TRANSITION TOWARDS INTEGRATED FLOOD RISK MANAGEMENT STRATEGIES

LESSONS LEARNED FROM PILOT PROJECTS IN THE NORTH SEA REGION

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■ Climate change will result in increased exposure of low-lying coastal areas to risks associated with accelerated sea level rise. Hard infrastructure measures may not be sufficient to protect citizens and prevent the consequences of future flooding. To deal with uncertainties, alternative options need to be considered for the future of flood risk management (FRM), including spatial planning and emergency management. This has been framed as a multi-layered safety (MLS) approach. MLS is a risk-based approach to manage flood consequences and adapt to the unexpected impacts of floods by combining prevention, mitigation via spatial planning and crisis management strategies (Kaufmann et al., 2016; van Herk et al., 2014). It has been argued by many scholars that a transition is required from flood protection (hard infrastructure) towards more integrated flood risk management (IFRM) approaches to reduce the impact of floods (Dawson et al., 2011; Newman et al., 2011; White, 2013; Zevenbergen et al., 2008, 2013; see van Herk et al., 2015). Integrated means a mix of both structural and non-structural responses to flood impacts (Zevenbergen et al., 2008).

In light of the above transition, this paper discusses the results of the EU Interreg VB North Sea Region project FRAMES (Flood Resilient Areas by Multi-layEred Safety). In FRAMES, regions in five countries (Belgium, Denmark, Germany, The Netherlands and the United Kingdom) have experimented with the MLS approach to reduce consequences of flooding (layer 2 and 3) and adding recovery as a 4th layer (see figure 1). Furthermore, FRAMES (2016-2020) was initiated to encourage transnational learning about diversified FRM.

The pilot projects within FRAMES align with the recommendations by van Buuren et al. (2015) to conduct pilots for MLS strategies and shape these as regional processes of joint searching and learning for the societal challenge of FRM (Buijs et al., 2018; Cosoveanu et al., 2019). To enhance our understanding of transition patterns in relation to IFRM, there is a need to analyse outcomes of various single elements (events, policies or projects) in a wider societal transition (van Herk et al., 2015). In transition literature, an experiment is a way to emphasize novelty,

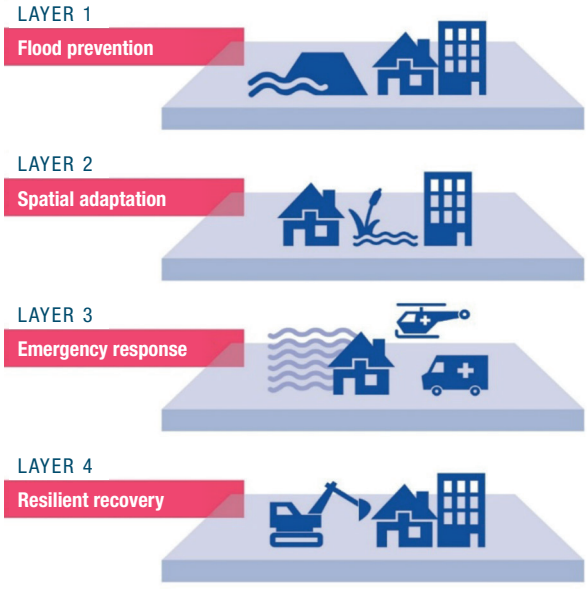

Figure 1: The Multi-Layered Safety Approach applied in the FRAMES project

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perform a test within a limited scale or repeat a test in another context (Kivimaa et al., 2017).

Experiments serve as policy instruments to introduce or test new practices, concepts or technologies (Vreugdenhil et al., 2012). They provide reliable knowledge about the effects of an intervention (McFadgen & Huitema, 2017b) on inducing shifts in ways of thinking, values and perspectives (learning), adjusting to a different context (broadening) or wider structural changes (upscaling). These pilot outputs are also called transition mechanisms (Grin et al., 2010). Thus, using this analytical lens the paper aims to answer the following research question: *How do experiments or pilot projects about MLS contribute to a transition towards integrated flood risk management in practice?*

In the *Conceptual background* (next section), this analytical lens will be further explained. Subsequently, the data collection is presented in the Method; followed by the analysis of the pilot outcomes in terms of the transition mechanisms in the *Results.* We conclude the paper with the most relevant findings.

