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When, at what speed, and how? Resilient transformation of the Vesdre river basin (Belgium) following the 2021 floods

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Abstract

Background Dual crises happen when an acute shock unfolds in the context of a creeping crisis. The July 2021 floods in the Vesdre river basin (Wallonia, Belgium) is a typical case of such dual crises in the context of climate change. This study is based on 16 semi-structured interviews (conducted in Spring 2023) with 10 mayors, 4 representatives of the Public Service of Wallonia, 1 person working for the federal government, and 4 project managers, coupled with a document analysis ($n = 13$). It investigates the temporal strategies that connect short and long-term considerations in the aftermath of this disaster (timing, futuring, pacing, cyclical adaptation, and determining time horizons), at two different governmental levels: river basin and municipal level.

Results In general, the window of opportunity to improve disaster resilience has been seized. Several studies were initiated by the Walloon region that shape the idea of an ideal future for the river basin and give recommendations for how to reach it. Unfortunately, those recommendations still come late compared to the temporal reality of the reconstruction process. Municipalities wish to strengthen disaster resilience as soon as possible, but they have to prioritize certain actions over others because of limited resources. The recommendations are considered flexible enough to adapt strategies to future contexts, but no monitoring and evaluation system for doing so has been implemented so far. In addition, clear policy agendas with transformational goals are scarce, and they diverge between the river basin and the municipalities. All these temporal strategies are shaped by elements of the institutional policy arrangement: resources, which affect them all, as well as actors, power, and formal rules, which affect some. These policy dimensions notably slow down the implementation of disaster resilience strategies and limit the determination of consensual time horizons.

Conclusions The temporal strategies are passively shaped by the policy arrangement dimensions to a greater extent than actively chosen by the stakeholders. A structural transformation of the institutional policy arrangement is therefore needed to enable more coherent temporal strategies between different governance levels and to facilitate the consideration of long-term resilience during the recovery process from disasters.

Keywords Disaster resilience, Long-term governance, Dual crisis, Floods, Belgium Wallonia Vesdre river basin, Policy arrangement approach, Temporal strategies

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Introduction

Policy makers are pressured to implement climate change adaptation strategies due to the increasing frequency and intensity of extreme weather events in the present. In July 2021, several European countries faced catastrophic floods caused by a period of enduring and intense rainfall. This event can be seen as a dual crisis, when acute shocks (such as floods) and other more long-term crises occur simultaneously [1], since it was at least partially caused by climate change [2–4] which is an underlying creeping crisis [5]. Yet, climate change adaptation practices often focus on the known risks threatening to unfold in the near term, without enough consideration of how those risks will evolve over time [6], despite climate change increasing the intensity and frequency of flood hazards [7], and being expected to affect similar disasters as the July 2021 events [8, 9].

This double temporality of dual crises constitutes a governance challenge since societies have to respond to the acute disaster and the emergency needs of victims and think about how to reduce the long-term creeping problems at the same time. Governments can however develop strategies to deal with this temporal duality [1], and short-term acute shocks can be turned into windows of opportunity to transform society over the long term because they trigger change [10]. For instance, floods can provoke policy changes [11], and in particular the reconstruction process can be used to strengthen disaster resilience in response to extreme events [12] through building back better [13].

Disaster resilience encompasses several dimensions (preventive, anticipative, absorptive, adaptive, and transformative) that relate to the different phases of disaster risk management (preparedness, response, recovery, prevention, and mitigation) [14]. Our paper focuses mostly on the transformative capacity, which is the “transformation through learning, self-organization, and exploration of new pathways along with flexibility and substantial modifications to existing structure” [14, p.4217], and the preventive capacity, which is the “ability of systems to adopt sustainable pathways and reduce vulnerability, presence, or impact of hazards” [14, p.4217], during the mitigation and prevention phase that takes place in the long-term post-event. Strengthening resilience has been called for after the 2021 floods [15]. A few studies investigate the links between these events and resilience, all of them focusing on the German case [12, 14, 16, 17]. In particular, Birkmann et al. [12] note that one of the main challenges to strengthening disaster resilience in reconstruction is the divergence between rapid recovery versus long-term planning.

Both building disaster resilience and managing dual crises require various spatial scales to work toward

shared goals. Disaster resilience must be implemented at various governance levels: from the international level (e.g. the European Union has created its own disaster resilience goals, see European Commission [18]) because the purpose is to face shared challenges (such as societal disasters), to the local level because improving resilience is context-dependent and local stakeholders hold a primary role in disaster response and recovery [19]. Indeed, mayors and municipalities are at the forefront when an acute shock like a flood occurs [20], but higher levels of governance such as the regional and national governments also have a say in the transformation of the territory, which can create tensions between the different layers of governance.

According to Birkmann et al. [12], the links between reconstruction and resilience-building are scarcely studied. Given the need to think forward after a disaster to increase resilience, our study contributes to this field of research by focusing on the use of temporal strategies that combine the short and the long term in the management of dual crises. Temporal strategies are a first step towards strengthening disaster resilience since they facilitate the consideration of long-term impacts, promote adaptation to new contexts over time, and reflect the intention and active involvement of stakeholders to improve disaster resilience. We therefore investigate the following overarching question: how are temporal strategies considered and shaped at different levels of governance to promote long-term resilience in the aftermath of a disaster?

The investigation focuses on the Vesdre river basin (Belgium) after the flood events of July 2021, and is further presented in the case background section. Three sub-research questions focusing on this case and based on the theories developed in the analytical framework section structure the study:

- RQ1. What are the main temporal strategies at the river basin level to strengthen resilience in the aftermath of the July 2021 floods?
- RQ2. What are the main temporal strategies at the municipal level to strengthen resilience in the aftermath of the July 2021 floods?
- RQ3. How does the institutional policy arrangement shape temporal strategies after the July 2021 floods in the Vesdre river basin?

The first two sub-research questions focus on identifying and describing the temporal strategies at two different levels (the Vesdre river basin level and the municipal level), while the third one analyses the role of the institutional policy arrangement in shaping those temporal strategies.

“Analytical framework” Sect. introduces the analytical framework for the study, and “Case background” Sect. presents the case study. “Methods” Sect. provides details on the methodology. “Results” Sect. presents the results, followed by a discussion in “Discussion” Sect. about the findings. “Conclusion” Sect. concludes.

Analytical framework

The following section presents both the temporal strategies for dealing with dual crises such as climate change-related floods and the policy arrangement approach to analyze the policy context that explains the adoption and use of those temporal strategies.

Temporal strategies for dual crises

To support our analysis, we use the time-sensitive governance framework for governing dual crises developed by Pot, Scherpenisse and ‘t Hart [1], who argue that navigating dual crises is challenging and requires temporal strategies that are embedded in anticipatory and adaptation governance. Temporal strategies are used by governmental actors and reflect how they strategically use time during policy development and implementation. They are especially valuable to bridge the short and long term, for instance to connect short-term policy cycles and pressing issues (such as acute shocks) with long-term policy problems and objectives (for example related to climate change).

The first temporal strategy is that of *timing*: purposefully choosing and crafting moments or seizing opportunities to act and influence crucial moments for policy change. Crisis, such as floods, can help open such windows of opportunity for policy change. Other important windows of opportunity are a change of government after elections, and also the more ‘planned’ and foreseen moments of long-term investments in for example water infrastructure that can be utilized [21, 22]. Timing can involve making an explicit connection between an acute shock (such as a flood) and the underlying issue of climate change.

Second, the strategy of determining *time horizons*: setting deadlines, formulating objectives, and scoping how far one will look into the future to anticipate future events. Time horizons differ per actor and policy domain [23, 24]. They capture how actors shape and experience the past, present, and future, as well as the relationships drawn between them. But time horizons are sometimes also made explicit: they are for example part of long-term visions, long-term objectives, future scenarios, spatial plans, or investment plans. Time horizons can be narrowed or expanded [25]. While narrowing the time horizon leads to a shorter time frame, often emphasizing immediate actions and short-term outcomes and

benefits, expanding time horizons can also expand the solution space and the possibilities of the future [26].

Third, *pacing* as a strategy determines the speed of the implementation of the mitigation and adaptation strategies. Pacing involves carefully controlling the speed and sequencing of actions, decisions, and interventions to achieve desired outcomes. By strategically playing with pacing, policy actors can modulate the rhythm of decisions and implemented measures, ensuring appropriate timing for effective implementation and adaptation. Pacing relates to using time pressure and purposefully accelerating or slowing down processes. ‘Benchmarking’ of time compared to others can be important here (how fast or slow are ‘we’ going, are we lagging or leading the way forward?), as this may give extra pressure to actually do something [27].

Fourth, *futuring*: the use of images of the future that help us imagine and anticipate possible future worlds [28]. Futuring enables policymakers and experts to develop robust and adaptive solutions for dealing with both acute and creeping crises. In disaster risk management, one aspect of futuring is to identify transfers of risks, that is, how flood risk management for instance can increase other types of risks in the future [29]. Futuring can be done in several ways, such as using scenarios as part of integrated assessment models as the IPCC provides [7], scenario planning [30], and visioning approaches [31].

Fifth, applying *cyclical adaptation*: embedding a plan for flexibility supported by monitoring and evaluation. Cyclical adaptation is essential because there are many uncertainties about what the future will look like and what type of solutions and climate risk data will then be available [32]. Cyclical adaptation involves an adaptive plan that connects the present to possible futures via choices of adaptive strategies and identification of tipping points showing until which threshold a strategy may be robust [33]. Furthermore, cyclical adaptation requires an iterative and adaptive governance process in which adaptation strategies and decisions are evaluated on a structural and repeated basis, in which the implementation and effectiveness of strategies are monitored, and in which experiments with novel adaptation measures are possible [34].

Policy arrangement approach

The policy context helps to understand how strategies are shaped and used in practice because governance is influenced by many policy elements that can explain the choices of, in our case, the temporal strategies. To analyze this institutional context, we use the policy arrangement approach. According to Arts, van Tatenhove and Leroy [35], “a ‘policy arrangement’ refers

to the temporary stabilization of the organization and substance of a policy domain at a specific level of policy making” [35, p.54] and is “the concept that links long-term processes of political change with specific processes of policy making and implementation on the ground” [35, p.53]. It therefore enables linking day-to-day policy practices with broader structural changes in society [36]. Since the policy domain is described broadly as all the policy practices related to an issue [35], it fits, in our context, the strengthening of disaster resilience following the 2021 floods in the Vesdre river basin. Because this theoretical framework gives a snapshot of an arrangement at one specific moment in time, it also enables analysis of path dependency and changes in policy processes [36]. In theory, four interrelated elements are part of the policy arrangement: actors and coalitions, resources and power, rules of the game, and discourses.

Actors are often grouped in different coalitions that can support or oppose the dominant discourses and rules with different actual opportunities to influence or intervene in the policy domain [35]. To increase resilience after a disaster, various actors are involved, ranging from individuals to international institutions from both the private and the public sector [37]. *Resources* are divided between these actors which leads to differences in power and influence [36]. For building resilience, many types of resources are needed, such as financial resources, but also knowledge, human capabilities, and time. The *rules of the game* “define the possibilities and constraints for policy agents to act within [the policy] domain” [35, p.61]. The rules can be formal or informal, with formal rules established in legislative documents and informal rules being part of the political culture [35]. The rules can help or hinder resilience; for instance, local spatial planning rules affect climate-resilient development [38]. *Policy discourses* are “dominant interpretative schemes, ranging from formal policy concepts to popular story lines, by which meaning is given to a policy domain” [35, p.63]. They encompass several aspects, such as the norms, values, definitions of problems, and approaches to solutions of the actors involved [36]. Resilience is called for in guidelines for sustainable development [SDGs, 39], climate change adaptation [Paris Agreement, 40], and disaster risk management [Sendai Framework for Disaster Risk Reduction 2015–2030, 13], so it has become a dominant discourse.

We adapted the policy arrangement approach to our case context in three ways in order to sharpen our focus. First, we limited the analysis of the rules dimension to the formal rules that can boost or slow down the implementation of resilience-building strategies. Second, we inductively decided to group the power aspect together with actors rather than resources, since the analysis

shows that the power to act for increasing resilience is often related to the responsibilities given to each stakeholder in our case, acknowledging that those responsibilities are elaborated by rules and in practice the capacity of the responsible actors to act depends on the resources at their disposal. This illustrates that the four dimensions of the policy arrangement are interrelated and have been separated for analytical purposes only [35]. Third, since the actors, resources, and rules elements refer to the organization of the policy arrangement while the discourses are about the substance of it [35, 36], we focused our analysis on the organizational aspect, and included in it discourse elements related to the temporal strategies. Therefore, substance aspects have been directly incorporated in the results presenting the other dimensions of the policy arrangement rather than being presented in a separate section.

