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Recurrent Governance Challenges in the Implementation and Alignment of Flood Risk Management Strategies: a Review

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Abstract In Europe increasing flood risks challenge societies to diversify their Flood Risk Management Strategies (FRMSs). Such a diversification implies that actors not only focus on flood defence, but also and simultaneously on flood risk prevention, mitigation, preparation and recovery. There is much literature on the implementation of specific strategies and measures as well as on flood risk governance more generally. What is lacking, though, is a clear overview of the complex set of governance challenges which may result from a diversification and alignment of FRM strategies. This paper aims to address this knowledge gap. It elaborates on potential processes and mechanisms for coordinating the activities and capacities of actors that are involved on different levels and in different sectors of flood risk governance, both concerning the implementation of individual strategies and the coordination of the overall set of strategies. It identifies eight overall coordination mechanisms that have proven to be useful in this respect.

Keywords Flood risk governance · Flood risk management · Coordination mechanisms · Participation · Collaboration · Europe · Literature review

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1 Introduction

Climate change is expected to result in sea-level rise and to induce more extreme weather events. As modifications in frequency, severity and duration of hydro-meteorological hazards will occur (Field et al. 2012), the probabilities of (combinations of) coastal, fluvial or pluvial flooding are increasing in many regions. The potential consequences of these weather events are intensified due to non-climatic factors. Among the latter are socio-economic changes like population growth, economic growth, urbanisation and terrestrial changes, such as sealing the land surface, a decrease in water retention volume in catchments and river regulation (Mitchell 2003). Urban areas in particular face increasing flood risks.

It is therefore argued that in order to reduce flood risks we cannot focus solely on keeping water away from people. Actors at various levels (international, European, national as well as regional) are making efforts aimed at the diversification of Flood Risk Management Strategies (FRMSs), in which multiple strategies are applied simultaneously and linked together. Both the UN Hyogo Framework and the EU Floods Directive opt for a simultaneous and coordinated application of multiple strategies. Literature supports the policy assumption that a diversification of FRMSs may lead to more resilience to flood hazards (Hooijer et al. 2004; Aerts et al. 2008; Tucci 2008; Green 2010; Innocenti and Albrito 2011; Van den Brink et al. 2011). Instead of limiting consideration to a fail-safe system that never fails, it is argued that societies should strive to build a safe-fail system that fails in a safe way (Kundzewicz and Takeuchi 1999) and recovers after failure.

However, diversification makes it less likely that water authorities or any other actors can take measures independently. They need the assistance of spatial planners and other actors. Diversification not only asks for the development of single FRMSs but also for the alignment of these FRMSs in area specific integrated visions. For both reasons diversification of FRMSs is a challenge for collaborative and participatory governance.

There is a huge body of literature on the implementation of specific strategies for flood risk reduction as well as on collaborative and participatory water governance more generally. What is lacking, though, is a clear understanding and a systematic overview of the complex set of governance challenges that may result from the ambition to diversify FRMSs and how to deal with these challenges. This paper therefore aims to contribute to the literature on flood risk governance by identifying recurrent governance challenges resulting from societal ambitions to diversify FRMSs and promising coordination mechanisms for dealing with these challenges. The lessons we aim to draw from this article may be relevant for future practitioners as well as future research in flood risk governance. Water managers and urban planners who seek to diversify FRMSs in order to make areas more resilient may benefit from it.

Section 2 clarifies our research approach and in section 3 and 4 we present our results. We first discuss the challenges that were addressed in the literature dealing with the implementation of individual FRMSs (prevention, defence, mitigation, preparation, recovery). Next we discuss the challenges and promising coordination mechanisms for aligning a set of FRMSs. We conclude this paper with a discussion and a short research agenda.

2 Conceptual Framework and Methods

Vulnerable regions can be protected against flooding by decreasing the *probability* or the *consequences* of flooding and by preparing for a *recovery* after a flood has struck

(Oosterberg et al. 2005; Klijn et al. 2009; Djordjevic et al. 2011). Based on this chain of responses Hegger et al. (2014) have made an analytical distinction between flood risk prevention, flood defence, flood risk mitigation, flood preparation and flood recovery. In Table 1 we give their main characteristics.