Conceptual background: Transition mechanisms in experimental governance

Transition is defined as 'a gradual, continuous process of structural change within a society or culture'. Transitions are complex, spread over long time frames, involve multiple actors and occur across multiple levels (Rotmans et al., 2001). In (sustainability) transitions literature, experiments are seen as niche (Geels, 2005, 2011) making new policy possible by demonstrating or testing policy inventions and innovation at small scales (Upham et al., 2014). Building upon the literature on experimental governance, McFadgen & Huitema (2017a) define policy experiments as 'temporary, controlled field trials of policy-relevant innovations that produce evidence for subsequent policy decisions'. A pilot projects is a specific type of policy experiment (Rondinelli, 1993). Often they are perceived as a safe way to explore new pathways for alternative management strategies aiming to find out whether new solutions or working methods to reduce the consequences of climate change before they are embedded into policies (van Buuren et al., 2018). With this definition in mind, FRAMES pilot projects experimented with MLS as an innovative policy approach in five EU countries to enhance flood resilience.

Experiments as well as pilot projects are means to generate learning outcomes and policy relevant information (McFadgen, 2013) about something that works in the real world (Kivimaa et al., 2017). Transition experiments are expected to create outcomes through three different mechanisms: deepening, broadening and scaling-up (Grin et al., 2010).

The mechanism of deepening includes shifts in ways of thinking, values and perspectives (culture), shifts in doing things, habits and routines (practices), and shifts in organizing the physical, institutional or economic context (structure) (Geels & Schot, 2010). An important underlying mechanism for knowledge development is the learning process. Learning processes in the context of experimentation in pilot projects have been addressed by several scholars (Farrelly & Brown, 2011; Kivimaa et al., 2017; Laakso et al., 2017; McFadgen, 2013; McFadgen & Huitema, 2017a, 2017b).

Broadening is adjusting and repeating an experiment in a different context and linking it to other functions or domains. What is repeated is the outcome of innovation and learning processes (deepening) (Geels & Schot, 2010). In literature, similar terms include 'diffusion' (Rogers, 1995), 'quantitative scaling-up' (Uvin, 1995; Uvin et al., 2000), 'spatial scaling' (Douthwaite et al., 2003), 'organisational growth' (World Bank, 2003), 'scaling-out' (Douthwaite et al., 2003), 'duplication' (Bai et al., 2010), 'replication' (Vreugdenhil et al., 2012) or 'horizontal scaling-up' (van Doren et al., 2018).

Scaling-up means inducing wider structural changes by embedding an experiment into the established ways of thinking (culture), doing (practices), and organizing (structure) of the governance regime (Geels & Schot, 2010). It involves a mechanism where information from one scale is transferred to another, thereby reaching a

MLS strategy	#	Main MLS action	Pilot projects	Country
Spatial adaptation measures (layer 2)	1	Flood proof zoning	Ninove, Geraardsbergen Denderleeuw	Belgium
			Butt Green Shield	United Kingdom
	2	Natural Flood Management	Medway, Southwell and Lustrum Beck	United Kingdom
	3	Critical infrastructure	Reimerswaal, Flood Proof Electricity Grid Zeeland	The Netherlands
			Kent	United Kingdom
Preparedness (layer 3)	4	Preparedness and emergency planning resulting in community resilience	Alblasserwaard-Vijheerenlandenand, Sloe area	The Netherlands
			Medway, Lustrum Beck, Southwell, Butt Green Shield, Kent	United Kingdom
			Wesermarsch	Germany
			Ninove, Geraardsbergen, Denderleeuw	Belgium
Resilient recovery (layer 4)	6	Resilient recovery	Roskilde	Denmark

Table 1.
Overview of MLS actions and FRAMES pilot projects

higher level of scale and a greater impact (Gibson et al., 2000; Schneider, refer to it as vertical scaling-up or the process where the information regarding ideas, values, knowledge or other lessons from individual experiments is used to inform institutions at higher administrative and organizational levels with wider-reaching impact. Vertical scaling occurs when an initiative influences formal institutions (policy goals or instruments) and/or informal institutions (values, ideas) enabling opportunities for (structural) change. Comparable terms include 'political scaling' (Gillespie, 2004; Uvin, 1995), 'institutionalization' (North, 1990), 'mainstreaming' (Bai et al., 2010) and 'translation' (Smith, 2007).

Methods

This section includes an overview of the FRAMES pilot projects, data collection and analysis methods.

Pilot projects in FRAMES experimenting with MLS actions

Within FRAMES, 16 pilot projects experimented with MLS actions combining mitigation via spatial planning, emergency planning and recovery strategies. Protection has been traditionally the main FRM strategy thus it was not part of FRAMES project. Table 1 provides an overview of FRAMES pilot projects and the main actions classified per MLS layer. More in depth information can be found on www.frameswiki.eu.

