties in the implementation phase of a process and a flood risk assessment (Evers et al., 2016).

In the EU Flood Directive economic, ecological and social aspects are interrelated and play crucial roles. The economic aspect consists of all the damages caused by floods. Such as damage to public infrastructure, hindrance of economic activity and damage to private property. The ecological aspect consists of the ecological functions' rivers have combined with ecological parameters for floods. The social aspect involves societal and personal vulnerability and potential personal damages such as injuries or fatalities (Evers et al., 2016). Since flood risk management depends on social factors such as preparedness, flood coping capacity and awareness. Communication and transparency between actors play a crucial role in successful flood risk collaboration (Evers et al., 2016).

The change in the paradigm implies that there is a shift to individualisation of social vulnerability and risk. Therefore, shifting from a top-down towards a participatory approach is crucial. In this regard, capacity building and participation processes can be considered an important prerequisite for flood risk management (Evers et al., 2016)

2.1.3 Framing

Shock events can create a new focus for political and public attention on the discourse surrounding the shock event. This could create a window of opportunity to adopt new policies. The media coverage surrounding the shock event could provoke questions about the quality of the public policies that should protect the people and their properties (Thistlethwaite et al., 2019).

Governmental actors and their critics will try to divert and escape the blame for the shock event. Blame is more likely to be attributed when core societal values are at stake (Albrecht, 2021). Therefore, a shock event causes a framing contest to interpret shock events, what their causes are, who is responsible and what lessons should be learned. All in a way that suits their political visions for future policy directions (Boin et al., 2009). Due to the uncertainty about how to best respond to a shock event, policymakers are often susceptible to arguments and narratives distributed by the media. The policy choices made by policymakers during a shock event are thereby influenced by the media framing of solubility and urgency of the problem (Thistlethwaite et al., 2019).

The public relies on (mass) media for political information (Simon & Xenos, 2000), especially during crisis periods. During these crisis periods, news media can frame the government's disaster management as a failure or as a success (Albrecht, 2021). The media creates awareness of the world people experience and imparts knowledge. The media not only create awareness of the world people experience but also the aspects of our existence which remain unexplained, hidden and unexperienced (Tankard, 2001). The media can influence public opinion by limiting and defining public discourses around a shock event. Which can narrow the scope of (policy) debate and can influence the political nature of a government's policy response altogether (Thistlethwaite et al., 2019). The media contributes towards the informal learning and sense-making of a community. The media is a powerful force for influencing public perceptions of risks, especially regarding flood events. The media plays a role at either the affected scale in physical and psychological coping or the recovery process (Bohensky & Leitch, 2013).

But as McNair (2009) points out, the media is not value-free. The media influences the policy processes and the public perception. Scholars have also shown that policy actors could use media to shape policy processes and outcomes (Adekola & Lamond, 2017). For framing events to catalyse learning and trigger adjustments, timing and context are also particularly important. For example, findings from formal inquiries could get overrun by a new election campaign or the start of a new political cycle (Bohensky & Leitch, 2013).

By examining how the shock event was framed in the media, an insight could be provided into the public perception of the shock event. For example, how the experience of a shock event frames perceptions about climate change and the government's ability to respond to shock events (Bohensky & Leitch, 2013). News media influence policy processes in two principal ways. Firstly, by selectively highlighting the number of issues. The media influences what is important and what is not important. The media focuses the attention of policymakers on a particular problem. If a shock event gets covered extensively, it is assumed by the public and policymakers to have significant societal relevance. Extensive publication informs and educates the public and creates a sense of urgency to react for policymakers (Thistlethwaite et al., 2019). Selective media coverage can create an incentive for policymakers to add new issues to the agenda or increase the attention already active issues get (Thistlethwaite et al., 2019).

Secondly, the media can frame an issue in ways designed to give a different meaning and increase noticeability. Media can emphasise specific attributes to influence certain audiences to let them understand the issue in a certain way. The attributes of policy issues are contested, and actors propose measures that align with their own biases and interests. Therefore, policy problems are socially constructed through public discourses. The news media play a central role in both shaping and reflecting these discourses. Thus, media framing also influences public attitudes and opinions (Thistlethwaite et al., 2019).

2.2 Theoretical framework

The main goal of the policy arrangement approach is to understand and analyse the ongoing institutionalisation of policy arrangements. As seen as the result of the interplay between interactions of actors and processes of political and social change (Arts et al., 2006). The four dimensions, illustrated in Figure 1, are strictly interrelated. So, a change in one factor affects all the other factors. Such a change can energise existing policy arrangements. The four aspects in this framework are actors, resources, rules of the game and discourses. The aspect actor consists of the actor on all levels, individual, actor collective and coalitions. The aspect resources consist of all available resources. For example, financial resources, available knowledge and organisational capacity. The aspect rules of the game consist of the procedural rules, the actual rules in power for political forms of interaction. The aspect discourses consist of the views that the involved actors have. The policy arrangement approach is a helpful tool for this research because it looks at the arrangement as a whole and helps see how a change in one aspect impacts the other aspects.

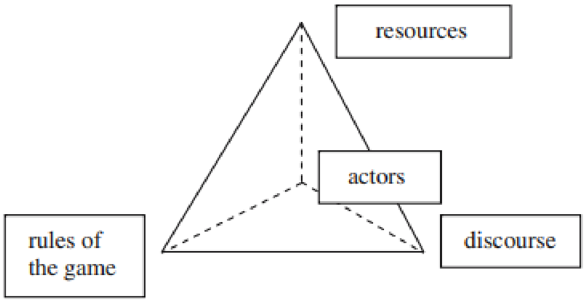

Figure 1: Policy Arrangement Approach. Source: (Arts et al., 2006)

The multiple streams framework made by Kingdon is illustrated in Figure 2. It explains how three problem streams influence the policy window and thus the government agenda. The three streams are the problem stream, the policy stream and the Political stream (Kingdon, 1995). The problem stream consists of the perceptions of issues that are public. Which, in this context, means that governmental action is required to resolve the problem. These issues often go paired with shock events such as a crisis or a flood. The shock event/crisis reaches the awareness of policymakers, often influenced by public opinion (Beland & Howlet, 2016). The policy stream consists of expert and analyst output that examines issues and proposes solutions. The political stream consists of factors that influence the political body. Such as interest group advocacy campaigns, swings in the national mood and legislative or executive turnover (Beland & Howlet, 2016). Policy windows, as described by Pal et al. (2020), are unpredictable openings in the policy process that create a possibility for influence over the direction and outcome of that process. The multiple streams framework can help this research in understanding how policy windows can be influenced by political and societal changes. The government agenda and the policy entrepreneur parts will be left out of the conceptual model of this research.

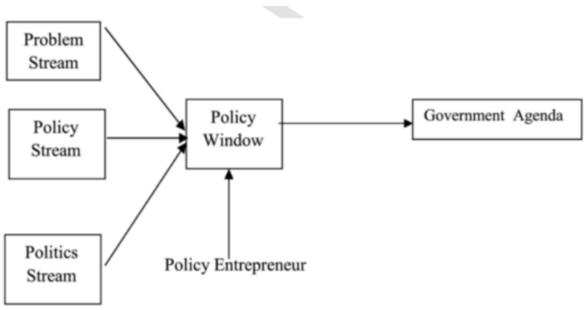

Figure 2: Multiple streams framework. Source (Kingdon, 1995)

The crisis as framing contest represents the constructed nature of crises, illustrated in Figure 3. Actors may react fundamentally differently to the same set of events. The framework distinguishes between 3 different reactions. The first is denial. In this reaction, the event is seen as an unfortunate incident. Therefore, there is no incentive to change politically or to change political repercussions (Boin et al., 2009). The second reaction is that the event is a threat to the collective good, which is embodied in the status quo. Thus, the reaction is to defend the current policymakers and tools against criticism. The third reaction is that such events are an excellent moment to reflect on the status quo and propose change (Boin et al., 2009). This framework can assist this research by gaining insight into the effect of crises/shock events on framing from the public. The values, interests and positions part of this framework will not be used in the conceptual model of this research. These factors are already included in the part used of the multiple stream framework by Kingdon.

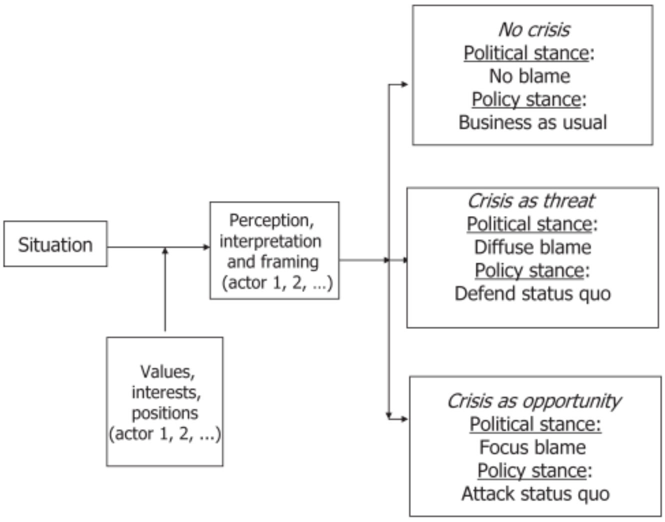

Figure 3: Crisis as framing contest. Source: (Boin et al., 2009)

2.3 Conceptual model

The Conceptual model, as illustrated in Figure 4, showcases fragments of the theoretical frameworks merged. The left side consists of a fragment of the crisis as a framing contest framework from Boin et al. (2009). The first three fragments are the no crisis, crisis as threat and crisis as opportunity components that influence the framing. The three components analyse how the media influence the framing. The framing directly influences the discourses about flood risk management. Both the framing and the discourses are directly influenced by the shock event. Discourses influence the opportunity for policy windows. The policy window is influenced by the problem stream, policy stream and political stream as derived from Kingdon's multiple stream framework. At last, the ability to collaborate is influenced by the available resources and the rules of the game. These fragments are derived from the policy arrangements approach from Arts et al. (2006).

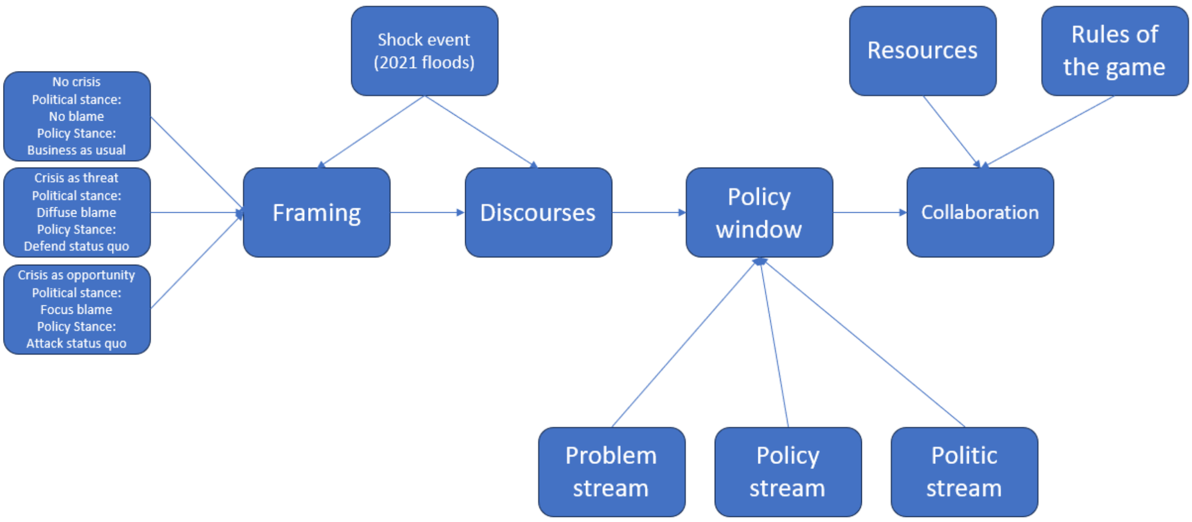

Figure 4: Conceptual model

The operationalisation of the conceptual model is illustrated in Table 3 below. The table consists of four columns. The column aspects consist of all the aspects found in the conceptual model. In the column indicators, the indicator for each aspect is briefly described. The column temporal dimension specifies how, if relevant, the temporal changes are studied. The column data source states the data source for each aspect. For more information about the data sources, see Chapter 3.2 and Chapter 3.3.

Aspects	Indicators	Temporal dimension	Data source
Framing	The number of risks, dangers and opportunities of the shock event as projected by the media and so experienced by the population.	The tone of the media during the flooding event and the frequency of specific narrative elements. Did the media deny, defend the status quo, or use it as a moment for change.	Media analysis + interviews
Shock event	The 2021 floods in the Netherlands, Belgium, and Germany.	Not relevant.	Content analysis
Discourse	The dominant storylines in policy documents, problem definitions and proposed solutions (e.g. prevention vs. response).	Difference in the dominant storylines, problem definitions and solutions compared to before the flooding event.	Media analysis + content analysis + interviews
Policy window	The willingness of policymakers to adjust current or create new policies. As well as the timing and presence of reforms, new funding, or institutional changes. And the influence of the media on emphasizing what policies need to be adjusted or created.	Difference in the policy window compared to before the flooding event.	Content analysis + interviews
Problem stream	Issues considering public safety.	How the flood influenced the perception of the issue considering public safety.	Media analysis + content analysis + interviews
Policy stream	Expert and analyst output that examines issues and proposes solutions .	New or revised policy proposals and evidence-based reports released after 2021 floods.	Content analysis + interviews
Politic stream	Interest group advocacy campaigns, swings in the national mood and legislative or executive turnover.	Difference in the politic stream compared to before the flooding event.	Media analysis
Collaboration	The corporation and coordination on policies, guidelines and protocols in flood risk management between the actors. The ability and willingness of actors to share resources.	Presence of new or strengthened joint agreements, joint exercises, joint working groups, or protocols. Improvement in cross-	Interviews + content analysis

		border information and resource-sharing practices.	
Resources	The financial, the organisational and the knowledge resources available in flood risk management projects.	Change in available resources after the flood event compared to before.	Content analysis + interviews
Rules of the game	The legislation and the standards on which the policies are based on. On European, national and regional level.	The creation of new legislation or the change of existing legislation.	Content analysis

Table 3: Operationalisation of the conceptual model

Chapter 3. Methodology

In this chapter, the methodology of this research is described. This is done by firstly describing the research strategy and methods. Afterwards, the data collection and the data analysis will be explained. Lastly, the validity and reliability of this research will be discussed.

3.1 Research strategy and methods

The research strategy is the logical procedure or the overall design of the research. There are four main research strategies: experiments, case studies, desk research and surveys (van Thiel, 2021). This research is a case study in combination with desk research. A case study is used to investigate a phenomenon in real life, it allows for investigation of what was planned to happen and what has happened (Noor, 2008). According to Goodrick et al. (2014), a comparative case study is suitable for research where there is a need to understand and explain how (certain) features influence policies and/or programs. When the understanding of a context is seen as important for understanding the success or failure of an intervention. And when there is an opportunity for iterative data collection and analysis. All these factors apply to this research.

Comparative case studies are qualitative in their nature. Therefore, this research has a qualitative nature. Comparative case studies are also specific in their nature. This research is a small specific case study. The research focuses only on the Netherlands, Germany and Belgium. To conduct this research, qualitative methods were used. Methods such as semi-structured in-depth interviews, media analysis and content analysis. This research consists of field research and desk research. The field research is conducted via interviews. The desk research is conducted via media analysis and content analysis.

3.2 Data collection and analysis

As mentioned in the research strategy and methods, the data was acquired via in-depth semi-structured interviews, content analysis and media analysis. The data acquired via content analysis was mostly found in policy documents and governmental websites. The data acquired via media analysis was found in articles about the 2021 floods and their consequences. For each country, the three major online newspapers were used, except in Belgium. There, the third biggest online newspaper had been replaced by a Wallonian newspaper. To broaden and diversify the information. For the in-depth semi-structured interview, an interview guide was created. The interviews were recorded, provided that the interviewee gave permission. The recorded interviews were transcribed. Most interviews were conducted in English or Dutch. Six interviews have been conducted for this research. For information about the interviewees, see Appendix 3.

For the first sub-question, mostly policy documents and governmental websites were used to assess the situation before the flood. For the situation during the flood, interviews combined with policy documents and governmental websites were used. For the second sub-question, a media analysis with an addition from information derived from the interviews was used. For the third sub-question, interviews were the main source of information in combination with policy documents. For the fourth sub-question, interviews combined with policy documents and governmental websites were the source of information.

According to Palic et al. (2016), qualitative data analysis is a process of the description, classification and interconnection of phenomena with the researcher’s concepts. Qualitative data analysis has three general aims. To describe phenomena in (greater) detail, to compare several cases on the differences between them or what they have in common and to develop a theory of the phenomenon from the analysis of empirical material.

The transcripts were coded to analyse the interviews. Atlas.ti was used for the coding. The transcripts were coded twice. Firstly, the transcript was open-coded, whereby interesting and relevant remarks made by the interviewees were coded. Secondly, the codes created in round one were categorised. And interrelations between codes or code groups were established. The media analysis was executed by text-mining the media articles. The results of the text mining were coded in Atlas.ti. From the codes, word frequencies, opinion mining and code document analysis were performed. The media articles used are displayed in Appendix 4. The Word Frequencies and the Opinion Mining are shown in Appendix 6. And the code document analysis is in Appendix 7. The results of the content analysis were analysed by studying the proposed changes, the counterarguments against those changes and the new policies that formed as a consequence of these changes.

3.3 Validity and reliability

The validity of research is divided into two components, the internal and external validity. The internal validity is the researcher measuring the data that he was supposed to measure. The external validity is about the generalisability of the research findings (van Thiel, 2021). The reliability of research is about the consistency and accuracy of the research findings. To verify that the results of the research are systematic and representative (van Thiel, 2021).

The internal validity of this research lies in the fact that multiple interviews were conducted with experts from different organisations and backgrounds. These interviewees were chosen on the basis of non-probability purposive sampling. Non-probability purposive sampling enables the researcher to select the interviewee based on some judgment. Enabling the researcher to seek representative interviewees (Wolf et al., 2016). The interview guide and transcripts ensure the internal validity of the interviews and can be found in Appendices 2 and 5. For the media analysis and the content analysis, text mining was used to ensure internal validity. The external validity of this research is the use of triangulation in data collection. During the coding of the collected data, coding cycles will ensure the external validity of the research. The coding cycles can be found in Appendix 4.

The reliability of the research is limited due to the nature of case studies, which often use a small number of units (Noor, 2008). To combat this, triangulation was used throughout the data collection. During the media analysis, the same process of acquiring the information from the newspapers in the three different nations ensures reliability. The coding scheme shows the systematic analysis of the interviews and systematic representation of the results, ensuring reliability.

Chapter 4. Results

In this chapter, the findings of the sub-questions will be answered with the gathered data. Each sub-question will be answered individually.

4.1 How did the Netherlands, Germany and Belgium collaborate before and act during the 2021 floods?

4.1.1 Before the floods

EU Member States are required to map flood-prone areas to identify the flood risks (Directive 2007/60/EC). Furthermore, member states are required to prepare flood management plans that include measures for protection, preparation and prevention (European Commission, z.d.). EU member states collaborate by exchanging information and data. The EU has provided numerous data- and information-exchanging networks and platforms for all its member states, such as the European Flood Awareness System (EFAS). This network provides flood forecasts up to 10 days in advance (Copernicus, z.d.). The Netherlands works with the information system LCMS, while Germany and Belgium use different systems. Belgian and German crisis officials do have access to the Dutch LCMS to take note of relevant information during a crisis (Wijkhuijs et al., 2021).

The EU financially supports Euregions with INTERREG funds. The Netherlands, Germany and Belgium are in several Euroregions together. In the Euroregion Meuse-Rhine, Euroregion Flanders-Netherlands and Euroregion Eems-Dollard (Wijkhuijs et al., 2021). The Euroregion is cross-border and creates partnerships between countries. The Euroregion Meuse-Rhine created the EMRIC (Euroregion Meuse-Rhine Incident Response and Crisis Management). Which is responsible for the fire brigade, technical assistance, emergency care, infectious disease control, disaster relief and crisis management within the Euroregion. EMRIC agency strives for improvements in, among other things, acute care, the exchange of information between control rooms and also provides joint exercises (Wijkhuijs et al., 2021; EMRIC, z.d.). The INTERREG funds were primarily used for joint projects, the preparation of projects and data exchange. These connections were not used during the 2021 flooding event (Interview 3).

The Netherlands, Germany, and Belgium work together in numerous committees regarding flood risk management and crisis management. Since 2002, the Netherlands, Germany and Belgium have been part of the International Meuse Commission (IMC). The IMC focuses on water management and flood risks. The IMC coordinates water management and plans measures for flood prevention, such as dike reinforcements and the creation of retention areas. The IMC ensures that water levels and discharges in all countries are well coordinated and shared. The IMC works on a joint flood control plan which considers the risk for the entire Meuse River basin. To realise all these objectives, the commission meets once a year and has five permanent working groups supplemented (Rijkswaterstaat, z.d-a; *CIM - de Internationale Maascommissie*, z.d.). The Netherlands, Germany and Belgium are also in the International Commission for the Protection of the Rhine (ICPR). The ICPR, with its members, annually meet to make decisions regarding the implementation of European law and the Convention on the Protection of the Rhine (ICPR, z.d.). The ICPR focus on water quality, river management, shipping and infrastructure, flood management and collaboration with other partners. The ICPR has numerous working and expert groups. The ICPR activities have been a model for many other river basins and inspired the EU during the creation of the Water Framework Directive and the Flood Management Directive (ICPR, z.d.). The commission's focus is on data and knowledge exchange. The commissions face a systematic barrier. They lack a mandate or the legislative ability to act (Interview 1).

The Netherlands, Germany, and Belgium are connected within the Marhetak project, funded by Euregio Meuse-Rhine. The Marhetak project aims to robustify the cooperation between the euregional services legally responsible for crisis management and weather, water, and soil services during a flood crisis. Participants of the project are the Public Service of Wallonia, Water Board Limburg, the Veiligheidsregio Zuid-Limburg in the form of EMRIC and the Federal Public Service Home Affairs Belgium. Within the project, participants work on aligning forecasts, linking data sources, crisis communication, harmonising risk assessments and facilitating uniform information provision. The project will end with a live exercise in the Euregio Meuse-Rhine (*MARHETAK*, n.d.).

The Netherlands and Belgium collaborate in the Schelde Commission. The commission focuses on the joint management of the Schelde River and estuary. The commission is involved in the joint prevention of floods, water quality and sustainable shipping (ISC CIE, 2020). Germany and the Netherlands collaborate in the Ems Commission. The committee has realised an overarching river basin management plan in 2009 and is responsible for its execution. The Dutch Rijkswaterstaat provides the Ems commission with the data and information (Rijkswaterstaat, z.d.-b).

The Dutch government has appointed a portfolio holder for cross-border cooperation in every border region. The portfolio holder is often assisted by one or multiple border liaisons. The portfolio holder maintains contacts with the bordering functionaries on the operational level to achieve coordination in working methods. Drawing up a joint risk profile and organising joint exercises are among the tasks of the portfolio holder. The task of the border liaison is linked to a picket officer who is well-versed in both the Dutch and foreign crisis structure. If an incident occurs in the border area that requires coordination with the neighbouring country, the border liaison will maintain contact with or join the crisis team in the neighbouring state (Wijkhuijs et al., 2021).

4.1.2 During the floods

On July 12, the Dutch weather analysts (KNMI) initially doubted whether the precipitation forecasts and the sequential water levels were correct. They could not believe such extreme amounts of water were coming towards the Netherlands. Especially in a season where heavy precipitation and floods do not occur. The Dutch weather analysts manually adjusted the prediction models based on expert judgement. Subsequently, further analysis revealed how extreme the situation was. The heaviest precipitation did not fall in the Netherlands, but in the neighbouring countries (Rijkswaterstaat, 2023). The real-time observations of the precipitation radar (the International Radar Composite) in Limburg strongly underestimated the actual precipitation. For the streams (such as the Roer and the Geul), it was communicated during the day on July 14 that extreme rainfall was expected and had the potential to be dangerous. In messages to residents, the safety region referred people to the website https://www.wachtnietopwater.nl. This website contains measures to reduce damage, indicates how to help others and advises avoiding travel (Expertise Netwerk Waterveiligheid, 2021).

Evacuations

The crisis has moved through Limburg from south to north. It started with extreme precipitation forecasts and high water on the Limburg streams, followed by high water on the Meuse due to extreme precipitation in the Meuse basin. Particularly for the streams, the contingency plans were not based on such extreme events as occurred. Which meant that areas such as Valkenburg were not evacuated before the flood, and many were taken by surprise (Expertise Netwerk Waterveiligheid, 2021). Approximately 50,000 people were evacuated before or during the flood. Inhabitants living in the Geul basin were not preventively evacuated, except for residents of surrounding healthcare institutions. The residents in the flooded area evacuated after the flood occurred. In the Meuse basin, most of the residents successfully evacuated before the expected moment of possible dike failure. Most people responded to the evacuation call, and self-reliance was encouraged during the evacuation. Civilians evacuated themselves and arranged their shelter based on the information and warnings provided. Emergency shelters had been made available in various places. However, usage was low. Most civilians provided shelter for themselves. The number of people rescued by emergency services was limited. These rescues received abundant media attention (Expertise Netwerk Waterveiligheid, 2021; Flycatcher, 2021). This is consistent with the literature indicating that during natural disasters, between 60-90% of people save themselves (Dynes, 1994; Starmans & Oberijé, 2006). A striking side effect was that when the safety region of Limburg North decided to evacuate. The decision caused some unrest in the surrounding regions. People in the border region have many cross-border contacts, so news spreads quickly (Interview 6).