A diversification of FRMSs implies that existing strategies will get more (or less) emphasis or that a new strategy is added to an existing mix. In the latter case the most likely outcome will probably be that a dominant strategy in an area (for instance flood defence) is *complemented* by one or more others, although in theory complete *replacement* of one strategy with another would also be possible.

Diversification of an existing mix of FRMSs is a governance challenge as it will ask for changes in existing flood risk governance arrangements (FRGAs), being the "institutional constellations resulting from an interplay between actors and actor coalitions involved in all policy domains relevant for flood risk management—including water management, spatial planning and disaster management; their dominant discourses; formal and informal rules of the game; and the power and resource base of the actors involved" (Hegger et al. 2014). Following this definition we argue that a diversification may result in actor-, discourse, rules- or resource-related challenges.

Actor-related challenges pertain to the need to involve different kinds of actors. Actors (those who have the power to act or conversely prevent others from acting) can be seen as a sub-group of the wider group of stakeholders (those with a stake or interest in the decision process). Besides changes in actor involvement there is also a need for coordination between the different actors involved.

Discourse related challenges reflect the way reality is framed. Narratives that rationalise the necessities for changes as well as potential solutions for perceived issues have to be produced and communicated among the actors involved. Both scientific and policy paradigms and uncertainties, policy concepts or programmes as well as historical metaphors and storylines

Table 1 Five types of Flood Risk Management Strategies (FRMSs)

Strategy	Characteristics
1. Flood risk prevention	Prevention measures aim to decrease the consequences of flooding by decreasing the exposure of people/property etc. via methods that prohibit or discourage development in areas at risk of flooding (e.g. spatial planning, re-allotment policy, expropriation policy etc.). The main focus of the strategy is on "keeping people away from water".
2. Flood defence	Flood defence measures aim to decrease the probability of flooding areas through infrastructural works, such as dikes, dams, embankments and weirs (so called "structural measures"), through measures that increase the capacity of existing channels for water conveyance or the creation of **new** spaces for water retention outside of the area to be defended**.** The focus is on "keeping water away from people".
3. Flood risk mitigation	Flood risk mitigation focuses on decreasing the consequences of floods through measures inside the vulnerable area. Consequences can be mitigated by a smart design of the flood-prone area. Measures include constructing flood compartments, or (regulations for) flood-proof building as well as measures to retain or store water in or under the flood-prone area (e.g. rain water retention).
4. Flood preparation	Consequences of floods can also be mitigated by preparing for a flood event. Measures include developing flood warning systems, preparing disaster management and evacuation plans and managing a flood when it occurs.
5. Flood recovery	This strategy facilitates a good and fast recovery after a flood event. Measures include reconstruction or rebuilding plans as well as compensation or insurance systems.

and policy and legal principles and values may provide for these narratives (Hajer and Versteeg 2011:175).

Rules-related challenges address the necessary changes in formal or informal frameworks of organisational, substantive and procedural *rules* that structure actors' interactions (Van Rijswick and Havekes 2012). Rules determine which authorities have which competences. Formal rules will be found in or based upon international agreements, EU-Directives, national conventions and laws. Informal rules are rooted in the daily practice of the actors involved.

Changing an existing mix of FRMSs is also a *resource-related challenge*. Legal authority, including the right to regulate property, financial power, knowledge, expertise and interaction skills will be needed for the effectuation of a diversification in FRMSs.

In the next sections we will discuss the challenges related to the diversification of FRMSs which we have found in relevant literature. We have supplemented our expert knowledge on flood risk governance (especially in the Netherlands, the UK and Poland) by conducting a Scopus search in the subject areas Social Sciences & Humanities and Physical Sciences. We have limited our search to the articles published since 2000 with a geographical scope on Europe. Table 2 summarises our search terms and the number of articles we have found.

Of these articles we have checked the abstract on relevance for our study. Articles that could teach us more about the implementation of FRMSs or their alignment were studied in more detail.