Data collection

The pilot process was evaluated through questionnaires, semi-structured interviews and document analysis. Baseline and result questionnaires about the aims, development and outcomes of the pilot projects were completed by pilot managers in collaboration with key stakeholders involved in the pilots. The questionnaires provided insight into the diversification of FRM strategies mitigation/preparedness/recovery before and after FRAMES. In the semi-structured interviews, pilot managers were asked to reflect on past and current FRM strategies in their pilot area, the pilot implementation process, struggles encountered, main accomplishments, the role(s) of the actors involved, and how all these factors could contribute to mainstream the pilot outcomes into the governance regime. This data was complemented with documents analysis (internal reports and presentations) to make the findings more robust. All lessons learned are presented in Buijs et al. (2020) and can be found on www.frameswiki.eu.

Data analysis

The three transition mechanisms are applied as an analytical lens to reconsider the lessons learned from the pilot projects in a transition towards integrated FRM. The lessons learned of 14 out of 16 pilots project are classified by using the definitions of the mechanisms deepening, broadening and upscaling as explained in the *Conceptual background*. The pilots Assens and Vejle were left out of the analysis in this paper because they are not directly linked to one of the diversification strategies.

Results

Flood risk management transition via multi-layered safety

Table 2 provides an overview of the main pilot outcomes for each layer of the MLS approach.

Deepening, broadening and upscaling

The lessons learned are analysed and discussed in terms of the transition mechanisms deepening, broadening, and upscaling for the strategies of mitigation via spatial planning, preparedness and recovery. Table 3 provides key examples of deepening, broadening and upscaling as empirical evidence from the pilots. Moreover, these are further explained below the table per each MLS layer.

Mitigation via spatial planning

The pilot projects experimented with several mitigation via spatial planning strategies, such as flood proof zoning, natural flood management (NFM) and critical infrastructure (table 2).

Pilot name	Layer 2, Spatial adaptation	Layer 3, Preparedness and emergency planning	Layer 4, Resilient recovery
BELGIUM			
1. Denderleeuw	Vision and an action plan including spatial adaptation measures for a flood proof neighbourhood Development of flood risk zoning based on the flood risk label method	Increase of flood risk awareness by providing access to information about flood risk to local community groups (citizens, schools and local authorities) Improvement of risk communication by providing a flood preparedness manual to citizens	
2. Geraardsbergen			
3. Ninove			
DENMARK			
4. Roskilde			Development of guidelines with concrete information, such as what to do and who to contact when a flood event occurs to enhance recovery process
GERMANY			
5. Wesermarsch	Development of flood risk zoning based on identified flood prone areas and integration of rural-urban drainage into FRM plans	Increase of flood risk awareness of citizens, water and crisis management authorities by developing information materials (such as leaflets, booklets, and brochures) about flood risk and preparedness Improvement of risk communication (for instance the evacuation procedure) by using updated flood risk maps	
THE NETHERLANDS			
6. Alblasserwaard-Vijfheerenlanden		Increase of flood risk awareness and collaboration of crisis management, regional water authorities and municipalities on combining evacuation and spatial development Improvement of evacuation routes and risk communication using updated flood risk maps Optimization of social capital for assistance during evacuation	
7. Reimerswaal	Inventory of spatial adaptation measures (e.g. increase height, location) for the most vulnerable electricity grid assets	Increase of flood risk awareness by crisis management, regional water authorities, municipalities and critical infrastructure managers by exchanging knowledge on flood vulnerability of critical infrastructure Improvement of asset management plans using updated flood risk maps Improvement of evacuation routes and risk communication using updated flood risk maps	
8. Flood proof electricity grid	Inventory of spatial adaptation measures (e.g. relocation, building restriction) for the most vulnerable electricity grid assets based on the risk label method	Increase of flood risk awareness by crisis management, regional water authorities, municipalities and critical infrastructure managers by exchanging knowledge on flood vulnerability of critical infrastructure Improvement of evacuation routes and risk communication using the risk label method	
9. Sloe area		Risk communication and evacuation strategies for citizens for potential flood events	
UNITED KINGDOM			
10. Butt Green Shield	Improved flood proof zoning by implementing water storage devices, such as water butts or raised flower beds, at household level	Increase of flood risk awareness of inhabitants and businesses by flood dialogues Enhanced social capital by involving local communities (citizens, businesses and schools) to implement and maintain the water storage devices	
11. Lustrum Beck	Improved flood proof zoning by implementing natural flood management measures such as leaky barriers and water ponds, to reduce flood damage at farm level	Increase of flood risk awareness of local communities, local and regional authorities and nature conservation organisations by demonstrating the effectiveness of natural flood management measures in FRM Enhanced social capital by engaging local communities and making them responsible for FRM actions	
12. Medway	Idem as above	Idem as above Idem as above	Increased capacity of local communities (social and health care sector) to recover from floods in the Kent County. Done in Kent pilot through Medway Flood Partnership
13. Southwell	Idem as above	Idem as above	
14. Kent	Improved spatial planning of health and social care infrastructure using updated flood risk maps	Increase of flood risk awareness of Kent County Council and care home organizations by providing more information about the vulnerability of communities, health and social care infrastructure Improved flood action plans at District Council level by using updated flood risk maps	Increased capacity of local communities (social and health care sector) to adapt their recovery plans in the Kent County