Crisis communication

During the flood event, various means of communication were used to inform residents. The safety region website with a live blog, social media, the public regional radio and emergency television channel L1 and an information number. The eleven affected municipalities also communicated locally via their websites and information numbers. The Limburg water board was available for questions from residents (Veiligheidsregio Limburg-Noord, 2021; Flycatcher, 2021). Most respondents used multiple channels to inform themselves about developments, the majority of which used their own municipality's website (36%), followed by the disaster channel L1 (both radio 35% and TV 34%). The safety region's communication channels were used less (live blog 19% and Twitter 2%). More than 40% of respondents were satisfied with the provided information, but an equally large proportion were (mildly) unsatisfied (Flycatcher, 2021). Additionally, NL-Alert was deployed. Of the respondents who had received an NL-Alert, the majority appreciated receiving this notification. However, more than half indicated that they had insufficient information to estimate any nuisance and/or risks caused by the flood event, that the location of the potential flood was not explicit from the report and that there was a lack of a perspective for action. Respondents gave an average of 6.1 for the information received from NL-Alert (Veiligheidsregio Limburg-Noord, 2021; Flycatcher, 2021).

Crisis management

Two weeks before the crisis, Waterschap Limburg had adopted the 2021-2025 crisis plan. Exercises for the new crisis plan were planned for the third quarter of 2021. As a result, the crisis plan had not yet been fully trained and experienced at the time the crisis broke out. Interviews with Waterschap Limburg employees showed that for more than 85% of the respondents, the new coordination lines were unclear. And for 80% of the respondents, the roles and how mandates were arranged were unclear. Leading to confusion among several employees (Perree, 2022).

Alongside the Meuse, the waterboard instructed so-called keringbeheerders (barrier managers) to install tens of kilometres of demountable barriers. The demountable barriers were constructed faster than expected, due to the help of the residents (Veiligheidsregio Limburg-Noord, 2021). These barriers were effective in preventing floods. In some cases, residents have used their equipment to take emergency measures. Sandbags were made available by municipalities at the municipal yards and moved to the weirs by residents. Thanks to the measures, areas were spared, and the damage was relatively limited to the regional water system (Rijkswaterstaat, 2023). Volunteers executed various emergency measures with instructions from professionals. During the flood, risk assessment was the basis for decision-making. The risk assessment was frequently updated whenever new information was available. The flood event took place during the COVID-19 crisis. While considering flood measures, the safety of people and animals was prioritised. The testing and vaccination against the COVID-19 virus was temporarily placed as a lower priority (Veiligheidsregio Limburg-Noord, 2021).

The water board supervised the deployment by instructing how demountable barriers should be placed. The required manpower was supplied by residents, the army and the fire brigade. Due to its self-reliant capacity, the Limburg water board could focus on geotechnical failure mechanisms and risk assessment. During the implementation, information provision and coordination of emergency measures, the Limburg water board was supported with resources by fellow water boards (Expertise Netwerk Waterveiligheid, 2021). In most cases, coordination and information provision from the water board went well. The water board worked hard on mapping the risks per dike section. However, there was tension between the requested information and the clarity about the risk assessment. From the security region, but certainly from municipalities and threatened institutions such as healthcare institutions. From those instances, there was a great need for clarity about what they could expect in order to take measures. The water board was reluctant to communicate an absolute threat. Because the risks could not always be presented explicitly. It was a unique situation for the water board, and not all information was immediately available (Veiligheidsregio Limburg-Noord, 2021). In addition to the official lines of communication via the Limburg Water Board, direct lines of communication were often established between inspectors, locally present dike experts and emergency services. A significant portion of the emergency measures were therefore determined without following the formal line of communication. WhatsApp groups were often created by inspectors and experts to efficiently share information, inform each other and transfer information after employment (Expertise Netwerk Waterveiligheid, 2021).

On July 12, the Deutscher Wetterdienst (German weather service) distributed a warning for heavy precipitation of around 200 millimetres within the next 24 hours. The water level and discharge predictions made in the Bundesland were good, but in some places, they were lower than the discharge waves that ultimately occurred. Many residents were unprepared and taken by surprise (Die Zeit, 2021). Although investigations are ongoing, indications arise that there was a lack of coordination between the various levels of government organisations involved. In the Rhineland-Palatinate, the question arises of who is responsible for coordinating crisis management. Individual municipalities/landkreise or due to the regional impact, the Ministry of Internal Affairs of the state? The legislation in Rhineland-Palatinate offers room for interpretation. In the hard-hit Landkreis Ahrweiler, in practice, neither the Minister of Internal Affairs nor the chairman of the Landkreis Ahrweiler appeared to have actively contributed to the coordination of crisis management. (Domrose, 2024).

Underestimation

Suspicions arose that residents had been insufficiently warned of the approaching flood. The German Public Prosecution Service started an investigation in August 2021 against Jürgen Pföhler, the president of the Landkreis at the time. The president is suspected of culpable homicide and grievous bodily harm due to negligence (deutschlandfunk.de, 2024). The flood was in no case an unexpected combination of circumstances (Deutscher Wetterdienst, 2021). On July 14, according to current insights, there would still have been opportunities to evacuate residents. However, this would have required a state of emergency to be declared by the president of the Landkreis. This only happened in the late evening, despite the mayors of the neighbouring municipalities urging it several times during the day. At that time, the first houses were already swept away (Duitsland Instituut, 2021; Domrose, 2024).

The Landkreis was not the only one to underestimate the danger of the situation. The Rhineland-Palatinate Ministry of Climate published on 14 July that no extreme flooding was expected. This was not adjusted, even after a deterioration in the forecast. Afterwards, it would become clear that the ministry did not communicate the flood warning to the national Prime Minister and the national Minister of Internal Affairs (SWR, 2024). North Rhine-Westphalia was not able to pass on warnings from the Ministry of the Environment to the surrounding municipalities and Landkreise. Due to a lack of capacity, in combination with uncertainty about contact procedures (Domrose, 2024). The state minister of North Rhine-Westphalia made an urgent appeal to take the situation seriously. The advice for evacuation was not immediately responded to. He also advised civilians not to look at the damage or water levels (Landkreistag Nordrhein-Westfalen, 2024).

Communication

Federal states have a selection of three alarm apps and sirens to warn the population. The communication towards the population was not optimal. For example, the inhabitants of Ahrweiler were warned via the warning app Katwarn to search for higher ground. But most of the inhabitants were asleep during the message. Approximately 1 in every 10 Germans had one warning app installed (Oude Egberink, 2021). According to the electricity companies, around 165.000 households experienced a power outage. In many places, the electricity had to be turned off for safety reasons. Therefore, mobile service was often unavailable (Trenczek et al., 2022). In other areas, inhabitants did not receive any alerts at all through any of the apps. Whether this was due to technical problems or because local control rooms failed to send warning messages is still being investigated (Domrose, 2024). Only a few municipalities/Landkreise have used sirens to alert the population. In some municipalities, this was due to the lack of required infrastructure. Most sirens were dismantled after the end of the Cold War. Other cities and municipalities omitted sirens to avoid interruption of emergency calls due to a lack of accompanying information dissemination via radio, TV or mobile speakers (Expertise Netwerk Waterveiligheid, 2021). In Rösrath in North Rhine-Westphalia, the sirens were deliberately not activated. The authorities feared mass panic without accompanying media coverage and probably underestimated the impending catastrophe (Die Zeit, 2021). Mistakes were made. Inhabitants in Ahrweiler were warned to avoid basements and underground parking lots. Crucially, this warning should also have included a warning to avoid houses on the ground floor. Multiple casus are known whereby inhabitants drowned in their ground-floor apartments/houses (Domrose, 2024).

On 12 July, the Belgian Royal Meteorological Institute (KMI) issued a warning. According to the forecast, as much precipitation would fall in a few days as would otherwise occur in a month. Precipitation forecasts always remain uncertain, but it soon became clear that the forecast was correct (Interview 5). Moreover, the thin, stony soils cannot absorb vast quantities of water. The soils were already water-saturated due to previous precipitation in June and early July. As a result, almost all precipitation was washed away immediately. The discharge volumes were huge. Small streams such as the Hoëgne, a tributary of the Vesder, had quickly become wild mountain streams (Verstraeten, 2021). Because the precipitation totals were extreme across the entire Ardennes, almost all streams experienced a sudden increase, with water converging in lower areas as a consequence (Verstraeten, 2021). On 14 July, the KMI would issue a code red warning, and the regional crisis centre and relevant municipalities would be informed. On 15 July, the mayor of Luik requested 200.000 inhabitants to evacuate the city, restrict cars from entering and close all shops. To nearby municipalities, advice was given to evacuate their inhabitants and a federal emergency was promulgated (Expertise Netwerk Waterveiligheid, 2021).

Crisis management

In Belgium, crisis management on national territory is managed at the competent level, directed by the respective competent authority. There are three levels of authority: the municipality spearheaded by the mayor, the province spearheaded by the governor and the federal government. For an overview of Belgium's crisis management and its Dutch and German counterparts, see Figure 5. Municipalities, if their resources are insufficient, inappropriate, exhausted or unavailable, submit a request to the governor's services, who will seek a solution at his level. When the crisis management proves insufficient, the governor can request the services of the federal government. The federal government will then activate the National Crisiscentrum, which can request aid from the army. Specific laws and guidelines apply, which determine the terms of these requests (Renders et al., 2021). In the acute crisis phase, soldiers were deployed with the necessary resources to provide direct assistance to people in need, focusing on evacuation (Renders et al., 2021). During the flood, many employees were searching for their roles. A properly written crisis management script was not available. This search for roles cost valuable time that could have been better spent (Interview 5).

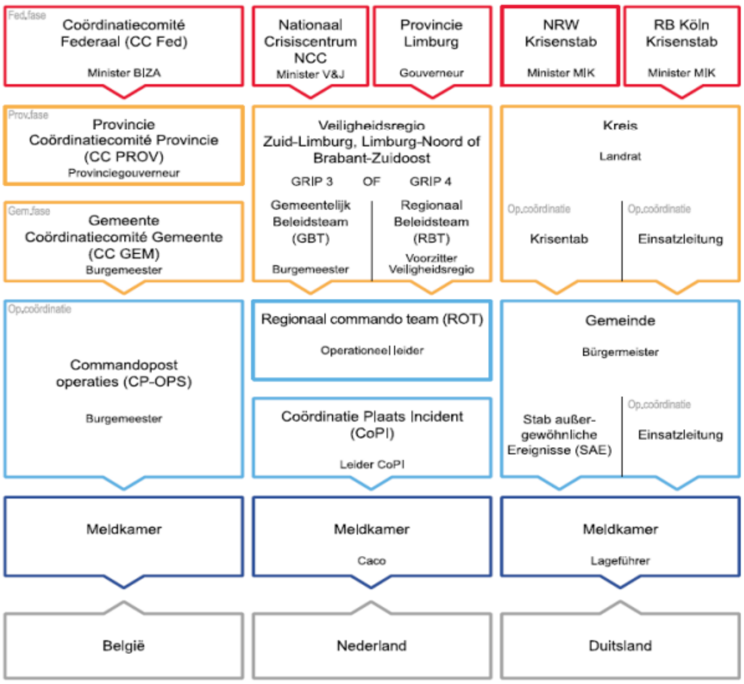

Figure 5: Belgium, Dutch and German crisis management structures. Source: Veiligheidsregio Zuid-Limburg, Crisis Plan 2020-23

Communication

During the crisis, there were frustrations about information exchange at all levels. Belgium's state structure dictates that police service, fire brigade, crisis management, and army deployment are decided at the federal level. However, water management is decided at the regional level, divided between Wallonia, Flanders, and Brussels. The flood mainly occurred in Wallonia, and the federal government activated the national crisis centre. Creating tension between federal crisis management and regional water management. For the Flemish region, the federal approach created some nuisance. The flood was under control in the Flemish region, but crisis managers had to attend various federal meetings focused mainly on Wallonia. The Flemish region had to communicate via the federal route, whereby the regional route would be sufficient (Interview 1).

Weather warnings from the KMI Weather Institute were difficult to interpret, and information about evacuations was absent or unclear. The KMI works with data provided by Rijkswaterstaat. There was a data delay of half a day (Keulen, 2021). During the flood, the flow of information and the fragmentation of powers proved to be important stumbling blocks. Many mayors appeared unfamiliar with disaster management and were lost between the municipal, provincial and federal levels. The lack of integration of the population in the risk management process has had consequences: some residents did not want to leave, others were prepared to evacuate but did not know where to go. Some residents engaged in disaster tourism or made donations that did not meet the needs of those affected (Keulen, 2021; Romans, 2023). A BE-alert was activated, but BE-alert only signals to subscribed phones. Consequently, many residents were not informed (Keulen, 2021). It proved difficult for the emergency services to gain insight into the situation. Informal communication channels such as WhatsApp gained the upper hand over official channels for emergency services, resulting in uncertainty (Romans, 2023).

Cross-border collaboration

Collaborative flood and crisis control between the Netherlands, Germany and Belgium during the 2021 flooding event proved difficult and almost non-existent. Difficulties arise for collaborative flood and crisis control when a crisis is simultaneous. Making it difficult to aid other regions/countries with resources. The resources were already being used (Unfried & Mertens, 2023). Another issue that occurred was that most committees and commissions lack the legal mandates to act. Most of the technical expertise and execution abilities lie with external authorities (Unfried & Mertens, 2023; Interview 1). For example, the Meuse Commission has no legal mandate to act. The collaboration during a flooding event in the Meuse Commission focuses on knowledge exchange. In the form of reports and recessions on this specific flood event (Interview 1). During the flood, there was interregional consultation regarding emergencies, such as the situation around the weir of Monsin. The contact was mainly between the Netherlands and Belgium. To inform and anticipate each other on possible outcomes of the situation (Interview 1). A positive effect of the numerous river commissions is that during such a situation, lines of contact are already established. In which bilateral contacts ensure that measures align with expectations (Interview 1).

There was a case of cross-border collaboration. Belgium requested aid from the Netherlands via the CECIS (Common Emergency Communication and Information System). The Dutch National Coordination Centre answered with the deployment of the National Rescue Fleet (NRV). Without any mandate to operate there (Interview 6). The NRV was immediately faced with issues. The NRV experienced a language barrier, making information exchange difficult. The NRV were not adequately prepared for the situation in Belgium and was unfamiliar with the Belgian deployment plan, which differs from the Dutch. The lack of structure, logistical support and leadership placed considerable demands on the incident command present to manage the situation safely (Unfried & Mertens, 2023).

During the flooding event, three of the five dams between Maastricht and Liège were under maintenance. As a result, only two were functional. There was communication between the Netherlands and Belgium surrounding this topic. If Belgium opens the dam, lots of water comes to the Netherlands. During the flooding event, the dams, especially the Monsin dam, threatened to break. That did not happen in the end, but the situation caused tension and political commotion (Interview 6).

It is remarkable to see the differences in the forecasting. The KMI quickly warned of heavy precipitation with possible critical consequences. While the KNMI did expect heavy precipitation in their forecasts in the Liège region, but did not expect any problems. It was remarkable to note that forecast models can diverge significantly while being only 30 km apart (Interview 6).

4.2 How did the Netherlands, Germany and Belgium frame the shock event?

4.2.1 The Netherlands

In July 2021, there was a coincidence of two crises: enormous water supplies from abroad and extreme precipitation locally. The water and weather conditions were so extreme that everyone understood that flooding and damage could not be prevented. So it's experienced as a natural disaster (Interview 4). This is in line with results from the code documentation analysis. It shows that, in the Netherlands, there is much more talk about a record water level, unlike in Germany and Belgium. In the Netherlands, there was a realisation that crisis management had not been optimal. Water managers realised there is plenty of room for improvement (Interview 4). The call arose from politics to declare the flood area in South Limburg a disaster area. In this way, the government could provide more and faster aid to the affected area through legislation. Victims can appeal to the WTS (Disaster Compensation Act).

In the Netherlands, adjustments were made to water policy after the high water in the nineties. The floods in 2021 were experienced as the ultimate test for those adjustments. For Rijkswaterstaat, the flood was also a test. An evaluation moment to see whether the interventions worked as intended and provided the desired results (NOS, 2021b).

In the Netherlands, part of the focus was on the situation in Belgium and Germany. Partly because the Netherlands is downstream and therefore dependent on their water management. This is evident in the code documentation analysis, where many reports in the Netherlands are about possible dam collapses or dyke failures. In contrast to the other countries. But also partly because there was considerably less damage and deaths in the Netherlands than in Belgium and Germany. In the word frequency, Germany and Belgium are mentioned often. In opinion mining, it emerges that when reporting about a (struck) city, it is often a German or Belgian city. Because there were no fatalities in the Netherlands, there are more reports about flooded/broken infrastructure and facilities instead of deaths. The focus lay more on evacuating the vulnerable and the military personnel who assisted in the evacuations, as evident from the word frequency and code documentation analysis. Incidentally, there is much reporting in the Netherlands about the fatalities in Germany and Belgium. The level of reporting is similar to that of the other countries.

Another theme often reported in the Dutch newspapers is disaster tourism. Disaster tourism was a bigger problem than in other countries. In the Netherlands, many areas declared an emergency ordinance. To be able to send disaster tourists away. This also explains why emergency ordinance occurs more in the code document analysis in the Netherlands than in other countries.

An interesting observation is the mention of COVID-19 and the COVID measures. At the start of the flood event, COVID-19 and COVID-19 measures were mentioned and followed. But after the flood became more severe, COVID-19 was no longer mentioned, and the measures were abandoned.

Within the crisis as a framing contest of Boin et al. (2009), the Netherlands positions itself in the No Crisis. It was (partly) seen as a natural disaster. There is room for evaluations and improvements, but there is no attack on the status quo. Who, therefore, remains mostly unchanged. So there is no blame and business as usual in effect.

4.2.2 Germany

In Germany, the flooding event took place during the elections. The floods can be a game changer for the election campaigns (Knobbe, 2021). Politicians were aware of this. This became clear in the word frequency and the code document analysis. Political concepts play a significant role in Germany. In the Netherlands and Belgium, that was not the case. The code document analysis shows that politicians in Germany visited the area more often. In Germany, there is more emphasis on political aspects. The political parties tried to influence the voters. In Germany, for example, emphasis is placed on the (non-German) nationality of the looters. And the Green parties explicitly point to climate change. There was criticism of Laschet and his actions. There was dissatisfaction among the residents with the politicians. Residents were tired of the politicians who came to show their support and left without contributing to the situation (Knobbe, 2021). This is consistent with the code document analysis, in which Germany scores higher in 'lack of trust in politicians' than the other countries.

Information reliability was also an issue during the floods in Germany. Opinion mining shows that when information is mentioned, it is almost always negative and contains misinformation. In Germany, misinformation was mentioned more often than in the Netherlands and Belgium. This is evident from both word frequency and code document analysis. Dissatisfied citizens were framed as 'Water Wappies', and the government was framed by dissatisfied citizens as incompetent and ignorant. Code document analysis also showed considerably more reporting in Germany about anger towards assistance. Anger towards assistance is not mentioned in the Netherlands and Belgium. That could be due to more damage and a greater number of deaths. As a result, people in Germany could be more dissatisfied than in the Netherlands and Belgium. Code document analysis also shows that German reporting focused on the situation of victims. And German news reports also often end with the number of missing and dead. These could be factors that increased dissatisfaction.

What is striking is that in Germany, more was written about insurance, in contrast to the Netherlands and Belgium. This could be because, in the Netherlands, the WTS was in force, which helped the uninsured by the state. Germany had no similar regulations, meaning that insurance and information about insurance policies were more important.

Within the crisis as a framing contest of Boin et al. (2009), Germany positions itself in the crisis as an opportunity. Politicians place the blame on the current politicians (status quo). The politicians use the opportunity and attack the status quo to politically benefit from it.

4.2.3 Belgium

In Belgium, there is a division between Wallonia and Flanders in the reporting. There is a significant focus on where the flooding is taking place. The opinion mining and word frequency data show that when media reports affected areas, they specifically mention whether it is in Wallonia or Flanders.

This division is also reflected in the attitude towards the government. In Wallonia, people were very dissatisfied with the government's actions. Citizens even sued the government. People were dissatisfied with the decision to release water from a dam to prevent it from collapsing. Which, according to the citizens, caused a tsunami to flow to downstream areas. This corresponds to the Code document analysis; in the Netherlands and Germany, this plays a much less or no role. There was also dissatisfaction with the cutbacks the Walloon government implemented in the previous years. A lack of commitment in recent years to providing reliable forecasting methods, adequate staff and a lack of the necessary investments (Interview 1). As a result, the government was less well prepared than necessary. In Flanders, the situation was different, which is why people did not blame the government (Interview 1). Moreover, the Walloon government had an independent investigation carried out into its actions. This investigation showed that there was no wrongdoing. The confidence of the residents in the reliability of this investigation appears to be low. Both the residents and governments were frustrated with each other. Fake news was circulating, which sometimes led to false accusations against institutions. Mostly by people without (actual) knowledge of the matter, who often point to the wrong things (Interview 5).

The code document analysis also shows that in Belgium, the words catastrophe and apocalyptic were more often used to describe the situation. In the Netherlands and Germany, the word apocalyptic was not used. The Belgian media framed it more as an immense natural disaster. The code document analysis also shows that in Belgium, there is a greater focus on material damage.

Within the crisis as a framing contest of Boin et al. (2009), Belgium positions itself in the crisis as a threat. The governmental institutions tried to diffuse blame and defend the status quo. An example of this is the conducted research, concluding no wrongdoing.

Cross-national themes

The reporting in all three countries was mainly about the course of the flooding, the damage it caused, the missing persons and the number of fatalities. Noticeably, the first fatalities were reported in detail. Who they were and how they died. But after the number of deaths increased, fatalities were reported in decreasing detail. Probably due to the large number of victims, making it increasingly impersonal and difficult to describe them in detail. In all three countries, the policy window is mostly affected by the three streams from Kingdon's multiple stream framework, not from the discourse changes caused by framing and the shock event.

4.3 What lessons were learned after the 2021 floods?

4.3.1 The Netherlands

In the Netherlands, the floods triggered a renewed look at flood risk. Key evaluations consist of the need for a paradigm shift, improvements required in information management, how to guide public participation and improvements needed for crisis management.

Paradigm shift

The 2021 flood caused a paradigm shift in the Netherlands. The Dutch have an 800-year-old history with water boards. But for the first time, they experience a dead end. Choices need to be made about what is acceptable during a flood or in water shortages. The Dutch cannot solve it all technically anymore. Flood and drought mitigation is becoming the new focus instead of flood- and drought prevention (Nederlands Instituut Publieke Veiligheid, 2024). A form of mitigation mentioned in various evaluation reports is spatial adaptation. For example, in flood-prone zones, construction should be avoided or customised to handle large-scale precipitation. Spatial adaptation can reduce the potential damages and consequences of large-scale precipitation (De Bruijn et al., 2022; Asselman & Van Heeringen, 2023).

Another form of mitigation mentioned is increasing the flood risk awareness of citizens (Nederlands Instituut Publieke Veiligheid, 2024; De Bruijn & Slager, 2022; Asselman & Van Heeringen, 2023). When citizens are aware of the flood risk and of what to do during a flood event, the likelihood of damage and casualties is significantly reduced (Asselman & Van Heeringen, 2023). Citizen awareness was limited during the 2021 flood. Three-quarters of the citizens were not prepared to evacuate. Three-quarters of residents had not considered leaving before the evacuation order was given (Flycatcher, 2021).

Citizens reported that the warning systems were insufficient and untimely. It is essential to inform citizens regularly and frequently and to prevent contradictory information and guidelines (Veiligheidsregio Zuid-Limburg, 2022). Only 40 % of citizens reported having received an NL-Alert. 26% of citizens felt supported and informed by reporting and information from the South Limburg Safety Region. 69% of the citizens preferred information earlier (Flycatcher, 2021). Improving the warning systems can reduce damage and casualties. For citizens, it is difficult to assess the danger of the situation. Even a code yellow, orange or red often provides insufficient information. Citizens require more direct information (De Bruijn & Slager, 2022; Rijkswaterstaat, 2023-b). Various advice mention raising citizen flood awareness. With targeted communication towards citizens and simplified information. For example, scientists and citizens created maps together whereby, instead of water depth, a person's height was referenced. Maps can also help visualise whether the important infrastructure is located in flood-prone areas. Creating a better understanding of the situation for the citizens and policymakers (Asselman & Van Heeringen, 2023; Waterschap Limburg, 2022). Citizen-oriented maps could be an effective tool for increasing citizens' awareness. But then the question arises, What is an acceptable nuisance or danger? Answering this question is a significant step in hazard map formation (Asselman & Van Heeringen, 2023). Inspiration for raising citizen awareness can also be taken from the past. Citizens in the past were more aware of where they lived and the associated risks (Nederlands Instituut Publieke Veiligheid, 2024).).

Public participation

Another evaluation point is the coordination of citizen initiatives and the use of citizen aid. During the flood, collaboration and self-reliance were encouraged. Citizens responded en masse, and citizen initiatives were actively supported by authorities. However, there was no plan for the deployment of citizen initiatives. According to local initiators, there was a lack of direction. Citizens required assistance in the form of information about actions and initiatives to assist. Letting the citizens aid, under professional guidance, increased morale and helped prevent unsafe situations (Veiligheidsregio Limburg-Noord, 2021). However, the massive citizen presence has its downsides. Instead of following the evacuation order, residents started an initiative to raise the dike. The sandbags were misplaced, making them effectively useless. During such initiatives, residents entered areas that, according to the waterboard, would be too dangerous. Authorities debated prohibiting citizens from aiding, but decided not to. Prohibiting would create unrest and be counterproductive (Veiligheidsregio Limburg-Noord, 2021). To prevent dangerous and counterproductive situations from occurring, recommendations were made to improve citizen initiatives and citizen aid. Expand the flood plans municipalities have with maps of evacuation zones and add clear instructions on how citizens can aid and behave during a flood (Veiligheidsregio Limburg-Noord, 2021).