3 An Overview of the Governance Challenges Found

Table 3 presents the results of the review. Since diversification implies that separate FRMSs may get more emphasis we will first discuss the actor-, discourses-, rules- or resources-related challenges that may result if society wants to change its emphasis on flood risk prevention, flood defence, mitigation, preparation or recovery. A discussion of the challenges and

Table 2 Number of articles found using combinations of title search terms in Scopus

	Flood risk management	Flood risk prevention	Flood defence	Flood risk mitigation	Flood preparation	Flood recovery
Diversification/ Multi-layered safety	6	0	0	0	0	0
Governance	76	2	2	2	0	3
Public participation	48	0	1	2	0	1
Stakeholder engagement	17	0	0	2	0	0
Integrated water management	172	2	0	11	1	8
Policy integration	53	0	0	5	0	4
Coordination	18	0	0	0	0	1
Participatory governance	22	0	0	0	0	0
Interactive policy making	15	1	0	0	0	0
Total*	484	19	107	33	10	104

* This figure indicates how many articles were found when only the search terms in the first row were used; it is not the mathematical sum of the figures in the rows above

coordination mechanisms related to the alignment of these FRMSs into area-specific mixes follows in section 4.

3.1 Implementing Flood Risk Prevention

Flood risk prevention focuses on reducing the consequences of floods through land use and spatial planning measures. These can focus on forbidding or discouraging the location of vulnerable societal functions (e.g. housing, power plants) in flood-prone areas, the establishment of building requirements or the dis-incentivising of urban development in vulnerable areas. Flood risk prevention is claimed to be the potentially most effective FRMS (Hooijer et al. 2004; Beucher 2009; Penning-Rowsell and Pardoe 2014).

However, in practice, implementation of flood risk prevention seems to be complicated. In a UK context it was found that urban development in flood-prone areas continues to be allowed (Burningham et al. 2008). In various other European countries, it was shown that parties interested in the continuation of urban development implicitly tend to believe that “water managers should enable spatial planning wherever spatial planners want them to do this” (Wiering and Immink 2006: Woltjer and Al 2007; Pardoe et al. 2011). Baubion (2015) for instance points at the presence of financial mechanisms that automatically compensate for flood losses and therefore trigger ongoing building activities in flood prone areas in Paris. In operational terms, three main barriers for achieving the implementation of flood risk prevention emerge from the literature.

A first barrier is that water managers and spatial planners generally operate through different modes of governance: water management in Europe tends to be centralised, while local governments have the dominant role in spatial planning (Wilson 2006; Storbjörk 2007).

Second, in many countries, including Italy and Germany, policy and legal frameworks for establishing risk prevention through pro-active spatial planning are limited in scope (Mysiak et al. 2013; Sapountzaki et al. 2011). In countries where such rules are in place (e.g. Plan de Prévention des Risques in France or Planning Policy Statements in England), implementation gaps have been reported. These are due to a lack of support from local planning authorities, tensions between national and local governments, a lack of coordination between stakeholders and a lack of clarity regarding hazard assessments (Beucher 20,090). In addition, the implementation of specific procedural instruments like the Dutch and Belgian Water Test – an instrument that explicitly asks spatial planners to reconsider water interests in spatial planning – has been found to be problematic (Hegger et al. 2013). Moreover, existing planning rules are often said to lack flexibility (Van den Brink et al. 2013; Harris and Penning-Rowsell 2011).

Third, *terminologies and the ways of working* of spatial planners differ from those of water managers. Spatial planners talk about “land-use functions” and “reconciling and combining functions” (Hartmann 2009); “land-use planning procedures”, “zoning measures”, and “environmental impact assessments” (Wiering and Immink 2006:427) while water managers’ prime focus is on “flood risks” (ibid).

