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Joint risk assessment with respects to disasters in EMR

Current situation, future options, and recommendations

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Aranco
Consultancy & Interim Management

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1 Introduction and background

The management of disasters has become increasingly important, as disasters are becoming more intense and involving a larger number of victims because of several reasons such as climate change. The disasters of the future are expected to affect even more people and it is therefore important to understand how disasters can be most efficiently managed to reduce the risk of damage (Edwards, 2009). Before moving into disaster management, we first aim to define a disaster. A disaster can be defined as: ‘’… *serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts.’’* (DeNolf and Kahwaji, 2023). To manage these disruptions on society, disaster management is used to effectively prepare for and respond to disasters and decrease as much as possible the harm that the disaster can cause on society. Disaster management therefore can be defined as: ‘’*The organization, planning and application of measures preparing for, responding to and recovering from disasters.’’* (UNDRR,n.d.). Disaster management involves different phases: mitigation, preparedness, response, and recovery (National Governor’s Association, 1979). It is important that disaster management is clearly documented and understood by the local, regional, and national governments (Edwards, 2009).

For effective disaster management, several building blocks need to be considered: risk assessment, mitigation, planning, training, exercises for response and recovery. When these building blocks are present, they enable the development of capabilities that enable effective action plan (Godshalk, 1991; Kartez and Lindell, 1990). It is especially important to investigate how the effects of disasters can be prevented, or at least reduced. This mostly relates to the assessment of risks (Tulane University, 2023). Risk assessment is described by Poljanšek et al. (2019) as a common understanding among stakeholders about potentially faced risks to determine an adequate response or defined otherwise: ‘’ … *a qualitative or quantitative approach to determine the nature and extent of disaster risk by analysing potential hazards and evaluating existing conditions of exposure and vulnerability that together could harm people, property, services, livelihoods and the environment on which they depend*. ‘’(Poljanšek et al., 2019, p.24, based on the definition of UNISDR, 2018). Especially in the response phase, it is important that at each local situation where the disaster hits, the risk is assessed in a comparable manner and shared with the designated persons to develop a thorough risk assessment of the disaster. Still, several challenges remain in the field of risk assessment: 1) most risk assessment approaches are still focusing on single risks, 2) most risk assessment approaches focus on specific elements of risk, 3) most risk assessment approaches are qualitatively oriented, 4) standardization is still low, and 5) it is difficult to collect relevant, appropriate, and up-to-date information.

Though disasters are infrequent, but the Euregion Meuse-Rhine (EMR) has faced two major disasters in recent years, namely the COVID 19 pandemic (2020-2022) and the high water/flood disaster (2021). Actions during disasters, but also smaller incidents, are monitored in the three countries of the EMR based on different risk assessment models that are used by different partners such as the Fire Department of the city of Aachen, the Ordnungsamt of the Kreis Heinsberg and the Ordnungsamt of the Städteregion Aachen in Germany, the Provinces of Limburg and Liège in Belgium and the Veiligheidsregio Zuid-Limburg and GGD Zuid-Limburg in the Netherlands. All these organizations are partners of EMRIC and are legally responsible for disaster and crisis management in their own country. As soon as an incident is happing at a neighbor country that might have physical effects on a country or when incidents are happening in several EMRIC regions at the same time, joint risk assessment is necessary. The floodings in 2021 have shown the importance of joint risk assessment, emphasizing the presence of differences in risk assessment models being used among the countries. The impact of these differences had an influence on the decisions being made during the disaster, for example some regions were already evacuated quite early, whereas others were not evacuated at all.

The current understanding is that differences in risk assessment can lead to differences in the analysis of a disaster . So far, these different risk assessments of NRW, Belgium, and the Netherlands have not yet been studied nor compared to each other. The aim of this study is to analyze how risk assessment is done and what the role of risk assessment is in relation to the disaster management systems for NWR, Belgium, and the Netherlands. The results of this study enable us to provide evidence-based advice on the desirability and feasibility of a common cross border risk assessment system for the partners in EMRIC. To arrive at uniform risk assessment system or an understanding of the differences between the systems, it is important to first know who to contact, who decides to take the measures and how the risk assessment is going with and between foreign colleagues. Therefore, this study will first provide a literature review on the disaster management literature, specifically focusing on the concepts risk assessment and cross-border disaster management. We then will analyze how disaster management is structured in Belgium, the .Netherlands, and the specific Bundesland Nordrhein-Westfalen (NRW) in Germany and what type of risk assessment model they use.

This study is one of the deliverables of the Marhetak project. The aim of the Mahretak project is to strengthen cooperation between the Euregional services responsible for disaster management and the services for weather, water, and soil in times of a flood disaster. The Marhetak project is an Interreg-funded project that will run until December 2023. The Marhetak research project is carried out by PLATO (Platform Opleiding, Onderwijs en Organisatie BV, a research institute of the University of Leiden), ITEM (Institute for Transnational and Euregional cross border cooperation and Mobility, a

research institute of the University of Maastricht), and Aranco (business consultancy company), on the instructions of EMRIC. EMRIC stands for the Euregio Meuse-Rhine Incidentbestrijding en Crisisbeheersing (Control and Disaster Management). EMRIC is the lead partner and order supplier of this study. EMRIC presents a unique collaboration of public services responsible for public safety across borders, including fire services, technical assistance, and emergency medical assistance and infectious diseases in their respective territories. Due to the special geographical location of EMRIC's working area and the three-country context in which EMRIC operates, the elaboration of these treaties is seriously and permanently arranged within EMRIC[1]. EMRIC ordered this specific study, as they aim to stimulate an intensive collaboration between crisis partners in the Euregio Meuse-Rhine, that they aim to continuously develop. With this study, they aim to get a better understanding of how joint risk assessment might be both desirable and feasible in the future.

[1] An overview of the treaties of EMRIC, check the following link: https://emric.info/nl/professionals/verdragen.

2 Objective, research questions and target audience

The current perspective is that there are differences in how the national disaster management is structured and organized in the Netherlands, Belgium, and NRW, which can lead to differences in risk assessment models being used at a regional and local level both within and between countries. In that context, this study will analyze how risk assessment takes place within each of the three countries, by looking at which specific model is used, and what the role of risk assessment is in the overall framework of a specific disaster management system per country or Bundesland (NRW). In this, we focus on the EMR region, the main focus area of EMRIC, representing a collaboration between several provinces and other organizational units spread over the Netherlands, Belgium and NRW. This region is centered around the Meuse river and consists of the area between and around the cities of Hasselt, Maastricht, Luik, Aachen and Eupen. When both questions are understood, we are better able to provide advice on the desirability and feasibility of the development of a common cross border risk assessment system within EMRIC. To develop a thorough understanding of risk assessment within NRW, the Netherlands, and Belgium as well as in a cross-border context, the following research questions are investigated in this research:

- How is risk assessment in emergency situations currently performed in the country/Bundesland concerned?
- What is the role of risk assessment in the overall framework of the country's/Bundesland's disaster management system?
- How desirable and feasible is a common cross border risk assessment system for making a common risk assessment?

The target audience for this report is the EMRIC-cooperation, which was briefly introduced in the introduction. Various treaties and agreements stipulate that organizations and individuals must help each other across borders in the event of accidents, disasters, and crises. It has also been laid down that information must be exchanged cross border about possible risks and about the (potential) dangers during an incident. The Euregio Meuse-Rhine is relatively rich in borders, and in some cases emergency services from neighboring countries can arrive faster than services of their own country.

EMRIC ensures that cross-border cooperation is possible, but it is not self-evident. Within cross border cooperation in the Euregion Meuse-Rhine, the operational and legal systems of the three countries differ to such an extent that a lot must be arranged before ambulances or fire trucks are allowed to cross the border.

This report aims at providing input that can be used to develop an e-learning for the members of the crisis staffs of EMRIC's partners. These crisis staffs are aiming at different levels: operational, tactical,

and strategic. EMRIC consists of the EMRIC office and EMRIC partners.The collaborating partners are the fire brigade of Aachen, the Ordnungsamt of Kreis Heinsberg and the Städteregion Aachen in Germany, the federal service of the governor for emergency planning and crisis management of the provinces of Liège and Limburg, and the Veiligheidsregio Zuid-Limburg and GGD Zuid-Limburg in the Netherlands. These organizations finance the collaboration and the so-called EMRIC-office. In addition to these seven partners, more than 30 services and governments are involved in the EMRIC collaboration (EMRIC, 2023). When a disaster has cross-border effects or involves cross-border deployment of people and resources, liaisons are often sent to or at least in contact with the various coordination teams.

3 Literature review

In this chapter, a literature review can be found in which the concepts disaster management, risk assessment and cross-border disaster management are investigated in the disaster management literature.

3.1. Disaster management

In the disaster management literature, several phases have been identified: mitigation, preparedness, response, and recovery (National Governor's Association, 1979). Scholars mostly focused on either pre- or post-disaster phases, not often focusing on the actual response phase. This research focuses on the response phase, because in the response phase the disaster has happened. The challenge then is to manage its impact on society as effectively as possible to reduce the potential damage that it can have. Response typically involves both a diversity and large number of different organizations depending on the scale and possible impact the disaster can have on society, such as the first responders, municipalities, and safety managers (Edwards, 2009).

For disaster management, it is important to use a valid model, as it can support stakeholders in simplifying complex disasters and understand what elements can be distinguished. A disaster management model can facilitate a planning process and helps at establishing a common understanding for all stakeholders involved (Kelly, 1998). For effective disaster management, several building blocks need to be considered: risk assessment, mitigation, planning, training, exercises for response and recovery. When these building blocks are present, they enable the development of capabilities, that enable an effective action plan (Godshalk, 1991; Kartez and Lindell, 1990). Asghar et al. (2006) mention that four types of models exist that can be used for disaster management:

1. *Logical:* simple definition of disaster stages and emphasizes the basic events and actions which constitute a disaster. Pre-disaster risk reduction and post-disaster recovery phase. Do not go beyond describing disaster stages and provide conceptual frameworks for the very basic activities of disaster.