Information management

During the flooding event, it proved challenging to acquire a clear understanding of the situation (Rijkswaterstaat, 2023-b; Waterschap Limburg, 2022). More difficulties arose in maintaining an actual understanding of the situation. Drawing up and delivering a reliable scenario for the coming hours or days proved difficult. The information needed to come from different sources, and an analysis had to be made for many areas simultaneously. Multiple sources of information created confusion, caused by the media, about the water level forecast on the Meuse (Expertise Netwerk Waterveiligheid, 2021). There was a great need for clarity locally, but the speed and capacity to do this simultaneously were lacking (Veiligheidsregio Limburg-Noord, 2021). A shared insight is that the information provision, the water predictions and situational predictions must be better organised and prepared. Adding flood experts during crisis meetings organised by the Safety region, joint crisis practices and workshops on internal processes and working methods could improve the understanding of the predictions. (Rijkswaterstaat, 2023-b; Waterschap Limburg, 2022).

It is necessary to improve the forecasting and monitoring systems to provide adequate information in time. To improve the ability of authorities to set priorities, create a clear overview of the situation. Where knowledge and measurements from neighbouring countries are used, as well as intensifying cross-border knowledge exchange (Veiligheidsregio Limburg-Noord, 2021; De Bruijn & Slager, 2022). The LCMS system was used for documentation during the crisis. In the LCMS system, it is impossible to read back and see how decisions, alternatives and arguments were made. It is also not documented who participated in decision-making. The current documentation in the LCMS is insufficient (Veiligheidsregio Limburg-Noord, 2021). Improvements are necessary in the documentation during a crisis. Improving documentation contributes to careful decision-making and will significantly simplify the learning process and accountability afterwards (Veiligheidsregio Limburg-Noord, 2021).

Crisis management

During the crisis, aid organisations from other regions, such as water boards and crisis management, were crucial. Those aids will be required again in the future. Therefore, it is beneficial to develop a process to streamline aid coordination. Improve aid deployment coordination and create a prepared plan with clear instructions for aid (Veiligheidsregio Limburg-Noord, 2021; Waterschap Limburg, 2022). Recommendations to strengthen the organisation are: Organise strategic crisis scenario sessions, Provide specific role training for decision-makers in a crisis scenario, Ensure awareness of the crisis plan among all crisis functionaries, In the event of a crisis, ensure frequent coordination moments between the decision makers of all crisis teams involved and create a control mechanism to ensure whether decisions and actions have been implemented (Waterschap Limburg, 2022).

Crisis management during a flood is intense and demanding for all involved. It is important to apply tailor-made solutions and offer aftercare in an appropriate way. The emotions of those involved during the crisis, the intensity, the often days-long deployment, the danger during the deployment, and the personal involvement should not be underestimated (Veiligheidsregio Limburg-Noord, 2021; Veiligheidsregio Zuid-Limburg, 2022; Waterschap Limburg, 2022). To reduce the demand for employees during a crisis, pay immediate attention to the continuity of the crisis organisation at the start of a crisis (Waterschap Limburg, 2022). It proved crucial to ensure local knowledge in the different operational and governing bodies. Not all functions in a crisis organisation lend themselves to being filled by officials from other regions. Also, keep an eye on the informal lines. It often proved more effective to follow an informal line (Veiligheidsregio Zuid-Limburg, 2022). In crises such as these, it is essential to be able to let go of the prepared structure. Make it explicit if there is a deviation from the standard collaboration structures and indicate changes in the responsibilities (Veiligheidsregio Zuid-Limburg, 2022).

During this disaster, it proved challenging to use existing relationships and connections efficiently and effectively. Therefore, it is important to evaluate how collaboration with partners and contacts in the cold phase comes into its own during the crisis (Veiligheidsregio Zuid-Limburg, 2022). By gaining more insight into each other's responsibilities, mutual understanding is created and improves collaboration between the organisations in the future (Rijkswaterstaat, 2023-b).

The lessons learned in the Netherlands, after the 2021 floods, are in a non-specific order:

- Invest in a paradigm shift towards a more mitigation-focused approach.
- Raising societal flood risk awareness.
- Involvement and coordination of civilians in crisis management.
- Improvement of the documentation during a crisis.
- Improvement of the ability to forecast and improving communication.
- Evaluate the assistance process and dedicate a team to integrate assistance.
- Aftercare for those involved and paying closer attention to the (mental health) of those involved.
- Create extensive crisis plans but remain flexible in implementation.

4.3.2 Germany

In Germany, the floods triggered widespread debate about institutional accountability and public warning systems. Key evaluations included reconstruction recommendations, improving risk awareness, improving warning and forecasting systems, reducing governmental fragmentation, and how to guide public participation in a crisis.

Spatial mitigation

Evaluation shows that flood warnings were often not taken into account or only to a limited extent in planning considerations and decisions at the municipal level. Therefore, the legal framework needs to be revised. The first measures recommended are to add large-scale flood hazard maps, flood risk maps and heavy precipitation maps to the water management statements (Ministerium für Umwelt, Landwirtschaft, Natur- und Verbraucherschutz des Landes Nordrhein-Westfalen, 2022). In addition to the maps, textual explanations should be added. Making the dangers more understandable (Rheinland-Pfalz, 2022). Another form of integrating flood risk management in spatial decision-making is preventive spatial planning. Recommendations for preventive flood protection are to banish existing buildings or facilities on land prone to flooding (Ministerium für Umwelt, Landwirtschaft, Natur- und Verbraucherschutz des Landes Nordrhein-Westfalen, 2022). Legislation should be adjusted to fundamentally prohibit the designation and development of building areas in flood-prone areas (Bollinger Landtag & Rheinland-Pfalz, 2023). Critical infrastructure should be revised to improve flood resilience (Heidbreder & Landtag Rheinland-Pfalz, 2023).

Reconstruction

The 2021 flood has caused immense damage in the Ahr Valley and other affected areas. Reconstruction of these areas should not be a 1:1 reconstruction, but reconstruction focused on climate neutrality and flood-resilience. 1:1 reconstruction would impose the risk that a flood, similar to the 2021 one, could again do immense damage (Heidbreder & Landtag Rheinland-Pfalz, 2023). Critical infrastructure should not be reinstalled in danger zones where it is structurally possible (Heidbreder & Landtag Rheinland-Pfalz, 2023). Close contact between the authorities and those affected on-site is important (Heidbreder & Landtag Rheinland-Pfalz, 2023).

Risk awareness

Risk communication and raising public awareness of extreme weather events and their consequences are central to disaster preparedness. In the evaluations, it became clear that improvements are required (Rheinland-Pfalz, 2022; Interview 2). The risk that extreme weather events can pose is often underestimated. The goal must be for an effective and easy-to-use warning system to trigger early warning messages. A mix of traditional and modern warning devices should provide a quick warning so that the population can quickly respond to warnings (Ministerium für Umwelt, Landwirtschaft, Natur- und Verbraucherschutz des Landes Nordrhein-Westfalen, 2022; Rheindland-Pfalz Landesamt Für Umwelt, 2022; Heidbreder & Landtag Rheinland-Pfalz, 2023). To increase public awareness, it is recommended to implement regular, annual, nationwide warning days combined with disaster response exercises. Information on how to behave during a flood event should also be visible in public places. The government must openly communicate the limits of protection provided by state authorities. The self-protection of the citizens of Rhineland-Palatinate must be promoted. Flood preparation is a task for society as a whole (Heidbreder & Landtag Rheinland-Pfalz, 2023; Haller & Landtag Rheinland-Pfalz, 2024). Another lesson learned after the 2021 flood is that many people had difficulty reading and understanding 2D maps. Civilians found it difficult to understand what the darker and lighter colours on the map meant in terms of flood risk. NRW is now revising the maps to make them more understandable for civilians (Interview 3).

Warning systems

The way people gather information has changed. People are increasingly requesting and searching for information directly. Crisis organisations now have to respond and adjust their information provision accordingly (Interview 3). Warnings should not just be the arrival of information. Fast and targeted warnings are a key component in protecting the population. It is equally significant how these warnings are understood. Warnings must be accessible, visualised, easy to understand and disseminated with concrete messages for action (Ministerium für Umwelt, Landwirtschaft, Natur- und Verbraucherschutz des Landes Nordrhein-Westfalen, 2022). There is a need for prioritisation and distinct determination of which institutions and, through which media and channels, authorised warnings are issued (Heidbreder & Landtag Rheinland-Pfalz, 2023). The use of social media has increased significantly in recent years. Therefore, social media must integrate into the information and warning chains. Regional and targeted. The aim is to expand the agreements on Modular Warning Systems (MoWaS) and to introduce additional legal obligations for the dissemination of warning messages to meaningfully supplement the existing public warning systems (Heidbreder & Landtag Rheinland-Pfalz, 2023). Sending forms by fax, which are first printed and filled out, is no longer up to date. A comprehensive digitisation of the system is urgently required (Haller & Landtag Rheinland-Pfalz, 2024). The warnings should be uniform nationwide (Heidbreder & Landtag Rheinland-Pfalz, 2023). According to Bollinger & Landtag Rheinland-Pfalz (2023), a comprehensive and holistic warning mixture of warning systems and means of warning is required. These warning methods should be combined with improved digital information platforms for citizens. On the digital platform, the state's specialist data should be presented, from which information on the risk of floods and heavy rainfall can be obtained without in-depth specialist knowledge required (Rheinland-Pfalz, 2022). Politicians are calling for the number of sirens to be significantly increased, especially in areas often affected by extreme weather (Die Zeit, 2021). The state government is committed to ensuring a siren support program (Heidbreder & Landtag Rheinland-Pfalz, 2023).

Evacuation

During the flood, civilians were less prepared for an evacuation than NRW expected. Evacuations in crises are a complex socio-technical process, with the available warning time being a crucial criterion to carry out evacuations in the best possible way. Even with very short warning times, preparation and regular exercises are essential (Interview 3). Prepared evacuation plans must be regularly reviewed and practised at all levels (Ministerium für Umwelt, Landwirtschaft, Natur- und Verbraucherschutz des Landes Nordrhein-Westfalen, 2022; Heidbreder & Landtag Rheinland-Pfalz, 2023; Interview 3). Without prioritising protected assets and vulnerable groups, it is impossible to respond in a targeted manner in the event of a major disaster (Haller & Landtag Rheinland-Pfalz, 2024). To provide orientation for everyone in the event of an incident, the evaluations recommend developing a state-wide, and if possible, nationwide guidance system with uniform symbols and uniform colours that signpost escape routes or the way to information points (Heidbreder & Landtag Rheinland-Pfalz, 2023). According to Heidbreder & Landtag Rheinland-Pfalz (2023), the evacuation plan should contain information and recommendations on the following points:

- Carrying out local or regional risk analyses and maintaining detailed and regularly updated information on vulnerable groups during evacuations.
- A list of institutions that can carry out evacuations. The commitment of emergency personnel to other activities must be taken into account and, if necessary, prioritised.
- Preliminary planning for the accommodation of people in need of support, in particular when significant areas of damage occur.

Public participation

The phenomenon of spontaneous helpers in civil protection is becoming increasingly important. The potential of spontaneous helpers is particularly evident in crises. Unlike the organised volunteers, the spontaneous helpers lack knowledge of the structural and management structures. It requires good coordination and communication with the volunteers. Other mechanisms are necessary here. In the future, particularly in large-scale damage events, press and media coverage need to be increased and proactive (Heidbreder & Landtag Rheinland-Pfalz, 2023). Public relations work must be carried out to coordinate and control spontaneous helpers. As well as preventing counterproductive activities, such as congested access routes and deployment areas that organised helpers can no longer reach. The use of social networks will play a significant role in this context. It should be emphasised that spontaneous helpers are not emergency services. Events with a latent or even acute danger do not warrant deploying spontaneous helpers, as well as operations that require special instruction, protective equipment and/or basic firefighting knowledge. These situations require emergency services with appropriate training. When properly coordinated, spontaneous helpers could be indispensable for operations such as clean-up work after a damage event, dike protection with sandbags, and food provision to those affected (Heidbreder & Landtag Rheinland-Pfalz, 2023). Furthermore, an evaluation point is that there are liability and insurance issues for volunteers and commercial helpers during their assistance. It is recommended to check to what extent this can be improved and whether there is a need for legal changes in this regard (Heidbreder & Landtag Rheinland-Pfalz, 2023). Another aspect concerns data transmission, which must work if the telephone and mobile networks fail. Independent satellite communications are explored for this purpose (Rheinland-Pfalz, 2022).

Forecasting

According to the Minister of Environment and Climate Protection, Katrin Eder, the scale of the disaster in Ahrdal could not have been predicted. Nevertheless, the knowledge gained from this event on the consequences of extreme flows in (narrow) valleys has made it necessary to review the approach to flood forecasting for the entire country (Rheinland-Pfalz, 2022). Many experts, those affected and relatives conclude that if administrators and officials had recognised the seriousness of the situation earlier, fewer people would have died (Domrose, 2024). A national forecast model system ("VISDOM") for individual events such as heavy rainfall is currently being established. In addition to updating the map for the "sudden flood after heavy precipitation" risk analysis, the so-called heavy precipitation hazard maps are intended to simulate and assess the effect of possible protective measures on the flood-affected area (Rheinland-Pfalz, 2022).

Another evaluation point is the request for on-site expertise in interpreting forecasts, maps and data. The 2021 flood event has shown an increased need for specialist water management advice (hydrological and hydraulic) to advise local operational management by explaining the data and information from the flood forecasts (Rheinland-Pfalz, 2022). Local people entrusted with disaster control must be able to understand information. Appropriate training courses are available for this purpose. However, forecasts could also be designed to be easier to understand (Haller & Landtag Rheinland-Pfalz, 2024). It is recommended to redesign the homepage of the flood reporting service, wherein warnings for water levels and warning areas are visible on an easy-to-understand general warning map (Rheinland-Pfalz, 2022). There is a need for a specialist career in water advice for leadership roles in civil flood protection, both in honorary and full-time positions (Haller & Landtag Rheinland-Pfalz, 2024). According to Rheinland-Pfalz (2022), the tasks of the specialist advice of the water department should include:

- Advice and support to authorities responsible for civil protection by interpreting weather data, possession of prepared water management data (hydrological and hydraulic) available.

- Organising regular flood-themed training for flood-prone neighbourhoods and regions.
- Advise during incidents.

Coordination within governmental organisations

From various evaluations arose the issue that there was a lack of coordination between the governmental organisations involved at multiple levels (Heidbreder & Landtag Rheinland-Pfalz, 2023; Interview 2; Domrose, 2024; Haller & Landtag Rheinland-Pfalz, 2024). In the hard-hit Landkreis Ahrweiler, neither the Minister of the Interior nor the President of the Landkreis Ahrweiler appeared to have made an active contribution to coordinating crisis management (Domrose, 2024). It is suggested to provide legal clarity on the responsibilities of coordinating during a crisis. As the flood has shown, the direct and constant exchange between governmental levels is significant for passing on relevant information and activating appropriate forces. In future disaster situations, information chaos, broken reporting chains and unclear responsibilities of various ministries and state authorities must be avoided at all costs. Therefore, responsibilities must be organised and communicated more clearly (Domrose, 2024). Joint crisis plans and regular exercises can be helpful in this. (Interview 3).

Information management

Heaps of information flow into the operations control centres and must be able to be accessed and evaluated across different districts in the event of a large-scale crisis. A nationwide uniform situation display system that all levels involved can access and via which all activities can be tracked in real time is recommended (Ministerium für Umwelt, Landwirtschaft, Natur- und Verbraucherschutz des Landes Nordrhein-Westfalen, 2022; Heidbreder & Landtag Rheinland-Pfalz, 2023). As soon as a major disaster occurs, a dense network of advice and information services regarding the application process for reconstruction aid should be quickly set up (Heidbreder & Landtag Rheinland-Pfalz, 2023). The responsible top officials must be specifically prepared for disasters. The reporting and reporting system between the federal and state governments should be further standardised, ensuring an automated and smoother flow of information (Heidbreder & Landtag Rheinland-Pfalz, 2023). The establishment of a state office for disaster control, combined with a regional contact person, is therefore expressly welcomed. A regional contact person from the affected region, based on their local and specialist knowledge, can classify incoming information and thus advise precisely on the required resources and inform about the current situation (Haller & Landtag Rheinland-Pfalz, 2024). In addition, in foreseeable or occurring disaster situations in which the country's action is necessary, a crisis team of the state government could be convened. To be able to react quickly and professionally in the event of an incident, mandatory, nationwide uniform personnel and uniform material equipment for civil protection units are required (Ministerium für Umwelt, Landwirtschaft, Natur- und Verbraucherschutz des Landes Nordrhein-Westfalen, 2022; Heidbreder & Landtag Rheinland-Pfalz, 2023; Haller & Landtag Rheinland-Pfalz, 2024). If necessary, all available help and capacity from other federal states could be employed as quickly as possible (Haller & Landtag Rheinland-Pfalz, 2024).).

Cross-border collaboration

Disaster protection is a community task. Europe, the federal government, the states and local authorities must work together. European cooperation in civil protection must be intensified and improved through cooperative exercises. During an emergency, language barriers must be avoided to avoid emergency resources being underused. In the last few years, progress has already been made within the rescEU project and should be further intensified (Heidbreder & Landtag Rheinland-Pfalz, 2023).

The lessons learned in Germany, after the 2021 flood, are in a non-specific order:

- Increase the integration of flood risk management in spatial decision-making.

- Insist on reconstruction focused on climate neutrality and flood resilience and not on 1:1 rebuilding.
- Increase civilian flood risk awareness and improve the warning systems. Improve the quality and availability of evacuation plans.
- Implement the use of volunteers and spontaneous helpers in crisis management.
- Improve the quality of the forecast and improve the decision-maker's ability to understand the forecast.
- Improve the coordination between the governmental organisations involved at multiple levels.
- Establish a state office for disaster control with nationwide universal operating systems, uniform personnel and uniform material equipment for civil protection units.
- Invest in European cooperation in civil protection and improvement against cross-border danger situations.

4.3.3 Belgium

In Belgium, the floods triggered widespread debate about governmental fragmentation. Key evaluations included the improvement of warning systems, restructuring the water system, and mainly reducing governmental fragmentation.

In Belgium, the evaluations of the 2021 floods had a high sense of déjà vu. Various bottlenecks cited during evaluations of the November 2010 floods turned out not to have been addressed 11 years later. While plans were created with several solutions, they still failed to be implemented in time for the 2021 floods. Therefore, it is important that this time, higher efficiency can be achieved by faster realisation of plans (Bekkenbestuur Demerbekken, 2022).

After the floods in 2021, the Flemish government appointed a panel of experts to conduct a 'what if' study. The experts studied what if the same amount of precipitation were to fall in Flanders instead of Wallonia, and what the impact of that precipitation would be. It appears that this would cause damage of around 8 billion euros in Flanders, meaning that approximately 86,000 homes would be flooded (Interview 1). Evaluations of the 2021 flood advise investing in the self-reliance of civilians. The government will never be able to ensure that all risks and negative consequences of flooding are prevented. There is a shared responsibility to limit flood consequences (Coördinatiecommissie Integraal Waterbeleid, 2021). Civilians must be prepared, informed and ready to contribute in emergencies (Bekkenbestuur Demerbekken, 2022). Based on evaluations, the provincial service has indicated that it will formulate recommendations and advice to help civilians and companies take action themselves if they are confronted with an emergency, such as placing sandbags and watertight fences. The local authorities and the Emergency Planning Service can sensitise the population about self-reliance via social media and/or websites. Raising citizen awareness is crucial for increasing self-reliance (Provincie Gouveneur Vlaams-Brabant, 2021; Expertenpanel Hoogwaterbeveiliging, 2022; Schmitz et al., 2023).

A paradigm shift is required in water management (Bekkenbestuur Demerbekken, 2022). Prepare the next generations through education about flood risks and promote the water challenge politically as an intersectoral challenge (Coördinatiecommissie Integraal Waterbeleid, 2021). Citizens and companies must become aware that water on the street or in the garden is not a problem during a potential flooding event, but contributes to flood prevention (Bekkenbestuur Demerbekken, 2022). The VMM has started several projects in which people from risk areas can register for free advice from experts regarding flood protection. However, experience shows that few people use this advice (Interview 5).

Warning systems
Improving the warning systems used to alert civilians during a crisis is an important area for improvement (Coördinatiecommissie Integraal Waterbeleid, 2021; Bekkenbestuur Demerbekken, 2022; Expertenpanel hoogwaterbeveiliging, 2022; Schmitz et al., 2023). Alerting civilians can be done via an explicit communication system in which citizens automatically receive warning messages, such as BE-alert (Bekkenbestuur Demerbekken, 2022). During the crisis, it became clear that BE-Alert was insufficient to inform and alert civilians (Keulen, 2019). BE-alert should be transmitted to everyone, not only the subscribers. The messages BE-alert could emit should be clear, easy to understand, and able to be differentiated from location to location (Coördinatiecommissie Integraal Waterbeleid, 2021). Improving the warning systems and increasing civilian flood risk awareness can also reduce stress on the emergency centre 112. E-counter www.1722.be will be actively promoted via various online channels of governments. The website www.1722.be is a site where civilians can apply for non-urgent assistance from the fire brigade (Provincie Gouveneur Vlaams-Brabant, 2021). External communication to the press must also be considered. Clear, streamlined cross-regional communication is desirable to avoid confusion and conflicting reporting (Coördinatiecommissie Integraal Waterbeleid, 2021; Interview 1).

Restructuring the water system
A lesson learned in evaluations of the 2021 flood is that more room for water, both physically on the site and in spatial planning, is required (Coördinatiecommissie Integraal Waterbeleid, 2021; Gouvernement de la Wallonie, 2023). Physically giving water more room requires differentiated water management and structural restoration (Bekkenbestuur Demerbekken, 2022). Delayed drainage must be a key point for water management (Coördinatiecommissie Integraal Waterbeleid, 2021). Restoring the water system can also be tackled more actively through structural restoration measures, such as reconnecting meanders or initiating the meandering process by introducing dead wood into the watercourse (Bekkenbestuur Demerbekken, 2022). For this perspective change in spatial planning, new legislation is required. From non-binding water advice and uncertain implementation to a robust and legally specific spatial and implementation framework. Make the flood risk and storage potential areas guiding spatial development. Enable the designation of areas where space for water is given priority in spatial plans (Expertenpanel hoogwaterbeveiliging, 2022).

Provide a legislative framework for the elimination policy of houses located in flood-prone areas and give new functions to flood-prone areas. Develop the necessary supporting instruments to remedy and compensate. Provide long-term structural financing, for example, by setting up a fund anchored in legislation (Expertenpanel hoogwaterbeveiliging, 2022). Create a legal framework that accelerates the realisation of climate-adaptive and green-blue infrastructure. For example, simplify procedures, exempt from permits for climate adaptive measures, continue to focus on instruments to promote the removal of surface asphalt and tiling, new environmental guidelines and better legal protection of natural elements and systems. (Coördinatiecommissie Integraal Waterbeleid, 2021; Expertenpanel hoogwaterbeveiliging, 2022; Schmitz et al., 2023).

Governmental fragmentation
During the floods, it became apparent how fragmented the Flemish water management system is. This fragmentation led to significant coordination problems, fragmented capacities and a loss of decisiveness and processing speed during a water crisis. Municipalities located in the border area between Flanders and Wallonia experienced a hindrance in information flows (Provincie Gouveneur Vlaams-Brabant, 2021; Romans, 2023). In evaluations, some waterboards indicated that not all were systematically involved. Those neglected waterboards indicated they could have offered personnel if they had been involved (Bekkenbestuur Demerbekken, 2022). Furthermore, a lack of evident

coordinated vision of crisis water management and an elaborate script for policymakers hindered crisis management. There is also no overview of the critical infrastructure and vulnerabilities in the water system. Which spans several water boards (Bekkenbestuur Demerbekken, 2022). Rearranging water objectives is also important. Diverse and vague water quantity objectives must be replaced by integrated water objectives. By developing clear water goals, efforts can be more targeted and efficient (Expertenpanel hoogwaterbeveiliging, 2022).

Due to the fragmentation of the water board, it was unclear for many municipalities and mayors what actions to undertake. Municipalities are therefore requesting a risk analysis of the various watercourses to take timely preventive measures in the future (Gouveneur Vlaams-Brabant, 2021). Making it evident to local authorities what concrete actions they could take during a flooding event and who has which responsibilities. Municipal administrators (often) do not know which water managers are responsible for which watercourses, how and when they could be reached and how the water manager could contribute in such a situation (Provincie Gouveneur Vlaams-Brabant, 2021). Therefore, it is recommended to work on a vision for the entire river basin consisting of an emergency and intervention plan in each basin, a rainwater and drought plan for each city and municipality, developing scenarios for emergencies such as dike breaches and a detailed plan for large-scale evacuation (Vlaamse Regering, 2021; Coördinatiecommissie Integraal Waterbeleid, 2021; Provincie Gouveneur Vlaams-Brabant, 2021; Schmitz et al., 2023).