Case background

In July 2021, catastrophic floods took place in the Benelux, Germany, and other places in Europe. They were one of the most severe disasters from natural hazards in Europe within the last half century [9, 41], with many human casualties (more than 220) and grave economic consequences (estimated to a total loss of EUR 46 billion) [42].

In Belgium, 209 out of 262 Walloon municipalities were affected by the 2021 floods [43], resulting in 39 casualties [43], and damages to transport, telecommunication, healthcare and education infrastructures, electricity, gas and drinking water supply, wastewater and solid waste [44]. The Reconstruction Committee, an entity created by the Walloon government following the disaster in order to supervise the rebuilding process, estimated that 100 000 people were affected, 45 000 houses damaged, and 559 bridges impacted, among other consequences [45].

The Vesdre valley, situated in the Eastern part of Wallonia (Province de Liège), at the border with Germany, was particularly affected [46]. Even though this area has been hit by other floods in the past [47], the 2021 events have been particularly traumatizing as witnessed by the books of Baba [48] and Deprez and Lamarche [49]. Figure 1 presents the delimitations of the Vesdre river basin [50] and its 27 associated municipalities. These municipalities have various socio-economic characteristics and potentials [51], as well as different degrees of urbanization (Appendix 1). The bottom of the valley has a higher concentration of lower-income households compared to the plateaus because of the industrial history of the area [52]. The municipalities have been affected to a different extent by the floods in July 2021, and the Walloon government has classified them into three different groups

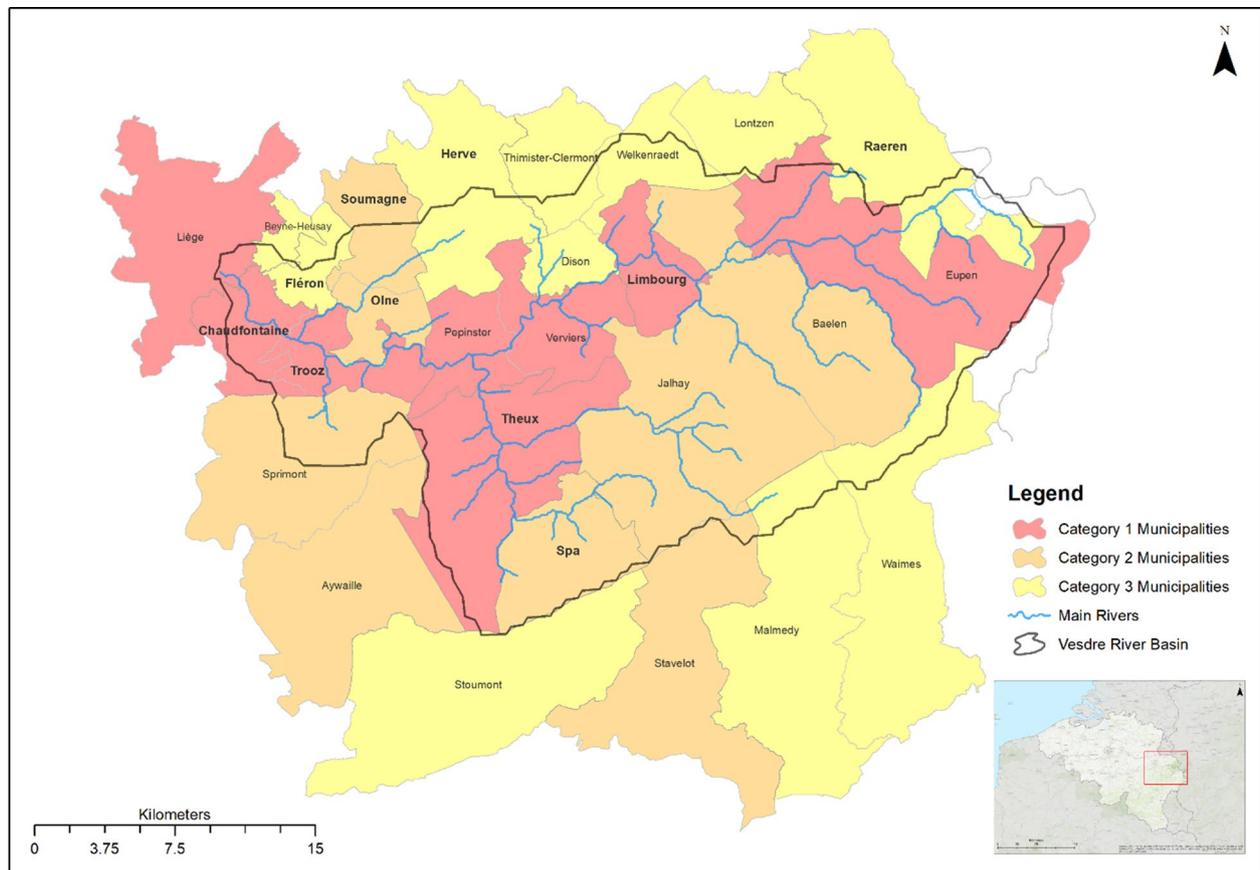


Fig. 1 The study area. In bold the name of the municipalities whose mayors were interviewed for the present study. Sources of data [Accessed December 2023]: Municipalities: Belgian federal geodata portal (geo.be); Rivers: European Environment Agency (eea.europa.eu); Watershed: HydroBASINS data (hydrosheds.org)

[53]: in category 1 are the most impacted municipalities (8 in the Vesdre river basin), in category 3 are the least affected (11 in the Vesdre river basin), and in category 2 are the ones in between (8 in the Vesdre river basin).

The management of floods in Belgium is complex and involves many different actors, which reflects the complex institutional settings in the country [54]: the federal, regional, provincial, and municipal authorities play a role in preventing and mitigating risks, in addition to private stakeholders (individuals and companies). Several groups of actors are involved in each of these categories. For instance, at least three Operational General Directories are taking part in water management (policy development and implementation) within the Walloon water system [54]. During a flood event, crisis centers are established at all levels of governance and collaborate with other actors such as meteorological services, military and state police, rescue services, civil protection, and so on. The municipal crisis cell holds a core role as it is the one deciding the actions of the emergency operation center [20]. In the case of the 2021 floods, a special committee

was missioned for a year by the Walloon government to overview the rebuilding process (the Reconstruction Committee). To this already complex situation have to be added the actors of climate adaptation and other relevant systems for building resilience, such as for instance forest management and spatial planning.

Spatial planning to manage water issues in the area is not new and the 2021 floods forced stakeholders to consider climate change in the future of the Vesdre basin spatial planning [55]. Following the July 2021 floods, the Walloon government has mandated several studies to enable the resilient rebuilding of the river basin [43]. These studies include a hydrological modeling study (still ongoing at the time of writing this article), the creation of two guidance documents to build in flood-prone areas and to manage rainwater, the Vesdre Master Plan (hereafter MP), and the Sustainable Neighborhoods (hereafter SN) programs. The SN programs consist of studies of specific locations in 9 municipalities that have been most affected by the floods, including 7 in the Vesdre valley (all the French-speaking ones categorized in the first

group). They were realized by two architect and urban planning consultancy firms and their results were made available in December 2022. The MP was being finalized when our interviews took place during the spring of 2023 and was published in May 2023, after the fieldwork of our study was completed. This work was preceded by an analysis of the territory concluding that the Vesdre river basin is highly heterogenous and that there is a potential to increase resilience based on the solidarity between the different areas [56]. The MP suggests a vision for the whole river basin territory, with scenarios that were discussed with local administrations and citizens. It also highlights specific territories with suggestions on how those could be transformed in order to become more resilient, considering climate change, and therefore both flood and drought risks.

The interplay of various spatial levels for managing a dual crisis is highly visible in this case. The mayors and municipal crisis committees were at the forefront to respond to the floods [57], and the recovery process was supported by resources from the federal and regional governments in the short and medium term [45], and resources from municipalities in the long term. After the crisis, the regional government called for strengthening resilience with the funding of studies to support such enterprise (as developed earlier), and the municipalities are in charge of implementing the recommendations that were developed by the studies.

Methods

This section introduces the case selection criteria and describes the data collection and analysis, as well as the limitations.

Case selection

The 2021 summer floods happened because of “complex interactions between meteorological, hydrological, and hydromorphodynamic processes and mechanisms” [41, p.531] that unfolded in overlapping spatio-temporal scales. As mentioned in the introduction, climate change was, at least partially, a trigger for the July 2021 floods [2, 3], and will affect future akin disasters [8, 9]. Therefore, the July 2021 events constitute a schoolbook example of a dual crisis, being a combination of an acute shock (flooding) and a creeping crisis (climate change). At the same time, land use, river management, and spatial planning have also been recognized as important factors explaining the disastrous consequences of these events [9, 58], and there is an official willingness to act on them in order to increase disaster resilience (see case background). The fact that this case involves both the characteristics of a dual crisis and a willingness to improve disaster resilience in the long run makes it ideal for our study, which

analyzes how the temporal aspects are considered by policy-makers in the aftermath of these floods.

In addition, other criteria justify the selection of this specific case: spatial, timing, and practical criteria. First, the theories used in our analytical framework were developed in a European context, and the case has therefore to match this context. Second, the 2021 floods happened recently enough so that it was possible to interview stakeholders who actually experienced and still have vivid memories of the floods and their management, and are still working in the same governmental role and were responsible for both immediate flood response and resilient recovery. At the same time, enough time has passed since the disaster so stakeholders could reflect on long-term implications. Third, accessibility was also a criterion: to be able to interview local stakeholders and access policy documents, the lead author needed to understand their primary language (French).

Data collection

The study is based on semi-structured interviews and document analysis. For RQ1, 6 interviews took place with representants of the Walloon government who had an active role during the response and recovery phases of the crisis management, with the project managers of the MP and the SN programs, and with an ex-researcher who has been studying the case and is now working with climate change adaptation in the federal government. In addition, 13 relevant documents about strengthening resilience after the 2021 floods were collected (see details in Appendix 2). For RQ2, all mayors of municipalities situated in the river basin were invited to participate in the study, and 10 responded positively (4 whose municipalities are listed in category 1 by the Walloon government, 3 in category 2, and 3 others in category 3) and were interviewed. For RQ3, all the aforementioned interviews and documents were used.

In total, 16 semi-structured interviews with 19 relevant stakeholders were conducted on-site in April and May 2023 (except one that had to be held online because of a last-minute setback), with the possibility of a walking interview to experience the field. The list is detailed in Appendix 3. The interview guide was adapted depending on the role of the interviewees, and fieldnotes were taken daily.

Data analysis

The data analysis followed a qualitative content analysis approach with a mix of deductive and inductive coding [59]. Based on the analytical framework, a first list of codes was deductively defined that included the five temporal strategies and the three elements of the policy arrangement approach included in our study. During

the coding process, subcodes were inductively added (Appendix 4). The interviews were first coded and analyzed, and then the fieldnotes served as a base to check that the overview of the findings fit with the understanding of the field at the time of the interviews. The documents were also analyzed with the final code list resulting from the analysis of the interviews.

The study was conducted in French and all quotes have been translated into English by the lead author.

Preliminary results were presented to the interview participants during two online sessions held by the lead author in November 2023, as a way to share results with the participants who took the time to answer our questions. No new insight emerged from these sessions.

Limitations

We identify two main methodological limitations. The first one concerns the selection of the mayors to be interviewed. All mayors of municipalities situated within the Vesdre river basin were invited to participate in the study, but not all were available. Therefore, the point of view of the mayors of some key urban areas (e.g. Verviers, Liège, Eupen) is not included. Yet, some urban perspectives are present with Chaudfontaine, one of the most urbanized municipalities in terms of number of inhabitants, and Fléron, in terms of inhabitants/km² (see Appendix 1). The second limitation is linked to the nature of the data set for the different research questions (see Appendix 2 and 3). The results presented for RQ2 are based on interviews with mayors only and do not include the analysis of documents such as municipal plans. Yet, the mayors have been interviewed as representatives of their municipal administration and as the main persons responsible for crisis and safety management, and they have the closest knowledge of the local policies, also those under development. The municipal plans and visions were discussed during the interviews in light of the MP and the SN programs.