2. *Integrated:* characterize the phases of a disaster by the evolution of monitoring. Modules linked as events and actions. Does not integrate response and recovery neither detailed step to take per phase.

3. *Causes*: not focused phases, but on vulnerable conditions that might affect disaster management by identifying underlying pressures and root causes of a disaster. Discussion about conditions affecting disaster management cycle is limited to vulnerability conditions, not including hazard or exposure conditions.

4. *Others:* combination of models as described above

Asghar et al. (2006) developed a model for disaster management that aims to show that the response phase is the most important phase of disaster management, while mitigation and preparedness are the basic fundament for a successful response (See Figure 1).

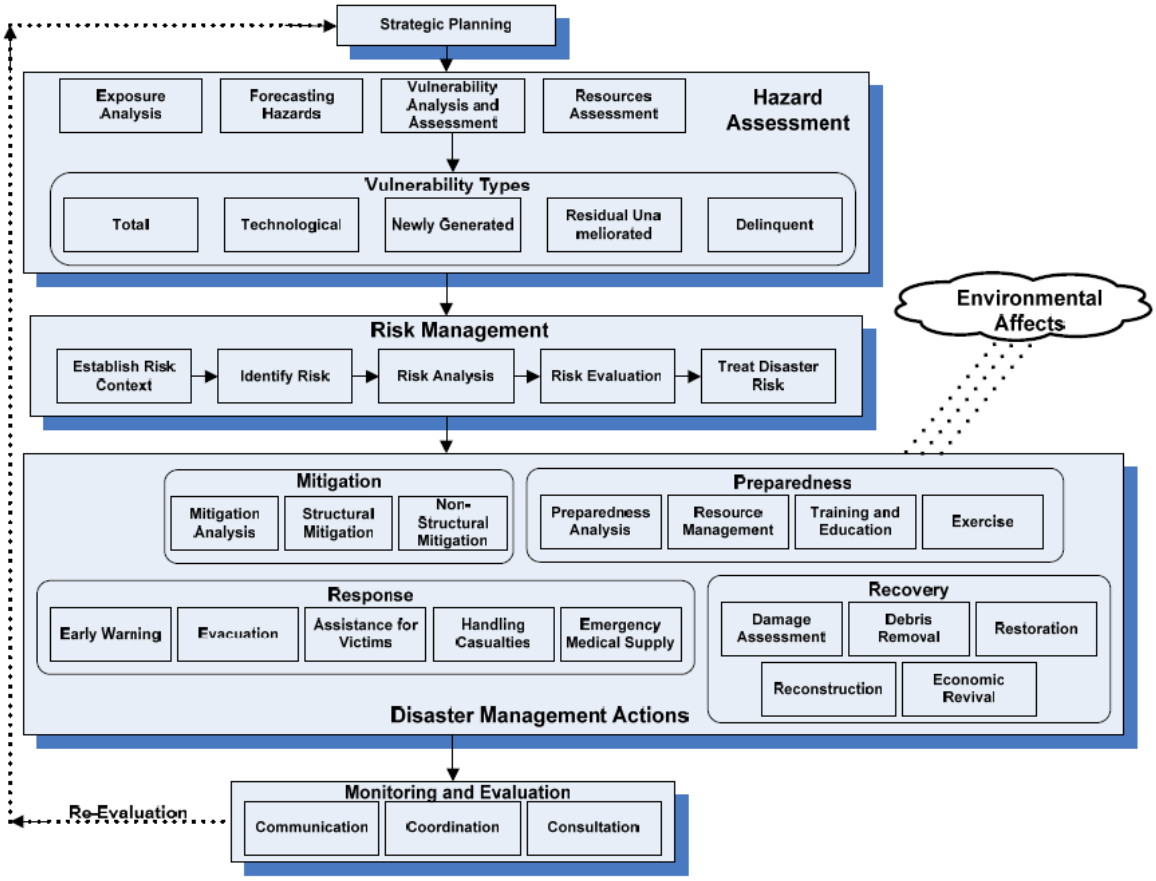

Figure 1 Model for disaster management (Source: Asghar et al., 2006)

3.2. Risk assessment

Risk assessment is one of the building blocks of disaster management. Risk assessment of disasters can be highly complex because of the involvement of a high variety of sectors and stakeholders as well as the variety of affected communities. Each of these groups has their own perspective, experiences, and knowledge regarding disasters. It is important to develop a shared risk assessment approach to create a common understanding of how to deal with perceived and faced risks and their relative priority to make a location, whether it is local, regional, national or cross-border, more robust to disasters (Poljanšek et al., 2019). For risk assessment, it is important that different geographical levels are combined. Depending on the impact of the crisis, the local, regional and/or national government must be included in the risk assessment. An understanding of risk assessment between organizations that cooperate across

borders and must manage a crisis together (due to their geographic location), but manage it differently due to national circumstances, is equally important.

The question remains what is risk assessment? Risk assessment is described by Poljanšek et al. (2019) as a common understanding among stakeholders about potentially faced risks to determine an adequate response or defined otherwise: ''… *a qualitative or quantitative approach to determine the nature and extent of disaster risk by analyzing potential hazards and evaluating existing conditions of exposure and vulnerability that together could harm people, property, services, livelihoods and the environment on which they depend*. ''(Poljanšek et al., 2019, p.24, based on the definition of UNISDR, 2018). In disaster risk assessment, risk is described as:'' … *the potential loss of life, injury, or destroyed or damaged assets which could occur to a system, society, or a community in a specific period of time, determined probabilistically as a function of hazard, expose, vulnerability and capacity.''* (Poljanšek et al., 2019, p.24, based on the definition of UNISDR, 2018). Risk is thus determined by hazard, exposure, and vulnerability. Vulnerability is a multidimensional concept being influenced by a variety of input variables, that can be categorized into economic, environmental, physical, and social influences (Kull, 2013).

Disaster risk assessment consists of several steps. Though different scholars have been using slightly different steps, in this research we build upon the risk management framework as developed by Salter (1997), as other scholars are assumed to build upon these steps (See Figure 2). This framework focuses on the interactions between sources of risk and elements at risk. The first and foremost step of each risk assessment always is problem structuring to create an understanding of what the actual problem is.

Figure 2 Risk management framework (Source: Salter, 1997)

The output of each step is output for communication between stakeholders as well as a summary for decision makers of local, regional, or national scales, depending on the potential impact of the disaster (Poljanšek et al..2019),

Risk assessment can be done by a variety of stakeholders. Risk assessment should provide stakeholders an understanding of the relative importance of different risks and the underlying input variables that can be used to predict these risks (Poljanšek et al..2019). Still, it is important that one authority has the

mandate to coordinate all stakeholders involved to make sure that each stakeholder is basing its decisions on the same input and information (Poljanšek et al., 2019). It is important that risk assessment is thus coordinated in a top-down matter to establish priorities. However, bottom-up approaches should not be ignored, as it is important to collect data on input variables on the specific location of the disaster by for example first responders. The coordination team will make sure that all risk assessments that are done bottom-up by expert teams are aggregated to provide a full picture of the disaster situation.

Interesting to mention is that several scholars have taken a participatory approach in disaster risk assessment. These approaches aim at letting a wide diversity of stakeholders participate in risk assessment to involve for example citizens of a specific area in managing the community risks by learning, managing, and monitoring local risks (Akemi Goto and de Lima Picanco, 2021). By letting a diversity of stakeholders participate in risk assessment, the community is empowered, generates knowledge, and provides a vehicle for negotiation (Pelling, 2007).

Scholars have addressed several challenges for risk assessment, both from an academic and practitioner perspective[2]:

1. Multi-hazard risk assessment (Albris et al., 2020; Hoyt and Liebenberg, 2011; Klijn et al., 2012; Kull et al., 2013; Poljanšek et al., 2019; Tehler et al., 2020): it is important to develop assessment models and tools that are able to understand how multiple risks influence each other as well as how different hazards influence a specific risk. Traditionally used approaches were often based on single risks, whereas the complex challenges that society is facing are too complex and interconnected. An individual hazard or risk approach can lead to biased or partially understanding of the crisis. In addition, single risk approach make it challenging to predict how risks influence each other in specific situation, as it is for example also influenced by environmental influences, and difficult to predict how different hazards and vulnerabilities influence risk (Klijn et al., 2021). Albris et al. (2020) suggest that it is important to look beyond only vulnerability or hazards to predict risks. They state that it is important to integrate the latest scientific insights and treat risk as being influenced by vulnerability, hazard, and expose. Many examples can be found of papers mostly focusing on vulnerability (e.g., Menoni and Pergalani, 1996). In addition, there is a lack of experts that can conduct newer types of risk assessment and therefore education of new experts as well as education of the communities is highly important (Akemi Goto and de lima Picanco, 2021).

[2] Note that these identified challenges focused on general risk assessment, and not on a cross-border risk assessment.

2. Quantitatively based risk assessment models (Kull et al., 2013; Poljanšek et al., 2019): it is important to understand how certain types of data, types of risks, types of input variables for the prediction of risk should be compared or aggregated. In addition, a large part of the data currently used in risk assessment is based on qualitative input variables. It is challenging to understand how different types of data, variables or risks need to be aggregated to assess the risks in specific risk situation. To let a quantitative based risk assessment model be successfully implemented and used, it is important to make sure that stakeholders agree upon a protocol, risk criteria and a classification. Kull et al. (2013) suggest that probabilistic approaches can provide a mathematical framework to combine both dependent and independent hazards, vulnerabilities, and exposures to determine multi-hazard risks. Interesting to mention is that De Bruijn et al. (204) feels that risk assessment methods are quantitative in nature, but that a combination of qualitative and quantitative methods could be of added value, while combining qualitative and quantitative information can map out most important risk factors and combine them to develop a qualitative indication of risk.