During the evaluations, the different waterboards in Belgium requested multiple times to tackle this problem with a more collaborative approach at an inter-municipal level in the future. A collaborative approach with clear agreements about competence, responsibilities, division of tasks and communication between water managers and crisis managers during a crisis (Coördinatiecommissie Integraal Waterbeleid, 2021). A coordinated approach that transcendences administrative and sectoral boundaries (Vlaamse Regering, 2021; Expertenpanel hoogwaterbeveiliging, 2022). Efforts must be made to expand and structurally anchor the organic and spontaneous cooperation between water managers that emerged during the crisis (Coördinatiecommissie Integraal Waterbeleid, 2021; Bekkenbestuur Demerbekken, 2022; Romans, 2023). To collaborate in the transcendence of administrative and sectoral boundaries, inter-municipal consultation structures are necessary (Provincie Gouveneur Vlaams-Brabant, 2021). In addition, it is recommended to educate local governments in using the ICMS system. Improving the usage of ICMS increases the actuality of the data for those involved (Provincie Gouveneur Vlaams-Brabant, 2021).

Waterinfo.be proved to be a strong instrument during the flood. Municipalities were positive about the website but remarked that the website should be more user-friendly. Data interpretation proved to be very difficult for authorities during the flood. Presenting the data on the site in a way suited for authorities would help clarify how to interpret the modelling results. In addition, develop training courses in the use and functionalities of waterinfo.be for those involved. Invest in the competency and capacity development needed to develop, implement and integrate in a co-creative manner, together with local stakeholders (Expertenpanel hoogwaterbeveiliging, 2022). Strengthening waterinfo.be with more input from Wallonia is also recommended (Coördinatiecommissie Integraal Waterbeleid, 2021; Bekkenbestuur Demerbekken, 2022).

Cross-border collaboration

Another evaluation point is that cross-border collaboration needs to be improved. Communication with France and the Netherlands for cross-border water management regarding information exchange (including data gauges and flow rates) and crisis management needs improvement (Coördinatiecommissie Integraal Waterbeleid, 2021). During the flood, collaboration and communication were limited. Expertenpanel hoogwaterbeveiliging (2022) has drawn up 3 points to strengthen and simplify international cooperation: Integrate the secretariats of the International Meuse Commission (IMC) and the International Scheldt Commission (ISC) to increase efficiency. And streamline the approach and scope of work with the International Commission for the Protection of the Rhine (ICPR). Increase the mandate of the committees by installing an international inter-ministerial committee on water with legislative powers. And use the Belgian presidency of the European Council in the spring of 2024 as an opportunity to get cross-border flood protection, including long-term thinking, higher on the European agenda and stimulate European solidarity between upstream and downstream regions.

Crisis management

To ensure that the recommendations are followed up, the committee of experts on crisis management makes one final recommendation: the establishment of a National Advisory Council (NAC). This council will aim to advise the leading (or political) authorities on emergency planning and crisis management (Schmitz et al., 2023). The NAC should be independent and competent in matters related to crisis management and emergency planning. The NAC should have the task to:

- Advise the government, parliament and the Minister of the Interior about proposals covering all aspects of emergency planning and crisis management.
- Ensure the follow-up of the implementation of various recommendations concerning crisis management and emergency planning that arose after the evaluation of the 2021 flooding event.
- Be approached for advice on draft laws, proposals, and any regulation that may impact crisis management and emergency planning.
- Be consulted by the authorities on the main policy lines of crisis management and emergency planning and their implementation (Schmitz et al., 2023).

Improvements in tuning the fire brigade, the water board and crisis management are needed (Coördinatiecommissie Integraal Waterbeleid, 2021). Civil protection works complement the fire brigade. However, the number of volunteers (in the fire brigade) and professionals in civil protection performing basic tasks has decreased due to budget cuts (D'Haese, 2021; Interview 1). The capacity of people and equipment is now mostly present in the technical services of local authorities. Unaffected municipalities could help by sending their technical services towards the affected municipalities (Coördinatiecommissie Integraal Waterbeleid, 2021; Provincie Gouveneur Vlaams-Brabant, 2021).

The lessons learned in Belgium, after the 2021 flood, are in a non-specific order:

- Create a legal framework that accelerates the realisation of climate-adaptive and green-blue infrastructure.
- Invest in the self-reliance of civilians and raise their flood risk awareness.
- Improve warning systems.
- A paradigm shift towards more room for water.
- Work on a vision for the entire river basin and create a practical script describing the actions authorities should take in the event of predicted flooding.
- Defragment the waterboards.
- Create a collaborative approach at an inter-municipal level.
- Improve cross-border collaboration.
- Integrate the army into emergency planning and crisis management.
- Increases the capabilities and possibilities of civil protection.

4.3.4 EUregio Meuse-Rhine

In Euregio Meuse-Rhine, the floods triggered a debate about the lack of cross-border collaboration. Key evaluations included fragmentation of responsibilities in the Member States and a lack of cross-border communication.

The 2021 flood was not only evacuated regionally and nationally but also within the European Union. On 28 September 2021, a virtual meeting was held. The meeting was part of the EU Programme for Civil Protection Mechanism (UPCM). The result was the following lessons learned:

- Improved embedding of scientific knowledge in all phases of the disaster risk management cycle.
- Continue developing early warning systems, such as the EFAS system, to obtain usable information for decision-makers.
- Improvements in cross-level, cross-sector and cross-national communication and coordination.
- Continues practice, training and exchange opportunities as part of the Union process.
- Improving the deployment of the EU Civil Protection Team with more EU liaison officers available (Unfried & Mertens, 2023).

Cross-border collaboration

The Euregio Meuse-Rhine, in the form of the Marhetak project, also evaluated the 2021 flooding event. The first result of the project is that, surprisingly, cross-border cooperation is barely mentioned in regional and national evaluations (Unfried & Mertens, 2023). A factor that hindered collaboration was the language barrier. The language barrier made it difficult to communicate and exchange information between competent local authorities. The lack of structure, leadership and logistical support placed considerable demands on the incident command present to manage the cross-border situation safely (Unfried & Mertens, 2023). It is recommended to reinforce communication reflexes by setting up drills, including water management and the general public (Tieleman et al., 2023). Additionally, coordinated communication could prevent misinformation and potentially dangerous situations from being based on rumours instead of mutually exchanged information (Unfried & Mertens, 2023).

The 2021 flooding event has made it clear that the topic of flooding and flood risk management has not yet played a role in the EMRIC. There are no specific agreements on flood management cooperation, as in other issues, such as those between fire brigades. The technical expertise in flood management lies with external authorities and is divided differently between the member states. Cross-border cooperation between the member states of the EMRIC is based on their joint agreements. According to the EMRIC office, the list of treaties has remained unchanged in recent years (Unfried & Mertens, 2023). Evaluations of the flooding event show that cross-border collaboration and coordination did not play a significant role in political and technical reappraisal. One of the main reasons why EMRIC has not immediately evaluated cross-border flood management is that EMRIC has no defined role or explicit mandate for coordinating operations, communication and measures between the various partners (Unfried & Mertens, 2023). The Marhetak project offers the option to implement the Marhetak flooding work packages into working groups after the Marhetak project has ended. This could be a prerequisite for the institutional integration of flood and crisis management into EMRIC (Unfried & Mertens, 2023). A recommendation from the evaluation is to give EMRIC a clear mandate to evaluate cross-border flooding events and cross-border crisis management as a part of the regular tasks (Unfried & Mertens, 2023). If EMRIC integrates its expertise in flooding in the long term, EMRIC could be seen as an Euregional competence network and expand accordingly (Unfried & Mertens, 2023).

Fragmentation

Another factor identified in the Marhetak project was the large number of players involved in flood risk management in the Euregio Meuse-Rhine. During the flood event, it became clear that there was a lack of inter-regional collaboration (Tieleman et al., 2023). Improvements are necessary for linking computerised information systems and data-based analysis between the EMRIC partners. The crisis communication was not harmonised between the partners, as there were no tools to do so yet (Unfried & Mertens, 2023). Due to the differences in crisis and water management structures in the countries, it is recommended to create a shared vision for flood management. Communication and coordination between crisis and water managers are crucial in this respect. It is recommended to clarify the responsibilities and roles per institution and insert a specialised contact person with an overview of the different spokespersons per institution (Tieleman et al., 2023). This also includes improvements in the methods used for information exchange at the national level. Information could be exchanged better and more effectively between the EMRIC partners (Unfried & Mertens, 2023). There is also a lack of concrete input from European projects and networks. European-funded projects often seem irrelevant because they're not very pragmatic, HR-intensive, too general and with limited significant results (Tieleman et al., 2023).

The lessons learned in EUregio Meuse-Rhine, after the 2021 flood, are in a non-specific order:

- Emphasise cross-border flood risk management and collaboration.
- Implement coordinated communication internally and also towards civilians.
- Improve and link computerised information systems and data-based analysis between the EMRIC partners.
- Create a shared vision for flood management.
- Equip EMRIC with a mandate to evaluate cross-border flooding events and cross-border crisis management.

Cross-national themes

Despite varied institutional arrangements, all three countries identified similar weaknesses in early warning dissemination, citizen preparedness, evacuation planning and crisis planning. All three countries focus on spatial adaptation, but execute that in different ways. Germany and Belgium focus more on recovering and rebuilding than the Netherlands, which focuses more on a paradigm shift towards increased acceptance of flooding. Germany and Belgium were hit harder and had more damage and casualties. This would explain why the focus is more on recovering and rebuilding compared to the Netherlands. The focus of recovery and repair, which makes sense considering the damage, is internal. Because the focus is internal, the opportunity for cross-border collaboration is reduced.

The three countries identified improvements needed in information and communication management. In Belgium, information management was hindered by fragmentation, uncertainty and informal direct lines of communication. Those informal direct lines of communication were often via WhatsApp between the regional actors. Belgian crisis managers experienced this as a hindrance. Communication became confusing, and information was lost/not addressed to the right actors. In the Netherlands, information management is also seen as an area that needs improvement. In contrast to Belgium, Dutch crisis managers experienced WhatsApp as a helpful tool. It decreased the communication lines, creating short, fast and distinct communication. Germany's focus on improving information management is on updating its methods and equipment. In Germany, many actors used fax machines. That machine proved to be outdated and slow. Hindering fast communication. Using different information management methods and systems makes information sharing more difficult and, therefore, reduces the opportunities for cross-border collaboration.

In Germany and Belgium, internal governmental fragmentation was a significant hindrance. Fragmentation led to confusion, delays and miscommunications. The fragmentation also led to difficulties in collaboration. For the three countries, it was unclear who to contact on the other side of the border. This uncertainty could be why the need for improvement in cross-border collaboration is barely mentioned in evaluations. Belgium and Germany focus on reducing internal governmental fragmentation. If the need to improve cross-border collaboration is mentioned, it is not specified how or what actions will be taken. The first focus in Belgium and Germany is to reduce fragmentation and organise their crisis management more effectively. The Netherlands is less fragmented, so it should focus more on cross-border collaboration.

Another scarcely mentioned factor is the many commissions the three countries are part of. The commissions are network centres and could provide resources, knowledge and cross-border connections. Unfortunately, the commissions are mainly used for evaluations afterwards. The cross-border commissions lack a mandate to act or guide during a crisis. Providing the commissions with a mandate to act and guide cross-border crises could improve collaboration. The commissions have a cross-border scope and could guide and inform crisis managers about cross-border actions. The commissions can then be a hub for cross-border collaboration instead of (mostly) evaluations.

4.4 To what extent did the learned lessons translate to changes in collaboration?

4.4.1 The Netherlands

In the Netherlands, flood evaluations caused various reforms. Key reforms included the creation of the WRL, improved information management, increased resources, improved crisis communication and a push for structural (cross-border) collaboration.

After the 2021 floods in Limburg, it became clear that more effort was needed to make Limburg resilient against extreme precipitation. For this purpose, the program Waterveiligheid and Ruimte (WRL) was created. In the WRL, multiple levels of government collaborate to prepare and protect Limburg against flooding (WRL, n.d.a). The WRL also clearly describes tasks, when it is expected to be completed and who finances them (Opbouwplan Programma WRL, 2022).

WRL

The WRL program consists of a joint design track with three pillars. Pillar 1 is named Physical Measures. Pillar 1 is designed to have a long-term trajectory. A trajectory of 15 years is planned. The program also pays explicit attention to short-term actions. The short-term actions are subdivided into four task packages. Task one is a starter package based on the study conducted by Deltares. Task two processing incidental urgent situations with significant social impact that manifested during the 2021 flooding event. Task three is to elaborate on the ideas, opportunities and concrete measures submitted by the municipalities, the Water Board, the Province, residents, land management organisations, entrepreneurs and social organisations. Task four is short-term opportunities from the design track (Opbouwplan Programma WRL, 2022). Pillar 2 is named Water and Soil Guiding for WRL. The Water and Soil Steering Pillar for WRL describes the objectives and demarcation from which spatial planning must be initiated to allow the water and soil system to play a guiding role in spatial planning. This principle is elaborated at the national level in the National Water and Soil Steering (WBS) program (Opbouwplan Programma WRL, 2022). Pillar 3 is named Climate Awareness and Self-reliance. Pillar 3 aims to increase climate awareness and self-reliance among residents to be better prepared for extreme flooding in the future. Pillar 3 consists of three tasks. Task one focuses on early warning methods for crisis management, mainly on forecasting and warning methods. Task two focuses on providing a 'toolbox' for civilians and companies, providing a perspective on what action to take when. Task three focuses on communication and participation, combined with improving flood awareness. The ambition of the WRL Programme about communication is to ensure uniform communication from the collaborating authorities. A distinction is made between internal and external programme communication, whereby the coherence at the programme level will be taken into account. Participation and process communication are interwoven (Opbouwplan Programma WRL, 2022). The WRL draws up a progress report every six months to ensure consistent progress (WRL, 2024).

As an elaboration of pillar 3, the WRL has established the WRL website www.wachtnietopwater.nl. On this website, the WRL has published several tools for civilians and companies. These tools help support and better prepare civilians and companies for floods. The WRL has composed an extensive brochure called Your Home Better Protected Against Flooding. This brochure contains tips and measures that you can undertake to protect your home, business or building against flooding and limit damage. The brochure also explains how to act before, during and after a flood. The brochure indicates the average cost of each measure (WRL, n.d.b). Rijkswaterstaat, Waterschap Limburg, Veiligheidsregio Zuid-Limburg and Veiligheidsregio Limburg-Noord created together Kerngroep Hoogwater (Coregroup High Water). Within this, a working group is focused on citizen participation. They advise and support municipalities in giving form and content to citizen participation (Interview 4).

The WRL not only undertakes measures but also provides subsidies. The WRL is making €10 million in subsidies available. The subsidy scheme aims to stimulate measures that better protect Limburg against flooding. Projects that ensure water retention, temporary storage, or controlled drainage (WRL, n.d.b). The WRL has also started a trial with free home scans in Limburg municipalities. Residents of selected neighbourhoods that may experience flooding will receive expert advice at home on limiting damage caused by flooding (WRL, n.d.b).

The WRL does not only focus on Limburg. The WRL actively seeks contact with neighbouring countries. Through regular consultation and collaboration in research, WRL hopes to achieve coordination. Measures taken abroad that reduce the risk of flooding in the Netherlands could be eligible for co-financing via the WRL programme. The WRL programme aims to realise an international low-threshold network, active collaboration at the project level, active collaboration, and an EU Climate Adaptation Fund (Opbouwplan Programma WRL, 2022). Internationalisation is an activity in WRL that affects all pillars, and where coordination between and with the pillars is significant. The WRL network and European support facilitate the pillars, while international cooperation at the river basin level focuses on demand from the pillars (Opbouwplan Programma WRL, 2022).

Structural collaboration

The province of Limburg is also working towards an intensive structural collaboration on water, instead of a project-based one. The province wants to think in river basin terms and not in fragments. Ideally, this leads to joint cross-border investments. Currently, it is uncertain whether the euros invested are also beneficial for Limburg or only yield results in Belgium or Germany. Furthermore, the province of Limburg wants a warning system established on the other side of the border so that Limburg is warned earlier (Trommel, 2022). The Waterschap Limburg also organises joint excursions with water managers from North Rhine-Westphalia. During these excursions, the water managers discussed challenges in the field of water safety and water quality. The aim is to continue intensive knowledge exchange in the future and to tackle joint initiatives such as the European Climate Fund, the need for which has accelerated following the 2021 floods in (Waterschap Limburg, 2023). Waterschap Limburg also looks beyond its immediate neighbours. International cooperation "far away" contributes to the sustainable and climate-proof development of the world. It is a form of knowledge exchange. An example is the Blue Deal programme, a collaboration between all Dutch water boards with the Ministries of Foreign

Affairs, Infrastructure and Water Management. The ambition of this programme is to help 20 million people worldwide access clean, safe and sufficient water in 2030. Waterschap Limburg is working on this in Romania, Colombia, eSwatini and South Africa (Waterschap Limburg, n.d.).

Crisis communication

During the 2021 flooding event, it became clear that crisis management cannot avoid answering questions from the media through press conferences, Q&As and interviews. As a result, a sub-plan for crisis communication has been drawn up and implemented (Interview 4). Crisis communication is now a significant pillar within disaster management and has an independent position within the crisis management organisation. The Crisis Communication team is responsible for carrying out the subplan for crisis communication. During a calamity or crisis, the officials in the crisis management organisation inform the persons involved within the Waterschap Limburg (Van de Vondervoort et al., 2024). Working agreements have also been made with the safety regions to coordinate communication messages (Interview 4). In an agreement between broadcasting services and the government, L1 Radio has been appointed as the official disaster broadcaster in Limburg. Part of the agreement is that the Safety Region updates the listeners every fifteen minutes about the current state of affairs. Waterschap Limburg can be asked to provide information (Van de Vondervoort et al., 2024).

Information management

Based on the evaluations of the 2021 flood, information management has been adjusted. To keep all officials and processes well informed, internal process agreements have been formulated. Using netcentric working, all teams and organisations share information swiftly (Van de Vondervoort et al., 2024). The reports can be shared via LCMS in a network-centric way. During a crisis, a case is created in the case system 'GoverMaxx' for the relevant crisis. Each case has a unique case number. Evaluations are archived under the same case number. All relevant documents are stored and archived in this system (Van de Vondervoort et al., 2024). The crisis management advisors are responsible for directing preparatory activities benefiting the crisis management organisation (Van de Vondervoort et al., 2024). Waterschap Limburg also uses CrisisConnect. CrisisConnect is an app that enables officials to have all the required information in the event of an incident. The user does not have to be logged in to the internal Waterschap Limburg network to consult the content, which means that the required information can be consulted regardless of location. All crisis officials have access to CrisisConnect. (Van de Vondervoort et al., 2024). There are also paper versions of all relevant documents available at the office in Roermond and the high-water sheds in Sittard and Horst. In the cold phase, maps (e.g. flood maps) will be prepared for use in the warm phase (Interview 4). Standards for flooding from the regional water system are the responsibility of the province. There is still much discussion about this (Interview 4).

Resources

The workload during the 2021 flood was extreme. Employees were working day and night for several days in a row. There were not enough employees available to arrange timely relief. After the crisis, discussions were held with the employees to share their experiences. Human Resource Management offered assistance, and when necessary, employees received individual guidance (Interview 4). The financial resources for combating flooding are not a limiting factor. Therefore, the roles in the crisis management organisation are now more robustly organised (more people per crisis role) and professionalised by educating, training and exercising. For the implementation of flood measures, Waterschap Limburg has contracts with contractors. Who must ensure sufficiently skilled employees and materials. During the annual flood exercise week (the first week of October), training and exercises are carried out together with employees from the contractors (Interview 4). A new protocol is implemented to improve the post-crisis phase and aftercare. In the aftercare, the regular organisation (managers and HRM) will take on a responsible role (Van de Vondervoort et al., 2024). For the handling of aftercare, all involved logbooks and other documents must be maintained and registered (Van de Vondervoort et al., 2024).

From the identified lessons learned, as seen in Chapter 4.3.1, most have been implemented in new legislation, amendments or projects. The lessons learned that have not (yet) been adjusted to or created new legislation/projects for are: “Evaluate the assistance process and dedicate a team to integrate assistance”.

4.4.2 Germany

In Germany, flood evaluations caused various reforms. Key reforms included measures to improve societal risk awareness, improve warning and forecast systems, increase resources available and improve collaboration with the Netherlands.

After the 2021 flooding event, Germany's first response was to offer support to those affected. Directly after the flood, the German government provided the Soforthilfe. The Soforthilfe was a monetary assistance of a maximum of 3500 euros (Borchert & De Pater, 2024). The obligation to file for bankruptcy was also temporarily suspended if the insolvency is due to the consequences of heavy rainfall or flooding, and there is a reasonable prospect of restructuring. In addition, the legislation provides for changes in, among other things, the protection against seizure to give those affected by financial difficulties some breathing space (Stern, 2021).

Reconstruction

The aftermath of the flooding event requires reconstruction and operation of infrastructure facilities to be tailored to the respective flood risk. However, four experienced architects and engineers explored the possibilities and limitations of flood-proof construction. But could not provide generally applicable planning and design principles or individual solutions due to the diversity of local problems (Rheinland-Pfalz, n.d.a). After the flood, the focus was on processing building applications quickly (Rheinland-Pfalz, 2022). The continuation was slower. By the end of 2023, most houses were renovated to be habitable again. The recovery was slower than hoped. When everyone wants to build simultaneously, construction workers become scarce, and delivery times for building materials increase. There have been complaints about cumbersome application procedures and late decision-making, which caused the reconstruction to stagnate (Borchert & De Pater, 2024). The administrative regulations of Rhineland-Palatinate state that public funds from the Fluthilfefonds are intended exclusively for repairing the damage that has occurred, thus for rebuilding as it was. Measures to make buildings more resistant to the consequences of a flood may not be paid from the Fluthilfefonds and will irrevocably lead to the rejection of the building plan. The result of these rigid regulations is that buildings are nevertheless being built on the same site again (Borchert & De Pater, 2024). New legislation also requires wastewater treatment plants to be constructed and operated in a flood-resistant manner. This regulation will be revised and specified in light of the 2021 flood disaster (Ministerium für Umwelt, Naturschutz und Verkehr des Landes Nordrhein-Westfalen, 2023).

Risk awareness

Efforts are being made in Germany to increase risk awareness (ICPR, n.d.b). To successfully increase risk awareness, mutual responsibility and recognition of these four basic principles are necessary: 1. Water is part of nature. Water is part of the natural balance everywhere and has its place in space. Water must be taken into account in all policy areas. 2. Retaining water. Water must be retained for as long as possible in the Rhine area. 3. Room for the river. We must give the river more space for a delayed, harmless discharge. 4. Being aware of the danger. Despite all efforts, there will always be a residual risk. Civilians must learn to live with this risk again. (ICBR, n.d.a). For this purpose, several information brochures have been drawn up (Interview 3). These brochures for the sub-basins of the water bodies in NRW and the national information brochure have been completed and published on various websites, such as Flussgebiete NRW (Ministerium für Umwelt, Naturschutz und Verkehr des Landes Nordrhein-Westfalen, 2023). The national information maps on heavy rainfall have been completely revised and improved (Heidbreder & Landtag Rheinland-Pfalz, 2023). The German authorities have noticed that people request and look up information directly from the relevant government organisation. Instead of waiting for the newspaper or the news. That is why the government website has also been renewed to accommodate this new demand for information. The websites have been updated and made easier to find relevant (flood) information (Interview 3). On government websites, you can make an initial assessment of the flood risk via the information box 'My Risk' (Rheinland-Pfalz, n.d.b). Advice is then given based on the risks. The website reminds the user that the state is not legally obliged to compensate for damage caused by natural disasters. It is, therefore, necessary that those who may be affected take personal responsibility for their property that is threatened by natural events (Rheinland-Pfalz, n.d.b). To alleviate exceptional emergencies resulting from damage caused by natural disasters beyond one's control (e.g. floods, storms and hurricanes), the state government can provide financial assistance under certain conditions. However, damage is only recognised if it is not insurable. This means that anyone who can take out insurance but does not do so will not receive any support from the state (Rheinland-Pfalz, n.d.b).

In addition to municipal precautions, the new Water legislation requires everyone to take personal precautions to minimise flood damage. Every homeowner must have an emergency plan (Rheinland-Pfalz, n.d.c). The websites also provide a detailed example of what an emergency plan should look like. It also points out that this emergency plan should be practised regularly and kept up to date. There are links to other websites that can provide more information, such as the Guide for Emergency preparation and my checklist (Rheinland-Pfalz, n.d.c). There is also a checklist available that lists everything civilians need in basic personal equipment (Rheinland-Pfalz, n.d.c).

Warning system

The strengthening of the warning infrastructure is initiated. Through the introduction of cell broadcast, the equipment with modular warning systems (MoWaS) and the establishment of a Rhineland-Palatinate-wide siren network. The first positive step for the new siren network was the federal and state siren funding program (Heidbreder & Landtag Rheinland-Pfalz, 2023). The federal government has launched a Siren funding program. From this, Rhineland-Palatinate will receive around 4.1 million euros. The state government is committed to ensuring that the federal government continue the siren support program (Heidbreder & Landtag Rheinland-Pfalz, 2023).