Results

The results are presented per sub-research question. Because we are investigating temporal strategies that can strengthen long-term transformative and preventive resilience, we decided here to focus on spatial planning and climate adaptation more than preparedness and crisis management strategies, even if some interviewees pointed out that the resilient reconstruction of the Vesdre river basin is aimed at taking three aspects into consideration: urgency, rebuilding, and anticipation, which themselves require spatial planning, enhanced preparedness, and improved risk culture.

The first section presents the five temporal strategies at the river basin level, the second section presents the

strategies at the municipal level, and Table 1 summarizes the findings of both. The third section identifies the institutional elements of policy arrangement that affects the temporal strategies identified in the first two sections.

Temporal strategies at the river basin level to strengthen the resilience of the territory in the aftermath of the July 2021 floods

Timing

The 2021 floods have created a momentum to act to improve disaster resilience in the territory but this window of opportunity can close rapidly.

"If there hadn't been flooding, there wouldn't have been a Scheme [Master Plan]" (Interview MP2), so in that sense, this disaster is considered as an opportunity to improve resilience in the territory. The floods triggered a discussion about the changes needed in the territorial system and promoted the creation of new ways of approaching resilience. For instance, the concept of SN programs did not exist beforehand and was created as a means to rebuild the destroyed areas while including broader development and resilience elements into the process. The Walloon government had an ongoing discussion about the theoretical idea of resilience, and the 2021 floods created a momentum to work on concrete implications in terms of spatial planning. In addition, some organizational changes related to preparedness took place after the floods, such as modifications in the management of the crisis center. In general, the 2021 floods uncovered a lack of risk culture in the area and the need to build one, which is called for by the various policy recommendations made after the crisis.

However, there is a fear that the momentum created by the 2021 floods will fade away, so the interviewees and the policy documents call for keeping the memory alive in order to keep pushing the implementation of actions to increase resilience: *"It really was an impetus, a trigger for many good things, a very strong awareness, and therefore also this famous culture of risk which is a blind spot [...]. So it's in the collective memory, this event is going to stay, and in any case it has to, if it's not the case we have to maintain this collective memory too" (Interview E1)*.

Time horizons

Only one general time horizon, 2050, is mentioned to build resilience at the river basin level, but there is no established schedule for the implementation of the recommendations.

When the Walloon government mandated the MP for the Vesdre river basin, it aimed at establishing a vision for 2050. That goes in line with other related objectives of the region such as the zero net land take and reduction of CO₂ emissions by 2050, and the MP mentions that time

Table 1 Summary of the temporal strategies present at the river basin and the municipal levels, with the elements that are similar at the two spatial levels in bold and the elements that are contrasting between the two spatial levels in italics (the rest are elements that have no equivalent at the other spatial level)

At the river basin level (RQ1)	Temporal strategies	At the municipal level (RQ2)
<ul style="list-style-type: none"> - 2021 floods as an opportunity to implement resilience - Risk of the momentum to fade away 	Timing	<ul style="list-style-type: none"> - 2021 floods as an eye opener - Momentum to prioritize risk management - Momentary drawback for sustainable development
<ul style="list-style-type: none"> - <i>Broad vision towards 2050</i> - No timeframe given for the implementation of the goals: mention of short, medium, and long term without definition/ calendar 	Time horizons	<ul style="list-style-type: none"> - <i>Very limited time horizons</i> - Duality between urgency and long-term resilience - Some recommendations can be immediately applied without time horizons
<ul style="list-style-type: none"> - Plans and vision elaborated quicker than usual - <i>But still the studies are too slow to provide results compared to the temporality onsite</i> - Different strategies require different time length to be efficient - Some actions taking place in one specific area have to be implemented in a specific order while different actions taking place in different places can be implemented at the same time 	Pacing	<ul style="list-style-type: none"> - <i>Willingness to implement as much as possible as fast as possible</i> - But limited resources slow down the implementation - Therefore, actions have to be prioritized
<ul style="list-style-type: none"> - Consideration of climate change and multi-risks - Elaboration of 4 scenarios to build the MP vision - Fear of limited operationality of the recommendations in the future 	Futuring	<ul style="list-style-type: none"> - Willingness to include scenarios into the decision-making process - But often dependent on studies conducted externally - Potential transfers of risks, notably toward socioeconomic risks
<ul style="list-style-type: none"> - The illustrative examples in the visions and plans are very precise, but they are given as examples only - Recommendation to adapt the plans based on future studies - No system of monitoring and evaluation explicitly implemented despite a call for them 	Cyclical adaptation	<ul style="list-style-type: none"> - Recommendations considered flexible - Focus on implementation at the moment with limited monitoring and evaluation systems

horizons must be established depending on the specificities of the territory and in accordance with the Walloon, Belgian, and European ones.

However, the goals that are elaborated in the different policy recommendations come without clear deadlines and schedules, even if the Reconstruction Committee recommended to establish some. Given the emergency of the situation, more precise temporal goals were set by the Reconstruction Committee when coordinating the immediate response, but the objectives related to increasing resilience over the long run are less distinct. The recommendations, for instance in the MP, mention complementary time horizons that encompass the short, medium, and long term, without giving any indication of what they concretely mean.

At least two reasons can be identified that partially explain the limited use of time horizons. First, the schedule is expected to come together with funding, since grants usually establish deadlines. Secondly, as one of the MP project managers explains, the climate scenarios predict an increase in flood risks until 2035, and after that more concerns about heatwaves rather than floods. It is therefore difficult to implement radical territorial changes for flood prevention given the relatively short timeframe, that is why the recommendations were built

based on flood return periods (e.g. to protect the territory from a 25-year or a 1000-year flood event) rather than temporal horizons (to protect the territory from the risks expected after a specific date).

Pacing

Two different pacing issues are identified here: the pacing of the elaboration of the plans and the visions for the territory, and the pacing of the implementation of the strategic recommendations to increase resilience.

The elaboration of the visions and the plans has been realized in a relatively limited amount of time (e.g. six months for the SN programs and less than two years for the MP), given the urgency to guide the reconstruction of the territory. Yet, the MP reports an inconsistent timing between the studies and the needs, as well as some time disconnections between the different studies which are problematic in relation to the objective to build a consistent knowledge base, despite the attempt at a regional coordination. “*Some things have already been implemented. That’s the difficulty we’re having, because the territory is evolving faster than the plan. Through this tendency to go back to the original, to what existed before; in fact, the ideal would have been to have the strategic plan on 12 July 2021*” (Interview MP1). Therefore, the process

of elaborating recommendations can be too slow compared to the actual rebuilding process that is guided by urgency, and yet more studies are called for in order to make the right decisions, which require additional time. This temporal challenge was also present within the Walloon governmental discussions, with some members willing to take the opportunity to think long term and others focusing on the immediate urgent needs.

Concerning the pacing of the implementation of the recommendations, the MP and SN programs identify some actions that can be done quickly with a high positive impact on the resilience of the territory and that should therefore be prioritized. The SN programs even classify each strategy in an order of priority (1, 2, or 3). In addition, different strategies to increase resilience require different timespans to be implemented; for instance, building a new cycling path in the valley is feasible within a couple of years while restoring the peat takes at least 50 years. The order of the implementation of the various strategies also depends upon whether or not their success is dependent on previous actions. Some strategies targeting various parts of the territory can be implemented at the same time (e.g. working on water retention uphill and at the same time making room for water downhill), while other strategies that target a specific area require a specific order of implementation (e.g. first acquiring the problematic buildings in the riverbed, then removing them, then adapting the riverbanks, then creating a social and environmentally friendly place).

Futuring

Futuring at the river basin level encompasses considerations of various types of hazards and therefore multi-thematic domains of actions, of four potential scenarios developed by the MP, and of implementation challenges.

Climate change is clearly considered in the visions and plans elaborated, and so increasing resilience should, in theory, help tackle an array of risks: not only floods but also droughts and heatwaves. In addition, other risks such as socio-economic ones are taken into consideration, for instance when the MP pays particular attention to avoiding an economic desert in the valley. Therefore, increasing resilience in the future is considered a multi-thematic effort, gathering environmental concerns, economic potentials, social needs, mobility, touristic value, risk culture, and risk management. This complexity raises questions about the limiting governance for transversality but also about the compatibility of the actions, for instance between protective strategies for flood events with low intensity and high frequency compared to strategies for low probability but high intensity events. Yet, this multi-thematic management is most often seen as a

potential for synergies when implementing the actions in the future.

In addition, the MP elaborates four different scenarios of what the future of the territory could look like, based on field observations and discussions with local stakeholders. One is the ‘future without disruption’ scenario, which is a business-as-usual development, and the opposite one is ‘what the river wants’ scenario, which makes room for water in a large riverbed. Alternatives are the ‘constellations’ scenario, with patches of urban areas connected together, and the ‘transversal continuities’ scenario which develops territorial main axes from north to south rather than the current west to east. The final vision is a mix between these different elements, starting from the ‘constellations’ scenario and adding elements from the ‘transversal continuities’ scenario and the ‘what the river wants’ scenario. There seems to be an agreement that no one wants to implement the ‘future without disruption’ scenario even though it is considered the most likely in practice: *“when we talk about the first [scenario], the future without disruption, that’s what everyone rejects. A priori, everyone says that’s not possible. But at the same time, that’s what we see on the ground. Most of the inhabitants and most of the public authorities have rebuilt identically for a whole series of reasons”* (Interview MP1).

Finally, there is a worry about the operability of the recommendations in the future, so that the plans and visions will not be realized completely because of the difficulties involved in turning them from theoretical ideas into concrete implementation. *“I’ve always been concerned about doing things that are operational, so taking into account the real possibility of carrying out projects, so taking into account the interplay of stakeholders, budgetary aspects, soil pollution aspects, etc.”* (Interview QD2). Because of this operability concern, the MP and the SN programs elaborate on some solutions to face the governance challenges, for instance through including a list of potential sources of funding for the strategies.

Cyclical adaptation

The recommendations and visions for the future are considered flexible, but there are no concrete monitoring and evaluation plans to adapt them to new contexts and challenges.

Even though the recommendations in the MP and the SN programs are quite precise and the scale of the drawings enables advice for specific buildings, those drawings are considered as suggestions and possibilities and not presented as exactly what should be done, since *“they are orientation studies, so it’s quite flexible. They’re not documents with legal or regulatory value, they’re more visionary documents, so I think the document itself talks*

more about principles, and where, and we show how we could implement them, but all the themes we've seen are clearly noted to be illustrative, to show examples of how we respond to a question" (Interview QD1). An example of the way in which the recommendations concern principles, illustrations, and examples rather than concrete instructions is that the MP visualizes extra space for the riverbed in the valley, but that "doesn't mean that it is possible to enlarge the river everywhere and in a uniform manner, but represents the main strategy and the aim to pursue in order to increase the capacity of the rivers, which should be refined with results from other studies, together with all the space available along the bottom of the valleys" (Master Plan, p.262). In that sense, the plans are expected to evolve together with knowledge (e.g. through the hydrological study), and the Walloon region clearly recommends to consider resilience-building as a dynamic process that constantly evolves over time to fit the changing context.

However, no specific indicators nor responsibilities for a monitoring and evaluation system have been established to keep track of the efficiency and usefulness of the actions taken to increase resilience, even though the Reconstruction Committee has clearly recommended establishing a monitoring system in order to learn from the situation and adapt the strategies to future needs and future contexts. In the resilience WG guidance note, most emphasis is put on ex-ante evaluation.

Temporal strategies at the municipal level to build resilience in the Vesdre river basin in the aftermath of the July 2021 floods

The interviews with the mayors as representative of their municipal administration enable us to describe the main-stream temporal strategies at the municipal level. The mayors interviewed for this study govern municipalities that have been differently affected by the 2021 floods, in terms of damage and casualties, which gives a broad and nuanced view of the temporal strategies at the municipal level.

Timing

The municipalities have seized a timing opportunity triggered by the 2021 floods because the floods have been either an eye opener or a momentum to prioritize disaster resilience in the municipal agenda.

For the mayors of the most affected municipalities, the eye-opener aspect is due to the gravity of the impacts of the disaster, which was not foreseen by local stakeholders. Some mayors describe the situation with very strong words, for instance referring to war: *"I went down into the valley 24 h after the waters had receded, you can't imagine it, the pictures are nothing, until you've been there and*

seen it: that's war. It's a battlefield" (Interview B8). Most mayors express a realization that more has to be done to avoid such a dramatic situation in the future: *"we realized that what we had been doing in the past was no longer good enough"* (Interview B6).