3. Standardization of risk assessment (Morsut, 2020; Poljanšek et al., 2019; Tehler et al., 2020): The high context-specificity of disasters makes it difficult to standardize risk assessment. It is challenging to harmonize and standardize risk assessment as well as the input variables used. Standardization is needed both for specific disasters as well as for specific geographical areas. Now, risk assessment models are highly specific (e.g., Mili et al., 2018 developing a model for assessing the risks of earthquakes and determining priorities). It is important to support the design of realistic risk scenarios that can provide at least generalization to a certain extent on either the type of disaster or a specific geographical area. Standardization can support the process of comparisons between countries, enabling an analysis of the relative importance of a variety of risks in different regions. In addition, standardization can support governmental bodies in increasing the preparedness of disaster management.

4. Collect relevant, appropriate, and up-to-date information and input for risk assessment models (Poljanšek et al., 2019; Tenerelli et al., 2015): to be able to develop and realize the challenges as identified above, it is important to retrieve correct data and input for the analysis. Tenerelli et al. (2015) provide an example of the challenges faced by data collection, by proposing a new methodology that can be used to perform population vulnerability analysis for night-time scenarios that can be used to develop population maps for risk assessment models.

3.3. Cross-border disaster management and risk assessment

Disasters do not respect borders and can impose high risks to human lives as well as economic, social, and health impacts (Neville et al., 2016). Cross-border cooperation is highly important in disaster management as in border areas it can be the case that first responders from another country can respond more quickly than the responders from the country itself. To create efficient cross-border cooperation, it is important that disaster management is standardized, and mutual knowledge exist to be able to operate effectively when a disaster occurs (Paquay et al., 2021). But the management of disasters across borders can be quite challenging, because of for example the existence of different and changing competencies between governments on both sides of the border (Janssen, 2008). As a result of the complexity, intensity, and frequency of disasters, it is important that national leaders move away from a nation perspective into embracing multidisciplinary and cross border cooperation (Goniewicz et al., 2020). Cross-border disasters create additional political, social, and diplomatic challenges (Edwards, 2009). Disaster management is mainly influenced by the national government's policy, which is shaped by for example its historical, political, and socio-economic contexts (Morsut, 2020; Neville et al., 2016). These challenges require additional effort to overcome these challenges (Edwards, 2009; Morsut, 2020; Renn and Luhmann, 2005; Wildavsky and Dake, 2009). Paquay et al. (2021) describe that the standardization of methods and mutual knowledge development could be a facilitator for cross-border collaboration, because shared knowledge provides better insights into how each actor operates and what actions are most effective in the development of joint prevention initiatives. Van Eerd et al. (2017) note that cross-border cooperation is often still too limited to just knowledge development and information exchange.

Research on cross-border disaster management is still limited. Some examples can be found, though most of them focused on describing the challenges faced with cross-border disaster management, not specifically focusing on risk assessment nor the response phase. One example was found of an article focusing on the Euregio Meuse-Rhine, specifically focusing on disaster management training and education (Paquay et al., 2021). Existing research mostly focuses on a national rather than regional level. Research on cross-border disaster management has not yet focused on the response phase specifically. Examples are found that focus on other phases such as Lai (2012) focusing on the recovery phase. To understand how cross-border disaster management works, a variety of literature streams, methods and constructs are used such as the collaborative governance and network literature(Lai, 2012), and cost-benefit analysis method (Kull, 2013).

Neville et al. (2016) developed the S-Help model for cross-border disaster management: securing health emergency learning planning. This model presents a decision-support tool that supports multi-agency decision making during cross-border disasters. It can be used in all stages of disaster management. To let it succeed, it is important to have accurate and valid information to enable stakeholders to make a

thorough decision. It is important that a balance is found between providing accurate and on-demand information and too detailed information (Janssen et al., 2010). To let this model be successfully implemented, it is important to have information specialists present that understand the unique requirements and stakeholders involved for the assessment of risk and to prevent an information overload.

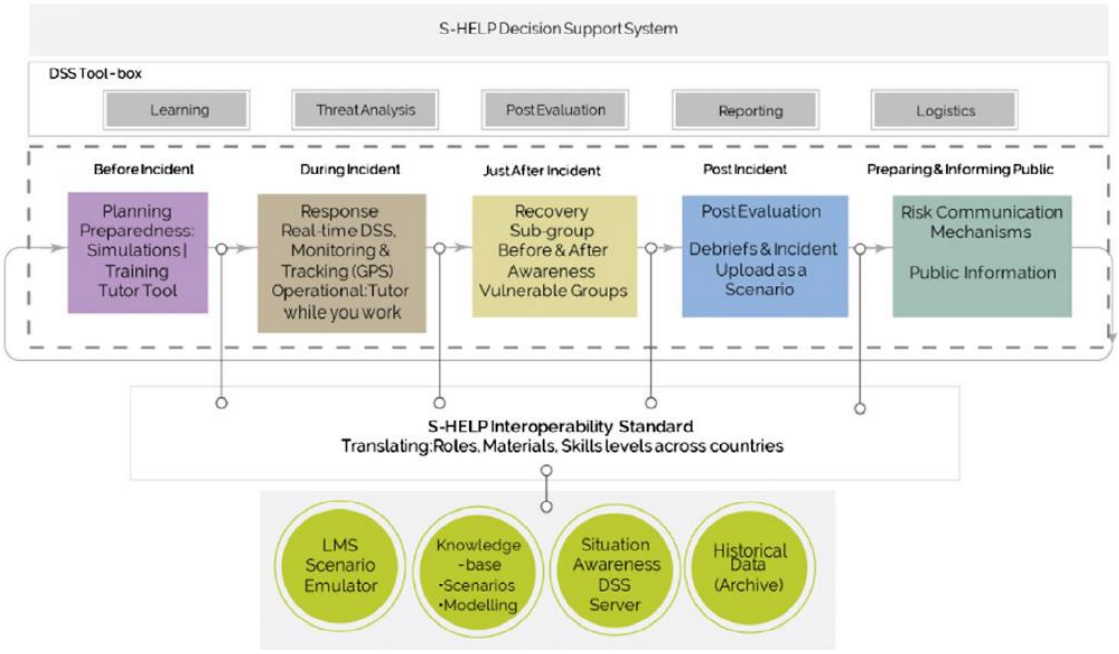

Figure 3 S-HELP (Source: Neville et al., 2016)

The literature also suggests that to enable efficient cross-border disaster management, it is important to develop mutual aid and support systems. A mutual aid system needs to provide information on when and how assistance will be provided, how liability is handled and who and whether any reimbursement will be received (Edwards, 2009). Edwards (2009) mentions that these mutual aid systems should be in line with the national ICS systems. To implement this mutual aid-system, it is important to develop a regional coordination hub that can efficiently and effectively manage the aid needed to manage a specific disaster. It is important to document the role of this coordination hub and make sure that this role is agreed upon and shared with and between the different countries involved (Edwards, 2009). Edwards (2009) mentions that to let the mutual-aid system work, it is important that the national governments support the local and regional municipalities. This is also confirmed by Paquay et al. (2021) who state that regional arrangements must be made to address disparities in cross-border legislation. Mutual aid systems are often difficult to implement as it can collide with the national sovereignty of individual countries. Therefore, agreements must be made that consider each country's laws and regulations.

The European Union is developing several initiatives at the level of legislation and operation to stimulate and facilitate cooperation between its member states to be better able to assess and deal with faced risks of disasters (Morsut, 2020). ISO 31000:2018 is for example focused on risk management. The European Union for example is developing guidelines on national risk assessment model for disaster management (Poljanšek et al., 2019). Joint risk assessment in disaster situations can support countries in their preparedness and response to disasters. Especially in the response phase, the joint risks can be reduced by efficiently managing the risks (Goniewicz et al., 2020).

4 BOB, IBOBBO and Führungskreislauf

4.1 Crisis management

4.1.1 Crisis management in the Netherlands

A crisis in the Netherlands is often taken care of by local or regional governments, depending on the crisis. If the crisis is on a local level, the major of a municipality is in command. In the Netherlands there are also so-called "Veiligheidsregios or translated: safety regions". These safety regions collaborate closely with police, local governments, and other vital organizations.[3] The different safety regions can also collaborate with each other. If a crisis is on a regional level, the chairman of the safety region is in command. The role of the central government ("Rijksoverheid") during a crisis is twofold: 1)the central government is a crisis partner to the local or regional government and, 2) the central government has an important part in the national crisis structure. In this national structure, the ministry of Justice and Safety has a coordinating role.

4.1.2 Crisis management in Belgium

In case of a crisis a Crisis Management Team (CMT) takes over command. This team normalizes the situation and ensures that normal services can be resumed. Since good communication is key, there is also a separate crisis communication team. It depends on the scale of the incident, if the CMT is put into action. If it is a relatively small problem, it can be dealt with within, for example, a local government. A small incident is called an "issue". An issue can evolve into a (larger) incident which in turn can escalate into a crisis. Depending on the stage in which an incident is, there can also be a role for the province. In this crisis-stage the CMT comes into action. In Flanders the CMT can call in the help of the so-called Coordination- and Crisis Centre of the Flemish Government. This Coordination- and Crisis Centre of the Flemish Government always steps in if a crisis pertains to multiple entities.

4.1.3 Crisis management in NRW

In Nord Rhein Westphalen "Kreise" (perhaps best translated as districts or smaller local governments), Bezirksregierungen (larger local government structure) and the ministry of Land Nord Rhein Westphalen are responsible for crisis management.[4] They can mobilize crisis teams which can take measures against the crisis.