Forecasting system

The forecasting system in Germany has been revised. The new forecasting system is based on different models depending on the size of the catchment area. For the hydrological forecast, the internal test operation of the LANUV (Landesamt für Natur, Umwelt und Verbraucherschutz Nordrhein-Westfalen) has been in operation (Ministerium für Umwelt, Naturschutz und Verkehr des Landes Nordrhein-Westfalen, 2023). The Ministry of the Environment, Nature Conservation and Transport of the State of North Rhine-Westphalia (MUNV) has commissioned an external engineering firm to develop a GIS tool to determine water level locations for flood warnings. This tool is used to identify the areas to be protected and possible measurement locations based on available data. These are then compared with existing LANUV measuring stations. (Ministerium für Umwelt, Naturschutz und Verkehr des Landes Nordrhein-Westfalen, 2023). To increase the density and further develop the measuring network, new Grundwassermessstellen (level tubes) will be built, existing Grundwassermessstellen will be upgraded and optimised if necessary, and the Grundwassermessstellen measurement data from third parties and the LANUV will be implemented (Ministerium für Umwelt, Naturschutz und Verkehr des Landes Nordrhein-Westfalen, 2023). With the continuous expansion of the systems, it is currently being investigated whether and how data or even entire models from water boards can be included in the LANUV flood forecast. The aim is not to have forecasting systems operated in parallel by different parties but to integrate existing systems (Ministerium für Umwelt, Naturschutz und Verkehr des Landes Nordrhein-Westfalen, 2023). In line with the single-voice principle, cooperation between water authorities, the weather service and civil protection improved and now has a 'co-design' approach (Interview 2).

The LANUV regularly publishes hydrological situation reports for the supra-regional water management assessment of upcoming and current flood situations in NRW. The hydrological reports are also a significant tool for information and flood warnings (Ministerium für Umwelt, Naturschutz und Verkehr des Landes Nordrhein-Westfalen, 2023). NRW also works together with the Dutch Rijkswaterstaat. The cooperation is primarily about data exchange. There is also cooperation to universalise the prediction models. Germany also uses data from the Dutch KNMI. There is currently consultation about how data exchange can be improved and how both countries can better adapt their prediction models (Interview 3).).

Crisis communication

In order to prevent fake news and better inform and warn the population, NRW made agreements with the media. There is now close contact between the water board and the media. The water board provides the media with information, and the media spreads the information. Creating a reliable source of information. There are also exercises every few months in which the press is also involved (Interview 3).

Resources

As a result of the 2021 flood, more resources have been made available. Additional staff are hired. For example, at LANUV alone, 30 additional experts have been hired. LANUV is still hiring additional staff (Interview 3). Other government agencies related to crisis management or flood risk management have also been given additional staff. In the districts and independent cities, the expert advisory service must also ensure that the contact persons are qualified. Therefore, they can act as a link between water management and the crisis management team in the event of an incident (Rheinland-Pfalz, 2022). More financial resources have also been made available. Currently, it is not difficult to obtain funding for a project. In addition, all election parties promised to continue investing in resources for water policy. To ensure the continuity of the projects (Interview 3).

Collaboration

Before the 2021 flood, the Netherlands and Germany collaborated on flood risk management. This collaboration mostly consisted of data exchange (Interview 3). Intensive coordination has taken place between the German-Dutch emergency response organisations to prepare for specific high-water situations. Joint high-water exercises are prepared, carried out and evaluated regularly. The primary goal of the working group is to be better prepared for floods and extreme rainfall in the GPRW (Transnational Platform for Regional Water Management) working area. This is achieved by contributing to cross-border crisis coordination and communication, promoting the exchange of knowledge and experience between the parties involved and optimising and planning joint high-water exercises (Interreg Germany-Netherlands, 2025). These initiatives are crucial for shortening response times and increasing the effectiveness of crisis management, with the cooperation between German and Dutch water authorities being central (Grenzüberschreitende Plattform für Regionale Wasserwirtschaft, n.d.). On average, there is contact between GPRW participants twice a month (Interview 3). In 2024, the SPW (Wallonia) joined the agreement on cooperation in the maintenance and support of flood prevention systems. The frequency of contact between NRW and the Belgian region of Wallonia, therefore, increased significantly compared to before the 2021 flood (Interview 2).

From the identified lessons learned, as seen in Chapter 4.3.2, most have been implemented in new legislation, amendments or projects. The lessons learned that have not (yet) been adjusted to or created new legislation/projects for are: “Insist on reconstruction focused on climate neutrality and flood resilience and not on 1:1 rebuilding”, “Implement the use of volunteers and spontaneous helpers in crisis management” and “Establish a state office for disaster control with nationwide universal operating systems, uniform personnel and uniform material equipment for civil protection units”.

4.4.3 Belgium

In Belgium, flood evaluations caused various reforms. Key reforms included measures to improve societal risk awareness, reformations within governmental structures, legislative changes and the creation of the warning system Paragon.

Repair

The Wallon government spent 5,2 billion euros on the recovery of the affected areas. On a new framework for municipalities to adapt better to climate change. With a focus on flood prevention, preparation, protection and post-flood analysis projects. On amendments to legislation to allow water and crisis management to intervene on private properties during crises (Gouvernement de la Wallonie, 2023). To improve preparations against extreme precipitation and drought, the Wallon government has made available a budget of 19 million euros for the construction of new temporary immersion zones and the redevelopment of waterways. To improve resilience during droughts and heavy precipitation while simultaneously improving biodiversity (Gouvernement de la Wallonie, 2023).

In October 2021, the Belgian government decided to change its recovery plan. The new recovery plans needed to integrate reconstruction measures in the affected areas, and a new understanding of recovery was constructed (Gouvernement de la Wallonie, 2023; Rollez, 2023). Recovery is now a significant new component in crisis management. Recovery cannot be seen as a return to normal. Recovery, now, is seen as an opportunity to rebuild better and more resilient to future crises (Rollez, 2023). Professionalisation of key figures who must make well-considered but quick choices during emergencies remains a priority. Such training courses have now been offered by various universities in Wallonia and Flanders since September 2023 (Gouvernement de la Wallonie, 2023; Rollez, 2023).

Risk awareness

The Wallon government and the Marhetak project have jointly made a rapport. This report aims to stimulate reflection by providing advice and tools to local authorities on existing methods and practices for reducing flood risk. With a particular focus on involving civil society and stakeholders in flood risk and crisis management. The rapport is focused on Wallonia but is also meant for the other participants in Marhetak (Waalse Overheidsdienst et al., 2023). The rapport has also extensively advised citizens on what to do and how to behave during and after a flooding event. The report advises on how to protect yourself and your family during a flood. Manuals have been made available for civilians. To enable them to evaluate the vulnerabilities of their homes to flooding. Certain municipalities also offer free flood vulnerability diagnoses (Waalse Overheidsdienst et al., 2023). The government has websites that can assist civilians in preparing for a flood, such as www.mijnnoodplan.be (Waalse Overheidsdienst et al., 2023). Inhabitants of a flood-prone area are advised to assemble a ‘survival kit for flooding’. The report has recommendations on what the survival kit should include (Waalse Overheidsdienst et al., 2023). The report also describes what to do when returning to the affected home and advises on how to deal with Belgian insurers (Waalse Overheidsdienst et al., 2023).

The Walloon government has developed and proposed forty-one global measures for the four phases of the flood management cycle. The measures have been approved by the Transversal Flood Group (GTI). The measures aim to intervene as early as possible in the flood management cycle. In particular, to improve flood prevention and the preparation of the general public (Waalse Overheidsdienst, 2021). Additional resources are intended to enable regional support for municipal authorities with implementation and reinforcement of projects for the prevention, protection, preparation and post-crisis analysis of flood risks (Waalse Overheidsdienst, 2021).

legislation

At the end of 2022, the Belgian government imposed new legislation regarding guidelines for permit and advisory providers for the application of climate-proof water tests and safeguarding water storage capacity in signal areas. The new legislation provides more clarification on the new flood maps and the newly optimised water test procedure. The new legislation imposes guidelines on how to prepare for various kinds of flooding events. The new legislation contains guidelines for a climate-proof water test by taking flooding and drought into account (Coördinatiecommissie Integraal Waterbeleid, 2023). To create more clarity, advisory maps and a set of maps that show flood sensitivity have been created. The advisory map indicates at the parcel level whether and from which bodies' advice must be requested for a plan, a spatial implementation plan or a permit (Coördinatiecommissie Integraal Waterbeleid, 2023). Furthermore, the Belgian government imposed more refined information obligations. With separate scores for the plot (P-score) and the building (G-score). The P-score and G-score must now be mentioned in advertising for the sale or long-term rental of real estate (Coördinatiecommissie Integraal Waterbeleid, 2023).

Reformation

The management of the Flemish navigable waterways is going to be reformed. The Flemish minister of justice and enforcement, environment, energy and tourism presented a plan to reduce the waterway administrators. There are currently 112 different administrators. The plan is to reduce it to a maximum of 12 and abolish their tax authority (Flemish Environment Agency) (Vilt, 2023). The polder boards and the separate polder taxes are experienced as remnants from the past. Such fragmentation does not benefit the necessary policy. The goal of the reform is to create fewer structures and more unity of command for the water challenges. The establishment and operation of these water boards are regulated in the new Article 30. Article 30 stipulates that "A water board is established per basin or for several sub-basins belonging to the same basin." The main participants in the Water Board are the Vlaams Gewest (the Flemish Region), the Province(s), the municipal authorities, the polders and the water boards *(Vereniging van Vlaamse Polders en Wateringen, n.d.).*The intention is to base the water boards as much as possible on the current water basins. The minister wants to tackle the reform gradually. The management and priorities in the field must not come to a standstill (Vilt, 2023).

A cooperation agreement, which gives substance to the mutual tasks of the Water Board Union and the VMM, was concluded between the Flemish Region, the VMM and the water boards (De Vlaamse Minister van Justitie en Handhaving, Omgeving, Energie en Toerisme, 2023). The Water Boards ensure a strengthening of Flemish water policy based on their local knowledge of the terrain, experiences and expertise. The water system is strengthened through an integrated management that works through the Flemish policy via the VMM, the Water Board Union and the Water Boards. To realise close cooperation and consultation with local coalitions combined with area-oriented projects based on a water-oriented focus (De Vlaamse Minister van Justitie en Handhaving, Omgeving, Energie en Toerisme, 2023). Integrated projects also offer opportunities for coupling with other domains. Through structural coordination with various other domains, area-oriented and integrated work can be done (De Vlaamse Minister van Justitie en Handhaving, Omgeving, Energie en Toerisme, 2023). It is noted that the Water Boards supplement to plans and initiatives such as the Sigma Plan, but do not imply a replacement. The Water Boards facilitate the roll-out and implementation of area-oriented programs in collaboration with dynamic area coalitions and thus offer a reinforcement of the integrated water and environmental policy (De Vlaamse Minister van Justitie en Handhaving, Omgeving, Energie en Toerisme, 2023).

The emergency planning has been elaborated. It is now more clearly written who plays which role during a flooding event. The roles remain similar. The tasks are now clearly divided (Interview 5). The coordination committee for integrated water policy (CIW) will reform into a fully-fledged knowledge and network organisation with a strategic advisory role to the Vlaamse Gewest. The CIW forms a broad think tank and forum that helps set the course for sustainable water management of a resilient water system. At the request of the policy, the CIW will issue advice and formulate policy proposals within concretely defined deadlines. Where necessary, the CIW will expand with direct representatives from the academic world and the water sector (De Vlaamse Minister van Justitie en Handhaving, Omgeving, Energie en Toerisme, 2023).

New government

On 30 September 2024, the new Diependaele government was sworn in. The new Flemish government has new plans for water management. The plans focus on the creation of wetlands, an increase in wet nature, and increased room for the river. In several situations, however, drainage, modernisation of weirs and dike reinforcement will be necessary (Vlaamse Regering, 2024). The government will continue to permit policy in agricultural areas regarding drainage, and will extensively evaluate the permit policy. The new government will implement measures tailored to hydrologically vulnerable areas and take transitional and/or support measures to adapt existing drainages (Vlaamse Regering, 2024). The new government will stop building in water-sensitive open space areas (WORGs). The government will demarcate additional WORGs to reduce hard developments in those areas (Vlaamse Regering, 2024). The new government will combat flooding with a reinforced Sigma 2.0 program and do a similar exercise for other basins (Vlaamse Regering, 2024). It should be noted that how the new government plans to reinforce the Sigma 2.0 plan and how to boost the implementation of Weerbaar Waterland is not mentioned in the coalition agreement.

According to the new coalition agreement, 14 million euros will be allocated to the plan in 2025 and 2026. In 2027 and 2028, this will increase to 54 million euros and in 2029 to 154 million euros (Vlaamse Regering, 2024). That makes a total of 290 million. That is lower than previously set up in the blue deal. Studies have shown that the Flanders region should invest between 250 and 300 million annually in projects that control water and improve water retention. The fact that N-VA and Demir, who passionately defended the Blue Deal as Minister of Environment and argued that more money should be allocated to it, are still part of the government makes it all the more striking that the new cabinet is cutting the budget for the Blue Deal (H20 waternetwerk, 2024).

The Blue Deal was an answer to the lack of financial security for integrated water projects. The blue deal brought extra budgets for projects, but too few projects are already at a sufficiently advanced stage. There is too little staff capacity and time to develop project embryos. There is also no structural financing for the integrated projects or the projects that arise within the framework of the integrated projects (Bekkenbestuur Demerbekken, 2022). Bekkenbestsuur (2022) recommends a structural link for financing the integrated projects. This could be achieved within the framework of the Blue Deal. Through more structurally developed project financing or cooperation agreements between the Flemish Government and the water managers. It is remarkable that budgets are already being cut on the blue deal.

Paragon

Since July 2024, the Belgian government has had a new national security portal named Paragon. The Belgian National Crisis Centre (NCCN) has developed the Paragon portal (Incident & Crisis Management System). The NCCN has developed Paragon in-house. Developing Paragon in-house has the advantage of being able to continuously refine Paragon. Each emergency is followed by an evaluation phase, and each evaluation leads to a list of possible improvements (Nationaal Crisiscentrum, 2024). Paragon is based on cartography. The platform is designed to visualise an emergency or incident on a map. Anchors mark the key intervention sites. All other functionalities of the platform are programmed around this cartographic approach (Nationaal Crisiscentrum, 2024). First impressions of the new Paragon platform are very positive (Nationaal Crisiscentrum, 2024). Over 140 tests and exercises are organised, focusing on testing emergency plans and using Paragon (Nationaal Crisiscentrum, 2024).

The province of (Belgian) Limburg is organising an extensive disaster exercise around floods in 2026. To test the new procedures and to train staff. The Netherlands is also involved in this exercise to test and practice mutual data exchange and communication (Interview 5).

From the identified lessons learned, as seen in Chapter 4.3.3, most have been implemented in new legislation, amendments or projects. The lessons learned that have not (yet) been adjusted to or created new legislation/projects for are: “Improve cross-border collaboration” and “Increase the capabilities and possibilities of civil protection”.

4.4.4 EUregio Meuse-Rhine

In the EUregio Meuse-Rhine, flood evaluations caused various reforms. Key reforms included improvements in European legislation and improved cross-border communication.

Cross-border communication

To improve the cross-border communication and link computerised information systems and data-based analysis between the EMRIC partners. The EMRIC network focuses on developing a joint Paragon system as part of Marhetak to improve the international cross-border exchange of information in crises (Unfried & Mertens, 2023). Paragon is EU-funded, rooted in the Belgian National Crisis Centre. Paragon is a perpetual program based on adopted, open standards and is secure, scalable and multilingual (Vansevenant, 2024). In addition, the Marhetak project also involved the purchase of emergency flood equipment that is deployable across borders (EMRIC, 2023). The Paragon system can vary between national standards. Data from any source can be used, so Paragon is applicable everywhere. Therefore, Paragon is unlimited by borders (Unfried & Mertens, 2023). Paragon is multilingual and uses modern authentication and authorisation technology (Vansevenant, 2024). Using these concepts and adding Big Data, prediction modelling and Artificial Intelligence, Paragon will enable the improvement of the outcome of flooding events in the future (Vansevenant, 2024). Paragon will be tested during live exercises in the EUregio Meuse-Rhine (Unfried & Mertens, 2023; Harbers et al., 2024).

Benelux-water day

On 29 November 2023, the first annual Benelux-Water Day was organised in Maastricht during the Dutch presidency of the Benelux. The conference brings together regional stakeholders, scientists and policymakers to address challenges related to regional watercourses jointly. The German state of North Rhine-Westphalia is also represented (Beck, 2023). The focus of the Benelux Water Day was to lay the foundations for a coherent and collective executive policy about regional water systems. There are opportunities to strengthen cooperation in this area by creating more coherence and promoting a structured approach (Harbers et al., 2024). The Benelux Water Day also marked the official start of the cross-border knowledge programme JCAR-ATRACE. This programme was set up on the initiative of the Dutch knowledge institute Deltares. The program facilitates scientific research into flood management and drought risks in regional river basins by strengthening regional knowledge and making the knowledge more available to civilians (Beck, 2023). Several universities from Belgium, Luxembourg and Germany are affiliated. The Benelux Water Day marks a significant step towards a more resilient and joint water policy (Beck, 2023). Another attempt to improve cross-border flood risk management and collaboration is the European Watertop in Lanake, on 26 March 2024. European water managers and knowledge institutions have joined forces to address the urgent need for improved cross-border flood risk management. A crucial step was taken with the signing of the roadmap for better cross-border water safety. The roadmap outlines specific goals, principles and actions to improve cross-border water safety (Harbers et al., 2024). The member states and EUregios are advised by the roadmap to execute a stress test of extreme weather conditions in cross-border river basins. Adapt a risk-based and area-based project approach for cross-border river basins, with measures from source to estuary. Improve forecasting methods by exchanging information and knowledge. Establish cross-border regional coalitions and facilitate financing for water safety projects. And streamline permitting procedures to accelerate project implementation (Harbers et al., 2024).

Copernicus

The European Commission supports Member States with forecasting by the Copernicus European flood awareness system. The Copernicus system supports preparatory measures before, during and after a flooding event. Copernicus' mapping service provides rapid on-demand provision of geospatial information, supporting emergency management before, during and after a flooding event. The Commission is encouraging the use of Copernicus services. As well as knowledge sharing between Member States about the usage of the Copernicus system (European Commission, 2025).

EMFloodResilience

Another attempt to improve cross-border flood risk management and forecasting is the EMFloodResilience project. The project is being implemented within the Interreg V-A Euregio Meuse-Rhine framework and is 90% financed by the European Regional Development Fund. Usually, participants finance 50% and Interreg finances the other 50%. In this project, participants only need to finance 10%, and Interreg covers the other 90%. This allowed partners to be brought in quickly. Leading the project to get off to a good start (Interview 6). The project aims to improve preparedness for future flooding events. Thereby preventing future socio-economic damages and limiting human casualties. The focus lies on improving the collection of meteorological and hydrological monitoring data, improving weather and water forecasts and making spatial planning more climate-proof (Interreg Euregio Meuse-Rhine, n.d.). The project is divided into six working groups. Workgroup 1 lays the foundation for meteorological forecasting. Workgroup 2 focuses on how extreme precipitation leads to extreme discharges and how rivers react to extreme precipitation. Workgroup 3 zooms in on the cross-border river Rur as a case study. Workgroup 4 researches the effects of floating debris during flooding events based on 2021 experiences. Workgroup 5 has investigated the effects and impact of a flood when a flood occurs. Workgroup 6 works out the lessons learned at the level of a river system. This will be conducted on the cross-border river Wurm (Interreg Euregio Meuse-Rhine, n.d.).

Resilience goals

The European Commission has developed five disaster resilience goals, adopted in February 2023. To anticipate and withstand the effects of future disasters and emergencies (European Commission, 2024). These goals aim to create a shared vision and steer work in disaster prevention and disaster preparedness. The goals serve as a compass for investment and policy development, supporting authorities in making better-informed decisions and protecting citizens, livelihoods, and the environment (*European Disaster Risk Management*, 2024). The disaster resilience goals consist of five steps. The first step is to anticipate, with a focus on improving anticipation. Member states must improve their risk assessment and disaster risk management. The interdependency and complexity of the risks the European Union faces makes it important to identify threats and hazards and to asses vulnerabilities in critical sectors. The second step is to prepare. Improvement of risk awareness by civil society is significant for this step. Increased risk awareness combined with improvements in society's preparedness will reduce the impact of a disaster (European Disaster Resilience Goals, 2023). The third step is to alert. Enhancing early warning systems is the focus of this step. Improving early warning systems ensures that warning messages reach the right people at the right time, transcending national borders. The fourth step is to respond. Important for this step is the enhancement of the EU Civil Protection Mechanism (UCPM) capacity. An improved UCPM can provide support and fill gaps to avoid (further) deterioration of a crisis when a country or Euregion is overwhelmed. The fifth step is to secure, creating a robust civil protection system. Civil protection systems must be operational 24/7, during and after a crisis. Member states are expressly requested to update business continuity plans and procedures. And are required to ensure coordination and information sharing across borders and sectors, including critical infrastructure providers (European Disaster Resilience Goals, 2023).

Data collection

Another UPCM amendment was conducted in 2021. Article 6(1)(f) was amended to improve the understanding of a disaster. The amendment states that the Member States must now improve data collection during a crisis. To improve evaluations and ensure evidence-based scenario building. The European Commission has developed a Risk Data Hub to collect crisis data. Furthermore, the UPCM will be enabled with new tools. Tools such as peer reviews, science-based disaster scenarios, financial and technical assistance and a Knowledge Network providing access to experts (European Union, 2023). A progress report on the implementation of Article 6 was published in March 2024. In this report, it is recommended that the European Commission continuously promote the uptake of the peer review framework. To regularly analyse and monitor the circumstances and reasons for activation per hazard. To support Member States in their efforts to improve their crisis prevention, crisis preparedness and further streamline the reporting process (European Commission, 2024). However, the analysis of practices collecting crisis data reported still shows many shortcomings (European Commission, 2024; *European Disaster Risk Management*, 2024).

From the identified lessons learned, as seen in Chapter 4.3.4, most have been implemented in new legislation, amendments or projects. The lessons learned that have not (yet) been adjusted to or created new legislation/projects for are “Public participation should be implemented in emergency planning” and “Give EMRIC a mandate to evaluate cross-border flooding events and cross-border crisis management”.

Cross national themes

The Netherlands and Germany are making efforts to improve collaboration. The Netherlands has implemented the WRL, and the WRL has focused its scope on cross-border. Germany, in the form of several federal states, also tries to look beyond its borders. Germany and the Netherlands collaborate to improve the coordination of information and forecasts. Understandably, the Netherlands tries to look cross-border the most. The Netherlands is downstream and depends on upstream measures in Germany and Belgium. That could explain why the Dutch focus is more cross-border and why that of Germany and Belgium is more inland. The countries are increasingly meeting and seeking each other out more. An example of this is the newly started annual Benelux Water Day.

The focus of Belgium was mainly on repairing damages and restructuring the crisis and water management, an inward focus. Within Belgium, there is tension between the Walloon and Flemish regions. This inward tension and focus do not benefit the opportunity for cross-border collaboration. It seems that the lack of internal stability in Belgium hindrances the possibility of collaborating with the Netherlands and Germany in flood risk management. Belgium has taken internal steps with the Blue Deal, but the question is whether the newly elected government will continue the Blue Deal or continue with the budget cuts. Belgium, in collaboration with Marhetak, is developing the Paragon system. Marhetak and its successor, EMFloodResilience, attempt to evolve this system into a cross-border collaboration. The EU region Meuse-Rhine is trying to stimulate this collaboration. The EU region is doing this through new EU legislation. The new EU legislation is a good step and makes countries evaluate cross-border flood risk management, but it is still too vague to provide decisive incentives.

Chapter 5. Interpretation

In this chapter, the research data from Chapter 4 will be interpreted. First, the research questions will be individually answered. Then, the results will be linked back to the conceptual model to see how the conceptual model compares with the data. The conceptual model is displayed in Figure 5 on page 17?

5.1 Research questions

To answer the first research question, how did the Netherlands, Germany and Belgium collaborate before and act during the 2021 floods? The Netherlands, Germany, and Belgium collaborated in numerous committees and commissions. The countries are all EU member states that comply with EU legislation, such as the EU Flood Directive. The three countries are all part of the Meuse Commission, the ICPR Commission and the EMRIC. Furthermore, the three countries have multiple committees and commissions among themselves. Despite all the committees and commissions, the countries responded individually during the flood. The numerous committees and commissions were unprepared for a simultaneous flood event. The actors were unprepared, and communication difficulties hindered (potential) cross-border collaboration. As a result, mistakes arose in crisis management and communication. This is in line with the literature from Evers et al. (2016), which states that communication and transparency between actors play a crucial role in successful (cross-border) flood risk collaboration. This was not the case in this situation, which partly ensured that there was no successful (cross-border) flood risk collaboration.

To answer the second research question, how did the Netherlands, Germany and Belgium frame the shock event? The Netherlands framed the flooding event as an unavoidable natural disaster. There was an understanding that flooding and material damages were unavoidable. However, this did not mean that nothing could be done. Afterwards, thorough evaluations were conducted. The disaster was also framed as a natural disaster so that the government could provide better (financial) support based on legislation (WTS). In Germany, the flooding event was framed as a disaster with political undertones. Various parties tried to blame the government. The government itself tried to make a positive impression by frequently visiting the affected area and expressing its support there. These actions are in line with the literature from Bohensky & Leitch (2013), which states that for framing events to catalyse learning and trigger adjustments. Timing and context are particularly important. For example, the findings from formal inquiries could be overrun by a new election campaign or the start of a new political cycle. In Germany, this was not the case. The learnings from the flooding event were a significant topic in the election campaigns. There was also discontent among the victims in Germany, and there was misinformation. The discontent that was expressed was sometimes framed as 'water wappies'. In Belgium, the flooding event was framed as a major government failure. Residents there sued the government over their discontent with its actions. This is in line with literature from Thistlethwaite et al. (2019) that media coverage surrounding the shock event provokes questions about the quality of public policies that protect people and their properties. This was evident in Belgium and Germany. The division between Wallonia and Flanders was also a massive topic in the Belgian media. The Belgian government itself framed it as a natural disaster. The Belgian government commissioned an independent investigation, which concluded that the government acted according to protocol. As a result, the government shifted the blame.