Depending on their previous knowledge, the mayors were more or less aware of the issues related to floods, and therefore the 2021 events have sometimes been perceived more as a momentum enabling the implementation of resilience strategies that were only discussed before, or an opportunity to reinforce policies that were already taking place, for instance as one respondent puts it, *"we've been working against land take for several years now. I don't have a precise term for it, but I think it's something that has gradually taken place. So now we've gone one step further and codified it even more"* (Interview B9). The switch in the focus of local priorities enables the policy changes, together with increased resources (such as money provided by the Walloon region), and thanks to an increased awareness of the importance of such policies that provide citizens support for implementing measures which are sometimes not so popular.

However, if the 2021 floods seem to offer a timing to implement measures to increase resilience, it is important to note that one mayor (whose municipality is classified as category 1) explains that the events have on the contrary been a major drawback in relation to the development of the municipality since all the visionary projects for the long term had to be put on hold. In that sense, the floods have delayed sustainable development policies, because of the need to focus on the urgency of the crisis and the rebuilding process.

Time horizons

The mayors refer to few concrete long-term time horizons, and they have to deal with the temporal duality of short-term safety and longer-term resilience.

At the municipal level, there are very few clear and established goals with targeted time horizons for resilience-building. When there is one, it is usually a couple of years ahead, ranging from one to 7 years at the time of the interviews. These time horizons are often determined by key administrators in the municipalities, such as the mayor. Either they are rather short term to motivate the team to act now, even though everyone is aware that such a calendar is not realistic, or on the contrary, they are based on the time that is expected to be needed to implement the strategies (e.g. to vote for the new policy, to implement it, to face legal issues if there are any). Yet, a mayor of a category 1 municipality (most affected) warns that if the time horizons were determined based on the budget needed, it would take hundreds of years

to implement all the recommendations with the normal allocation of resources in the municipal budget.

In general, for the municipalities that were directly affected by the 2021 floods, there is a duality between two time horizons; on the one hand, the emergency one for citizens' safety, and on the other, the more long-term one for increasing resilience. It reflects a common situation for municipalities since *"it's a bit of a politician issue [...] you have to respond to immediate needs, like the hole in the road, but you also have to look ahead and think about what you want for your municipality in 30 or 50 years' time"* (Interview B5).

Finally, when some large investments are realized in terms of infrastructure, the municipalities generally hope that they do not need to reinvest in them for about 20 or 25 years. It is also interesting to note that time horizons with specific rebuilding goals apply only in relation to the modification of already existing buildings and infrastructures, while some recommendations are about limiting construction in some areas, and in that case it is a constant concern that does not necessitate scheduled goals.

Pacing

Most mayors express willingness to implement as many recommendations as possible to increase resilience as soon as possible, but the limited resources slow down the process and force them to determine priorities among the actions.

The majority of the mayors want to implement as much as possible as soon as possible and therefore speed up the actions to strengthen resilience, first of all because there is a fear that a similar event will happen again before the strategies have been implemented to limit the impacts of a new crisis. In addition, the momentum might fade away, so the opportunity to invest in more resilience should be seized immediately. Finally, the mayors of the most affected municipalities must address the urgent needs, since they are responsible for the safety of the citizens living in the municipality. Since the priority for most municipalities is that as much as possible is done as quickly as possible, there is no or very limited consideration of coordinating the pacing among the municipalities. Yet, it seems to be accepted that the municipalities which have been the most affected by the floods should be prioritized in terms of financial support from the region. If all the recommendations are implemented within a few years, it would be considered as very impressive and efficient by the mayors.

However, pacing is related to the ability to implement the new recommendations, and this is highly dependent on resource availability. The general feeling is that the implementation process is not going fast enough, notably because of a lack of money. This is obvious for

instance in comparison with a private rebuilding process which is much faster than the one of the public spaces in some municipalities. *"It's a difficulty I've always pointed out, about the difference between administrative time and people's time. People, even psychologically, need to see that things are moving forward, they also need to project themselves [in the future], and it's true that the administrative time is slow"* (Interview B3). Indeed, the administrative system (e.g. public procurements) is time-consuming and can also explain the slow pace of the implementation of the strategies. Also, the information needed to make the necessary decisions is not always available yet (e.g. the hydrological study that was not yet available at the time of our interviews).

Because of these limited resources, actions to increase resilience have to be ranked in order of priority. Among the different actions that can be implemented for flood protection, the priority is usually given to the most urgent ones in terms of what the citizens need to restart a 'normal' life, such as sportive, cultural, and social facilities, and the ones that are labeled as the most efficient in terms of flood protection, if this information is available. *"In fact, what we prioritized here were the most effective projects in terms of the flood plan. So that means we have thirty measures in the flood plan, and we prioritized, I think ten or fifteen of them, because we felt that these were the ones that would have the greatest impact on flood control. The other fifteen measures are also extremely important, but we realized that they would have less impact. So that's it. So we really started with the most effective structures"* (Interview B6). The prioritization process concerns the choice between different strategies to protect against floods, but also municipal policies in general. Not everything else can be paused while taking care of flood protection measures.

Futuring

The mayors express a willingness to include scenarios about the future in the decision-making process, but they face some practical challenges. They also identify potential transfers of risks.

The mayors are willing to include scenarios and anticipations of the future in the municipal decision-making processes, but most municipalities have limited resources that restrict their ability to create or order their own scenarios. They are therefore dependent on external studies such as the MP, or micro-level scenarios provided by investors in order to get approval for their construction plans. Given that different studies foresee different possible futures in relation to climate change, it is challenging for decision-makers to consider all of them. Yet, a shared conclusion is that similar extreme events are likely in the future and therefore the mayors express a feeling

of emergency to prepare their municipalities, either with the hope of resisting such a meteorological event better in the future, or with the idea that it will not be possible to completely prevent such a crisis and therefore the goal is to reduce its impacts and ease the reconstruction process. The mayors also identify other issues that need to be dealt with in the future such as fires, droughts, road or train accidents, storms, industrial accidents, water pollution, as well as mental health problems due to the trauma of the 2021 floods.

Even though strategies to increase resilience can potentially generate positive spillover effects on other sustainable development goals (e.g. temporary immersion zones increase biodiversity and provide pleasant leisure areas), most mayors express worries about possible transfers of risks, that is, strategies implemented to reduce the risk of flooding might increase other risks, especially socio-economic ones. There is a fear of the development of what they call a 'ghost valley' in which the lower areas are depopulated or missing economic and leisure activities, and the risk of real estate pressure with rising prices on higher ground. Other transfers of risks are related to climate change (e.g. the risk of increasing greenhouse gas emissions if some economic activities are delocalized for the benefit of flood protection) and to spatial issues (e.g. *"it's not just a question of building a wall, so I asked for an estimate to build a wall to protect my fire station, but if I protect my fire station, won't I affect the houses around it?"* (Interview B2)). Finally, the question of the balance between improving collective resilience in the future and limiting individual freedom (e.g. the freedom of citizens to choose where they want to live) is also a challenge.

Cyclical adaptation

The mayors perceive the recommendations from the MP and SN programs as flexible enough to adapt to future needs and challenges, but the monitoring and evaluation systems are not yet elaborated at the time of the interviews.

The recommendations to strengthen resilience presented in the MP and SN programs are perceived as quite flexible for several reasons. First of all, they are still relatively theoretical and not binding, and therefore easily adaptable before their implementation. Second, managing water for flood protection also enables water management for future drought risks, for instance keeping water onsite uphill when it rains to avoid flooding downhill can also be used as water reservoirs in case of heatwaves and droughts. Third, it is possible to modernize and re-work existing infrastructures to adapt to new needs and newly available technologies. It has been done in the past (e.g. the enlargement of retention basins) and can be done in the future. Fourth, urgent work for safety such as the

re-building of the river banks is sometimes considered temporary, before having the capacity to arrange more pleasant areas to let room for water.

However, there are barely any impact evaluation systems in place to be able to find out how the measures should be adapted in the future and to judge the efficiency of the strategies put in place. Only one mayor that was interviewed mentions that someone is in charge of checking the efficiency of the new infrastructures when it rains a lot. The rest of the municipalities focus on the implementation of the strategies rather than their impact evaluation, and therefore the monitoring and evaluation systems will be implemented after the changes have taken place. For now, there is a monitoring of the pace of the implementation rather than the impacts. A mayor mentions that the most important evaluation should be done beforehand, with studies modeling what will be the impacts of potential infrastructure, rather than after the implementation.

Elements of institutional policy arrangement that shape the temporal strategies to build resilience in the Vesdre river basin following the July 2021 floods

As described in the theoretical background, we do not separately analyze the discourse dimension of the policy arrangement in this section. A new official discourse from the Walloon government is in fact what triggered our study, that is, the willingness to work for change after the 2021 floods and the call for increasing resilience during the rebuilding process (see case background). This section therefore describes the institutional elements of the policy arrangement (actors, resources, and formal rules) that shape, at least partially, the temporal strategies presented precedingly. Figure 2 summarizes those influences.

Actors and power

The actors and their power to act for strengthening resilience affect at least three temporal strategies: pacing, since the implementation of strategies is dependent on the capability of each person or institution; time horizons, since different stakeholders respond to different agendas; and futuring, since the actors involved have heterogenous interests and therefore can desire different types of futures.

"Current governance is not adapted to resilient reconstruction. We need to rethink the systems of actors" (Interview QD2). Many different actors are involved in the actions aimed at increasing resilience in the territory, and that affects the pacing of their implementation, either accelerating the implementation or slowing it down depending on their motivations and interests. Among the many stakeholders involved are private individuals and

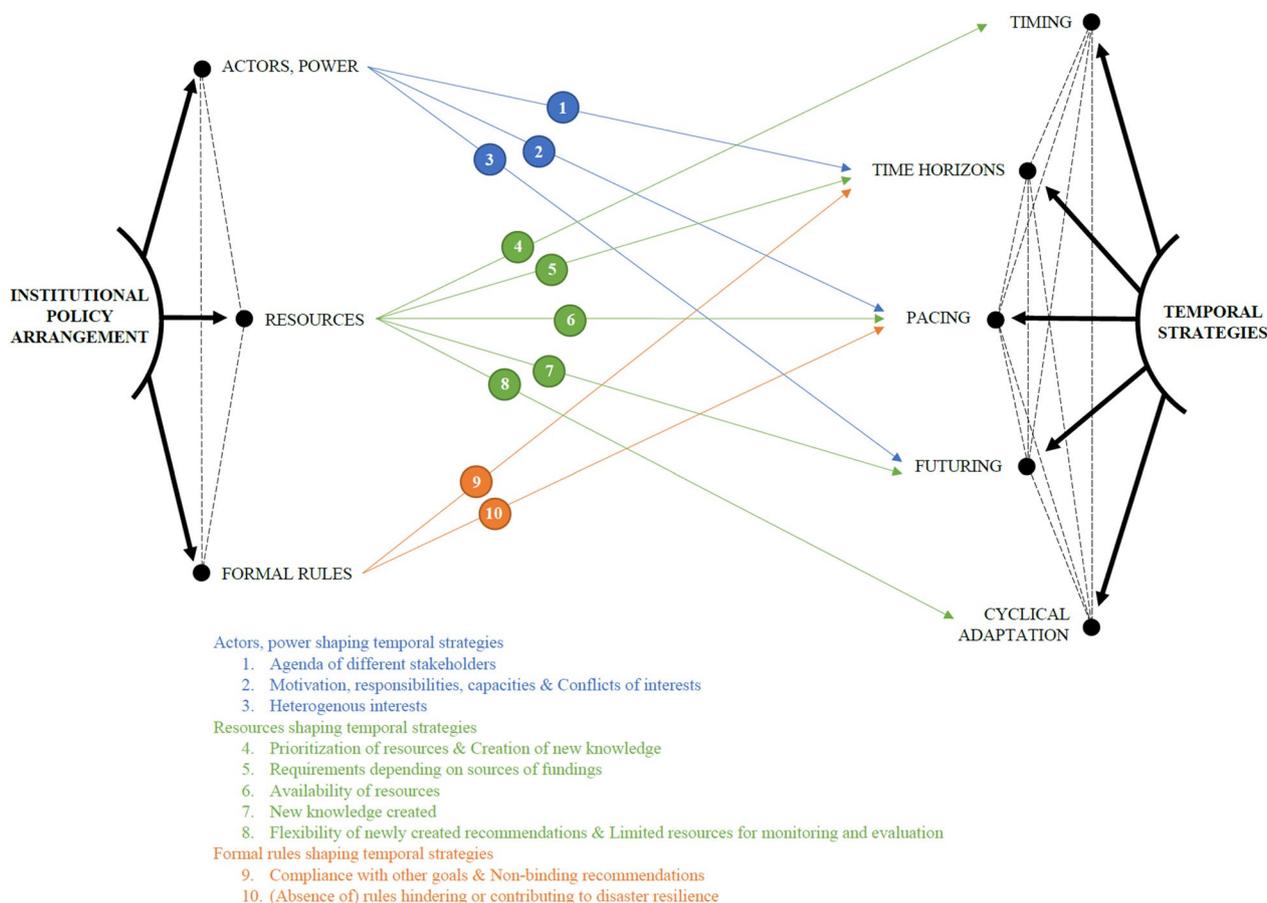


Fig. 2 The main contributions of the institutional policy arrangement to the temporal strategies