4.1.4 Upscaling during a crisis

Before going into detail into the specifically used risk assessment models, we first aim to briefly describe the three levels involved in commanding disaster management. Table 1 shows a brief explanation of the strategic, tactical, and operational level of command and provides an overview of its key features. Based

[3] As described on: https://www.rijksoverheid.nl/onderwerpen/veiligheidsregios-en-crisisbeheersing/crisisbeheersing

[4] As described on: https://www.im.nrw/themen/gefahrenabwehr/katastrophenschutz

on Azadehdel et al. (2011), the strategical commander aims at defining what to do, by making organizational highest-level decisions. Tactical managers focus on translating policy and strategy into practice and providing boundaries for the operational level. Operational managers focus on the actual response at the place of an incident, responsible for quickly making decisions based on the available information on-site. Each level has its own responsibilities and role in the total level of command in case of a disaster. Risk assessment is done at all three levels, though used differently in all three countries under study,

Table 1 Levels of command (Source: Azadehdel et al., 2011)

Level	**Key features**
Strategic	• Defines what to do • Goals general, unclear, and implicit • Determines policy, overall strategy, resource deployment, and the parameters within which lower levels of command will operate • Decision-making analytical, in-depth, and broadly referenced • Strategic commander has overall command and responsibility for an incident
Tactical	• Defines how to do it • Goals multiple and relatively general • Decision-making identifying and evaluating options which requires analytical approach • Input focusing on hazards, vulnerabilities, risks, and resources that translate strategy and policy into practice • Tactical commander determines and directs tactics of operational team within the strategy, parameters and resources defined at strategic level
Operational	• Doing it

	• Task-oriented • Output aimed at maintaining accurate and relevant operational overview • Decision-making based on training and intuition • Operational commander works within functional and/or geographical area of responsibility to implement the tactical plans

The three paragraphs in the previous section demonstrate that each country has its own methods when it comes to tackling a crisis, and thus also its own line of command control. It varies per country to whom risk of a crisis is reported, in some cases being the safety region, in others the municipality or province (See Figure 4 for a more detailed perspective on upscaling for a potential crisis). The strategic, tactical, and operational line of command thus varies for the Netherlands, Belgium, and NRW.

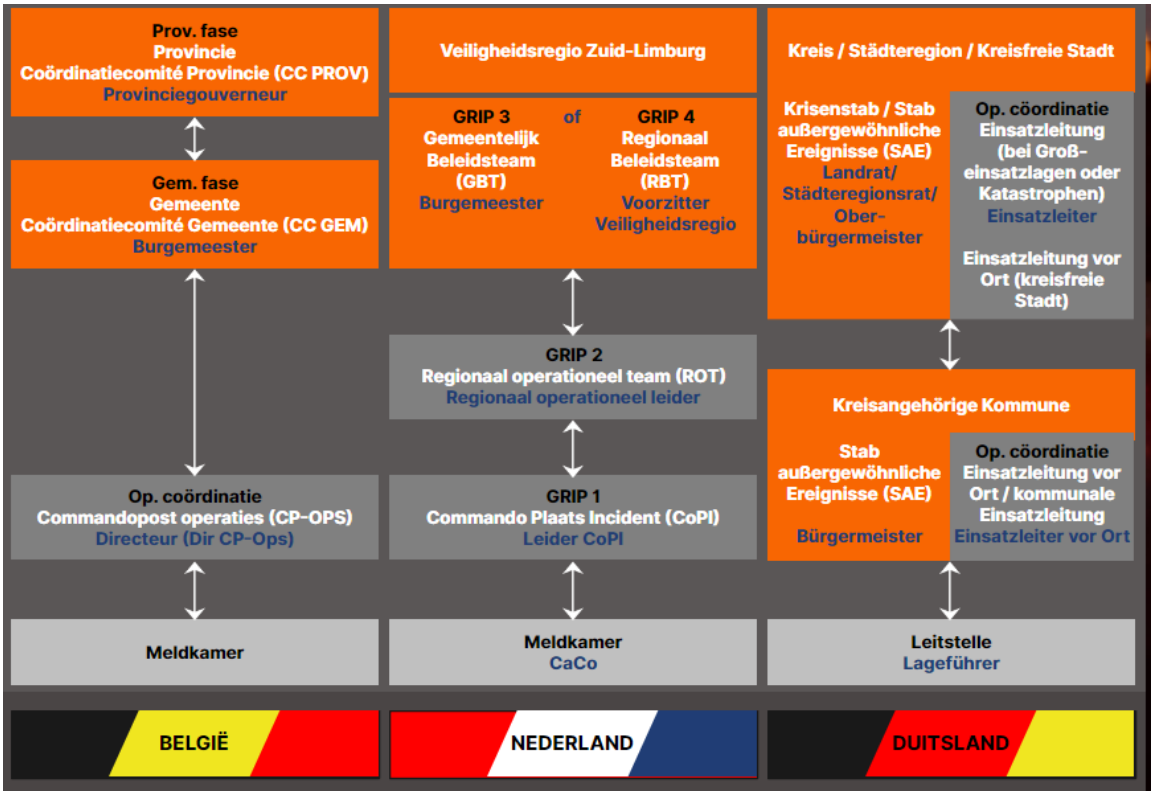

Figure 4: Upscaling in crisis situations (Source: EMRIC, 2000)

Table 2 below shows a more detailed perspective on Figure 4, providing more information on which level the risk assessment models (as will be discussed in section 4.2) are used and by whom. As the table shows, the Netherlands, Belgium, and NRW are organized in a comparable manner at the operational

level. In each of the countries, the on-site command and control units are responsible for risk assessment and making decisions in a specific geographical and/or functional area. At the tactical level, Belgium is more locally oriented, whereas NRW and the Netherlands are locally/regionally oriented (depending on the intensity/severity of the incident). At the strategic level, all three countries are managed differently, though all at the regional level. The three countries are thus comparable at least to a certain extent, though each country uses different names and has its own institutional climate.

Table 2 RA per level for each of the three countries

	The Netherlands	**Belgium**	**NRW**
Strategic	RA model: BOB By the Veiligheidsregio Zuid-Limburg, in GRIP 3 situation Gemeentelijk Beleidsteam (GBT) chaired by the mayor and in GRIP 4 situation by the Regionaal beleidsteam (RBT) chaired by the chairman of the safety region BOB used to structure discussions, as method for	RA model: IBOBBO (to best of our knowledge) At the level of the province, by the Provincie Coördinatiecomité Provincie (CC PROV) chaired by the governor of the province. At the level of the municipality, by the Gemeente Coördinatiecomité Gemeente (CC GEM) chaired by the mayor IBOBBO used to structure discussions and analyze which decisions to make	RA model: Which model is used is depending on how the staff is trained and what standards are used in a specific area By the Kreis/Städteregion/Kreisfreie Stadt, Krisenstab/Stab aussergewöhnliche Ereignisse (SAE) chaired by the Landrat/Städteregionsrat/Oberbürgermeister. At the level of the Kreisenangehörige Kommune, Stab aussergewöhnliche Ereignisse (SAE) chaired by the mayor

	scenario analysis, to analyze which decisions to make Used when the incident takes place	Used when the incident takes place	
Tactical	RA model: BOB In case of GRIP 2 situation, by Regionaal operational team (ROT) chaired by the regional operational leader and at GRIP 1 situation by Commando Plaats Incident (CoPI) chaired by the leader of the CoPi management, often municipality based (chaired by the mayor)	RA model: IBOBBO By Commandopost operaties (CP-OPS chaired by the director (Dir CP-Ops) IBOBBO used to structure discussions and analyze which decisions to make Used when the incident takes place	RA model: Which model is used is depending on how the staff is trained and what standards are used in a specific area By Einsatzleitung vor Ort/kommunale Einsatsleitung chaired by the Einsatzleider vor ort. Model used to structure discussions and analyze which decisions to make Used when the incident takes place

	BOB used to structure discussions, as method for scenario analysis, to analyze which decisions to make Used when the incident takes place		
Operational	RA model: BOB By on-site command and control units (e.g., firefighters) when incidents happen to analyze what the risks of an incident are and how to deal with it Used when the incident takes place	RA model: IBOBBO By on-site command and control units (e.g., firefighters) when incidents happen to analyze what the risks of an incident are and how to deal with it Used when the incident takes place	RA model: Führungskreislauf By on-site command and control units (e.g., firefighters) when incidents happen to analyze what the risks of an incident are and how to deal with it. Led by the municipality belonging to the district. Used when the incident takes place

4.2 BOB, IBOBBO and Führungskreislauf

In this part three models, BOB, IBOBBO and Führungskreislauf, used for risk assessment will be discussed. The models are used in the Netherlands, Belgium, and NRW during meetings of the crisis management team, which have risk assessment as their goal, in the response phase. All three models are cyclical-oriented. They are used on each one of the different levels shown in Figure 4. During these meetings it is decided what kind of actions are needed. These models are continuously run through during a crisis to continuously make a good and in-depth analysis of the situation on site. Priorities are set to deal with the biggest risks first, as risk is determined by multiplying the chance that it will happen times the effect of the risk. These models are used at a variety of levels, ranging from operational, to tactical and strategical levels. It is used in crisis situations to collect information from a variety of sources, locations, people, etc. to understand the situation of the crisis and make an informed choice. In this way, the models can be used to assess the risk of a situation.

The first model which will be discussed is the BOB model. Secondly, the IBOBBO model will be examined. Finally, the German Führungskreislauf will be described. After having discussed these models separately, a comparison between these three models will be made. Lastly, we will look at the scientific theory behind these models.

4.2.1 BOB model

The first of the three models that will be discussed is the BOB model. BOB is a Dutch abbreviation. In Dutch this stands for *beeldvorming – oordeelsvorming – besluitvorming*. "B*eeldvorming*" means as much as " conceptualizing the situation?"; "*oordeelvorming*" can roughly be translated as "judgement" and "*besluitvorming*" means "decision-making". This model is used in Dutch crisis structures and is used in a cyclical manner, for example during official meetings. This model is used at the operational, tactical, and strategic level. The main goal of the model is to determine the most appropriate approach and develop priorities. Before applying BOB, the information manager collects and arranges the available information. After decision-making, the agreed measures are elaborated and set out for each discipline involved in the specific incident.

The first phase of the BOB model is about conceptualising the situation, or said very simply: What is going on? This means that it is important to collect as much information as possible bearing relevance to the actual situation, until there is enough information to make an initial assessment of the situation. Also, it should be considered whether there is information that is not yet available and how to collect this information. The idea behind this phase of the BOB model is that participants of the crisis management team ask questions like: what do we know? Is everything we know, or at least think we

know, correct? What do we not know? Do we really need this information to come to the right decision? How are we going to collect this information?