Some authors however, see the obligation stemming from the EU Floods Directive to produce flood risk management plans by 2015 as a promising development, as it may lead to “spatial water governance”, a hybrid between the centralised mode of water managers and the interactive mode of spatial planners (Hartmann and Driessen 2013:7). Others point at positive experiences, gained amongst others in a Dutch context, with bringing water managers and spatial planners together by enhancing communication and learning through climate adaptation atlases or flood maps, the establishment of special learning and action alliances, ‘networks of

Table 3 Implementing FRMSs; an overview of the governance challenges (references in subsequent sub-sections)

Strategy	Flood Risk Prevention	Flood Defence	Flood Risk Mitigation	Flood Preparation	Flood Recovery
Actor-related challenges	Improving cooperation between water managers and spatial planners	Involving more actors in societal debates on flood defence	Creating willingness to participate amongst all actors	Increasing risk awareness and preparedness and establishing cross-scale linkages	Developing working forms of cooperation between residents, insurance companies and reinsurers
Discourse-related challenges	Reconciling ideals on the relationship between water and spatial planning; bridging the different ways of working	Stimulating societal debates on safety norms, acceptable risks, funding principles (user pays/solidarity)	Developing storylines to convince all actors to take mitigating actions and mainstreaming flood risk issues in water and spatial planning	Developing probabilistic strategies while avoiding the institutional trap of overemphasising reactive crisis management	Deciding and communicating which risks will be covered by governmental funds and which by (mandatory?) privatized flood insurances
Rules-related challenges	Developing rules that encourage flood risk prevention but still provide enough flexibility	Developing a rule system endorsed by society, including a legitimate financing regime and transparent decision-making processes	Developing rules to introduce mitigation in spatial planning, adjusting building codes and concluding (voluntary) agree-ments to clarify responsibilities	Clarifying and formalising responsibilities and linking national flood management plans to regional and local levels	Developing rules to address moral hazard problems
Resource-related challenges	Enhancing communication and learning through communicative tools, networks and communicative settings;	Developing risk communication mechanisms and solutions for dealing with distributional effects of measures	Exploring ways in which flood risk mitigation can provide economic opportunities at the local level	Developing accurate, timely and reliable warning systems, disaster management and evacuation plans	Stimulating the mobilisation of resources for private insurance as well as (governmental) emergency funds

expertise' or interaction settings like climate ateliers (Potter et al. 2011; Van Herk et al. 2011; Goosen et al. 2014).

3.2 Implementing Flood Defence

More emphasis on flood defence may entail improving existing structures (heightening or strengthening dikes) or applying new options such as delta dikes, unbreakable dikes, innovative dikes (that can be overtopped but do not breach), multi-functional dikes (combining flood defence with other spatial functions such as parks, roads, housing etc.) (Tennekes et al. 2013). Apart from this improving existing drainage channels) or retaining water upstream of the area to be protected (rather than keeping it out) are options as the German and Dutch Room for the River programmes show (Rijke et al. 2013).

Two dominant features seem to characterise the implementation of flood defence. First, due to the public goods character of flood defences, governments at different levels are often key actors, being responsible for their construction, financing and maintenance, Second, discourses on flood defence are highly technical. The design of flood defence structures is based on calculations using estimated probabilities and taking into account factors as population density and potential economic damage (Immink 2005). As a result, flood defence has become *de-politicised* in many cases. Flood protection standards in The Netherlands are for instance formalised in law, but not discussed with the public. Despite the presence of distributional effects, normative choices (different protection levels, divisions of costs and benefits, risk acceptability) often remain implicit. Examples have been documented where these distributional effects have been made more visible (Warner and Van Buuren 2011; Van Buuren et al. 2013) and politicisation occured. The creation of an emergency retention storage in the Dutch Ooijpolder is a case in point. Inhabitants of this polder successfully resisted this plan, the moment they became aware of it (Roth and Warner 2007).

An overall picture seems to emerge in which the question of who gains and who loses with which types of flood defence measures is becoming more diverse (Penning-Rowsell and Pardoe 2012, 2014). Hence, a key challenge of implementing flood defence can be interpreted as coordination the gap between water system management and society at large by explicating societal debates on flood protection (Mees et al. 2014b; Buchecker et al. in press), employing adequate communication mechanisms (Keller et al. 2006) and providing solutions for dealing with the distributional effects of measures on people, nature, landscape and cultural heritage (Wiering and Driessen 2001).

3.3 Implementing Flood Risk Mitigation

Mitigation strategies take as a starting point that areas can occasionally be flooded. Examples of this FRMS are the construction of floating houses, urban green infrastructure, and adaptive building.