companies, governmental entities at all levels (the municipalities, the province of Liège, several entities of the Walloon government, the federal government), the SPI (territorial development agency of the province of Liège), and the urban planners responsible for elaborating the visions and plans (see the report from the Reconstruction Committee [44] for a detailed list of actors involved in the reconstruction process). To accelerate the implementation process, all these actors have the power to increase resilience depending on their responsibilities, which are essentially based on the ownership of the different elements of the territory. For instance, some streams are owned by the Province, some infrastructures such as certain roads and bridges by the region, some others by the municipalities, some riverbanks by private individuals. Therefore, the pace of the implementation is dependent on the capacities and motivations of each responsible stakeholder. The agenda of the various stakeholders also influences the time horizons that are considered. Despite signs of collaboration between the various actors, especially within the silo competencies of the regional government and between the mayors, there is currently

no entity responsible for the overview of building resilience coherently on the full territory of the river basin, which is said to be one of the biggest governance challenges according to the interviewees and the MP since “the vision and its strategic plan need to be coordinated across different skills, fields of action, and stakeholders, rather than being compartmentalized between different areas of intervention and departments (operating in silo)” (Master Plan, p.42).

Despite visions that promote solidarity, partnerships, and coordination between the stakeholders, conflicts of interest arise, which slow down the implementation of the recommendations from the MP and the SN programs and therefore impact the pacing of disaster resilience building. The first type of conflict is between the interests of a municipality and the ones of the whole river basin. Even though the mayors are well aware that the actions taken in their own municipality affect the neighboring ones, and even though the solidarity between the municipalities has been strongly reinforced by the 2021 events, each mayor stays responsible for the safety of his or her own citizens and not for the whole Vesdre territory. In

addition, some recommendations, such as limiting new buildings uphill, contradict the interests of some municipalities that seek tax revenues by increasing the number of inhabitants. To summarize, *"I think we really need to be able to trust a higher authority that coordinates and must coordinate. I wouldn't want to get involved in what's going on in another municipality because I wouldn't want them to get involved in what's going on in mine"* (Interview B3).

The second type of conflict is between the interests of private stakeholders and the ones of the municipality. These conflicts do not happen systematically, but they can appear for three reasons. First, some aspects of the collective plans constitute an individual disaster for citizens who live in houses that are supposed to be removed to enlarge the riverbed. The negotiations can be complicated, and the municipalities need financial resources to compensate the homeowners. Second, most people agree with the idea of implementing resilience-building strategies, but do not wish to participate actively themselves, since some strategies are synonymous with extra costs for them: *"It's sometimes complicated for people too. So, people build a small extension, and we tell them, well, as long as you're building your extension, install a small water tank if you don't have one. And we impose this in the permit. But oh no, we hadn't budgeted for that, it's too expensive, it's over our budget, so there you go... Some accept, some don't"* (Interview B8). Third, when the municipalities deny building permits, the individuals can appeal the local decision and often win since they have the right to build according to the spatial planning rules: *"One gentleman wanted to build a huge house. We said no in every language, we've always said no, we refused the permit, but there are administrative appeals that can be made to the government, to the minister, and the minister granted the permit"* (Interview B5). In general, since different actors can have different interests, what future they desire varies, and that affects the futuring of the territory.

Resources

Resources are about financial means, human resources, and available knowledge. The availability of the resources is related to all the temporal strategies: pacing, since the resources are essential to be able to implement strategies; timing, since the 2021 floods have made stakeholders prioritize investing in resilience and therefore dedicating resources to it; futuring, since the knowledge that is created encompasses scenarios and ideas about the future; time horizons, since different sources of funding have different requirements; and cyclical adaptation, since the recommendations, based on knowledge, have to be flexible enough and monitoring and evaluation require financial and human resources.

Financial resources The biggest challenge for the implementation of strategies to increase resilience is money: additional financial resources influence the timing of investing in disaster resilience, but the complicated landscape of sources of funding and the fact that budgets cannot be fully dedicated to disaster resilience affect the pacing of the implementation.

On the one hand, financial resources have been specifically dedicated to the sustainable rebuilding of the Vesdre valley because of the 2021 events, an additional budget that enables the timing of the implementation of actions to strengthen resilience. On the other hand, the current amount of financial resources available does not cover the entirety of the actions that are necessary to implement the recommendations from the MP and the SN programs, which slows down the transformation. *"We're back to the crux of the matter, which is money. I think the biggest problem we're going to face is who's going to pay"* (Interview B4). Even if some strategies can be implemented without a budget (e.g. limiting the construction of new buildings uphill to avoid land take), many of them are costly (e.g. buying properties to reshape the landscape near the riverbed). So prioritization is necessary: *"now we'll be prioritizing where the biggest problems are, but we'll take budgets into account, because that's the basis of everything. If budgets don't keep up, we're out of business, so we'll do things progressively"* (Interview B10).

The complicated landscape of funding sources affects the speed of the resilient transformation. There are several sources of funding, both public and private. To some extent, the municipal government can force private companies and citizens to observe reasonable demands to get permit approval (e.g. building a water tank). Insurance companies are another source of financial resources, though *"insurance companies finance rebuilding, not improvement"* (Interview MPI). Public sources of funding are diversified and include yearly budgets but also money coming from calls for proposals, notably funded by the Walloon region, and from fixed allocation of subsidies for a specific purpose, such as the implementation of the SN programs. Another financial tool currently promoted by the region is the 'quickwins' which are funds for actions that can be implemented and have visible effects quickly. In addition, possibilities exist to apply for relevant European grants as well. The pacing of the implementation of resilience-building is highly dependent on the influx of public funding, and the willingness of private actors to agree to finance the demands put in place by the municipalities. All those sources of funding shape the temporal horizons to strengthen disaster resilience, for instance in the sense that fixed municipal budgets can help establish long-term goals, while calls for proposals or subsidies are more volatile. Furthermore, calls for proposals

often come in silo with different requirements to apply and to spend the money, which is a struggle for some administrations not capable of dealing with this complexity, and an issue for the coherence of resilience-building that encompasses undividable interrelated issues. At the time of the interviews, the region was looking for simplifying procedures to obtain financial resources in order to reduce the time lag between the elaboration and the implementation of resilient actions, and therefore accelerate the speed of implementation: *“If you have funding resources that go hand in hand with streamlined procedures, things can go much more quickly. But if you have to submit several applications to several departments with different procedures, it takes a lot longer. I’m thinking that if it were centralized in the same way as the European Structural Funds, that is, located in a single envelope with a standardized process, regardless of the competencies involved, it would be a simpler way of allocating existing resources”* (Interview SPW).

In addition to the difficulties of finding financial resources that slow down the resilience-building process and limit the establishment of time horizons, the governmental budgets cannot be dedicated to finance the implementation of resilience strategies only, since governmental institutions have other projects to finance as well. The share of the budget that is allocated or not to flood prevention and disaster resilience raises questions of fairness since some places are more affected by floods than others: *“It’s an expression I always use: we can’t have a double punishment, that is, first the damage caused by the floods and then not make any more investments in the other districts of the municipality because we’d be in financial trouble after taking measures in the valley. No. Because that would really be a double punishment. We’d have the whole problem of flooding in the valley and we’d do nothing elsewhere. That’s something I absolutely wanted to avoid, firstly because I think there’s an aspect of general solidarity in the municipality that has worked very well and I don’t want us to stir up opposition between the districts on the plateaux and the districts in the valley”* (Interview B9). Moreover, inflation also makes it difficult to foresee the share of the budget needed in the future to implement the recommendations. In the attempt to limit the burden of the resilient transformation on local budgets and to speed up the process, the SN programs suggest improvements to projects already underway and therefore already financed.

Human resources The availability of human resources shapes the pacing and futuring of disaster resilience.

While human resources were reinforced during the crisis response phase in some municipalities, most

municipal administrations in the Vesdre river basin face a problem of limited capabilities to implement the recommendations coming from the MP or the SN programs in the long run. The pacing of the implementation is therefore slowed down by limited human resources both within the municipal administration (to answer calls for proposals on time, to manage public procurements, etc.) and outside of it (companies capable and willing to answer the proposals of the public market are overbooked). An example of the first issue is that *“you have to wait for the funds anyway before you start implementing because they come with terms and conditions and there’s a concern about the human capacity to manage everything at once when the funds arrive. There may not be enough people to implement everything when the funds arrive if these people are already busy”* (Interview B2). An illustration of the second issue is: *“after that, we’ll have to put the measurements out to tender. There are no engineers in our administration. We need to find an engineering and construction firm. We don’t think it’s easy to find one, because most engineering and construction firms already have projects. And the projects in Raeren are considered too small to be of interest to construction companies. It’s not profitable enough for construction companies because they have to invest human resources and time, and the margin isn’t great. And the administration doesn’t have anyone dedicated to it. There aren’t enough projects to pay someone in the administration for that”* (Interview B7). An example of a strategy that requires a great deal of human resources is the implementation of a preemptive right to facilitate property acquisition. Even when the municipal administrations have the budget to hire more employees, they have encountered, at least shortly after the 2021 floods, a shortage of competent candidates.

Limited human resources within several municipal administrations also influence the idea of what the future could and should be (futuring), since they rely on external experts to conduct studies such as the SN programs or the MP because they do not have the capabilities to build their own scenario. Indeed, *“you have to put everything into context: there are 8000 inhabitants in Trooz and 40 employees. We have absolutely no specialists in hydrology, meteorology, or risk analysis, so we have no choice but to follow the recommendations given to us by the studies organized by the Walloon region. We are therefore preparing for similar future events on the basis of studies carried out by researchers and specialists from all over the world. So we have no choice but to refer to them. We don’t have the personal capacity in our teams to analyze this kind of phenomenon on the scale of a region, a city, or even a country. So we have no choice but to follow the specialists”* (Interview B1).

Knowledge The creation of new knowledge (provided by several sources such as studies and media investigations) shapes the speed of the implementation (pacing) and the possibility of adapting the strategies (cyclical adaptation) by providing the information needed to make decisions. It can also create a timing opportunity for other territories to implement resilience. In addition, the new knowledge that is created both determines and is influenced by the idea of the future the territory should aim for (futuring).

The 2021 floods highlighted the need for and created an occasion to seek knowledge related to such disasters and resilience-building at the river basin level. Since the 2021 floods are seen as an opportunity to change the development of the territory, new knowledge is created for that purpose: lessons learned from the event and recommendations for the future. There is also hope that the challenges the Vesdre river basin goes through will serve as a basis for knowledge that will benefit other territories *"by clearly saying to ourselves that we need to learn lessons from this crisis that will enable us to anticipate future risk"* (Interview SPW).

On the one hand, studies such as the MP and the SN programs are considered to have been elaborated very quickly compared to the time usually required for such efforts, which enables stakeholders to use the window of opportunity before it fades away. On the other hand, the recommendations clearly call for further studies to clarify some aspects (e.g. related to the hydrological modeling of the territory), and to overcome some methodological limitations that could not be resolved in the available time. The need for more knowledge, when it is (or will be) available, and its constant update shape the pacing of the decision-making process to increase resilience and the possibilities for a cyclical adaptation. For instance, *"I want to have a plan from the RWTH [University of Aachen] with measures, projections, a plan that defines exactly how to deal with the situation in the hotspots. And I don't know myself, if I take a measure maybe here in Raeren [...] I don't know the consequences of this measure, it may perhaps worsen something else. And that's why we did this study, to also know the consequences of the measures"* (Interview B7). In order for the new knowledge to boost the implementation of strategies to strengthen resilience, it has to be communicated in a comprehensible way to the decision-makers, and it has to be practical enough. The mayors often perceive the MP as too theoretical for instance. It is a challenge to establish recommendations precise enough while at the same time keeping some flexibility to enable cyclical adaptation.