Once these questions are properly addressed, it is possible to move on to the second phase, judgement. The first phase made clear what information is available and what the situation entails. The second phase are the different options of actions discussed. In this second phase it is important to explore every possible option and the possible risks and dangers. To get to these options for several questions must be asked: What is the goal and what do we need to worry about? How can we manage these risks and which conditions should a decision be in line with to represent an acceptable decision? The goal of these questions is creating a lively discussion. This discussion is only useful if it adds to the information and if it aids the decision-making process which is the final phase in the BOB model.

If the previous two steps have been done successfully, a team should arrive at the final step of the BOB model, the decision-making phase. During this phase, it is decided what the final decision will be and what the follow-up actions will be. This should flow naturally from the discussion in the previous phase. It is possible that, during this discussion in the judgement phase, a majority of the group already sides with one of the options. This makes the decision-making phase the easiest of the three phases. Still, it is necessary that a few questions are posed to arrive at the correct decision: what do we decide? What are we going to do? Does everyone know which decision is made? Does everyone agree with this decision? Answering these questions should yield the most optimal decision and would end the meeting.

In Figure 5 the different steps of the BOB model can be found in a graphical presentation. It also includes the question which I have listed in the previous paragraphs. Note, however, that, since the model is originally a Dutch model, the questions in the Figure are in Dutch.

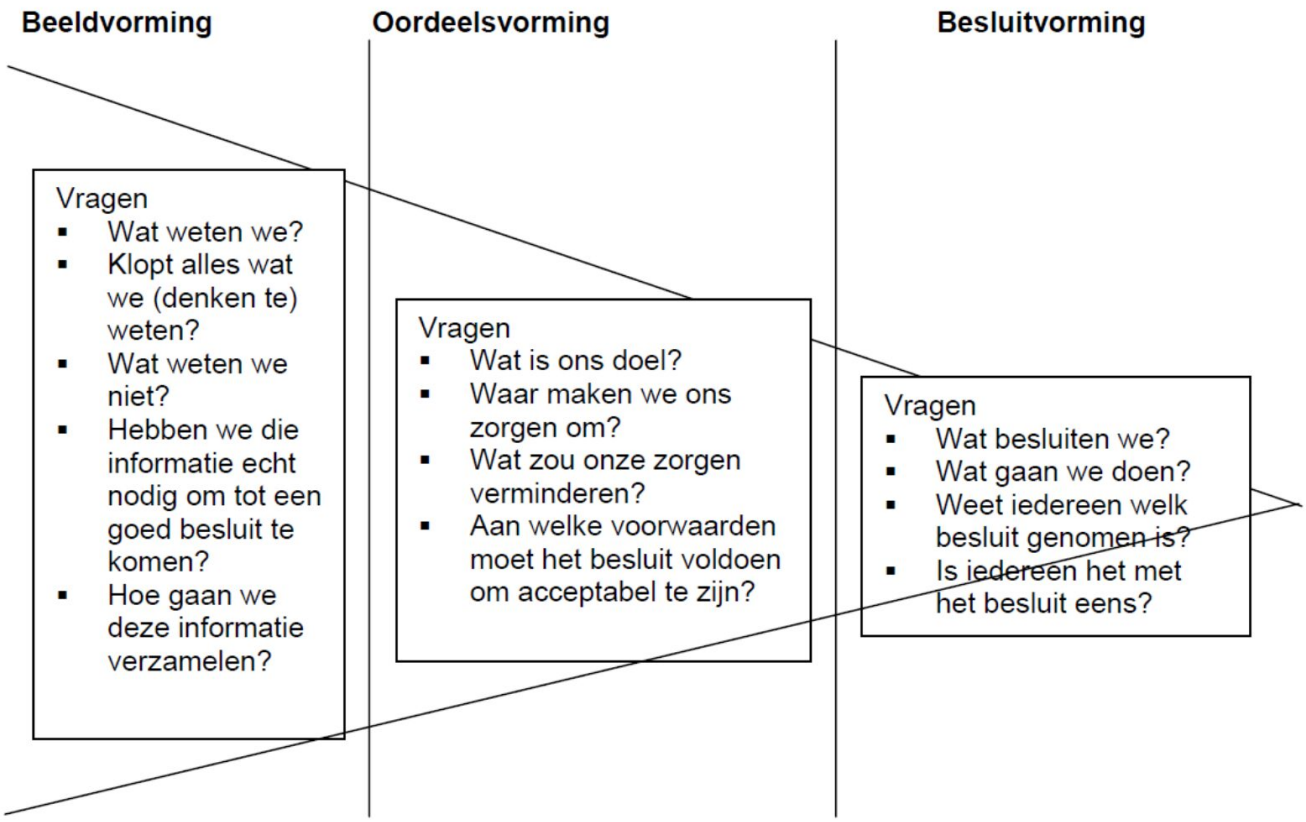

Figure 5: BOB model (Source: https://www.atim.eu/kennis-en-inspiratie/blog/vergaderen-met-het-bob-model)

4.2.2 IBOBBO model

The second model, the IBOBBO model, is mainly used in Belgium. IBOBBO is, like BOB, a Dutch abbreviation. This model is used in the Belgian crisis structures and is used in a cyclical manner, for example during official meetings. This model is used at the operational, tactical, and strategic level. The main goal of the model is to determine the most appropriate approach and develop priorities. The model is sometimes also called FAN (Factors, needs, action), though in general this abbreviation is not dominantly used. In Dutch the letters stand for:

- *informatiegaring*
- *beeldvorming*
- *oordeelvorming*
- *besluitvorming*
- *bevelvoering*
- *opvolging*

The translation of "*informatiegaring*" is "information gathering". The next three words are the same as in the BOB model: "B*eeldvorming*" means as much as "conceptualize of …"; "*oordeelvorming*" can roughly be translated as "judgement" and "*besluitvorming*" means "decision-making". "Bevelvoering"

means “command” and finally, “opvolging” can be translated as “followed-up”. This model, as can be seen in Figure 6 divides these phases in two categories, an individual and a common category. This means that the information gathering, command and follow-up phase are performed on an individual level (per discipline), whereas the conceptualize, judgement and decision-making phase happen on a common level (multidisciplinary).

The first phase focuses on gathering as much information as possible about the problem at hand. It is important to collect information on the actual situation, until there is enough information to make an initial assessment of the situation. It is very relevant to get a correct perspective of the situation.
The next phase, conceptualising, has as its goal to make sure everyone has a similar picture of the crisis and knows what the meeting is about. The leader of the meeting starts this phase by giving a multidisciplinary view of the situation answering questions like: “Why are we meeting?”; “what do we know so far?” etc. After this explanation, the rest of the participants will get a chance to add his or her perspective on the situation. It is important to make sure that only relevant information is discussed.
The third phase of IBOBBO is the judgement phase. During this phase an overview is made of the different types of problems, questions and needs. These problems can be divided into two groups: problems which already existed but were not yet solved and new problems. After this, actions must be determined based on the overview of the current situation. For this, choices must be made based on set priorities.

The next phase of IBOBBO is decision-making. During this phase, the results from the previous phases are summarized. This is done by listing the unsolved questions, the assigned tasks and discussing the decisions which followed from the judgement phase. Decisions are made that enable assertive, efficient, and safe management of the actual situation. If necessary, priorities are set, to make sure that everyone knows where his or her focus should be. The next phase is the command phase. This can quite simply be described as the phase in which the commands, connected to the decisions made in the previous phase, are given. Finally, the follow-up phase comprises a continuous cycle of the previous phases. It is necessary to keep gathering information and if new information turns up which necessitates a new meeting the conceptualize phase starts again etcetera.

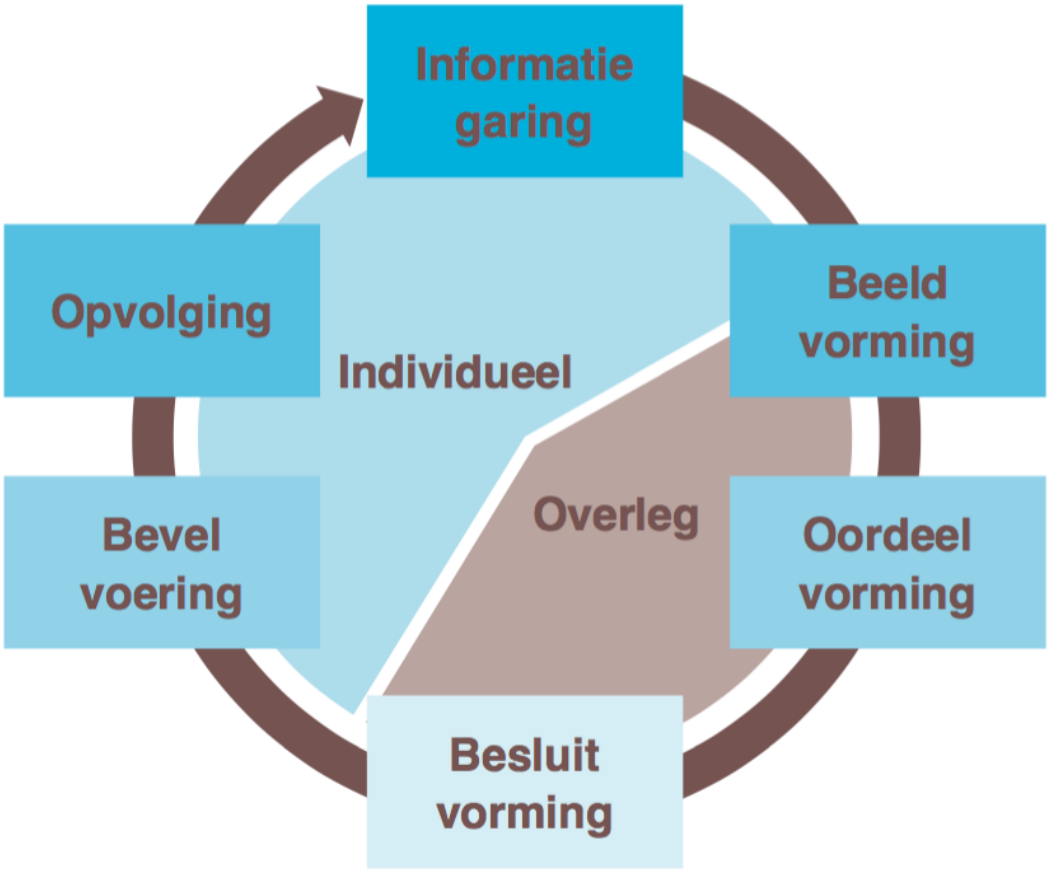

Figure 6:IBOBBO model (Source: Bruelemans, Brugghemans & Van Mechelen – 2015)

4.2.3 Führungskreislauf

The *Führungskreislauf*, also known as *Führungsvorgang*, is a goal-oriented, recurring, and self-contained process of thought and action. It is used in the German crisis structures. Decisions are prepared and implemented. It is not limited to the activity of the head of operations but is to be applied analogously by leaders at all levels of leadership from operational till strategic levels. The main goal of this process is to determine the right approach and prioritization. The goal of the *Führungskreislauf* is that the leader(s) use(s) the right means in the right place at the right time to avert danger. The process of the *Führungskreislauf* is visualized in the following circular diagram.