In general flood risk mitigation is developed and implemented on a local or regional level. While it is widely acknowledged that mitigation (and non-structural measures) are potentially more efficient and sustainable solutions to flood risks than flood defence (Bergström 2006;; Greiving and Angignard 2013; Green 2014), there are no robust requirements for flood risk mitigation measures at the EU or the national level (Van Rijswick and Havekes 2012). Mitigation measures tend to be informal and non-binding. Local governments tend to avoid the implementation of such measures (Neuvel 2009; Heintz et al. 2012). Mainstreaming flood management in future urban planning by adjusting national building codes (Spence 2004) has often been pinpointed as problematic (Fratini et al. 2012; Hartmann and Driessen 2013; Uittenbroek et al. 2014). The WMO (2012) indicates this might be due to the difficulties urban planners have to encompass the vulnerability of areas to flooding.

Measures found in the literature that could stimulate the implementation of flood-risk mitigation strategies include concluding voluntary multi-stakeholder agreements (De Moel et al. 2009), encouraging responsibilities of local authorities (Thaler and Priest 2014) and stressing the local economic benefits of mitigation measures to the community (Holub and Fuchs 2009). In the aftermath of flood events, governments could use arising 'windows of opportunity' to make infrastructure and houses (more) flood-proof (Powell and Ringler 2009; Field et al. 2012).

Overall, creating more flood risk awareness and acceptance is key for enhancing the acceptance of new, more resilient urban development (UNECE 2009; Mees et al. 2014a; Fratini et al. 2012; Spence 2004).

3.4 Implementing Flood Preparation

Flood preparation includes organisational activities and measures taken in advance to ensure an effective emergency response (Caragliano and Manca 2007).

Key actors in flood preparation measures are – on one hand – the meteorological and hydrological services that prepare forecasts, and on the other the actors that are responsible for developing a flood warning. Another group may be responsible for disseminating the warning to the end-users and also for responding to requests from the end-users for further information. Emergency and social services on their turn have the tasks of taking appropriate actions based on the warning issued. They have to develop and implement evacuation plans.

A communication protocol has to be developed in order to adequately inform the people., since the decision-making process for mass evacuation is influenced by great uncertainties and consequences. A clear formalisation of responsibilities can help to reduce these uncertainties. It must be clear who has to play what role, who is in charge and who is accountable. When it comes to flood preparation, communication is crucial to strengthen awareness and to motivate the population at risk to be prepared for an emergency (Hagemeier-Klose and Wagner 2009).

Risk awareness, key to adequate flood preparation, tends to be low, especially as Kolen and Helsloot (2014) argue in cases in which the return period of a flood is far greater than a lifetime. Such a low public awareness restricts decision-makers when prioritising emergency planning (Ten Brinke et al. 2008). Trust in the government on the other hand causes people to refrain from making private preparations.

3.5 Implementing Flood Recovery

Aim of this FRMS is to facilitate a good and swift recovery after a flood event has taken place. Measures include the development of compensation and insurance systems as well as the preparation of reconstruction or rebuilding plans.

Flood recovery can be a rational FRMS, as it might be too expensive to implement structural flood defence measures. This will be the case for less populated or economically more marginal areas. As there will always be a chance of dike breaches, piping or overtopping, recovery also has to be organised for protected areas (Klijn et al. 2009).

Rebuilding costs can be very high. Key question in cases like these is of course who must pay the bills (Penning-Rowsell and Pardoe 2012).

Profit-driven private insurance systems will not be solvent to do so in cases of serious flooding (Botzen and Van den Bergh 2008) and do exclude those unable to pay their tariffs. Either governments or civilians have to deal with the non-insured risks (Aerts and Botzen 2011, p. 1046).

In a comprehensive disaster insurance program different actors can be discerned: property owners (self-insurance), insurance companies (private insurance), reinsurers and capital markets (risk transfer) and state reinsurance (state funds, multi-state pools) (Kunreuther and Pauly (2006, p. 112). In Germany (Thieken et al. 2007), the UK (Penning-Rowsell et al. 2014) and France the insurance industry plays a role in flood risk management (Botzen and Van den Bergh 2008). In the Netherlands however, only one private flood insurance scheme (in a pilot phase) exists. In cases of flooding a national disaster fund would pay the victims (Aerts and Botzen 2011).