Finally, the creation of new knowledge is tightly linked with futuring, since the recommendations are based on the idea of what future the territory should aim for (the

MP provides four potential scenarios at the river basin level that have been described earlier).

Rules of the game

The analysis here focuses on the formal rules, namely the regulations that apply in the context of acting to strengthen disaster resilience in the territory. They influence the pacing of the implementation of the recommendations, either by contributing to and accelerating it or by being in contradiction and therefore slowing down the process. The rules can also affect time horizons, either because the investments in resilience must comply with European, Belgian, and Walloon laws and objectives, or because the recommendations are not binding.

The existing rules can boost the efforts put into increasing resilience and thus speed up the transformation. For instance, the 'Code de l'Eau' (Water Code) helps with water management: *"there's the Water Code that currently applies to all urban planning and development permits, and so we enforce compliance with this Water Code, that is, infiltration of water on the plot, and all water retention mechanisms, so to try and prevent. In other words, for new building permits, we require rainwater tanks to be installed, to act as a buffer, and for flat roofs, we require them to be planted with vegetation, or we leave gravel on them, again to act as a buffer in the event of heavy rain, so that the water doesn't run directly into the drainage system and flood our neighbours"* (Interview B8). Also, some protected natural areas (e.g. UNESCO, Natura 2000) promote the protection of biodiversity, which contributes to resilience.

On the other hand, other rules are perceived to slow down or block resilience-building. For instance, in Spa, there are restrictions to water infiltration in the soil to limit pollution, and that goes against the idea to keep the rainwater where it fell to protect lower lands from flooding. Another example is that private homeowners need a new permit if they want to rebuild their damaged houses differently, while they do not need one if they re-build it identically, which encourages people to go back to the pre-flood state rather than aim for a resilient reconstruction: *"but why did they rebuild their houses exactly as they were? Because they would need a permit to modify their house. Without a permit, they can rebuild the same house; but imagine someone who wants to build on stilts, and they have to build a new house, they need a new permit, but will they get their permit because the area is now floodable? [...] Even if his house has been destroyed, administratively he can rebuild it identically, without needing a permit, because he already had a permit to build his house originally. But he can't if he wants to build his house on stilts. You need a permit. But it would be more sustainable"* (Interview B5). Similarly,

there is no condition of building back better to access the European solidarity fund. There are also protected heritage buildings that cannot be removed from the riverbed. In addition, the rules of the public procurement system are time-consuming. But by far the biggest issue pointed out by the interviewees is the 'Plan de Secteur' (lit. 'sector plan', which is the regulatory tool for the Walloon regional land use and urban planning) that determines whether or not it is allowed to build on a specific land plot. This is problematic because local governments are powerless in relation to individual wills to build in a zone that is officially designated as buildable, and because buying land that is classified as buildable to make room for water is much more expensive.

Since the 2021 floods have acted as an eye-opener, some changes in the governance for resilience-building are informally taking place (e.g. increased collaborations between the different entities of the Walloon government). But the Parliamentary Commission, the MP, and the interviewees also call for more changes in formal rules, notably to install a preemptive right on the problematic buildings, to install new rules for water-transparent architecture, and to modify the 'Plan de Secteur'. The MP provides suggestions to make the 'Plan de Secteur' fit better with resilience goals. However, official changes in it would result in enormous costs to compensate owners: *"it's very difficult to change the color of the sector plan, because it's linked to money. If I own a plot of land that's red [buildable] and tomorrow it's turned agricultural, well, I've lost I don't know how many percent of its value. And so there are questions of compensation, in terms of plans but also financial"* (Interview MP2).

Finally, the absence of formal rules, that is, the fact that the MP and the SN programs are not binding, also shapes the pacing of increased disaster resilience and can limit the establishment of clear time horizons. *"This strategic plan [Master Plan] is not the law. That's just it, there's the plan, and then there's all the work that needs to be done to transform the laws, the regulations, to perhaps integrate elements into them"* (Interview MP2). Because those documents elaborate recommendations only and not formal rules, there is a worry that they will not be implemented by all the actors and therefore the actions taken will lose coherence and so the efficiency of the efforts to strengthen resilience will decrease. An additional potential issue is that some stakeholders might take the opportunity to invest and build in some places before it gets officially forbidden to do so, which is a timing opportunity for them but goes against resilience-building: *"the region has launched the Stop Béton (zero net land take) program. We'll stop progressively toward 2050, but today we can still build. That's how a developer or someone interested in investing in the area sees it. The window is*

closing, but it's still open" (Interview MP2). Therefore, some interviewees explain that it is more important to work towards making the recommendations immediately binding than establishing deadlines and future time horizons to implement the goals, since this type of time lag would be likely to delay the application of the resilience principles.

Discussion

The discussion presents the theoretical, empirical, and practical contributions of our study together with suggestions for further research.

Theoretical contribution: the policy arrangement approach explaining temporal strategies

We combine two theories (temporal strategies and policy arrangement approach) in a novel way to explain how the institutional context affects the use of time by decision-makers in the aftermath of the 2021 flood events. Our study shows how the policy arrangement influences the temporal strategies that are important to be able to strengthen long-term resilience after an acute crisis, because policy-makers use them to integrate long-term perspectives in their choices which is needed given the long-term characteristics of climate-related issues. The July 2021 floods are a typical case that highlights different temporalities at stake in dual crises and therefore the importance of temporal strategies: on the one hand the challenges of rapid response and recovery [41, 60–70], on the other of long-term adaptation and resilience-building [12, 14, 16, 17, 71]. The temporal strategies help to promote a long-term focus in the aftermath of an acute shock [1], and the policy arrangement approach helps to identify factors of stability or change [36] of that policy domain. Our study shows that the institutional policy arrangement shapes the temporal strategies in the Vesdre river basin case, with resources playing the biggest role. To some extent, the formal rules and the capacity of the different actors to implement measures also influence some temporal strategies. This latter aspect is of particular importance since it underlines that the mayors, for instance, do not necessarily use the same temporal strategies as the regional level.

Indeed, we notice different temporal strategies between the different governance levels (Table 1), with some aspects of the temporal strategies that are contradictory, and others that are present at one level of governance but do not present any equivalence at the other level. These divergences highlight the need to consider different spatial scales when studying the temporal strategies, as they do not unfold as a coherent whole. The policy arrangement can explain those spatial differences.

In theory, temporal strategies are actively chosen in order to enable the inclusion of long-term thinking into the decision-making process for the implementation of resilient measures [1]. In our case, we see that in practice the temporal strategies are often more a result of the situation and the context than consciously applied. For instance, if the timing opportunity to strengthen resilience is actively seized after the floods, the pacing of the measures is particularly dependent on the policy arrangement.

Therefore, the analysis of those temporal strategies in light of the institutional policy arrangement explains at least some of the causes that shape the temporal strategies in practice. Of course, there are many additional elements coming from other aspects of the policy domain and from outside of it that affect the temporal strategies, such as the perception and support of the inhabitants, the problem pressure, international regulations such as the European Union Floods Directive, and so on. Additional research should also study those factors and could investigate to what extent changes within the policy arrangement affect the temporal strategies.

Empirical contribution: main opportunities and challenges to strengthen disaster resilience

Our study helps identify main opportunities and challenges of efforts to strengthen disaster resilience, notably through the possibility of actively choosing temporal strategies in order to include the long run in the decisions. This section also relates our findings to the ones of other relevant studies.

Main opportunities

Several aspects of the Vesdre case show that opportunities exist to strengthen disaster resilience in the aftermath of the 2021 floods.

First, Belgian flood risk management is dynamic and adaptable. The difficulties for changing policies in the context of climate change are usually due to lock-in mechanisms [72], which shape flood risk management [73]. Yet, Liefferink et al. [74] compare the policy arrangement in four European countries and conclude that flood risk governance is more stable in the Netherlands and Poland than in Belgium and France. The dynamism of the Belgian flood governance over the period 1995–2015 comes mostly from changes in discourses and rules, and to a lesser extent actors, together with floods that have turned out as windows of opportunities according to Mees, Crabbé and Suykens [75]. Our findings show that there is indeed a clear willingness to improve disaster resilience through the creation of new knowledge and recommendations for the Vesdre river basin since the 2021 floods, which have been an eye opener and enabled

the prioritization of policies strengthening disaster resilience. This event is therefore considered an opportunity for challenging established policies (such as spatial planning) [76].

Since “most of the shifts within Belgian FRG [flood risk governance] were initiated by the influx of a new discourse” [75, p.275] in the past, we identify several discourse elements related to the other dimensions of the policy arrangement that affect the temporal strategies in various ways: there is an official call for resilience-building that directly affects timing, the recommendations of the Master Plan (MP) ask for changes in the formal rules which could potentially shape the future pacing, and a narrative of the future through the choices of potential scenarios in the MP affects time horizons and futuring. Further research should investigate discourses in general related to that case, not only the elements that are related to the temporal strategies, as well as the influence of informal rules, to broaden the understanding of the policy arrangement shaping the temporal strategies.

Second, the way flood management for resilience-building is presented in the MP and Sustainable Neighborhoods (SN) programs as well as by the interviewees reflects an increasing interest in integrated risk management, which requires the integration of different spatial and temporal scales, among other elements [77]. Notably, the MP promotes planning the way land is used and enhancing natural water retention in the Vesdre river basin, which has been proven to reduce inland flooding [7]. Spatial planning was identified as an opportunity to strengthen resilience in Germany following the 2021 floods as well [12]. The integration of flood management with spatial planning includes several dimensions: territorial, policy, and institutional integrations [78]. In the Vesdre river basin, those integrations are improving thanks to an increased awareness of the spatial impacts of each action over the whole territory, even if the ability of the stakeholders to coordinate and align the implementation of strategies is limited by formal rules and conflicts of interest. In addition, resilience is now understood as encompassing a large set of policies, and the 2021 floods are seen as an opportunity to improve resilience in general and not only focus on flood management. For instance, climate adaptation includes spillovers related to biodiversity preservation [7] and social improvements, and these are captured in the visions and plans elaborated, therefore connected to the futuring of the territory.

Main challenges

One of the main challenges to strengthening disaster resilience over the long run in the Vesdre river basin is that most of the temporal strategies at the different levels of governance do not align, notably because of

limited resources. Our study brings in the point of view of the mayors, who are at the forefront to manage disasters and short-term shocks that are part of the dual crisis. It is therefore interesting to find that in spite of the recommendations established at the river basin level to implement policies that increase disaster resilience over the long term, the implementation of strategies is highly dependent on resources available at the municipal level. Therefore, even though local measures can have immediate positive effects and hence are very important for climate adaptation and mitigation [17], we find that municipalities in the Vesdre river basin face several governance challenges that limit their capacities to actively implement temporal strategies for long-term disaster resilience, in particular to determine time horizons and to choose the pacing of the change. The main element of the institutional policy arrangement that shapes all temporal strategies is the limited availability of resources, and despite the fact that futuring can help mobilize resources [79], the MP vision of an ideal future and the numerous recommendations about how to reach it have not yet mobilized enough resources to implement all those recommendations.

In addition to the limited resources, some formal rules and conflicts of interest limit the ability to act of the involved actors and some temporal strategies such as pacing. According to Mees, Crabbé and Suykens [75], the Belgian flood risk governance is highly fragmented in spite of attempts at coordination, which can counteract change because not all actors adopt new policies, or be a factor of change since many different actors means many different entry points for novel ideas. Our findings rather reflect the first type of situation, with disparate priorities, willingness, and capacities of the different actors that slow down the implementation of resilient strategies and for instance lead to divergent time horizons. Concerning the rules dimension, Mees, Crabbé and Suykens [75] find that most changes in Belgian flood risk governance in the past have come from modifications in rules (together with discourses mentioned earlier). At the moment in the Vesdre river basin, our results show that the formal rules are often stabilizing the existent non-resilient situation. Notably, the legislation is slow to change in spite of recommendations to do so, and the MP and SN programs are not binding. The 'Plan de Secteur' is an example of such legislative lock-in, which is also mentioned by Mees, Crabbé and Suykens [75].