Figure 7: Circular diagram of the Führungskreislauf (Source: FwDV100 AFKzV. FwDV 100 Führung und Leitung im Einsatz)

Lagefeststellung (Erkundung der Lage) / Situation status (reconnaissance of the situation)

To determine the situation status reconnaissance is the first phase of the *Führungskreislauf*. It is the basis for decision-making and comprises the collection and processing of available information on the type and extent of the hazard situation or the damage event as well as on the urgency and the possibility of averting and eliminating existing hazards and damage. Thus, information is collected about the readiness of the emergency forces and resources and the legal basis for emergency response as well as the local, temporal, and climatic conditions at the scene of the emergency. The situation status is determined by the following factors: location, time, weather, hazard situation and the possibilities for damage prevention. The information required to determine the situation status is obtained among others from reports from subordinate emergency forces and other competent persons as well as from operation documents, such as alarm and operation plans, maps, service regulations and legal provisions. Usually, reports are the most important basis for determining the situation picture. These reports must fulfill conditions such as being valid, including the time when the event or cause was identified, being factual and unambiguous and being marked and treated according to their urgency. In all reports, it must be made clear whether the content of the report is based on own perceptions, on the testimony of third parties or based on the assumptions of the reporting person. In order for all those involved in the *Führungskreislauf* and the emergency forces concerned to be able to lead and act optimally at all times, a constant exchange of information is required. Therefore, the flow of information in the hierarchy of

command levels must not only be one-way from the bottom to the top. The leader(s) must therefore also inform the units appropriately about the situation.

Planung mit Beurteilung der Lage & Entschluss / Planning with assessment of the situation & decision

Planning is the systematic evaluation of information and facts and the resulting definition of measures and contains the assessment of the situation and the decision.

Assessment of the situation is the consideration of how the hazard prevention or damage elimination mission can best be carried out with the available forces and resources under the influences of location, time, and weather. This assessment must be based on a targeted evaluation of the information from the situation status. The information must be evaluated and possibilities of fulfilling the task and acting in accordance with the situation must be sought. By weighing up the advantages and disadvantages of the various possibilities, the decision to carry out hazard prevention or damage repair must be prepared.

The decision is on how to carry out the operation. It is the logical result of the assessment of the situation. The decision reflects the operational planning.

Befehlsgebung / Commanding

Commanding is the instruction to the emergency forces to carry out measures to avert danger and limit damage. The commanding puts the decision into action. The leader(s) usually give(s) the orders in writing or orally according to a given scheme. The scheme to be used is unit, order, means, target, and route and must contain at least one unit and one order. In addition, each leader is obliged to report regularly to the respective higher level of command. In doing so, the reporting scheme *MELDEN* must be followed:

- Meldender/Reporting party
- Einsatzort/Place of deployment
- Lageschilderung/Description of the situation
- Durchgeführte Maßnahmen/Measures carried out
- Eingesetzte Einheiten/Units deployed
- Nachforderung/Additional request

Kontrolle/erneute Lagefestellung / Control/new situation status

The *Führungskreislauf* is a dynamic process of decision-making and action and demands quick acting. Often decisions must be taken, and orders given immediately, without the reconnaissance and assessment of the situation having been fully completed. These decisions and orders must then be immediately followed by a more detailed reconnaissance, which may lead to renewed planning and

issuing of orders. Hence, the leader can usually not fulfil the mission with a single run through of the *Führungskreislauf*. Only by repeatedly assessing the situation can the necessary control over the execution and correctness of the given orders be ensured and, if necessary, renewed planning and giving of orders be triggered. Therefore, after giving the commanding the *Führungskreislauf* must be continued with a control/new situation status. In addition to the general determination of changes in the situation that have occurred and the completion of the situation picture, this serves above all to check the effect of the orders given so far. The control compares the achieved change of situation and the success of the operation with the given order in a target-actual comparison. It is a permanent task within the framework of the situation status.

4.2.4 Comparison between BOB, IBOBBO and Führungskreislauf

In this paragraph the three models, BOB, IBOBBO and Führungskreislauf, will be compared to each other starting with similarities. The three models have a lot of similarities. Every model starts with gathering/collecting information. All the models assess the information which was collected in the first (respectively second for IBOBBO) phase. The third phase of BOB and Führungskreislauf and the fourth phase of IBOBBO also show many similarities. This phase focuses on decision making and acting.

The main differences between the models lies in the fact that both IBOBBO and the Führungskreislauf explicitly state that it is a continuous cycle that is repeatedly run through, whereas this is not explicitly mentioned in the BOB model. However, the BOB model is also cyclical because during a crisis meetings happen regularly, and the BOB-model is repeated. A second difference is that IBOBBO and the Führungskreislauf include a few more steps in their model. Firstly, IBOBBO's first phase is about gathering information which is exchanged in the second phase. Also, in the Führungskreislauf information is exchanged between all actors involved in the process. This is not the case within the BOB model, although this is, of course, necessary for it to be exchanged in the first phase of this models. Even though the BOB model does not mention gathering information, this is done, and this information can be imported and exported to and from the LCMS-tool. Interestingly, no model explicitly includes information exchange across borders. However, in practice EMRIC has tools and liaisons to share information across borders. Soon, Paragon will be used as gather and sharing tool. Also, IBOBBO and Führungskreislauf add two phases after the decision has been made. The BOB model stops after the group has come to a decision. Of course, this decision will be put into action, but this is not part of the model itself.

Summarizing, these models show more similarities than differences. Thus, cooperation of actors from the different models in a cross-border context can be built based on a common approach considering theoretical model in a risk situation.

4.2.5 Theory behind the models

The scientific theory underlying the three models belongs to the field of research focusing on the development of groups. The different models for group development can be divided into two categories, sequential and nonsequential models. This group of models mainly focuses on describing the actual sequence of behaviors exhibited by groups over time. Sequential models are usually divided into two types: progressive and cyclical (Chidambaram and Bostrom 1996, 162).

Nonsequential models differ from sequential models because they do not have a predetermined sequence of events. These models explain the underlying factors that cause shifts in group development. Similar to sequential models, there are two types of nonsequential model: time based, and structure based (Chidambaram and Bostrom 1996, 172.). (See Figure 8 for a more detailed overview of the types of models.)

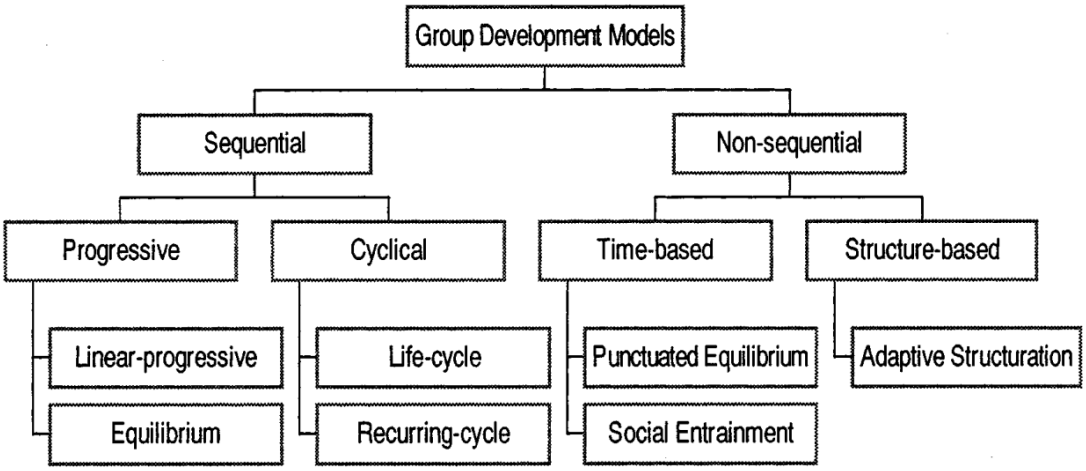

Figure 8: classification of group development models (Source: Chidambaram and Bostrom 1996, 161)

The model on which BOB, IBOBBO and Führungskreislauf are based, is part of the sequential models and is called the equilibrium model. This model is around 70 years old and was developed by Bales (Bales and Strodbeck 1951). This model describes the balance between the expressive (socioemotional) and instrumental (tasks related) needs of the group during different phases (Chidambaram and Bostrom 1996, 161; Mennecke et al. 1992, 527). If a group puts effort in one, this effort cannot be put into the other one. A mature group reaches an equilibrium between these two. These three phases are the following: firstly, there is the orientation phase. This phase has an exploratory nature. It is mainly used to exchange information between the different members. The second phase is called the evaluation phase. During this phase opinions on the situation are exchanged between the members of the group. Thirdly and finally, the control phase concludes the equilibrium model. This final phase is about exerting pressure and guiding action. If we compare these three phases to the three models, BOB, IBOBBO and

Führungskreislauf, we can easily see that the equilibrium model is used to construct these models. In all the models the first stage is collecting and exchanging information to make sure that the group knows what the situation is which will be discussed. This aligns with the orientation phase of the equilibrium model. The second stages of the models are about discussing and assessing the situation based on the information which was gathered and exchanged in the previous stage. This is very much like the evaluation phase. And finally, the final stages of the BOB, IBOBBO and Führungskreislauf models are about deciding which actions must be taken. This is like the control phase which also deals with acting.