In the Literature review, Thistlethwaite et al. (2019) stated that policymakers are often susceptible to arguments and narratives disseminated by the media. Selective media coverage can create an incentive for policymakers to add new issues to the agenda or increase the attention already given to existing problems. In contrast to this literature, the interviews showed that, in this case study, the media had no significant influence on decision-making by policymakers during the flooding event (Interview 1; Interview 2; Interview 4; Interview 5). Therefore, the (media) framing did not influence the policy window in this case study. Contradicting the theoretical assumptions made in chapter 2.1.3. Why the (media) framing did not influence the policy window remains unclear and requires further research.

To answer the third research question, what lessons were learned after the 2021 floods? The Netherlands evaluated that there is a need for a paradigm shift. A need to mitigate flood risks with spatial adaptation and improved risk awareness. A need for better implementation of public participation in crisis management. The aftercare for workers and civilians also requires improvement. Germany evaluated that spatial adaptation and risk awareness need improvement. The reconstruction of the affected areas provides an opportunity to adapt to a flood-robust design. Furthermore, a key evaluation is to improve governmental coordination and collaboration, combined with improving warning systems and forecasting methods. A small mention is made to increase and improve cross-border collaboration. Belgium evaluated that governmental fragmentation needs to be reduced. To reduce fragmentation, a restructuring of the water management system is required in combination with other measures. Furthermore, the warning systems need upgrading, and crisis management needs to be improved. The EUregio Meuse-Rhine evaluated that there was a lack of cross-border coordination, collaboration and communication. The responsibilities are fragmented in the Member States, hindering collaboration. The EUregio advised creating a shared vision for (cross-border) flood management. To link computerised information systems and data-based analysis between the EMRIC partners. And to empower EMRIC with a mandate to evaluate and manage cross-border flooding events.

The Netherlands, Germany and Belgium all focused their evaluation on their functioning. Not entirely unexpected because that is the only thing they have a mandate for and, therefore, make changes to. Limiting the possibility of cross-border collaboration. This complies with literature from Van Popering-Verkerk & Van Buuren (2017), which states that collaboration is achievable if stakeholders are willing to act and think beyond the boundaries of legislation and organisations. The collaborative attitude, combined with personal and collaborative capacity, is significant for successful collaborative research. In this case, the willingness and/or capacity to act beyond legislative boundaries was absent during the flood event. The EU region Meuse-Rhine is trying to draw attention to this. If the countries think more broadly, they can achieve more. The EU region advises to give an umbrella organisation, such as EMRIC, a mandate so that it can evaluate, advise and steer from a cross-border perspective. Legislative hindrances proved to be a serious limiting factor for the policy window. Legislation, described as rules of the game in the conceptual model, not only directly influenced collaboration but also the policy window.

To answer the fourth research question, to what extent did the learned lessons translate to changes in collaboration? The Netherlands implemented various reforms. Key reforms included the creation of the WRL, improved information management, increased resources, improved crisis communication and a push for structural (cross-border) collaboration. Germany took measures to enhance societal risk awareness, improve warning and forecasting systems, increase available resources, and enhance collaboration with the Netherlands. Belgium took measures to improve societal risk awareness, implemented reforms within governmental structures to reduce fragmentation, made legislative changes, and created Paragon. The EUregio Meuse-Rhine focused its efforts on the new European legislation and improving cross-border communication and coordination.

The changes the Netherlands and the EU region Meuse-Rhine implemented have influenced the collaboration. The establishment of the WRL ensures an active search for improvements in cross-border collaboration. Germany and the Netherlands collaborate to improve the coordination of information and forecasts. Communication and transparency between actors play a crucial role in successful flood risk collaboration (Evers et al., 2016). Therefore, improvements in the coordination of information and communication will lead to improved collaboration. A mechanism that emerged, which was not anticipated in the theoretical framework, is the importance of aligning information coordination and data exchange. To be able to collaborate. It appears that the ability to collaborate is influenced by the extent to which the data systems align with each other.

Van Popering-Verkerk & Van Buuren (2017) state that for successful collaboration, resources such as (local) knowledge, sufficient time and budget, organisational capacity and legitimacy need to be accessible to all collaborating stakeholders. Implying the development of new rules or the adjustment of already existing legislation. The Netherlands has little structural change, leaving organisational capacity for cross-border collaboration. Germany improved and changed its systems. Spending some time, budget and organisational capacity. But there was still time, budget and organisational capacity left for some cross-border collaboration. Belgium has restructured a lot internally, spending a lot of time and organisational capacity. Meaning that there was little left to look and think cross-border. As a result, many of the lessons learned and measures implemented are internally oriented. Therefore, these measures hardly translate to changes in cross-border collaboration.

5.2 Conceptual model

Although the countries framed the shock event in different ways, the interviewees indicate that the media did not influence any way of working during or after the flood. In this case, framing and discourses had no direct effect on the policy window during and immediately after the shock event. So, the first part of the conceptual model seems to have had little influence on the cross-border collaboration in this case. The discourse in the countries concerned has been shifting for some time. The countries are increasingly aware that space for water is needed and that not everything can be solved with technical measures. The flood did contribute to increasing support for this shift. In this casus, the shock event did influence the framing and discourse.

The problem stream, in this case, was clear. The floods were a threat that required governmental action. The policy stream consisted of extensive evaluations with recommendations for measures that the countries should implement. The evaluations focused mainly on their own country. There were hardly any recommendations to improve cross-border cooperation. If there was, it was flat and vague. The policy stream influenced the policy window in this case, but hardly any cross-border collaboration. The political stream had little influence on the policy window in the Netherlands and Belgium. In Germany, it did. Because the flooding took place just before the elections. Several political parties played on this to prove their positions or to damage political opponents. And as a result, influencing the policy window. The policy window, as described by Pal et al. (2020) as an unpredictable opening in the policy process that creates the possibility for influence over the direction and outcome of a process, was present. There were many evaluations, and the authorities were open to recommendations and potential changes. Many adjustments and measures were implemented.

The policy window was present and exploited. However, cross-border collaboration was not significantly developed. In the final part of the conceptual model, modelled after the policy arrangement approach from Arts et al. (2006), resources and rules of the game directly influence collaboration. In this case, Belgium lacked the resources to focus on cross-border collaboration. Belgium had spent its resources on restructuring its organisations. Another factor hindering the potential collaboration is the rules of the game. The current legislation does not adequately mandate a cross-border organisation to properly evaluate, steer or act during or after a crisis. The policy arrangement approach is strictly interrelated, so a hindrance in one aspect affects all others. Therefore, the lack of available resources in Belgium, combined with legislative problems, hindered the opportunity to establish cross-border collaboration. The internal stability of (crisis) management organisations appear to have influenced the ability to make use of the resources, which was not anticipated in the theoretical framework of this research.

Chapter 6. Conclusion

In this chapter, the main research question will be answered. Secondly, the limitations of this research will be discussed. Lastly, recommendations for additional research will be provided.

6.1 Conclusion

The main research question is to what extent the 2021 flood events in Limburg influence the collaboration between the Netherlands, Germany and Belgium in flood risk management and influence the flood risk management discourse. To answer this question, the flood events of 2021 influenced the flood risk management discourse. The countries now understand that not everything can be prevented with technical measures. Learning how to live with flooding events is the new discourse. The discourse change started in recent years, but the flooding event of 2021 in Limburg accelerated the change. The collaboration in flood risk management was partly influenced by the 2021 flooding event. The three countries are trying to collaborate more. However, the lack of available resources in Belgium, combined with legislative problems, hindered the opportunity to establish cross-border collaboration.

6.2 Limitations

A limitation of this research is the language barrier. Dutch is the native language of the researcher. The ability of the researcher to communicate in German is limited, restricting the ability to interview Germans in their native language. In Wallonia, French is the official language. The researcher cannot understand or speak French. For this reason, documents in French were translated via Google Translate. This could cause the information to be mistranslated or slightly misinterpreted, limiting the reliability of this research. Causing a Dutch bias. Another limitation of this thesis is that the research was conducted in 2024 and the beginning of 2025. Therefore, the implementation of the lessons learned could be limited. Research projects are still unfinished due to the length of the projects, and new legislation is still in preparation.

Due to the limited time, 15 articles per county were analysed. A bigger sample size would improve the reliability of the research. Six experts have been interviewed. Two experts per country. This limited the reliability of the thesis because it proved difficult to interview experts from different regions. So there is a lack of interviewees from Wallonia. They might be less inclined to participate in a non-native language interview. Another limitation of the research is that various commissions, such as the ICPR, have undertaken measures to improve cross-border collaboration. But the measures were implemented in 2015. They are, therefore, not included in this study. Their implementation was not affected by the 2021 flood.

6.3 Recommendations

Various projects and (legislative) changes are yet to be implemented or finished during the research. For example, the EMfloodResilience project just started. Therefore, redo the research a few years later. To get the full effect of the changes brought by the 2021 flooding event. The research also focuses on the Netherlands, Germany and Belgium. It is recommended to perform a similar study in a different part of the world. For example, in Asia or South America. To see if the results of shock events on collaboration are similar to those found in this research.

It is recommended to explore how to implement civilian participation effectively in crisis management. Civilian participation has many positive stories, but crisis managers wonder whether citizens are taking unnecessary risks in dangerous situations for which they are untrained. Civilian participation requires guidance to be effective, putting more pressure on crisis managers. Governments have included this in evaluations, but have not found an answer yet on how to effectively include civilian participation during a crisis. In an extension of civilian participation, it is recommended to explore how local app groups can be used to share knowledge and skills and mobilise people. And how WhatsApp groups can guide this commitment. Residents and companies, as an extension of the water board and safety region, can be better utilised.

A finding of this research is that there is a lack of adequate mandate for a (crisis) organisation that can evaluate, advise and steer from a cross-border perspective. Follow-up research could investigate how realistic it is to create such a mandate and how that could function legally. Within the current legislation, and if not, which legislation prevents that. A practical recommendation is to implement an annual cross-border crisis exercise. This way, policy makers and crisis managers have contact and practice annually. During the exercises, problems that hinder collaboration can come to light. The exercise does not necessarily have to be about floods. Another cross-border crisis can also be practised, such as a forest fire or an epidemic.

References

Adekola, O., & Lamond, J. (2017). A media framing analysis of urban flooding in Nigeria: current narratives and implications for policy. Regional Environmental Change (Print), 18(4), 1145–1159. https://doi.org/10.1007/s10113-017-1253-y

Albrecht, F. (2021). Natural hazards as political events: framing and politicisation of floods in the United Kingdom. Environmental Hazards (Online), 21(1), 17–35. https://doi.org/10.1080/17477891.2021.1898926

Almoradie, A., Arevalo, V. J. C., & Jonoski, A. (2013). Web-based stakeholder collaboration in flood risk management. Journal Of Flood Risk Management, 8(1), 19–38. https://doi.org/10.1111/jfr3.12076

Arts, B., Leroy, P., & Van Tatenhove, J. (2006). Political Modernisation and Policy Arrangements: A Framework for Understanding Environmental Policy Change. Public Organization Review, 6(2), 93–106. https://doi.org/10.1007/s11115-006-0001-4

Asselman, N., & Van Heeringen, K. J. (2023, 1 januari). *Een watersysteemanalyse - wat leren we van het hoogwater van juli 2021*. Deltares. https://www.deltares.nl/expertise/publicaties/watersysteemanalyse-wat-leren-we-van-het-hoogwater-van-juli-2021-inzichten-in-het-functioneren-van-beeksystemen-bij-grote-hoeveelheden-neerslag-en-het-effect-van-verschillende-typen-maatregelen

Beck, P. (2023, November 30). *Benelux-Waterdag legt fundamenten voor gecoördineerde aanpak voor overstromingen op regionaal niveau - Benelux*. Benelux. https://www.benelux.int/nl/post/benelux-waterdag-legt-fundamenten-voor-gecoordineerde-aanpak-voor-overstromingen-op-regionaal-niveau/

Bekkenbestuur Demerbekken. (2022). *Overstromingen juli 2021 Demerbekken: Aan een catastrofe ontsnapt*. https://www.integraalwaterbeleid.be/nl/bekkens/demerbekken/afbdemer/overstromingen_juli2021_demerbekken.pdf

Béland, D., & Howlett, M. (2016). The Role and Impact of the Multiple-Streams Approach in Comparative Policy Analysis. Journal Of Comparative Policy Analysis: Research and Practice, 18(3), 221–227. https://doi.org/10.1080/13876988.2016.1174410

Bohensky, E., & Leitch, A. (2013). Framing the flood: a media analysis of themes of resilience in the 2011 Brisbane flood. Regional Environmental Change, 14(2), 475–488. https://doi.org/10.1007/s10113-013-0438-2

Boin, A., Hart, P. ‘., & McConnell, A. (2009). Crisis exploitation: political and policy impacts of framing contests. *Journal Of European Public Policy (Print)*, *16*(1), 81–106. https://doi.org/10.1080/13501760802453221

Bollinger, J. & Landtag Rheinland-Pfalz, (2023). Abschlussbericht der Enquete-Kommission 18/1 „Konsequenzen aus der Flutkatastrophe in Rheinland-Pfalz: Erfolgreichen Katastrophenschutz gewährleisten, Klimawandel ernst nehmen und Vorsorgekonzepte weiterentwickeln“ („Zukunftsstrategien zur Katastrophenvorsorge“). In *Drucksache 18/8222*. https://dokumente.landtag.rlp.de/landtag/drucksachen/8222-18.pdf

Bonn, I., & Rundle-Thiele, S. (2007). Do or die—Strategic decision-making following a shock event. Tourism Management, 28(2), 615–620. https://doi.org/10.1016/j.tourman.2006.04.021

Borchert, J., & De Pater. (2024, February). *Na de vloedgolf van 2021: Herstel is zaak van lange adem in Ahrdal*. Geografie.nl. https://geografie.nl/artikel/na-de-vloedgolf-van-2021-herstel-is-zaak-van-lange-adem-in-ahrdal

Bronstert, A. (2003). Floods and Climate Change: Interactions and Impacts. *Risk Analysis*, *23*(3), 545-557. https://doi.org/10.1111/1539-6924.00335

Carter, T. R., Benzie, M., Campiglio, E., Carlsen, H., Fronzek, S., Hildén, M., Reyer, C. P., & West, C. (2021). A conceptual framework for cross-border impacts of climate change. *Global Environmental Change*, *69*, 102307. https://doi.org/10.1016/j.gloenvcha.2021.102307

Christensen, S. L., & Kohls, J. (2003). Ethical decision making in times of organisational crisis. Business and Society, 42(3), 328–358.

CIM - de Internationale Maascommissie. (z.d.). https://www.meuse-maas.be/Accueil/La-commission-internationale-de-la-Meuse.aspx?lang=nl-NL#:~:text=De%20Internationale%20Maascommissie%20(IMC)%20is,internationaal%20stroomgebiedsdistrict%20van%20de%20Maas.

Coördinatiecommissie Integraal Waterbeleid*. (2021). EVALUATIERAPPORT OVERSTROMINGEN ZOMER 2021. https://www.integraalwaterbeleid.be/nl/nieuws/downloads-van-nieuwsberichten/ciw-evaluatierapport-overstromingen-2021.pdf*

Coördinatiecommissie Integraal Waterbeleid. (2023, February). *Vernieuwde watertoets en informatieplicht van kracht sinds 1 januari*. Integraal Waterbeleid. https://www.integraalwaterbeleid.be/nl/nieuws/vernieuwde-watertoets-en-informatieplicht

Copernicus (z.d.). European Flood Awareness System. Retrieved on 19 november 2024, from https://www.copernicus.eu/en/european-flood-awareness-system

De Bruijn, K., & Slager, K. (2022, 19 januari). 7 aanbevelingen naar aanleiding van het hoogwater juli 2021. *Deltares*. https://www.deltares.nl/nieuws/7-aanbevelingen-naar-aanleiding-van-het-hoogwater-juli-2021

De Vlaamse Minister van Justitie en Handhaving, Omgeving, Energie en Toerisme. (2023). Conceptnota beheer onbevaarbare waterlopen. In *DE VLAAMSE REGERING* (pp. 1–12) [Report].

Deltares. (2023). *Gevolgen overstromingen Limburg*. Retrieved on 27 May 2024, From https://publications.deltares.nl/11207700_007_0011.pdf

Deutscher Wetterdienst (DWD). (2021, juli). *The weather in Germany – July 2021* [Persbericht]. https://www.dwd.de/EN/press/press_release/EN/2021/20210730_the_weather_in_germany_in_july_2021.pdf?__blob=publicationFile&v=2

Deutschlandfunk.de. (2024). *Nach Flutkatastrophe 2021 - Untersuchungsausschuss legt Abschlussbericht vor - Schwere Vorwürfe gegen ehemaligen Landrat Pföhler*. Die Nachrichten. https://www.deutschlandfunk.de/untersuchungsausschuss-legt-abschlussbericht-vor-schwere-vorwuerfe-gegen-ehemaligen-landrat-pfoehler-100.html

DIE ZEIT, 2021: https://www.zeit.de/digital/2021-07/warnsysteme-deutschland-hochwasser-cell-broadcast-sirenen-katastrophenschutz-meldeketten-sicherheit?utm_referrer=https%3A%2F%2Fstartpage.com%2F (accessed: 25/09/24)

Domrose, J. (2024, 2 augustus). *Blog: Terugblik watersnood Duitsland in juli 2021*. Nederlands Instituut Publieke Veiligheid. https://nipv.nl/nieuws/blog-terugblik-watersnood-duitsland-in-juli-2021/

Duitslandweb. (2021, 16 juli). *Overstromingen Duitsland: Meer dan 100 doden, huizen Erftstadt ingestort*. Duitsland Instituut. Retrieved on 11 September 2024, From https://duitslandinstituut.nl/artikel/44884/overstromingen-duitsland-meer-dan-100-doden-huizen-erftstadt-ingestort

Duitsland Instituut. (2021). *Catastrofale overstromingen eisen meer dan 140 levens*. Retrieved on 2 oktober 2024, from https://duitslandinstituut.nl/artikel/44916/Catastrofale-overstromingen-eisen-meer-dan-140-levens#

Duitsland Instituut. (2022). *Een jaar na de "Flutkatastrophe"*. Retrieved on 27 May 2024, From https://duitslandinstituut.nl/artikel/50823/een-jaar-na-de-flutkatastrophe#:~:text=Daarnaast%20raken%20ongeveer%20800%20mensen,geraamd%20op%2030%20miljard%20euro.

Dynes (1994) Community emergency planning: false assumptions and inappropriate analogies. International Journal of Mass Emergencies and Disasters 12.

D'Haese, J. (2021, juli). *Verslag plenaire vergadering maandag 19 juli 2021 | Vlaams Parlement*. https://www.vlaamsparlement.be/. https://www.vlaamsparlement.be/nl/parlementair-werk/plenaire-vergaderingen/1547187/verslag/1547380

Elston, T., MacCárthaigh, M., & Verhoest, K. (2018). Collaborative cost-cutting: productive efficiency as an interdependency between public organizations. Public Management Review, 20(12), 1815–1835. https://doi.org/10.1080/14719037.2018.1438498

EMRIC. (2023, December). *Marhetak: verbeterde euregionale samenwerking bij overstromingen | EMRIC*. https://emric.info/nl/nieuws/actueel-nieuws/75/marhetak-verbeterde-euregionale-samenwerking-bij-overstromingen

EMRIC. (z.d.). Rampen en grote ongevallen. Retrieved on 19 November 2024, from https://www.emric.info/nl/burgers/wat-doet-emric/rampen-en-grote-ongevallen

Etaamb.Openjustice.Be. (2021, 1 October). Decreet van 23/09/2021 tot instelling van een bijzondere vergoedingsregeling voor bepaalde schade ten gevolge van de overstromingen en de zware regenval die zich van 14 tot en met 16 juli 2021 en op 24 juli 2021 hebben voorgedaan en die als openbare natuurramp zijn erkend. https://etaamb.openjustice.be/nl/decreet-van-23-september-2021_n2021033385

European Commission. (z.d.). Floods. https://environment.ec.europa.eu/topics/water/floods_en

European Commission. (2024). REPORT FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL: on progress on implementation of article 6 of the Union Civil Protection Mechanism (Decision No 1313/2013/EU). Preventing and managing disaster risk in Europe. In *https://eur-lex.europa.eu/*. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52024DC0130

European Commission. (2025). *REPORT FROM THE COMMISSION TO THE COUNCIL AND THE EUROPEAN PARLIAMENT: on the implementation of the Water Framework Directive (2000/60/EC) and the Floods Directive (2007/60/EC) Third river basin management plans Second flood risk management plans*. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52025DC0002

European Disaster Resilience goals. (2023, June). European Civil Protection and Humanitarian Aid Operations. https://civil-protection-humanitarian-aid.ec.europa.eu/what/civil-protection/european-disaster-risk-management/european-disaster-resilience-goals_en

European Disaster Risk Management. (2024). European Civil Protection and Humanitarian Aid Operations. https://civil-protection-humanitarian-aid.ec.europa.eu/what/civil-protection/european-disaster-risk-management_en

European Union. (2023). European Union Disaster Resilience Goals. In *www.ec.europa.eu*. Retrieved on 26 februari 2025, from https://ec.europa.eu/echo/files/aid/countries/factsheets/thematic/factsheet_disaster_resilience_goals.pdf

Evers, M., Jonoski, A., Almoradie, A., & Lange, L. (2016). Collaborative decision making in sustainable flood risk management: A socio-technical approach and tools for participatory governance. Environmental Science & Policy, 55, 335–344. https://doi.org/10.1016/j.envsci.2015.09.009

Expertenpanel hoogwaterbeveiliging. (2022). Weerbaar Waterland, ons voorbereiden op wat al gebeurt. In *Vlaamse Millieumaatschappij*. https://vmm.vlaanderen.be/nieuws/advies-weerbaar-waterland.pdf

Expertise Netwerk Waterveiligheid. (2021). *Hoogwater 2021 Feiten en duiding*. https://klimaatadaptatienederland.nl/publish/pages/192998/hoogwater-2021-feiten-en-duiding.pdf

Fekete, A., & Sandholz, S. (2021). Here Comes the Flood, but Not Failure? Lessons to Learn after the Heavy Rain and Pluvial Floods in Germany 2021. Water, 13(21), 3016. https://doi.org/10.3390/w13213016

Flycatcher. (2021). Overstroming Juli 2021. In Veiligheidsregio Zuid-Limburg, *Veiligheidsregio Zuid-Limburg*. https://www.vrzl.nl/application/files/3016/4301/9487/Samenvatting_rapport_inwoneronderzoek_overstroming_VRZL.pdf

Goodrick, D., UNICEF OFFICE OF RESEARCH, & United Nations Children's Fund (UNICEF). (2014). Comparative case studies. In Methodological Briefs (pp. 1–2). UNICEF Office of Research. https://www.unicef-irc.org/publications/pdf/brief_9_comparativecasestudies_eng.pdf

Gouvernement de la Wallonie. (2023). *Le Plan de Relance de la Wallonie Qu'est ce que c'est, concrètement ? Aperçu des décisions prises par le Gouvernement depuis l'adoption du Plan*. https://www.wallonie.be/sites/default/files/PRW%20-%20Factsheet_avril%202023.pdf

Grenzüberschreitende Plattform für Regionale Wasserwirtschaft. (n.d.). *Werkgroep hoogwater en zware regenval*. GPRW. https://gprw.eu/nl/projecten/werkgroep-hoogwater-en-zware-regenval

Haller, M. & Landtag Rheinland-Pfalz. (2024). Untersuchungsausschuss 18/1 „Flutkatastrophe". In *https://dokumente.landtag.rlp.de/*. Retrieved on 16 januari 2025, from https://dokumente.landtag.rlp.de/landtag/drucksachen/10000-18.pdf

Harbers, M., Frans Weekers, & Nijhof, A. (2024). BENELUX-WATERDAG. In *BENELUX* (p. 29.11.2023 10:30-29.11.2023 15:45) [Conference-proceeding]. BENELUX. https://www.benelux.int

Heidbreder, L. & Landtag Rheinland-Pfalz. (2023). Abschlussbericht der Enquete-Kommission 18/1 „Konsequenzen aus der Flutkatastrophe in Rheinland-Pfalz: Erfolgreichen Katastrophenschutz gewährleisten, Klimawandel ernst nehmen und Vorsorgekonzepte weiterentwickeln" („Zukunftsstrategien zur Katastrophenvorsorge"). In *Drucksache 18/8222*. https://dokumente.landtag.rlp.de/landtag/drucksachen/8222-18.pdf

Hurlbert, M., Gupta, J., 2015. The split ladder of participation: a diagnostic, strategic, and evaluation tool to assess when participation is necessary. Environ. Sci. Policy 50, 100–113.

H20 waternetwerk. (2024, October). *Nieuwe Vlaamse regering beperkt budget voor Blue Deal*. H2O/Waternetwerk. https://www.h2owaternetwerk.nl/h2o-actueel/nieuwe-vlaamse-regering-beperkt-budget-voor-blue-deal

ICPR. (z.d.). About us. iksr.org. https://www.iksr.org/en/icpr/about-us

Interreg Deutschland-Nederland. (2025, February 5). *GPRW-Landrätetreffen 2025: terugblik en vooruitblik op samenwerking waterbeheer - EUREGIO*. EUREGIO. https://www.euregio.eu/actueel/gprw-landratetreffen-2025-terugblik-en-vooruitblik-op-samenwerking-waterbeheer/

Interreg Euregio Meuse-Rhine. (n.d.). *About EMFloodResilience*. EM Flood Resilience. Retrieved February 26, 2025, from https://emfloodresilience.eu/about-us/about-emfloodresilience/

ICBR. (n.d.a). *Overstromingspreventie*. https://www.iksr.org/nl/themas/hoogwater/overstromingspreventie

ICBR. (n.d.b). *Hoogwaterbewustzijn*. https://www.iksr.org/nl/themas/hoogwater/hoogwaterbewustzijn

ISC CIE. (2020, 31 januari). De ISC in enkele woorden. https://www.isc-cie.org/over/de-isc-in-enkele-woorden/

Kaufmann, M., Lewandowski, J., Choryński, A., & Wiering, M. (2016). Shock events and flood risk management: a media analysis of the institutional long-term effects of flood events in the Netherlands and Poland. *Ecology And Society*, *21*(4). https://doi.org/10.5751/es-08764-210451

Keulen, M. (2021, juli). *Verslag plenaire vergadering maandag 19 juli 2021 | Vlaams Parlement*. https://www.vlaamsparlement.be/. https://www.vlaamsparlement.be/nl/parlementair-werk/plenaire-vergaderingen/1547187/verslag/1547380

Kingdon, J.W., 1995. Agenda, alternatives and public policy. Little, Brown, Boston, MA.