Another challenge is that long-term considerations are perceived as quite theoretical, resulting from studies mostly conducted at the regional governance level, while actions in the short term at the municipal level are much more concrete because of the emergency triggered by the floods. This duality between the rapid recovery and

long-term planning following the 2021 floods was also identified as a challenge in Germany by Birkmann et al. [12].

Finally, the cyclical adaptation strategy is only partially considered at both levels of governance. In the Vesdre river basin, the recommendations are considered flexible because they allow a great deal of freedom for their implementation in practice, which is positive for cyclical adaptation, but there is a need to be able to judge what should be modified depending on the future context and new knowledge through monitoring and evaluation systems that have not been enacted yet, even though monitoring and evaluation of the re-building process have been shown to present a clear benefit for disaster resilience [12].

Further research could investigate how the temporal strategies are shaped by the policy arrangement in other places that have been affected by the 2021 events or other floods to compare the opportunities and challenges depending on the territory. Other studies could also investigate the temporal strategies and policy arrangement after another type of acute crisis in Wallonia to compare the opportunities and challenges depending on the type of hazard. Moreover, our study could be repeated after the implementation of all the recommendations in the Vesdre river basin to investigate changes in the temporal strategies (e.g. if the cyclical adaptation has been enacted in practice), and to study how long it takes in practice to implement a process of resilient recovery.

Further research should also assess the causal relationships between the temporal strategies and resilience-building processes. For this, it would be necessary to go back to the case in some years and retrospectively analyze the concrete impacts and effectiveness of the identified temporal strategies on policy changes in the long run.

Practical contribution: lessons learnt and recommendations

This case study enables us to identify lessons learnt, both to help strengthen disaster resilience in the Vesdre River basin, but also to assist the management of other dual crises (e.g. the flood events in Northern France that started in November 2023). Indeed, according to Birkmann et al. [12], "the challenge of rapid recovery versus resilience building in the medium and long-term" [12, p.2] is of global relevance and extends beyond any case study. For instance, the recommendations for the state of Vermont (USA) established by the Environmental Protection Agency [80] to plan for flood recovery and long-term resilience have many similarities with the ones established for the Vesdre river basin by the MP.

The main recommendation for the Vesdre river basin and other places facing acute crises is to work on governance challenges to enable the establishment of clear and chosen temporal strategies rather than using those that are imposed by external factors such as the elements related to the policy arrangement. To strengthen disaster resilience more efficiently, there is a need to align the temporal strategies, such as the time horizons and the pacing, between the municipal and the river basin levels. To do so, the capacity of the municipalities to work on long-term resilient recovery after the floods should be strengthened in addition to their existing crisis management capacities. For that, more resources are needed. Moreover, formal rules in relation to municipal spatial planning that contribute to disaster resilience should be reinforced to fortify coherent futuring, discourse, and action plan promoting disaster resilience and to enable the acceleration of the policy implementation.

In the Vesdre case specifically, certain temporal strategies can also be improved to design resilient policies after the floods, such as cyclical adaptation. Our findings show that flexibility is present, but monitoring and evaluation systems still need to be established and implemented to be able to adapt those strategies over time. Clear and precise temporal goals are also lacking at the municipal and river basin levels despite the fact that necessary short, medium, and long-term efforts are identified. Transparently determining time horizons that connect the urgent recovery with long-term planning for resilience and that are agreed upon between the different stakeholders can help with dedicating the resources needed and prioritizing between different actions, and therefore shape the pacing of the resilient transformation as well.

For other places that are exposed and vulnerable to climate risks but not yet hit by an acute shock, the main lesson that can be drawn from the Vesdre case is to anticipate possible futures before acute crises happen. For that, resources are needed to develop techniques of futuring, such as scenarios and visions. By doing so, the territory will already possess the knowledge needed to implement disaster resilience during the recovery when a disaster, such as a flood, happens. If an idea of a more resilient future is already agreed upon between the different stakeholders and the pathways to reach that goal have already been studied, the governmental actors will be better prepared to manage dual crises and seize the timing opportunity to do so, and the resilient strategies will be implemented faster, as soon as the emergency phase of the disaster has been dealt with.

Conclusion

Temporal strategies enable the inclusion of considerations for the long run while dealing with the consequences of an acute crisis: timing, determining time horizons, pacing, futuring, and enabling cyclical adaptation. In the context of climate change, disastrous floods affected the Vesdre river basin in Belgium in July 2021. Several temporal strategies can be identified in this typical dual crisis case, at two different levels of governance: the river basin as a whole and the municipal levels. These strategies are, at least partially, shaped by the institutional policy arrangement, which encompasses elements related to actors, resources, and formal rules.

At the river basin level, the 2021 floods have been used as a window of opportunity to improve disaster resilience, but there is a fear that this momentum will fade away. The regional government has ordered several studies with the aim to improve disaster resilience toward 2050, but without setting a clear and established timetable, therefore with limited time horizons. Those studies also shape futuring as they present a vision of what future should be aimed for and how to reach it. Even if the recommendations provided by those studies have been elaborated relatively quickly, they come late compared to the needs when facing the urgency of the crisis recovery. Despite a call for it, no monitoring and evaluation system has been put in place to adapt the policies in the future, even though the recommendations are perceived as flexible enough to adapt to future contexts.

At the municipal level, the 2021 floods have been an eye-opener and enabled the prioritization of policies preventing flood impacts. Again, very few and limited time horizons are made explicit, but there is a willingness to implement as much as possible as soon as possible because there is a fear that similar events will happen again before there is time to improve disaster resilience. However, actions have to be ranked in order of priority because of limited resources, notably money. When imagining the potential future of disaster resilience in their municipalities, mayors often refer to external studies, and they are worried about potential transfers of risks such as improving flood protection at the cost of aggravating socio-economic issues. In general, the current focus is given to building resilience; therefore, the monitoring and evaluation of actions are most often postponed.

Our findings reveal that these temporal strategies at both river basin and municipal levels are shaped by the institutional policy arrangement, which is the main theoretical contribution of this paper since it shows that temporal strategies are not always explicitly decided upon in practice. Notably, the availability of resources (money, human, knowledge) affects all the temporal

strategies. In addition, the system of actors involved influences the time horizons, the pacing, and the futuring of disaster resilience. The formal rules sometimes help, but often hinder resilience-building, which affects the pacing of the implementation and time horizons. Therefore, pacing and time horizons are affected by all the dimensions of the institutional policy arrangement. Futuring is shaped by elements related to both actors and resources, and timing and cyclical adaptation are mostly shaped by resources.

Accordingly, acting on the governance system is key to enhancing opportunities to improve disaster resilience and to reduce the challenges encountered in practice by the local governments. It can also help synchronize policy efforts at different levels of governance using temporal strategies in order to render the consideration and the implementation of long-term resilience more coherent. A structural transformation of the institutional policy arrangement is therefore needed to enhance temporal strategies and hence consider the strengthening of long-term resilience during the recovery from acute shocks.

Supplementary Information

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Supplementary materials 1.

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Author contributions

This study was designed by MDGDH and conceptualized by MDGDH and WP. Data collection and analysis were done by MDGDH. The draft of the manuscript was written mostly by MDGDH. WP co-developed the theoretical section and suggested improvements and edited parts of the draft manuscript.

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Availability of data and materials

The policy documents (primary data) that are public are available via the links provided in Appendix 2. The interview transcripts are not made publicly available due to limited agreement among the interviewees.

Declarations

Ethics approval and consent to participate

The study has been approved by the local ethical board at Karlstad University (Review number HS 2023/293). All participants consented prior to their participation.

Consent for publication

All co-authors consented to the final version of the manuscript.

Competing interests

The authors declare no competing interests.

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References

- Pot WD, Scherpenisse J, 't Hart P (2023) Robust governance for the long term and the heat of the moment: temporal strategies for coping with dual crises. *Public Adm* 101:221–235. <https://doi.org/10.1111/padm.12872>
- Faranda D et al (2022) A climate-change attribution retrospective of some impactful weather extremes of 2021. *Weather Clim Dynam* 3:1311–1340. <https://doi.org/10.5194/wcd-3-1311-2022>
- Tradowsky JS et al (2023) Attribution of the heavy rainfall events leading to severe flooding in Western Europe during July 2021. *Clim Change*. <https://doi.org/10.1007/s10584-023-03502-7>
- Kreienkamp F, et al. (2021) Rapid attribution of heavy rainfall events leading to the severe flooding in Western Europe during July 2021. *World Weather Attribution*: <https://www.worldweatherattribution.org/wp-content/uploads/Scientific-report-Western-Europe-floods-2021-attribution.pdf>. Accessed 20 Dec 2023.
- Boin A, Ekegren M, Rhinard M (2020) Hiding in plain sight: conceptualizing the creeping crisis. *Risk Hazards Crisis Public Policy* 11(2):116–138. <https://doi.org/10.1002/rhc3.12193>
- United Nations Environment Programme (2022) Adaptation gap report 2022: Too little, too slow - Climate adaptation failure puts world at risk. UNEP, Nairobi.
- IPCC (2023) Climate Change 2023: Synthesis Report. Contribution Working Groups I II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Core Writing Team, Lee H, Romero J (eds). IPCC. Geneva. <https://doi.org/10.59327/IPCC/AR6-9789291691647>.
- Fettweis X, Doutreloup S (2022) Analyse météorologique de l'évènement pluvieux de Juillet 2021 et évolution climatique du bassin versant de la Vesdre. In: StudioPaolaViganò & ULiège Team-Vesdre (eds) Vallée de la Vesdre: Schéma stratégique multidisciplinaire du bassin versant de la Vesdre. Diagnostic, pp 114–122.
- Ludwig P et al (2023) A multi-disciplinary analysis of the exceptional flood event of July 2021 in central Europe—part 2: historical context and relation to climate change. *Nat Hazards Earth Syst Sci* 23:1287–1311. <https://doi.org/10.5194/nhess-23-1287-2023>
- Birkmann J et al (2010) Extreme events and disasters: a window of opportunity for change? Analysis of organizational, institutional and political changes, formal and informal responses after mega-disasters. *Nat Hazards* 55:637–655. <https://doi.org/10.1007/s11069-008-9319-2>
- Wiering M, Liefferink D, Crabbé A (2018) Stability and change in flood risk governance: on path dependencies and change agents. *J Flood Risk Manag* 11:230–238. <https://doi.org/10.1111/jfr3.12295>
- Birkmann J et al (2023) Strengthening resilience in reconstruction after extreme events—Insights from flood affected communities in