So, if BOB, IBOBBO and Führungskreislauf are based on the same theoretical model, how is it possible that the outcomes (the decisions which were made) differ, like during the flood crisis in 2021? A possible answer to this question can be found in Figure 8. This figure shows a variety of different models. Several researchers have found that it is not necessarily the case that these models are exclusive. Some may complement each other (Chang et al. 2003; Chidambaram and Bostrom 1996). The sequential models describe the ways groups develop whereas nonsequential models aim to find the causes of this development. Especially relevant for risk assessment, may be the Punctuated Equilibrium model. This model takes time as a factor into account. Contrary to other models, this model suggests that groups alternate between stable periods of activity and extreme changes in behavior (Chidambaram and Bostrom 1996, 172). This model states that the group process undergoes two phases. During the first phase, a group sets a certain direction in which the different activities are to be performed. At the midpoint the group realizes that it must deal with time constraints. This causes the group to alter its original direction. New plans are or a new approach is made to perform the task at hand (Gersick 1988, 16). The fact that the realization of time pressure has influence on people's behavior when working in a group can be very meaningful for crisis management. When a group comes together to assess the risks of a certain situation, time is often limited. This may influence the way the group behaves. This can also mean that, although the group should develop according to a certain model (in this case three models which are based on the equilibrium model), it may develop in a different way, depending on the factor time. Thus, a possible explanation of why the three countries, working with models based on the same theory, reached different outcomes, is that time pressure caused different types of behavior within the groups.

Of course, apart from time pressure other possible factors which could influence the risk assessment process could be considered such as cultural, legal, and political factors. These differences can result in different plans being made and different priorities being set regarding risk assessment. The political structure is slightly differently organized in each of the three countries, and as a result, the influence of politics is different in Belgium, NWR, and the Netherlands. Each country for example deals differently with openness and transparency. In addition, in each of the three countries under study disaster

management and the corresponding risk assessment systems are structured and organized differently. Different levels are identified in each of the three countries in terms of structure. In the Netherlands, it is the simplest: the structure consists of the national government and so-called Veiligheidsregio's. In NRW, the structure consists of municipalities, Kreisen, Bezirke, national government. In Belgium, the structure consists of municipalities, provinces, and the national government. The number of levels as well as the responsibility and power per level differs per country. It can be for example the case that in Belgium, the federal government is responsible for the decision-making, whereas in the Netherlands the chairman of the Veiligheidsregio is responsible for the decision-making. This example shows the complexity of creating a joint risk assessment system, as each country represents a different institutional system. Another possible reason of the difference between the outcomes is that the available information between the countries differs. This influences the first step of every model, the orientation phase.

5 Discussion

In this report, we aimed at developing a thorough understanding of how risk is assessed in disasters, what the role of risk assessment is in relation to its overall disaster management system and to collect different perspectives on future improvements of the current handling/procedures of risk assessment to be able to work towards a joint risk assessment system for the EMR region. Therefore, the following three research questions were investigated in this study/research:

- How is risk assessment in emergency situations currently performed in the country/Bundesland concerned?
- What is the role of risk assessment in the overall framework of the country's/Bundesland's disaster management system?
- How desirable and feasible is a common cross border risk assessment system for making a common risk assessment?

Below we will aim to provide an answer to the three questions as identified above.

Risk assessment in emergency situations

This study has shown that different types of risk assessment systems are used in all three countries. In the Netherlands, the BOB model is used, in Belgium the IBOBBO model, and in NRW the Führungskreislauf. We found that these models are very similar to each other, and the differences were insignificant. We also found that the models are based on the same theoretical model, the equilibrium model. However, the outcomes, i.e., the decisions which were made in each country, were not the same. A possible explanation for this is the fact that the equilibrium model does not take certain factors into account, such as time or cultural, legal, and political aspects. To make sure that the crisis teams in the Netherlands, NRW, and Belgium are on the same wavelength it may be useful to add other factors, like time, into the model, for example by creating a model based on the punctual equilibrium model which does consider time as an important factor. Furthermore, other factors like culture, politics and availability of information should also be considered. Thus, it is important to acknowledge the fact that the three countries use comparable models, but because of other factors the outcomes may not always correspond.

Disaster management models are often developed at a national scale, after which they are implemented regionally and locally. In line with national disaster management, countries should develop national risk assessments to create a common understanding of the faced risks and the relative priority set by the national government. Though European guidelines exist on how to develop this national risk assessment, these models are still highly influenced by the national politics, culture, and socio-economic

characteristics of a specific country. Each country sets different priorities and makes different decisions regarding the development and implementation of disaster management and risk assessment models being used. As a result, each of the countries under study does not use a slightly different model, but each country also presents a different organization and structure of risk assessment (e.g., who has the power to make decisions). Therefore, the risk assessment models are assumed to result in different choices being made at the time of crisis. Even though they are based on the same theoretical model they cannot be isolated from the institutional climate they are used in. Also, during a crisis some countries may experience more time pressure than others which also can influence the outcomes. Furthermore, the availability of information also influences the choice made during the risk assessment process.

Role of risk assessment in partner's disaster management system

As Table 2 discussed, risk assessment models can be used at three different levels: operational, tactical, and strategical level. The BOB model of the Netherlands is used at the operational, tactical, and strategic level. The model is used at all levels in different ways. At the operational level it is for example used by the firefighters to analyze what the risk of the specific location is and how to deal with it, while in, for example, crisis management teams, it is also used as a method for discussion or scenario analysis. In NRW, the Führungskreislauf is used at the operational level mostly. It is used by the on-site command and control units when incidents happen by for example the firefighters, comparable to the Dutch context, by the fire brigade personnel and its managers in the NRW area. At the tactical and strategical level, it depends which model is being used for risk assessment, depending on how the staff is trained and what standards are being used in the specific area. NRW does risk assessment and disaster management at the Kreise region level. With no general national disaster management system in place so far, it turned out to be very difficult to have an overview of the overall situation in NRW. In Belgium, the IBOBBO-model is used at the strategic, operational, and tactical level. The model is being used at the tactical level by local emergency planning coordinators. In addition, all employees from municipalities working on disaster management are using the IBOBBO model. The three countries are thus comparable at least to a certain extent, though each country uses different names and has its own institutional climate.

Euregional risk assessment system

Based on our analysis, a common Euregional risk assessment system is desirable, but not yet feasible. Regarding desirability, the intention to cooperate is present both in practice and academic literature. In the disaster management literature for example, cross-border cooperation is identified as important because in border areas it can be the case that first responders from a different country can respond more quickly than responders from the country itself. Based on several interviews done with disaster

management experts from the flooding in 2021, we conclude that also from an expert point of view, it is desirable to create a common risk assessment system. It was mentioned that such a system can result in more standardization, equal access of information, better understanding of each other's system, etc. These types of factors can increase the efficiency of the risk assessment.

Regarding the feasibility, we identify several issues that currently make it difficult to implement a common Euregional risk assessment system. National leaders need to move away from nation perspective into embracing multidisciplinary and cross border cooperation (Goniewicz et al., 2020). As such, it requires a shift of mindset at different governmental levels to be able to both develop and implement a common risk assessment successfully. Several steps need to be taken, before a common risk assessment can be implemented. Despite both academia and practice shows the desirability of a common risk assessment system, all countries have different interpretations of for example structure, or political, legal, or economic aspects. Below we will share the main issues as identified:

Differences in culture, politics, and socio-economic contexts

Disaster management is mainly influenced by the national government's policy, which is shaped by its cultural, political, and socio-economic contexts. As a result, NRW, Belgium, and the Netherlands are inherently differently structured and governed. They for example are differently organized (e.g., federal vs regional responsibility for disaster management), have different cultures (for example regarding hierarchy and dealing with failures), and have different political backgrounds. Regarding for example the differences in legislation, In NRW, the Bundesland is dominant in determining the legislation, which is then implemented at lower levels such as the Kreise. In the Netherlands, the federal government is leading in legislation development, and the Veiligheidsregio Zuid-Limburg should implement it. In Belgium, the federal government designs the legislation, which is then applied at the level of provinces and the municipalities. The differences in crisis structures lead to differences in competences between EMRIC partners. Differences in culture, politics as well as laws and regulations can lead to different decisions being made during crisis.

These differences can result in challenges during disaster management. During the flood crisis for example, some information in NRW and the Netherlands was deliberately withheld, possibly because of the fear for failures and the fear of being held accountable for these failures. This might also be the result of a lack of transparency. As a result, not everyone has the same access to information, either consciously withheld information for others or because of differences in interpretations. The reasons of this lack of transparency could be cultural but also political (a fear of political consequences for possible mistakes). In short, cultural, political, and socio-economic factors may influence the way people act during a crisis but also how a government has structured its disaster management. Since the Netherlands,

Belgium, and NRW each have their own cultural, political, and socio-economic contexts, their ways of dealing with crises and their reactions during a crisis also differ. Since some of these factors, like culture, cannot easily be changed, it is important to acknowledge this so that this can be considered during a crisis. So, you may use the same theoretical model for risk assessment but differences in outcome are still possible and sometimes even unavoidable due to several factors. As it is difficult to change the institutional environments of each of the countries under study, it is important to create awareness of each of other's political, cultural, and legal structures to enable a joint understanding and respect for each other's systems.

Lack of knowledge on agreements and educational programs

Not only cultural, political, and socio-economic factors may cause differences between countries and make cooperation more difficult, but also a lack of knowledge on certain agreements or educational programs relevant for cross-border cooperation may hinder a correct Euregional risk assessment. The flood crisis showed that several interviewees did not know who they needed to contact nor how the system of their neighboring countries worked. This may partly be related to the lack of knowledge of existing agreements, intentions, and educational programs. Several educational programs exist that for example provide information on the disaster management systems of other countries, but either the practitioners did not know about their existence, or they forgot its contents. As disasters do not happen that often, it can be difficult to make sure that all staff members involved in disaster management are properly educated. Still, it also seems that agreements are not sufficiently implemented within the individual countries.