Knobbe, M. (2021, 16 juli). a-aa180f24-ba95-4a90-b6c4-aa767a81a31a. *DER SPIEGEL, Hamburg, Germany*. https://www.spiegel.de/politik/deutschland/news-flutkatastrophe-klimawandel-angela-merkel-usa-robert-habeck-a-aa180f24-ba95-4a90-b6c4-aa767a81a31a

Landkreistag Nordrhein-Westfalen. (2024, 10 augustus). *Die Jahrhundertflut im Rhein-Sieg-Kreis*. Landkreistag NRW*. https://www.lkt-nrw.de/aktuelles-und-presse/verbandszeitschrift/schwerpunkte/die-jahrhundertflut-im-rhein-sieg-kreis/

MARHETAK. (n.d.). https://www.interregemr.eu/projecten/marhetak

McNair B (2009) News and journalism in the UK. vol Book, Whole, 5th edn. Routledge, Oxon

Ministerie van Algemene Zaken. (2024, 26 april). Regeling voor particulieren in financiële nood door wateroverlast in 2021. Nieuwsbericht | Rijksoverheid.nl. https://www.rijksoverheid.nl/actueel/nieuws/2024/04/26/regeling-voor-particulieren-in-financiele-nood-door-wateroverlast-in-2021

Ministerie van Justitie en Veiligheid. (2024, 12 augustus). *Veiligheidsregio's*. Veiligheidsregio's en Crisisbeheersing | Rijksoverheid.nl. https://www.rijksoverheid.nl/onderwerpen/veiligheidsregios-en-crisisbeheersing/veiligheidsregios

Ministerium für Umwelt, Landwirtschaft, Natur- und Verbraucherschutz des Landes Nordrhein-Westfalen. (2022). *Lernen aus dem Hochwasser – 10-Punkte Arbeitsplan Hochwasserschutz in Zeiten des Klimawandels*.

Ministerium für Umwelt, Naturschutz und Verkehr des Landes Nordrhein-Westfalen. (2023). Zweiter Jahrestag der Flutkatastrophe: Umsetzungsstand des 10-Punkte-Arbeitsplans „Hochwasserschutz in Zeiten des Klimawandels". In *Schriftlicher Bericht*.

Nationaal Crisiscentrum. (2021, oktober). *Federale ondersteuningscel: balans september en vooruitzichten - Crisiscentrum*. crisiscentrum.be. https://crisiscentrum.be/nl/newsroom/federale-ondersteuningscel-balans-september-en-vooruitzichten

Nationaal Crisiscentrum. (2024, August 2). *Nationaal Crisiscentrum lanceert innovatieve tool voor noodplanning en crisisbeheer - Crisiscentrum*. https://crisiscentrum.be/nl/newsroom/nationaal-crisiscentrum-lanceert-innovatieve-tool-voor-noodplanning-en-crisisbeheer

Nederlands Instituut Publieke Veiligheid. (2024, 24 mei). *Voor het eerst in 800 jaar zeggen waterschappers dat er een einde aan de maakbaarheid is - Nederlands Instituut Publieke Veiligheid*. https://nipv.nl/verhalen/voor-het-eerst-in-800-jaar-zeggen-waterschappers-dat-er-een-einde-aan-de-maakbaarheid-is/

Nick, F. C., Sänger, N., Van Der Heijden, S., & Sandholz, S. (2023). Collaboration is key: Exploring the 2021 flood response for critical infrastructures in Germany. *International Journal of Disaster Risk Reduction*, *91*, 103710. https://doi.org/10.1016/j.ijdrr.2023.103710

Noor, K. B. M. (2008). Case Study: A Strategic Research Methodology. American Journal of Applied Sciences, 5(11), 1602–1604. https://www.researchgate.net/profile/KhairulBahareinNoor/publication/26517241_Case_Study_A_Strategic_Research_Methodology/links/5462bd800cf2c0c6aec1b83e/Case-Study-A-Strategic-ResearchMethodology.pdf

NOS. (2021a, juli). *Watersnood*. Retrieved on 22 mei 2024, from: https://nos.nl/collectie/13869-watersnood

NOS. (2021b, 14 juli). *Overstromingen en overlast: hoe kan het zo misgaan in Limburg?* https://nos.nl/collectie/13869/artikel/2389352-overstromingen-en-overlast-hoe-kan-het-zo-misgaan-in-limburg

Opbouwplan programma WRL. (2022). In T. A. J. Reinders, Regionale Actietafel - WRL, Ambtelijk OpdrachtgeversOverleg - WRL, K. C. M. Cremers, & J. J. Maka, *wachtnietopwater.nl*. https://wachtnietopwater.nl/publish/pages/9396/definitief_opbouwplanwrl.pdf

Oude Egberink, J. (2021). *Nu dan toch: Duitsland gaat voor eigen NL-Alert*. Duitsland Instituut. Retrieved on 2 oktober 2024, from https://duitslandinstituut.nl/artikel/45131/nu-dan-toch-duitsland-gaat-voor-eigen-nl-alert

Pal, L. A., Auld, G., & Mallett, A. (2020). *Beyond policy analysis: Public Issue Management in Turbulent Times*.

Palić, M., Ph. D., Vignali, C., Ph. D., Hallier, B., Ph. D., Stanton, J. L., Ph. D., & Radder, L., D. Comm (Reds.). (2015). Research Methodology. In International Journal Of Sales, Retailing And Marketing (Vol. 4, Nummer 9) [Journal-article]. Access Press UK. https://www.circleinternational.co.uk/wp-content/uploads/2021/01/IJSRM4-9.pdf#page=57

Perree, H. (2022, January). *Waterschap Limburg moet oefenen met crises*. Binnenlands Bestuur. https://www.binnenlandsbestuur.nl/ruimte-en-milieu/limburg-moet-voorbereid-zijn-op-watercrisis

Provincie Gouveneur Vlaams-Brabant. (2021). *WATERSNOOD JULI 2021 IN VLAAMS-BRABANT: EVALUATIE VAN NOODPLANNING*. https://cdn.nimbu.io/s/3putlmp/assets/Evaluatie%20watersnood_dienst%20noodplanning%20VLB.pdf

Renders, H., BE Defence, & BE Defence. (2021). *Operaties – opérations* [Report]. https://www.defence-institute.be/wp-content/uploads/2022/06/rmb%2023%2002%20Hans%20RENDERS.pdf

Rheinland-Pfalz. (2022, 9 december). *Katrin Eder stellt Sieben-Punkte-Plan zur Verbesserung der Hochwasservorsorge vor*. https://mkuem.rlp.de/service/pressemitteilungen/detail/katrin-eder-stellt-sieben-punkte-plan-zur-verbesserung-der-hochwasservorsorge-vor

Rheindland-Pfalz Landesamt Für Umwelt. (2022). Hochwasser im Juli 2021. In *https://www.hochwasser.rlp.de*. Landesamt für Umwelt Rheinland-Pfalz. Retrieved on 16 januari 2025, from https://www.hochwasser.rlp.de/static/shared/documents/Hochwasser_im_Juli2021.pdf

Rheinland-Pfalz. (2024, July 6). *Landen pleiten voor betere financiering van overstromingsbescherming*. https://hochwassermanagement.rlp.de/service/presse/detail/laender-machen-sich-fuer-bessere-finanzierung-des-hochwasserschutzes-stark-1

Rheinland-Pfalz. (n.d.a). *Overstromingspreventie in gebouwen en in de planning. Overstromingsrisicobeheer in Rijnland-Palts*. https://hochwassermanagement.rlp.de/unsere-themen/wie-koennen-wir-uns-vorbereiten/hochwasservorsorge-an-gebaeuden-und-in-der-planung

Rheinland-Pfalz. (n.d.b). *Financiële bescherming: verzekering tegen natuurrampen. Overstromingsrisicobeheer in Rijnland-Palts*. https://hochwassermanagement.rlp.de/unsere-themen/wie-koennen-wir-uns-vorbereiten/finanzielle-absicherung-elementarschadenversicherung

Rheinland-Pfalz. (n.d.c). *Informatie over gedragspreventie. Overstromingsrisicobeheer in Rijnland-Palts*. https://hochwassermanagement.rlp.de/unsere-themen/wie-koennen-wir-uns-vorbereiten/informationen-zur-verhaltensvorsorge

Rijkswaterstaat. (2023, 20 maart). *Terugkijken op rampzalige regenbui in 2021*. MER-Nieuws. https://www.magazinesrijkswaterstaat.nl/mer-nieuws/2023/103/terugkijken-op-rampzalige-regenbui-in-2021

Rijkswaterstaat. (2023, 14 april.-b). Rijkwaterstaat pakt aanbevelingen evaluatie hoogwater 2021 op. *Rijkswaterstaat*. https://www.rijkswaterstaat.nl/nieuws/archief/2022/05/rijkwaterstaat-pakt-aanbevelingen-evaluatie-hoogwater-2021-op

Rijkswaterstaat. (z.d.-a). Internationale Maascommissie. Waterinfo Extra. Retrieved on 19 november 2024, van https://waterinfo-extra.rws.nl/rapportages/internationale-rapportages/internationale-riviercommissies/internationale-maascommissie

Rijkswaterstaat. (z.d.-b). Internationale Eemscommissie. Waterinfo Extra. https://waterinfo-extra.rws.nl/rapportages/internationale-rapportages/internationale-riviercommissies/internationale-eemscommissie/

Romans, S. (2023, januari). *Rapport na overstromingen in Wallonië hekelt chaotische communicatie*. tijd.be. https://www.tijd.be/politiek-economie/belgie/wallonie/rapport-na-overstromingen-in-wallonie-hekelt-chaotische-communicatie/10439224.html#:~:text=Rapport%20na%20overstromingen%20in%20Walloni%C3%AB%20hekelt%20chaotische%20communicatie,-Kopieer%20link&text=Chaotische%20informatiedeling%20en%20het%20'schreeuwende,de%20aanpak%20van%20de%20ramp.

Schmitz, O., Claesen, J., Derenne, X., Murengerantwari, S., & Commissie van deskundigen inzake crisisbeheer. (2023). *Witboek. Aanbevelingen tot verbetering van het crisisbeheer in België*.

Simon, A. F., & Xenos, M. A. (2000). Media Framing and Effective Public Deliberation. Political Communication (Print), 17(4), 363–376. https://doi.org/10.1080/10584600050178979

Söderholm, K., Pihlajamäki, M., Dubrovin, T., Veijalainen, N., Vehviläinen, B., & Marttunen, M. (2017). Collaborative Planning in Adaptive Flood Risk Management under Climate Change. Water Resources Management, 32(4), 1383–1397. https://doi.org/10.1007/s11269-017-1875-3

Starmans & Oberijé (2006) Burgerparticipatie bij rampen en zware ongevallen Versie 443N6001/443N6004: 10.11.2006. NIBRA. Arnhem.

Stern, L. (2021). Deutscher Bundestag - 30 Milliarden Euro zum Wiederaufbau nach der Flutkatastrophe geplant. Deutscher Bundestag. https://www.bundestag.de/dokumente/textarchiv/2021/kw34-de-hochwasser-854470#:~:text=Sonderverm%C3%B6gen%20zum%20Wiederaufbau%20beschlossen,in%20den%20betroffenen%20Gebieten%20ausgesetzt.

SWR. (2024, 14 juli). *Was ist in der Flutnacht passiert? - Ein Protokoll*. swr.online. https://www.swr.de/swraktuell/rheinland-pfalz/flut-rekonstruktion-ahrtal-protokoll-100.html

Tankard, J. J. (2001). The Empirical Approach to the Study of Media Framing. In *Routledge eBooks* (pp. 111–121). https://doi.org/10.4324/9781410605689-12

Thistlethwaite, J., Henstra, D., Minano, A., & Dordi, T. (2019). Policy framing in the press: analyzing media coverage of two flood disasters. Regional Environmental Change, 19(8), 2597–2607. https://doi.org/10.1007/s10113-019-01576-7

Tieleman, M., Thiry, A., & Fallon, C. (2023). Developing a culture of risk in the face of extreme rainfall in the Euregio. In *Final Research Report - Marhetak Project*. https://spw.wallonie.be/sites/default/files/EN%20D%C3%A9velopper%20la%20culture%20du%20ris que%20face%20aux%20extr%C3%AAmes%20pluviom%C3%A9triques%20en%20Euregio%20-%20Rapport%20de%20recherche.pdf

Trenczek, J., Lühr, O., Eiserbeck, L., Leuschner, V., & Prognos AG. (2022). Kosten durch Klimawandelfolgen in Deutschland. In Bundesministerium für Wirtschaft und Klimaschutz, Institut für ökologische Wirtschaftsforschung (IÖW), & Gesellschaft für Wirtschaftliche Strukturforschung mbH (GWS), *Kosten Durch Klimawandelfolgen in Deutschland* (pp. 1–7). https://www.prognos.com/sites/default/files/2022-07/Prognos_KlimawandelfolgenDeutschland_Detailuntersuchung%20Flut_AP2_3b_.pdf

Trommel, S. (2022, April). *'Tackel wateroverlast met België en Duitsland.'* Binnenlands Bestuur. https://www.binnenlandsbestuur.nl/ruimte-en-milieu/wateroverlast-samen-met-belgie-en-duitsland-aanpakken

Rollez, H. (2023, October 7). *Twee jaar na de overstromingen: Minister Verlinden komt met totaalaanpak voor noodsituaties en crisissen*. AnneliesVerlinden.be. https://www.anneliesverlinden.be/twee_jaar_na_de_overstromingen_minister_verlinden_komt_met_totaalaanpak_voor_noodsituaties_en_crisissen

Unfried, M., & Mertens, P. (2023). Innovative forms of cooperation and crisis management at the strategic-political level. In *MARHETAK Project*. https://crossborderitem.eu/wp-content/uploads/EN_reportcrisismanagementfinal.pdf

Van Popering-Verkerk, J., & Van Buuren, A. (2017). Developing collaborative capacity in pilot projects: Lessons from three Dutch flood risk management experiments. Journal Of Cleaner Production, 169, 225–233. https://doi.org/10.1016/j.jclepro.2017.04.141

Van Thiel, S. (2014). Research Methods in Public Administration and Public Management (S. P. Osborne, O. Hughes, & W. Kickert, Eds.). Routledge.

Van de Vondervoort, M.-J., Janissen, B., Peereboom, W., & Waterschap Limburg. (2024). *Crisisplan Waterschap Limburg: Versie 3.0*.

Vansevenant, D. (2024). *Paragon: For an integrated approach to emergency planning and crisis management*. https://civil-protection-humanitarian-aid.ec.europa.eu/document/download/ddd672c5-53ce-4d58-bd2f-76cae3fa1ac3_en?filename=UCPM%20Call%202021%20Track%201%20Belgium.pdf

Veiligheidsregio Limburg-Noord. (2021). Rapportage Leerevaluatie Hoogwater Maas en Roer: Multidisciplinaire crisisorganisatie Veiligheidsregio Limburg-Noord. In *Rapportage Leerevaluatie* [Report]. https://www.vrln.nl/sites/vrln/files/2022-10/Leerevaluatie_Hoogwater_Maas_en_Roer_VR__Limburg_Noord_2021_rapportage.pdf

Veiligheidsregio Zuid-Limburg. (2020). Samen veilig - Meerjarenbeleidsplan 2020-2023. In *Veiligheidsregio Zuid-Limburg* (pp. 2–43). https://repository.officiele-overheidspublicaties.nl/externebijlagen/exb-2021-26562/1/bijlage/exb-2021-26562.pdf

Veiligheidsregio Zuid-Limburg. (2022). Voorbij het ergste scenario: Leerevaluatie hoogwater Veiligheidsregio Zuid-Limburg. In *Leerevaluatie* (p. 1). https://www.vrzl.nl/application/files/9916/4301/9256/Voorbij_het_ergste_scenario_Leerevaluatie_Hoogwater_VRZL_def_jan_2022.pdf

Vereniging van Vlaamse Polders en Wateringen. (n.d.). *Waterschappen*. https://www.vvpw.be/webpagina/IWB_Waterschappen.html

Verstraeten, G. (2021, 19 juli). *De overstromingen van juli 2021 doorgelicht: natuurlijke overstromingsgebieden als buffer in laaglandgebieden*. KU Leuven Blogt. https://kuleuvenblogt.be/2021/07/19/de-overstromingen-van-juli-2021-doorgelicht-natuurlijke-overstromingsgebieden-als-buffer-in-laaglandgebieden/

Vlaamse Milieumaatschappij. (2021). Rapport wateroverlast 29 juni – 28 juli 2021. https://waterinfo.vlaanderen.be/Rapporten

Vlaamse Regering. (2021, oktober). *Hoogwaterbeveiligingin Vlaanderen*. https://beslissingenvlaamseregering.vlaanderen.be/document-view/6171785A364ED900080002AA.

Vlaamse Regering. (2024). VLAAMS REGEERAKKOORD 2024-2029. In *publicaties.vlaanderen.be*. https://publicaties.vlaanderen.be/view-file/69476

Vilt. (2023, 19 juli). Demir maakt schoon schip in het waterloopbeheer en gooit 100 beheerders overboord. *vilt.be*. https://vilt.be/nl/nieuws/demir-maakt-schoon-schip-in-het-waterloopbeheer-en-gooit-100-beheerders-overboord

Vrtnws, (2021, 27 oktober). Schade van overstromingsramp afgelopen zomer opgelopen tot ruim 2 miljard euro. *vrtnws.be*. https://www.vrt.be/vrtnws/nl/2021/10/27/schade-van-overstromingsramp-opgelopen-tot-ruim-2-miljard-euro/#:~:text=Het%20totale%20schadebedrag%20bedraagt%20er,schade%2C%20verspreid%20over%20249%20schadegevallen.

Waalse Overheidsdienst. (2021). Internationale stroomgebiedsdistricten van de Maas, de Schelde, de Rijn en de Seine: Overstromingsrisicobeheersplannen voor Wallonië. In *Overstromingsrichtlijn – 2e Cyclus* (pp. 1–474).

Waalse Overheidsdienst, Le Gall, E. Al., Brajkovic, E. Al., IPCC, E. Al., Keys, E. Al., Silva Corrêa, E. M., Beny, E. Al., Namdar, E. Al., Verenigde Naties, & Directie Defensie en Civiele Veiligheid. (2023). Beheer van het overstromingsrisico in de Euregio. In C. GLESNER (Red.), *Leidraad Voor de Lokale Actoren* [Book]. https://spw.wallonie.be/sites/default/files/Rapport%20de%20guidance%20MARHETAK%20NL%20FINAL.pdf

Waterschap Limburg. (2022). *Leerevaluatie Watercrisis Juli 2021*. https://www.waterschaplimburg.nl/publish/pages/5867/waterschap_limburg_-_leerevaluatie_watercrisis_juli_2021_1.pdf

Waterschap Limburg. (2023, September). *Euregionale Samenwerking en Inspiratie: Kennisdeling over Wateruitdagingen*. https://www.waterschaplimburg.nl/actueel/2023/euregionale-samenwerking-inspiratie/

Waterschap Limburg. (n.d.). *Onze internationale samenwerking*. https://www.waterschaplimburg.nl/overons/internationaal/onze-internationale-samenwerking/

Wolf, C., Joye, D., Smith, T. W., & Fu, Y. (2016). The SAGE Handbook of Survey Methodology. SAGE Publications Limited.

Wiering, M., Verwijmeren, J., Lulofs, K. R., & Feld, C. K. (2010). Experiences in regional cross border co-operation in river management. Comparing three cases at the Dutch–German border. Water Resources Management, 24(11), 2647–2672. https://doi.org/10.1007/s11269-009-9572-5

Wijkhuijs, V., Domrose, J., Heijmen, D., Van Duin, M., & Instituut Fysieke Veiligheid*. (2021, 21 May). Grensoverschrijdende samenwerking bij rampen en crises. Een inventarisatie van mogelijkheden om de samenwerking te versterken. In Ministerie van Justitie en Veiligheid, IFV. IFV. https://nipv.nl/wp-content/uploads/2022/04/20210521-IFV-Grensoverschrijdende-samenwerking.pdf*

Williams, T. A., Gruber, D. A., Sutcliffe, K. M., Shepherd, D. A., & Zhao, E. Y. (2017). Organizational Response to adversity: fusing crisis management and resilience research streams. The Academy of Management Annals, 11(2), 733–769. https://doi.org/10.5465/annals.2015.0134

WRL. (2024). *Voortgangsrapportage WRL – oktober 2023 t/m mei 2024*. https://wachtnietopwater.nl/publish/pages/9216/voortgangsrapportage_wrl2024h1.pdf

WRL. (n.d. a). *Programma WRL*. Wacht Niet Op Water. https://wachtnietopwater.nl/wat-doet-de-overheid/programma-wrl/

WRL. (n.d. b). *Hulpmiddelen*. Wacht Niet Op Water. https://wachtnietopwater.nl/hulpmiddelen/

Appendices

Appendix 1. Planning

Chapter finished	Week number
Introduction	5
Literature review	5-8
Theoretical framework	5-8
Data Collection	8-20
Data processing	10-20
Finishing results	21-23
Discussion & conclusion	23-24
Reflection	25/26
Abstract & finishing draft	26

Appendix 2. Interview guide

English:

<u>Flood</u>

- What was your role/your companies role in the 2021 flood?
-
- According to your personal opinion, what could have been done differently during the flood?
-
- How was the communication between the authorities and the locals?
-
- How was the communication within the authorities?
-

<u>Framing</u>

- How did the media frame the floods in your country? (for example, was it seen as a unpreventable natural disaster or mismanagement)
-
- Did the media influence working conditions? If yes, please elaborate what conditions were affected and how.
-

<u>Discourses</u>

- What were the key narratives or discourses surrounding the flood event?
-
- How did different stakeholders (e.g., politicians, media, the public) talk about the event?
-
- Were there dominant messages about who was responsible or how the situation should be handled? If yes, please explain towards whom.
-
- Did the media influence what consequences of the flood were emphasised? If yes, please elaborate what and how.
-

<u>Shock event</u>

- Can you describe how the 2021 floods affected your country and/or organisation?
-
- What were the immediate and long-term consequences of the floods from your perspective?
-

Policy Window

- Were policies or methods adjusted/changed as a consequence of the flood?
-
- If yes are these adjustments/changes still in place?
-
- Are there differences in working policies/methods after the flood?
-

Problem stream

- Did you experience the floods as regional or national problem? Why is that?

Resources

- Is there a change in available resources after the floods compared to before? (for example, in financial regard, in knowledge available, in manpower available etc.)
-

Collaboration

- Where there significant changes in collaboration between different actors (e.g., government, NGOs, private sector, etc.) after the floods? If yes, please elaborate on these changes.
-
- How were resources and rules shared or negotiated in this process?
-
- Were there any new partnerships or coalitions that emerged after the 2021 flood?
-
- What kind of contact did you have with Germany and/or Belgium before the 2021 floods?
-
- How frequent was that contact and on what level was that contact?
-
- What kind of contact did you have with the Germany and/or Belgium during the 2021 floods?
-
- How frequent was that contact and on what level was that contact?
-
- Did the frequency of the contact increase after the 2021 flood?
-
- Are there differences in the collaboration compared to before the flood? If yes, please elaborate on what differences.

Dutch:

Flood

- Wat was uw rol/uw bedrijf rol tijdens de 2021 overstroming?
-

- Wat had er volgens uw persoonlijke mening tijdens de overstroming anders kunnen gebeuren?
-
- Hoe was de communicatie tussen de overheden en de locals?
-
- Hoe was de communicatie binnen de overheden?
-

Framing

- Hoe heeft de media de overstroming geframed in uw land? (bijvoorbeeld, werd het gezien als een natuurramp of mismanagement)
-
- Heeft de media de arbeidsomstandigheden beïnvloed?
-

Discourses

- Wat was het leideinde narratieve/discourse rondom de overstroming? Hoe werd het beschouwt?
-
- Hoe communiceerde verschillende stakeholders (bijvoorbeeld, politici, media, het publiek) over de over de overstroming?
-
- Was er dominante berichtgeving over wie verantwoordelijk was/zou moeten zijn of over hoe de situatie behandeld zou moeten worden?
-
- Heeft de media beïnvloed welke aspecten benadrukt warden tijdens de crisisbeheersing?
-

Shock event

- Kunt u beschrijven hoe de 2021 overstromingen een impact op uw bedrijf/land heeft gemaakt?
-
- Wat zijn de long-term consequenties van de overstroming vanuit uw perspectief?
-

Policy Window

- Is er beleid aangepast/veranderd als gevolg van de overstroming?
-
- Zo ja, zijn deze veranderingen nog steeds in plaats?
-
- Is er verschil in de manier waarop (samen)gewerkt wordt als gevolg van de overstroming?
-

Problem stream

- In uw ervaring, werd de overstroming ervaren als een regionaal of nationaal probleem?