The overall challenge for actors that want to put more emphasis on flood recovery is to clarify which risks will be covered by governmental funds and which by privatised flood insurances, and whether buying private insurance is voluntary or mandatory (Kunreuther and Pauly 2006). The development of private flood insurance systems may be easier if all natural disasters insurances can be combined into a single policy, as it is more likely that a property owner will consider purchasing insurance because the likelihood of some loss is above a threshold level of concern. If all natural hazards were included in a homeowners' policy the risk might be large enough to get the consumer's attention. Insurance companies can offer landowners reduced premiums if they take measures themselves to reduce their risks (Hartmann 2009, 541). The latter also implies that working forms of cooperation (e.g. partnerships) have to be developed between residents, (re)insurance companies and governments (Kunreuther and Pauly 2006).

Insurance companies somehow have to address moral hazard problems (like moving unwanted furniture to the basement in order to have the insurance companies pay for their replacement). Furthermore, some residents will not buy policies even at subsidised rates because they believe disasters would not happen to them. This again points to the necessity of risk communication in clear language (Kunreuther and Pauly 2006).

4 Coordination Mechanisms

Apart from the implementation of individual FRMSs, the alignment of these FRMSs is of importance. In an abstract sense alignment refers to the process of adjusting parts so that they are in proper relative position. In the context of FRMSs it implies that FRMSs supplement each other in an optimal area-specific mix (in terms of risk reduction and finances, legal possibilities and required capacities). Area specific visions will clarify what relative roles will be played by each FRMS in dealing with an area's flood risks. Ideally diversification may change existing mixes of FRMSs into a more effective and efficient mix which is based on trust and engagement of stakeholders (OECD 2015).

However, ambivalence of goals, uncertainty of knowledge and distributed power makes alignment challenging (Voss et al. 2007). Such situations ask for more reflexive governance approaches, a steering philosophy of controlled trust rather than top-down governance (Rijke et al. 2013). This asks for multi-actor, multi-level and multi-sector involvement. Studies on flood risk management, integrated water management, policy integration, participatory governance and interactive policymaking as identified in our Scopus search suggest that a combination of coordination mechanisms is required to organise these processes in an effective way. Below we list eight of those mechanisms distilled from our literature review.

First, authors stress the importance of clear leadership (Van den Brink et al. 2011; Rijke et al. 2013). Visionary leadership is perceived to be important, to link different time scales and to convince others to anticipate potential future threats. Entrepreneurial leadership is necessary to get things done, for example to gain access to the necessary resources for realising adaptation projects. The presence of a dedicated neutral and skilled process manager will be helpful to organize the entire process in such a way that participants are kept at the table, remain interested and learning (Dieperink et al. 2012). Collaborative leadership is necessary to bridge gaps, span boundaries and build coalitions between different actors and sectors. Policy entrepreneurs may provide for this type of leadership (Partzsch and Ziegler 2011; Huitema and Meijerink 2009).

Second, leadership ask for a facilitating program office involving different competencies as well as a set of management instruments for gathering data and information, assessing resource levels and needs, and allocating resources for use (Medema et al. 2008), developing learning capacities, organizing single and double loop learning by monitoring and evaluation of policy experiences (Van den Brink et al. 2011), setting up teams for community building and progress evaluation (Fleischhauer et al. 2012.

Third stakeholder engagement for informed and outcome-oriented contributions to water policy design and implementation has to be promoted (OECD 2015). This is challenging for in practice this means that policy entrepreneurs have to find a balance between involving too many actors (which might be good from a democracy point of view) on one hand and too few (which might be more effective in the short term) on the other hand via *selective activation* (Green and Penning-Rowsell 2010). Pro-actively involving the community in itself may result in different perspectives on the issues at stake (Garrelts and Lange 2011; Bruchnach and Ingram 2012). The involvement of some actors will also be crucial because of the resources they have, while the involvement of others might be motivated to get more societal support for the final proposal that has to be developed. Of course, whether stakeholders will actually participate depends on their capacities to do so and the presence of other ‘hot items’ on their agendas (Ruiz-Villaverde and García-Rubio 2016).