Last, the lack of knowledge about the cross-border situation might be caused by the fact that during a crisis such as the flood crisis, individual countries were fully focused on the management of the disaster within their own country. Disasters do not happen that often, and as a result, the focus is mostly on providing a reactive rather than proactive approach. Disasters do not happen that often, but cross-border disasters are even less frequent. As a result, they are even more difficult to understand for most of the involved stakeholders during a crisis. Only when a disaster happens, governments of different levels often will consider how to deal with disaster management and risk assessment. Still, this is no excuse, and it is important that each country enables proper risk assessment and disaster management implementation at the national, regional, and local scale. Thus, a lack of knowledge on agreements and on educational programs combined with the fact that during a crisis almost everyone is preoccupied with solving the issues in their own countries creates a situation in which communication between the countries is suboptimal, people do not know who to contact or where to get certain information. This could severely hinder the risk assessment process because the people involved in the risk assessment process may not have a clear picture on the situation over the border.

Information- and data management

Whereas the previous identified issue focused on knowledge about each other's risk assessment models and who to contact (strategical/tactical level), also problems regarding information- and data management were identified at the operational level. According to the disaster management literature, it is important that stakeholders have access to valid and accurate information (Neville et al., 2016). When specifically looking at the flood crisis in 2021, information exchange between the countries turned out to be extremely difficult, as the telecommunication structures stopped working during the flood. In addition, several measurement points were not working, which resulted in difficulties with the information exchange. There is national system in the Netherlands (LCMS) and Belgium (ICMS). The Dutch system can be accessed by Belgians and Germans, and the Belgian system by Germans and Dutchmen. Still, this is not happening often in practice. The EMRIC liaisons were also not always able to reach each other. This probably is the result of a lack of implementation of joint agreements.

However, at the time of writing preparations are being made for such an international system, called Paragon. Even though this will not solve every problem with respect to information management, it may help to ensure that every country has access to the same information which in turn may aid the risk assessment process. More information on Paragon can be found in the recommendation section.

Standardization and mutual understanding

In all three countries, both the responsibility of the development and implementation of disaster plans is differently organized. Disaster plans are developed at different levels and by different organizations, such as the municipality, province, large companies, and high-risk companies. In the Netherlands for example, the safety regions organize the development of disaster plans as well as its implementation. When disaster management experts develop plans and scenarios for disaster management, often the past is used as an inspiration, but the question remains; what can we learn from the limited knowledge of specific disasters? Often, we do not know how disasters will develop nor when they will arise, and therefore knowledge is often limited. It is therefore key to stimulate shared learning to create an understanding of how each country assesses risk. Table 2 showed that differences are present in how risk is assessed, though the differences are mostly based on the specific institutional climate (e.g., the names of the organizations involved and the level of responsibility). The differences cannot simply be overcome by changing each institutional climate. Still, by creating a mutual understanding of how each system is structured and organized, it might become possible to at least understand who to contact at which level and at what type of incident.

The importance of standardization and sharing of mutual knowledge was also confirmed by the literature review, which found that proper knowledge of how the different actors operate can contribute to

effective cooperation when a disaster happens, with most effective actions being focused on joint prevention initiatives. The literature review suggests that the sharing of mutual knowledge and standardization starts through training and exercise. The literature view discussed that the high context-specificity of disasters makes it difficult to standardize risk assessment as well as input variables needed. Whereas the literature review made this comment specifically on risk assessment in general, it also holds for a cross-border context. Each country is differently organized and structured, but also has its unique geographical and functional characteristics. This is seen in the example that in the case of the flood crisis decisions were being made on different levels in each country. This meant that it was difficult for people to exchange information and have meeting with each other because for example in Belgium risks were assessed and decision were made on a federal level whereas in the Netherlands the safety regions made the decisions. It can therefore be difficult to harmonize and standardize risk assessment models that can be used not only for specific disasters and geographical areas, but also for different institutional environments. More research is needed on how risk assessment is done in other cross-border areas to learn from their challenges and opportunities.

6 Recommendations

A part of the retrieved results provides suggestions for the risk assessment of future disasters. These suggestions and the insights from our research form the basis for the following managerial implications specifically for the Veiligheidsregio Zuid-Limburg and the national, regional, and local governments. To increase the feasibility of a common risk assessment system, we will below present several recommendations that need to be considered before considering a joint risk assessment system.

1. **Knowledge exchange and education through standardization**

   The academic literature showed us the importance of education for joint risk assessments. Each country has its own institutional environment and will therefore handle disaster differently than other countries. As it is difficult to change the institutional environments of each of the countries under study, it is important to create awareness of each of other's political, cultural, and legal structures to enable a joint understanding and respect for each other's systems. It is important that each of the countries invests resources to create a better understanding of each other's systems at the operational, tactical, and strategic level. To do so, knowledge exchange both top-down and bottom-up is highly important. At the tactical and strategical a top-down approach can support the establishment of priorities, while a combination with a bottom-up approach will translate these priorities to the specific regional and local circumstances as well as setting priorities from a cross-border perspective. Knowledge about each other also includes knowledge on political, cultural, and socio-economic differences between countries. These factors may influence the way risks are assessed.

   One way to create a better common understanding, is the development of educational programs. Training programs must be developed to educate the people involved in disaster management, to 1) create a common understanding of the disaster management systems of each country, and 2) create more specific knowledge about for example risk assessment systems used, escalation structures, responsibilities, people to contact, etc. To a certain extent, these educational programs already exist. In NRW for example, an educational program exists that educates firefighters about different perspectives and organizations in the different Euregion countries. It is important to continue the development of these type of educational programs. On the other hand, the lack of knowledge of these educational programs with most practitioners, also invites for a more thorough implementation of educational programs in agreements. It is important that the knowledge of the existence of these educational programs is widespread across the organizations dealing with disaster management as well as it is embedded in the organization who needs to follow these courses and why.

To summarize, knowledge exchange is highly important for joint risk assessment to be feasible, though a common understanding and education is important to create the much-needed exchange. Several conditions need to be fulfilled for creating efficient knowledge exchange: 1) be willing to talk to each other, 2) contact each other through liaisons, 3) coordinate about communication with the public, and 4) coordinate decisions and measures for comparable risk assessment.

2. Information- and data management

Whereas it is important to develop a better understanding of each other's system at the tactical and strategic level, it is also important that the three countries collaborate well at the operational level. In this, it is important to enable transparent and standardized information- and data exchange. In this way, the risk assessment models can be improved by for example using aggregated data.

When considering the development of (improved) risk assessment models, it is important to consider:

- Multi-hazard risk assessment that integrates multiple risks and the relations between them to predict how risks influence each other as well as vulnerability, hazard, and exposure rather than one or two of them, as elements of each type of risk.
- Integration of quantitively and qualitatively risk assessment models to combine the strengths of both approaches and develop models that can aggregate different types of data, variables, or risks into proper risk assessment in specific situations.
- Standardize risk assessment for different types of disasters to be able to harmonize and standardize the choices being made as well as the input variables being used. By developing models for different types of disasters, it can become easier to develop realistic risk scenarios, providing at least some generalization, to be able to better compare what for example a flooding will do to several countries and decide (preparedness) on how already in advance prepare for the potential disasters that might happen.
- Collecting relevant, appropriate, and up-to-date information and input from each of the three countries and share them with each other to make a risk assessment on data available from each of the countries.
- Include the factor time in the model: time pressure may influence the way actions in the risk assessment process are performed. This means that it may also influence the way data is processed and an eventual decision is made.

- By standardizing at which point during a crisis risk assessment shift to a different level it would help creating more congruent risk assessments: if risk assessments are made on different levels in country x than in country y this is bound to lead to different outcomes. Also, by having the same levels better communication and information exchange are possible. People on each level often have had contact with each other prior to a crisis and are familiar with each other. This eases communication.

Several initiatives exist, such as for example in Belgium an expertise group, called CELEX, initiated in 2021, who develop lessons learned from the floodings in 2021. This cell unites various regional and federal services and aims at investigating in a multidisciplinary way the forecasts and the expected impact of the behavior of the water, develop scenarios and prediction models and to prepare a synthetic report. The expert group will be called together in the anticipation of possible floods and during the flood period. This will be done when the vigilance levels for escalation reach an orange or red level, automatically when a flood alarm messages in specific water basins are reached or at the request of an authority with mandate to do so.

Belgium is also developing a European disaster management system (Paragon), ahead of the other countries. Paragon is a disaster management system that aims at providing a digital tool that connects its user to a diversity of information as well as information on specific risk objects. In this tool, the user can share their observations and decisions.

It is important to map the initiatives already in place and investigate how these initiatives can be supported and facilitated in what they do. In addition, an analysis is needed on what topics need to be further investigated and how initiatives concerning these topics can be initiated. This might be done by for example providing community of practice or pilot projects.

3. **Pro-active attitude towards risk assessment and disaster management**

When the flood crisis happened in 2021, all three countries were not optimally prepared. The countries tend to behave reactive rather than proactive, and we therefore invite each country to investigate how they can take a more proactive approach, and for example update their national, regional, and local disaster management plans based on the latest developments. EMRIC takes a role in this by developing joint plans on how to for example deal with climate change. NRW has for example developed a 15-point work plan/framework with recommendations how the North Rhine-Westphalia region can be better prepared for disasters in the future. When the three countries work together, they are better able to invest in research and development of disaster

management and risk assessment models that are better able to deal with the potential disasters that can be faced in the future. Especially in the light of climate change, it is important to investigate which disasters might struck us in the future and how to efficiently deal with the potential risks of each of them. As disasters do not stop at borders, especially in border regions such as the Euregion, it is important to bundle strengths and to jointly investigate how can be collaborated, hereby considering the inherent differences between the institutional climates.

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