Resources

- Is er verschil in beschikbare resources vergeleken met voor de overstroming? (bijvoorbeeld in financieel opzicht, in beschikbare kennis, in beschikbare mankracht etc.)
-

Collaboration

- Zijn er significante veranderingen in samenwerking tussen de verschillende actoren na de overstroming? (bijvoorbeeld de overheid, NGO's, de particuliere sector, enz.)
- Hoe werden middelen en regels gedeeld of onderhandeld tijdens de overstroming?
- Zijn er nieuwe partnerships of samenwerkingsverbanden ontstaan na de 2021 overstroming?
- Wat voor contant had u met Duitsland en/of België voor de 2021 overstroming?
- Zo ja, hoe frequent was dat contact en op wat voor niveau gebeurde dat?
- Wat voor contant had u met Duitsland en/of België tijdens de 2021 overstroming?
- Zo ja, hoe frequent was dat contact en op wat voor niveau gebeurde dat?
- Is de frequentie van contact toegenomen na de 2021 overstroming?
- Zijn er verschillen in collaboratie vergeleken met voor de overstroming?

Appendix 3. Interviewee information

Interviewee 1 is responsible for the management and investments at the Vlaamse Waterweg. Within his position, he is responsible for operational policy regarding management and investments. These concerns include the impact of climate change, environmental policy, waste policy, and integral water policy. Regarding the integral water policy he is also actively involved within the International Meuse Commission, where he is in the hydrology working group and also in the International Schelde Commission, where he is chairman of the hydrology working group and within Flanders he is chairman of the drought advisory group, as well as secretary of the Drought Commission and also the theme coordinator for floods and drought in Flanders. Interviewee 2 has been working for over 30 years at landesamt für umwelt rheinland-pfalz (Rhineland-Palatinate State Office for the Environment). The interviewee works in the Hydrometeorology and Flood Reporting Service departments. Within the state office, the interviewee works with their NiedSim technology. The NiedSim is a stochastic generator that generates precipitation time series for any freely selectable point in Rhineland-Palatinate. Due to the workload, this interview was conducted via email by sending the research questions to interviewee 2. Interviewee 3 is the head of the flood centre in NRW and is with his team responsible for the distribution of water management data (time series) and generated information at the NRW State Agency for Nature, Environment and Consumer Protection (LANUV), North-Rhine-Westfalia, Germany. Interviewee 4 was also conducted by sending the questions via email. The emails were answered by three employees of Waterschap Limburg: a crisis management specialist, a Senior crisis management advisor, and a program management employee for crisis management improvement measures. The senior crisis management advisor was involved in the development of the Crisis plan for Waterschap Limburg. Interviewee 5 is specialist water modelling for the Vlaamse Milliue Maatschappij (VMM). The VMM is responsible for managing non-navigable waterways. Interviewee 6 is retired, but until 2023, she was a program manager within EMRIC and a border liaison. She was also involved in the Marhetak project.

Interview 1: N. van Steenbergen, personal communication, October 28, 2024
Interview 2: N. Demuth, personal communication, November 29, 2024
Interview 3: M. Scheibel, personal communication, January 15, 2025
Interview 4: M.J. van de Vondervoort, personal communication, February 6, 2025
Interview 5: S. Rombauts, personal communication, April 23, 2025
Interview 6: M. Ramakers, personal communication, 24 April 2025

Appendix 4. Coding cycles

Code	Grounded	Code Groups
○ change in legislation	3	changes after flood Rules of the game
○ change in perception of public saftey	1	policy stream
○ change in policies and/or methods	2	Starting conditions Rules of the game
○ connecting (international) organisations witl	2	Changes implemented
○ crisis as opportunity	1	framing
○ cross-border contact and communcation be	1	Starting conditions
○ discourse change compared to before flood	3	Discourse
○ discourse, differnces in working cultures	1	Discourse
○ discourse, lack of (civlian) risk awareness	3	Discourse
○ discourse, more emphasises on disaster ex	1	Discourse
○ discourse, trying to improve risk awareness	2	Discourse
○ flood was unexpectedly severe	2	policy stream
○ focus on the small rivers instead of the big r	1	During flood
○ forecast differences	1	During flood
○ framing, adjusting to changing forms of med	7	framing
○ framing, attacking the status quo	4	framing
○ framing, attention shifted with the flood	1	framing
○ framing, crisis as natural disaster	1	framing
○ framing, fact checking information	1	framing
○ framing, improved collaboration with media	2	framing
○ framing, no way to 100% protect everyone	2	framing
○ framing, suiting information for civilians	2	framing
○ improved (international) forecasting method	1	Changes implemented
○ improved action plans	2	Changes implemented
○ improved collaboration between authorities	1	Changes implemented
○ improved international collaboration	3	Changes implemented
○ improved international communication	3	Changes implemented
○ improved warning systems and communicat	3	Changes implemented
○ improvement in (civilian) preparedness requ	1	Changes implemented
○ improvement required in (international) com	8	Evaluation
○ improvement required in (international) fore	2	Evaluation
○ improvement required in international collab	2	Evaluation
○ improving international contact methods	3	Evaluation
○ increased international contact after floodin	3	changes after flood
○ increased resources	8	Resources
○ internal discussion between authorities	7	During flood
○ international contact about nuclear power p	1	During flood
○ international contact before flooding event	4	Starting conditions
○ international contact during flooding event	8	During flood
○ interviewee	3	Starting conditions
○ lack of communication and information exch	3	Evaluation
○ lack of internal communication and action pl	14	Evaluation
○ lack of mandate for international commision	2	Evaluation
○ lack of resources	1	Evaluation
○ lack of self-reliance	1	During flood Evaluation
○ lack of subsidies hinders progress	1	During flood
○ language issues	2	During flood
○ location where disaster takes place is impor	1	During flood
○ media contact during flood event	1	During flood
○ media framing no influence during flooding e	3	framing
○ need for clear (cross-border) communicatio	2	Evaluation
○ need for international collaboration	2	Evaluation
○ negative tone of media	1	framing
○ new policy proposals/evaluations	9	policy stream
○ no change in resources	1	Resources
○ no collaboration between international orga	5	During flood
○ Occupation/function	9	Starting conditions
○ organisation	6	Starting conditions
○ organisational differences	1	Starting conditions Resources
○ politic stream, politics due to elections	1	Politic stream
○ political commotion	1	framing During flood
○ problem experienced on a national level	2	Problem stream
○ psychological aid for those involved	2	Changes implemented
○ simultane disaster more difficult then region	1	Evaluation
○ situation before flood	5	Starting conditions
○ Situation during flood	4	During flood
○ willingness to ajdust or change policeis	6	Policy Window
○ workload too high	1	Evaluation

Appendix 5. Media sources for media analysis

The Netherlands:

https://nos.nl/collectie/13869-watersnood

https://nos.nl/collectie/13869/artikel/2389352-overstromingen-en-overlast-hoe-kan-het-zo-misgaan-in-limburg

https://nos.nl/nieuwsuur/video/2528276-beter-beschermd-na-overstromingen-limburg-we-zien-niets-we-horen-niets

https://nos.nl/artikel/2447911-extremer-weer-kost-verzekeraars-steeds-meer-geld

https://nos.nl/nieuwsuur/artikel/2435912-een-jaar-na-de-overstromingen-in-limburg-wachten-nog-altijd-mensen-op-hun-huis

https://nos.nl/collectie/13869/artikel/2389244-wateroverlast-limburg-in-beeld-zandzakken-hevige-buien-en-ondergelopen-snelweg

https://nos.nl/collectie/13869/liveblog/2389373-dringend-advies-maastricht-aan-10-000-mensen-ga-je-huis-uit-dodental-duitsland-boven-55

https://nos.nl/artikel/2402265-veel-limburgers-waren-niet-voorbereid-op-overstroming

https://www.nu.nl/wateroverlast-limburg/6145917/meer-dan-100-doden-en-veel-vermisten-door-noodweer-in-duitsland-en-belgie.html?referrer=https%3A%2F%2Fwww.google.com%2F

https://www.nu.nl/wateroverlast-limburg/6145883/dit-is-nu-de-stand-van-zaken-in-limburg-oost-belgie-en-west-duitsland.html

https://www.nu.nl/buitenland/6146259/zware-overstromingen-treffen-nu-ook-oost-duitsland-en-beieren.html

https://www.nu.nl/wateroverlast-limburg/6145783/dit-weten-we-over-de-enorme-wateroverlast-in-zuid-limburg.html

https://www.ad.nl/buitenland/live-al-3-miljoen-opgehaald-voor-limburg-op-giro-777-hevige-overstromingen-in-oost-duitsland~a01fd4dc/

https://www.ad.nl/collecties/wat-maakten-de-mensen-mee-tijdens-die-enorme-modderstroom-en-hoe-kon-deze-ontstaan-vijf-verhalen-over-het-noodweer-in-spanje~a236836c/#:~:text=Vooral%20Limburg%20kampte%20in%202021,nabije%20toekomst%20wel%20mogelijk%20zijn%3F

https://www.ad.nl/binnenland/snelweg-a2-in-limburg-dicht-door-wateroverlast-burgemeester-voorziet-voedseltekort~a0caed33/?referrer=https%3A%2F%2Fwww.google.com%2F + liveblog

https://www.ad.nl/binnenland/2021-was-extreem-jaar-met-warmste-zomer-overstromingen-in-europa-en-bosbranden~aeafa5fd6/

Germany:

https://www.spiegel.de/panorama/ahrtal-nach-der-flut-die-leute-kamen-wie-geister-aus-ihren-haeusern-raus-a-cc3415cd-14d4-45a5-b62f-4008476b549c

https://www.spiegel.de/panorama/in-den-fluten-a-8eff4472-ed2d-4943-bab3-295dca691b18

https://www.spiegel.de/politik/deutschland/hochwasser-armin-laschet-besucht-betroffene-gemeinden-in-nordrhein-westfalen-a-b28bec56-b6b8-4c2a-a57a-2167e663aa7a

https://www.spiegel.de/politik/deutschland/eifel-malu-dreyer-spricht-nach-wetterkatastrophe-es-ist-wirklich-verheerend-a-a08f0624-62a4-4fca-838c-83845da95a23

https://www.spiegel.de/panorama/hochwasser-im-landkreis-ahrweiler-nur-wenige-minuten-um-zu-fliehen-a-e15c921f-779d-462b-be25-65f0c8942ef0

https://www.spiegel.de/panorama/unwetter-in-nrw-und-rheinland-pfalz-dutzende-tote-bei-hochwasserkatastrophe-a-42c7a3a1-cf3b-41dc-8a6b-2425ef05172f

https://www.spiegel.de/panorama/eifel-unwetter-videoreportage-aus-dem-stark-betroffenen-schuld-a-c6c9e24f-f6ef-4bce-a396-fee261cb20d1

https://www.spiegel.de/panorama/sinzig-zwoelf-tote-in-wohnheim-fuer-menschen-mit-behinderung-a-846e8ca7-8687-4e26-b317-903c6a4a54a9

https://www.spiegel.de/panorama/hochwasser-in-westdeutschland-zwischen-aufraeumen-und-ueberforderung-a-17f81445-ae17-457c-91b1-dae681a46ee0

https://www.spiegel.de/panorama/ahrweiler-und-erftstadt-warum-so-viele-menschen-als-vermisst-gelten-a-cd86be1b-f412-4923-8549-3f5b8fce694d

https://www.spiegel.de/panorama/gesellschaft/hagen-nach-dem-hochwasser-alle-helfen-mit-a-282806bd-629f-4451-8561-f8e453c67b25

https://www.bild.de/news/2021/news/hochwasser-in-deutschland-flut-bestattern-fehlt-es-teils-an-leichenwagen-alle-news-im-ticker-77083926.bild.html (live blog)

https://www.bild.de/news/inland/news-inland/hochwasser-in-deutschland-die-ueberflutungs-katastrophe-in-bildern-77088462.bild.html

https://www.bild.de/politik/inland/politik-inland/so-nutzten-kriminelle-die-katastrophe-aus-die-flut-pluenderer-83029116.bild.html

https://www.tagesschau.de/inland/gesellschaft/hochwasser-bayern-sachsen-103.html

https://www.tagesschau.de/faktenfinder/hochwasser-flut-fake-news-101.html

https://www.tagesschau.de/wirtschaft/verbraucher/unwetter-versicherung-zahlungen-101.html

Belgium:

https://www.vrt.be/vrtnws/nl/dossiers/2022/07/een-jaar-na-overstromingen/

https://researchportal.vub.be/nl/publications/the-media-for-democracy-monitor-2021-how-leading-news-media-survi belgische studie

https://www.vrt.be/vrtnws/nl/2021/07/15/overzicht-wateroverlast-belgie/

https://www.vrt.be/vrtnws/nl/2021/07/15/bekijk-beelden-wateroverlast/

https://www.vrt.be/vrtnws/nl/2021/10/14/herbekijk-pano-overstroming-onderschat/

https://www.vrt.be/vrtnws/nl/2021/07/23/slachtoffers-overstromingen/

https://www.vrt.be/vrtnws/nl/2021/10/11/overstromingsramp-kan-niet-gelinkt-worden-aan-beheer-eupense-stu/

https://www.hln.be/dossier/extreem-noodweer-2021~d4fd8b76c-894e-471f-8e40-929838cc5f7a?referrer=https%3A%2F%2Fwww.google.be%2F (overzicht met meerdere artikelen)

https://www.hln.be/video/productie/ruim-80-doden-in-duitsland-na-overstromingen-238494

https://www.hln.be/binnenland/oplichters-benaderen-slachtoffers-overstromingsramp-beloven-voor-500-euro-de-stroom-te-herstellen-en-verdwijnen-dan~a9816f32/https://www.hln.be/nieuws/zowat-40-000-gebouwen-door-noodweer-beschadigd-zegt-waals-minister-collignon~af3eb058/

https://www.hln.be/binnenland/woedende-inwoners-van-vernielde-steden-dreigen-met-rechtszaak-leegloop-stuwmeer-veroorzaakte-tsunami-dat-zegt-zelfs-brandweer~a1c2ebe6/

https://www.hln.be/binnenland/reddingswerkers-zoeken-niet-langer-naar-overlevenden-maar-naar-lichamen-we-moeten-realistisch-zijn~a3c26090/

https://www.hln.be/binnenland/reportage-trooz-waar-de-helft-van-de-bevolking-bijna-alles-kwijt-is-na-de-eerste-dag-vroeg-mijn-baas-wanneer-ik-weer-kwam-werken-hij-heeft-makkelijk-praten-vanuit-zijn-grote-huis-in-sprimont~a3f3509c/

https://www.hln.be/binnenland/belgie-krijgt-87-miljoen-europese-noodhulp-in-nasleep-overstromingen~a5fd4df0/

https://www.nieuwsblad.be/cnt/dmf20210719_94216418

https://www.facebook.com/story.php?story_fbid=10158973512127326&id=37823307325&post_id=37823307325_10158973512127326&_rdr

https://www.nieuwsblad.be/cnt/dmf20210824_95398626

Appendix 6. Opinion mining and word frequencies results

Figure 1: Word frequencies the Netherlands

Figure 2: Word frequencies Germany

Figure 3: Word frequencies Belgium

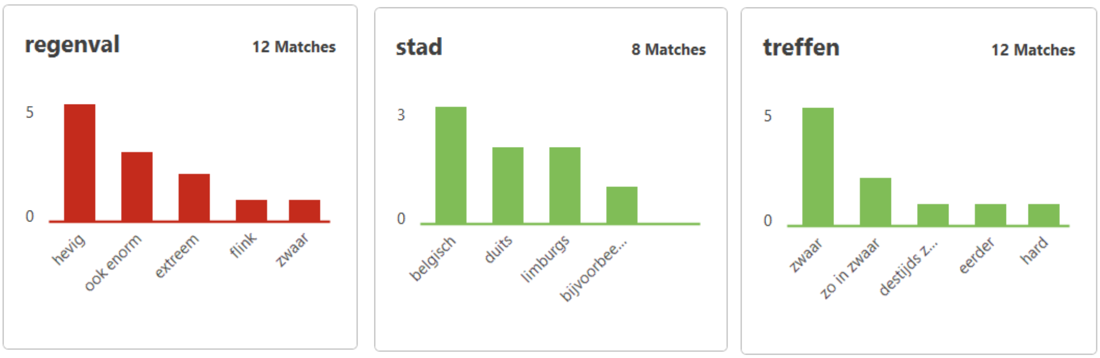

Figure 4: Opinion mining the Netherlands

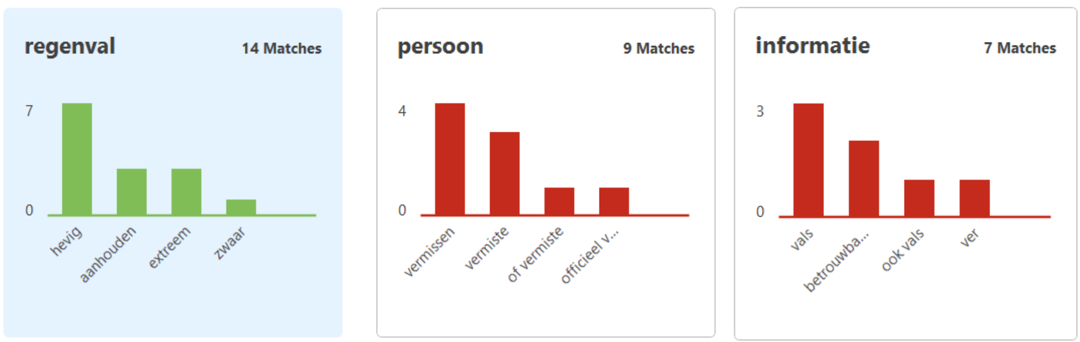

Figure 5: Opinion mining Germany

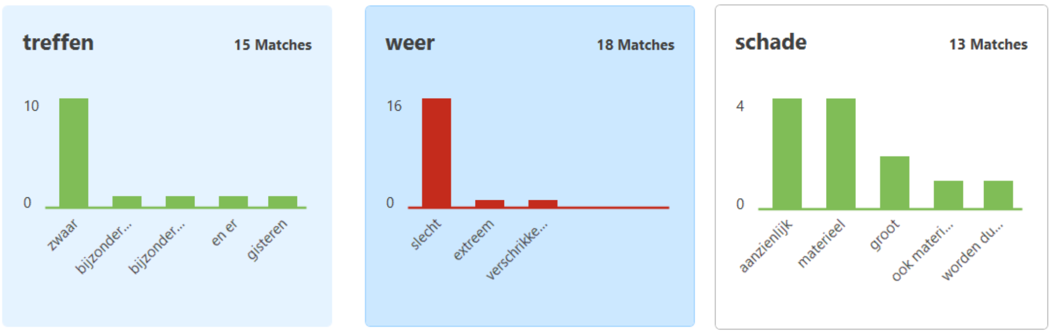

Figure 6: Opinion mining Belgium

Appendix 7. Code document analysis

	Articles Belgium Gr=419; GS=3	Articles Germany Gr=391; GS=3	Articles Netherlands Gr=487; GS=3	Totals
○ advice to evacuate Gr=8	4	0	4	8
○ aid from other regions Gr=13	1	1	11	13
○ aid worker died Gr=7	0	7	0	7
○ aid worker saved a life Gr=5	0	5	0	5
○ aid workers are heroes Gr=2	1	1	0	2
○ amount of damage Gr=4	1	3	0	4
○ anger towards assistance Gr=7	0	7	0	7
○ apocalyptic Gr=5	5	0	0	5
○ asking for donations Gr=3	1	2	0	3
○ blaming government Gr=4	1	3	0	4
○ Bondspresident attending Gr=5	0	5	0	5
○ catastrophe Gr=13	7	5	1	13
○ civilians providing aid Gr=4	0	0	4	4
○ clearing rubble Gr=10	9	1	0	10
○ climate neutrality needed Gr=2	1	1	0	2
○ collapsing houses Gr=11	9	1	1	11
○ collective civilian aid Gr=3	0	0	3	3
○ complaint about lack of aid Gr=3	0	2	1	3
○ covid Gr=4	1	0	3	4
○ crime during flood Gr=5	0	5	0	5
○ death in other country Gr=42	4	0	38	42
○ deaths Gr=97	76	21	0	97
○ demanding situation for mental health aid workers and volunteers	0	1	1	2
○ deporting foreign criminals who stole during the flood Gr=2	0	2	0	2
○ destruction Gr=14	3	9	2	14
○ disaster Gr=22	7	11	4	22
○ disaster like never before Gr=7	3	3	1	7
○ disaster tourism Gr=16	1	0	15	16

○ dyke failure Gr=13	0	0	13	13
○ dyke failure fixed Gr=2	0	0	2	2
○ emergency assistance provided	0	3	0	3
○ emergency ordinance Gr=10	0	0	10	10
○ evacuated returns home Gr=6	0	0	6	6
○ evacuation Gr=85	28	1	56	85
○ evacuation of vulnerable Gr=22	0	3	19	22
○ everybody helps Gr=5	0	5	0	5
○ everything is destroyed Gr=5	2	3	0	5
○ extra emergency beds Gr=8	0	0	8	8
○ extra militairy aid Gr=23	7	0	16	23
○ extraordinary difficult situation Gr=4	1	1	2	4
○ extraordinary weather situation	0	1	1	2
○ extreme flooding Gr=2	1	1	0	2
○ extreme precipitation Gr=6	2	1	3	6
○ false information Gr=9	0	6	3	9
○ financial aid Gr=12	6	3	3	12
○ flood occur more often due to climate change Gr=8	5	0	3	8
○ flood warning active Gr=5	0	1	4	5
○ food shortages Gr=4	0	0	4	4
○ frustrated victims Gr=2	0	2	0	2
○ government agencies overwhelmed by the disaster Gr=6	5	1	0	6
○ government decided to release a sluice Gr=6	6	0	0	6
○ hospital evacuated Gr=4	0	0	4	4
○ house uninhabitable Gr=6	0	4	2	6
○ ignoring covid Gr=1	0	1	0	1
○ improving flood preparation Gr=2	0	2	0	2
○ improving sirens Gr=3	0	3	0	3
○ infrastructure destroyed Gr=24	10	3	11	24

○ infrastructure flooded Gr=89	43	0	46	89
○ injured Gr=3	0	3	0	3
○ insecure forecast Gr=4	1	2	1	4
○ insurance Gr=8	2	4	2	8
○ insurance difficulties to prove damage Gr=1	0	1	0	1
○ insurance information for those affected Gr=7	0	7	0	7
○ insurance payout Gr=4	1	1	2	4
○ insurances not wanting to insure flood prone areas Gr=2	0	1	1	2
○ lack of mobil warnings Gr=2	0	2	0	2
○ lack of reliable information Gr=2	0	2	0	2
○ lack of trust in politicians Gr=6	2	4	0	6
○ legislative change needed Gr=2	0	2	0	2
○ life-threatening Gr=2	0	2	0	2
○ looters after evacuation Gr=10	2	5	3	10
○ looting disaster tourist Gr=4	0	0	4	4
○ material damage Gr=45	31	8	6	45
○ mismanagement created a tsunami	7	0	0	7
○ missing persons Gr=50	29	20	1	50
○ missing persons in other country	1	0	35	36
○ more extreme weather Gr=2	0	1	1	2
○ nationality of criminals Gr=2	0	2	0	2
○ neighbours helping eachother in the aftermath Gr=7	3	3	1	7
○ no electricity in regions Gr=45	16	2	27	45
○ no mistakes made by government	8	0	0	8
○ no mobile reception Gr=12	5	4	3	12
○ normal life shutting down as result of flood Gr=2	0	2	0	2
○ not enough financial aid Gr=2	0	2	0	2
○ people lost all their stuff Gr=2	0	2	0	2

○ police patroling evacuated areas	3	0	5	8
○ political commotion bondspresident Gr=3	0	3	0	3
○ political commotion Laschet Gr=13	0	13	0	13
○ politician promises aid Gr=3	0	2	1	3
○ politician visits area Gr=8	0	8	0	8
○ praising solidarity Gr=11	4	2	5	11
○ praising volunteers Gr=13	4	4	5	13
○ prepare for an potential evacuation	0	0	6	6
○ preparedness to help Gr=2	0	2	0	2
○ preventing traffic jams for aid workers Gr=3	0	1	2	3
○ preventive evacuation Gr=10	6	0	4	10
○ previous projects proved to be succesful Gr=3	0	0	3	3
○ reconstruction Gr=3	1	2	0	3
○ reconstruction coordination Gr=2	0	2	0	2
○ reconstruction will take a long time	2	2	1	5
○ record water level Gr=14	0	0	14	14
○ regional volunteers first to aid Gr=4	1	2	1	4
○ respect for aid workers Gr=5	3	2	0	5
○ searching for a place to sleep Gr=1	0	1	0	1
○ shock about the devastation Gr=7	0	6	1	7
○ situation is the ultimate test for previous project Gr=2	0	0	2	2
○ situation is uncertain Gr=8	0	7	1	8
○ sluice may fail Gr=19	3	0	16	19
○ social media live streaming the disaster Gr=2	0	1	1	2
○ social media spreading lies Gr=3	0	3	0	3
○ spreading false information Gr=6	0	5	1	6
○ tension Gr=2	0	2	0	2
○ traffic jams Gr=6	0	4	2	6
○ traumatizing for inhabitants Gr=5	0	3	2	5
○ travel warning Gr=3	2	1	0	3
○ urgent call to stay home Gr=7	0	1	6	7
○ victims receive compensation from the state Gr=7	3	0	4	7
○ volunteers aiding with sandbags	0	0	2	2
Totals	391	302	477	1170