As a fourth mechanism the clarification of roles and of responsibilities within complex polycentric networks can be mentioned (Warner et al. 2008, 134; Moss and Newig 2010). On the catchment level, river basin organisations can be charged with the development of hydrological models and scenarios for flood forecasting. The catchment level will also be the optimal level to discuss upstream retention options as well as the potentials of improvement of flood flow conditions. On lower geographical scales, actors representing different policy sectors, especially those that represent the water and spatial planning sector, will discuss the potentials of flood risk prevention, flood defence, mitigation, preparation and recovery. Overall, processes will be more successful if the rules of the game are clear to all involved parties. Drafting agreements or covenants might be helpful to achieve this.

Fifth, inspiring visions may be developed which involve a variety of policy frames and solutions - connecting scale levels, both geographically and in time (Van den Brink et al. 2011; Bruchnach and Ingram 2012) and balance multiple (spatial) objectives (Rijke et al. 2013). Ideally they can initiate and integrate different societal discussions (Greiving and Angignard 2013) which result in common problem definitions (Bruchnach and Ingram 2012), a shared sense of urgency, normative consensus and creative solutions. *Multi-layered safety* is an example of such a vision that is introduced in the Netherlands, Flanders and England in pilot projects dealing with diversification (Hegger et al. 2014).

Sixth, as stated before it can be hard to involve stakeholders as their responses tend to be more reactive than proactive, especially if flood frequencies are low and stakeholders have trust in traditional flood defence measures. However, a focus on innovative area development may trigger participation as this may enable to link flood risk management with other benefits like an improved spatial and or housing quality. Retention measures to combat flood risks can be combined with restoring flood plains and ecological recovery (OECD 2014 p 44).

Seventh, the results of societal discussions on diversification must be formalised (Dieperink et al. 2012). Rules must be developed to formalise normative consensus on the risks to be addressed, acceptable protection levels, funding principles and burden sharing, land use priorities, the role of private flood insurance companies and compensation schemes for actors disadvantaged by (a lack of) physical measures like dikes. A formalisation of more specific targets and time paths for implementing specific measures is also required.

The final coordination mechanism is the presence of a well-developed and joint knowledge base (Van Herk et al. 2011; Quevauviller 2011). According to the Floods Directive such knowledge base must a.o. consist of maps showing topography, land use, the location of vulnerable areas as well as a description of historical and potential floods (Yannopoulos et al. 2015). These data and information may enable proactive justification and policy cycles (Rijke et al. 2013). Positive experiences with the establishment of knowledge action arenas, dedicated data bases and maps have been documented e.g. in The Netherlands (ibid).

5 Discussion and Research Agenda

Diversification of FRMSs has been extensively discussed, both in practice and in literature. However, as said in the introduction, an overview of the governance challenges of implementing and aligning a diversified set of strategies is missing. We tried to fill this gap by identifying recurrent governance challenges that societies must address if they wish to diversify their FRMSs, both related to specific strategies as well as related to the alignment of strategies. This has resulted in a state of the art overview of these challenges and the conditions for addressing these. Our review clearly shows that addressing these challenges asks for collaborative and participatory governance. We distilled eight coordination mechanisms which have recurrently been documented as being useful in the context of diversifying FRM. Since these mechanisms clearly stand out from the analysed literature, we deem it safe to label them as good practices.

Although we have got a good impression of the recurrent challenges that practitioners as well as scholars have to face, our literature review is only a first step in getting a better understanding of the issue of diversification of FRMs and the strategies that could enable this. Further empirical research is necessary to learn from ongoing attempts to diversify FRMSs how challenges are addressed in specific areas. By conducing in-depth case studies in areas where actors try to diversify their FRMSs we can get more detailed insights into the shape of our eight coordination mechanisms and the conditions under which they can be effective. A challenging question for such case studies will be whether these strategies truly result in a diversification or whether institutional lock-ins finally prevent this. Another option for future research would be to study whether and how areas that recover after serious flood events use the eight coordination mechanisms to develop new mixes of FRMSs.

By comparing different diversification attempts, in the end we may find out what works where, when and how. Based on this, policymakers can better learn what to do if they aim at a diversification of FRMSs.

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