- Germany. *Int J Disaster Risk Reduct* 96:103965. <https://doi.org/10.1016/j.ijdrr.2023.103965>
13. United Nations (2015) Sendai framework for disaster risk reduction 2015–2030. UNISDR, Geneva
 14. Moghadas M et al (2023) The wisdom of crowds for improved disaster resilience: a near-real-time analysis of crowdsourced social media data on the 2021 flood in Germany. *GeoJournal* 88:4215–4241. <https://doi.org/10.1007/s10708-023-10858-x>
 15. Kuhlicke C, et al. (2021) Five principles for climate-proof municipalities and cities. Available from Helmholtz Centre for Environmental Research: <https://www.ufz.de/index.php?en=48382>. Accessed 20 Dec 2023.
 16. Manandhar B et al (2023) Post-flood resilience assessment of July 2021 flood in western Germany and Henan. *China Land* 12:625. <https://doi.org/10.3390/land12030625>
 17. Bosseler B et al (2021) Living with urban flooding: A continuous learning process for local municipalities and lessons learnt from the 2021 events in Germany. *Water* 13:2769. <https://doi.org/10.3390/w13192769>
 18. European Commission (2023) Commission Recommendation of 8 February 2023 on Union disaster resilience goals (2023/C 56/91). Official Journal of the European Union. Available from EUR-Lex: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32023H0215%2801%29&qid=1676531610023>. Accessed 20 Dec 2023.
 19. UNDRR (2019) Words into action: Local disaster risk reduction and resilience strategies. UNDRR, Geneva
 20. Hagenlocher M, et al. (2023) Building climate resilience: lessons from the 2021 floods in western Europe. UNU-EHS, UNU-CRIS & UNU-MERIT, Bonn, Brugge & Maastricht.
 21. Kingdon JW (2011) *Agendas, alternatives, and public policies*. Longman, Boston
 22. Pot WD (2023) Deciding for resilience: utilizing water infrastructure investments to prepare for the future. *WIREs Water* 10:e1661. <https://doi.org/10.1002/wat2.1661>
 23. Segrave AJA, van der Zouwen MWM, van Vierssen WW (2014) Water planning: from what time perspective? *Technol Forecast Soc Change* 86:157–167. <https://doi.org/10.1016/j.techfore.2013.08.019>
 24. Bauer A (2018) When is the future? Temporal ordering in anticipatory policy advice. *Futures* 101:36–45. <https://doi.org/10.1016/j.futures.2018.06.002>
 25. Feitsma J, Swinkels M (2021) De verleiding van bestuurlijke blikver-nauwing: schuld en tijd in COVID-19-crisisbeleid. *Bestuurskunde* 30(4):11–20. <https://doi.org/10.5553/Bk/092733872021030004002>
 26. Haasnoot M et al (2020) Defining the solution space to accelerate climate change adaptation. *Reg Environ Change* 20:37. <https://doi.org/10.1007/s10113-020-01623-8>
 27. Scherpenisse J (2019) *Tucht van de tijd: Over het tijdigen van bestuur en beleid*. Dissertation, Nederlandse School voor Openbaar Bestuur.
 28. Oomen J, Hoffman J, Hajer MA (2022) Techniques of futuring: on how imagined futures become socially performative. *Eur J Soc Theory* 25(2):252–270. <https://doi.org/10.1177/1368431020988826>
 29. Nilson F, de Goër de Herve M (2023) Exploring the transfer of risks. *Saf Sci* 166:106240. <https://doi.org/10.1016/j.ssci.2023.106240>
 30. Amer M, Daim TU, Jetter A (2013) A review of scenario planning. *Futures* 46:23–40. <https://doi.org/10.1016/j.futures.2012.10.003>
 31. Nalau J, Cobb G (2022) The strengths and weaknesses of future visioning approaches for climate change adaptation: a review. *Glob Environ Change* 74:102527. <https://doi.org/10.1016/j.gloenvcha.2022.102527>
 32. Swart R et al (2023) Can managing climate risks be a catalyst for broader transformative change? *Soc Sci* 12:158. <https://doi.org/10.3390/socsci12030158>
 33. Haasnoot M, Warren A, Kwakkel JH (2019) Dynamic adaptive policy pathways (DAPP). In: Marchau VAWJ et al (eds) *Decision making under deep uncertainty from theory to practice*. Springer Nature, Cham, pp 71–92
 34. Hasselman L (2017) Adaptive management; adaptive co-management; adaptive governance: what's the difference? *Aust J Environ Manag* 24(1):31–46. <https://doi.org/10.1080/14486563.2016.1251857>
 35. Arts B, van Tatenhove J, Leroy P (2000) Policy arrangements. In: van Tatenhove J, Arts B, Leroy P (eds) *Political modernisation and the environment: the renewal of environmental policy arrangements*. Springer, Dordrecht, pp 53–69
 36. Liefferink D (2006) The dynamics of policy arrangements: turning round the tetrahedron. In: Arts B, Leroy P (eds) *Institutional dynamics in environmental governance*. Springer, Dordrecht, pp 45–68
 37. Polcarová E, Pupiková J (2020) Stakeholders engagement in the disaster recovery phase as a means of increasing resilience community. *Trans VSB Techn Univ Ostrava XV*. <https://doi.org/10.5182/tses-2020-0008>
 38. Baer E et al (2022) Local solutions to the global crisis: a guide to climate-resilient development. *Environ Law Reporter* 52:10883–10892
 39. United Nations (2015) *Transforming our world: The 2030 Agenda for Sustainable Development (A/RES/70/1)*. Resolution adopted by the general assembly on 25 Sep 2015.
 40. United Nations (2015) Paris Agreement. Agreement adopted by the Parties of the United Nations Framework Convention on Climate Change on 12 December 2015.
 41. Mohr S et al (2023) A multi-disciplinary analysis of the exceptional flood event of July 2021 in central Europe - Part 1: event description and analysis. *Nat Hazards Earth Syst Sci* 23:525–551. <https://doi.org/10.5194/nhess-23-525-2023>
 42. Munich Re (2022) Hurricanes, cold waves, tornadoes: Weather disasters in USA dominate natural disaster losses in 2021. Munich Re: <https://www.munichre.com/en/company/media-relations/media-information-and-corporate-news/media-information/2022/natural-disaster-losses-2021.html>. Accessed 20 Dec 2023.
 43. Gouvernement Wallon (2022) Inondations de juillet 2021 Bilan et perspectives. Communiqué de presse du 4 juillet 2022.
 44. Koks EE et al (2022) Brief communication: Critical infrastructure impacts of the 2021 mid-July western European flood event. *Nat Hazards Earth Syst Sci* 22:3831–3838. <https://doi.org/10.5194/nhess-22-3831-2022>
 45. Commissariat spécial à la Reconstruction (2022) 1 an après les inondations... Bilan de la gestion post-inondations et continuité de la reconstruction.
 46. Dewals B et al (2021) Extreme floods in Belgium the July 2021 extreme floods in the Belgian part of the Meuse basin. *HydroLink* 4:104–107
 47. Pissart A (1961) Les inondations dans la région Verviers-Eupen: Etude préalable à un aménagement du territoire. Centre Belge d'Etude et de Documentation des Eaux (123)
 48. Baba L (2022) *Vesdre. L'Arbre à paroles*, Amay
 49. Deprez F, Lamarche C (2022) *Toujours l'Eau*, Juillet 2021. Editions du Caïd, Tavier
 50. Journée M et al (2023) Quantitative rainfall analysis of the 2021 mid-July flood event in Belgium. *Hydro Earth Syst Sci* 27:3169–3189. <https://doi.org/10.5194/hess-27-3169-2023>
 51. Bianchet B, Eme A (2022) Contextualisation socio-économique des communes du bassin versant. In: StudioPaolaViganò & ULiège Team-Vesdre (eds) *Vallée de la Vesdre: Schéma stratégique multidisciplinaire du bassin versant de la Vesdre*. Diagnostic. pp 52–57.
 52. Poussard C et al (2021) Environmental inequalities in flood exposure: a matter of scale. *Front Water* 3:633046. <https://doi.org/10.3389/frwa.2021.633046>
 53. Gouvernement Wallon (2021) [Inondations] Liste et catégorisation des communes reconnues comme calamités naturelles. Available from Wallonie: <https://www.wallonie.be/fr/actualites/inondations-202-communes-wallonnes-reconnues-comme-calamites-naturelles>. Accessed 20 Dec 2023.
 54. Mees H et al (2016) Analysing and evaluating flood risk governance in Belgium: dealing with flood risks in an urbanised and institutionally complex country. STAR-FLOOD, Utrecht
 55. Pirard M (2023) Inondations et barrages dans la vallée de la Vesdre. L'aménagement du territoire en question. *Terrestres* 1(1)
 56. Studio Paola Viganò, ULiège Team Vesdre (eds) (2022) *Vallée de la Vesdre: Schéma stratégique multidisciplinaire du bassin versant de la Vesdre*. Diagnostic
 57. Parlement Wallon (2022) Rapport de la Commission d'enquête parlementaire chargée d'examiner les causes et d'évaluer la gestion des inondations de juillet 2021 en Wallonie
 58. Dietze M et al (2022) More than heavy rain turning into fast-flowing water—a landscape perspective on the 2021 Eifel floods. *Nat Hazards Earth Syst Sci* 22:1845–1856. <https://doi.org/10.5194/nhess-22-1845-2022>
 59. Fereday J, Muir-Cochrane E (2006) Demonstrating rigor using thematic analysis: a hybrid approach of inductive and deductive coding and

- theme development. *Int J Qual Methods* 5(1):80–92. <https://doi.org/10.1177/160940690600500107>
60. Thieken AH et al (2023) Performance of the flood warning system in Germany in July 2021—insights from affected residents. *Nat Hazards Earth Syst Sci* 23:973–990. <https://doi.org/10.5194/nhess-23-973-2023>
 61. Juling D (2022) The German military response to national disasters and emergencies: a case study of the flooding in the summer of 2021. *J Adv Mil Stud* 13(1):210–218. <https://doi.org/10.21140/mcu.20221301010>
 62. Bier M et al (2023) Spontaneous volunteers and the flood disaster 2021 in Germany: development of social innovations in flood risk management. *J Flood Risk Manag*. <https://doi.org/10.1111/jfr3.12933>
 63. Fekete A (2021) Motivation, satisfaction, and risks of operational forces and helpers regarding the 2021 and 2013 flood operations in Germany. *Sustainability* 13:12587. <https://doi.org/10.3390/su132212587>
 64. 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* 13:3016. <https://doi.org/10.3390/w13213016>
 65. Nick FC et al (2023) Collaboration is key: exploring the 2021 flood response for critical infrastructures in Germany. *Int J Disaster Risk Reduct*. <https://doi.org/10.1016/j.ijdrr.2023.103710>
 66. Fathi R, Fiedrich F (2022) Social media analytics by virtual operations support teams in disaster management: situational awareness and actionable information for decision-makers. *Front Earth Sci*. <https://doi.org/10.3389/feart.2022.941803>
 67. Thiry A, Fallon C (2021) La planification d'urgence sous tension. *Bull Soc Roy Sci Liège* 90:22–42. <https://doi.org/10.25518/0037-9565.10651>
 68. Platzer EK, Knodt M (2023) Resilience beyond insurance: coordination in crisis governance. *Environ Syst Decis* 43:569–576. <https://doi.org/10.1007/s10669-023-09938-7>
 69. Gathen M et al (2022) Are orthopaedic surgeons prepared? An analysis of severe casualties from the 2021 flash flood and mudslide disaster in Germany. *Eur J Trauma Emerg Surg* 48:4233–4241. <https://doi.org/10.1007/s00068-022-01967-2>
 70. Apel H, Vorogushyn S, Merz B (2022) Brief communication: Impact forecasting could substantially improve the emergency management of deadly floods: case study July 2021 floods in Germany. *Nat Hazards Earth Syst Sci* 22:3005–3014. <https://doi.org/10.5194/nhess-22-3005-2022>
 71. Duijndam SJ et al (2023) A look into our future under climate change? Adaptation and migration intentions following extreme flooding in the Netherlands. *Int J Disaster Risk Reduct* 95:103840. <https://doi.org/10.1016/j.ijdrr.2023.103840>
 72. Groen L et al (2023) Re-examining policy stability in climate adaptation through a lock-in perspective. *J Eur Public Policy* 30(3):488–512. <https://doi.org/10.1080/13501763.2022.2064535>
 73. Garrelts H, Lange H (2011) Path dependencies and path change in complex fields of action: climate adaptation policies in Germany in the realm of flood risk management. *Ambio* 40:200–209. <https://doi.org/10.1007/s13280-010-0131-3>
 74. Liefferink D et al (2018) Explaining stability and change. comparing flood risk governance in Belgium, France, the Netherlands, and Poland. *J Flood Risk Manag* 11:281–290. <https://doi.org/10.1111/jfr3.12325>
 75. Mees H, Crabbé A, Suykens C (2018) Belgian flood risk governance: explaining the dynamics within a fragmented governance arrangement. *J Flood Risk Manag* 11:271–280. <https://doi.org/10.1111/jfr3.12330>
 76. Boin A, 't Hart P, McConnell A (2009) Crisis exploitation: political and policy impacts of framing contests. *J Eur Public Policy* 16(81):106. <https://doi.org/10.1080/13501760802453221>
 77. Sandoval V et al (2023) Integrated disaster risk management (IDRM): elements to advance its study and assessment. *Int J Disaster Risk Sci* 14:343–356. <https://doi.org/10.1007/s13753-023-00490-1>
 78. Ran J, Nedovic-Budic Z (2016) Integrating spatial planning and flood risk management: a new conceptual framework for the spatially integrated policy infrastructure. *Comput Environ Urban Syst* 57:68–79. <https://doi.org/10.1016/j.compenvurbysys.2016.01.008>
 79. Carlson JM et al (2020) Paying attention to climate change: positive images of climate change solutions capture attention. *J Environ Psychol* 71:101477. <https://doi.org/10.1016/j.jenvp.2020.101477>
 80. EPA (2014) Planning for flood recovery and long-term resilience in Vermont: smart growth approaches for disaster-resilient communities. Office of Sustainable Communities & Smart Growth Program, Washington

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