<< Table 2.
Pilot outcomes
per layer of MLS

	Mitigation via spatial planning	Preparedness	Recovery
Deepening	Include local knowledge for flood proof designs	Raise flood risk awareness Foster social capital Define clear evacuation routes and shelter locations based on updated flood risk maps	Learning from flood recovery processes
Broadening	Connect with existing networks and domains to expand knowledge and experiences	Take the local context into account to adjust FRM actions when replicating them	
Scaling up	Pilots results about critical infrastructure as input for national policy advise		

Table 3. >>
Key lessons learned
of FRAMES pilots
as examples
of transition
mechanisms

Knowledge about the role of spatial planning has been **deepened** by including new perspectives about flood proof design and planning (table 3). E.g. by including local knowledge in flood risk assessments (Ninove, Geraardsbergen, Denderleeuw pilots in Belgium; Medway, Lustrum Beck and Southwell pilots in the United Kingdom) or by conducting or updating thorough flood risk analysis of the flood prone area (all pilot projects). Not only the local knowledge about the area but also the flood risk governance context is essential to conduct a thorough flood risk analysis adapted to the local conditions. Within several pilots, new partnerships have been developed between responsible organizations for spatial planning and FRM to work with new approaches on shared goals (Medway, Lustrum Beck and Southwell pilots in the United Kingdom, Ninove pilot in Belgium). E.g., the specific NFM measures and their location was decided in collaboration with existing partnership combining spatial planning and FRM (Medway and Lustrum Beck pilots in the United Kingdom). Another lesson learned is the essential need of building up trust among stakeholders (all pilots), more specifically for the critical infrastructure sector (Flood proof electricity grid Zeeland, Reimerswaal pilots in the Netherlands). Currently, critical infrastructure is a new sector addressed in FRM. Deepening of knowledge is required to understand the vulnerabilities of critical infrastructure and opportunities for flood risk reduction in this sector, that can be hampered by its confidential character. As a result, flood risk awareness was raised among asset managers of critical infrastructure and the relevance of this domain for flood resilience of society as a whole.

Related to **broadening**, many pilots tried to combine spatial planning measures with other functions and domains (table 3). E.g., implementing NFM interventions at the catchment level (Medway, Lustrum Beck and Southwell pilots in the United Kingdom) meant crossing political and administrative boundaries. This resulted in broadening the implementation of the pilot activities in a different political, hydrological, geological and social context of this and and other catchments. Moreover, monitoring and dissemination of pilot outcomes is essential to facilitate the pilot replication in another context. Likewise, other pilots (Ninove pilot in Belgium; Medway, Lustrum Beck and Southwell pilots in the United Kingdom) made use of existing or new actors networks to link spatial planning measures with emergency planning measures (table 3) and facilitate the diffusion of pilot results.

In relation to **upscaling** or embedding spatial planning into a wider flood risk governance system, pilot projects provide relevant evidence. The monitoring and dissemination of knowledge emerged from pilot projects is key to ensure a wide use of NFM interventions as a FRM strategy (Medway, Lustrum Beck and Southwell pilots in the United Kingdom). The empirical evidence from these pilots facilitates integration of NFM measures into flood action plans at the local and regional level. Moreover, transforming knowledge about impacts of floods on critical infrastructure and a catchment based approach into policy advise resulted in embedding this knowledge into regional and national policy development (table 3) (Kent pilot in United Kingdom; Reimerswaal, Flood proof electricity grid Zeeland pilots in the Netherlands, respectively).

Preparedness

The pilots experimented with preparedness strategies such as emergency response and evacuation planning (table 2).

The main **lesson learned** regarding preparedness actions is the need to change stakeholders' perception about flood risk and increase their flood risk awareness (table 3). In order to do so, sharing information and continuous communication (informative materials, community events, face to face discussions, social media) with stakeholders were crucial to increase risk awareness (all pilots). Communication made stakeholders feel part of the process, take ownership and build up trust. Once stakeholders are aware of the flood risk in their area, they start to feel responsible. Therefore, changing to a bottom-up approach, from a single responsibility

perspective to a collective responsibilities' perspective, will result in enhanced community resilience. Moreover, new ways of doing things, such as update local flood risk maps, helped pilot managers to improve emergency planning by defining evacuation routes (Alblasserwaard – Vijfheerenlanden pilot in the Netherlands, Wesermarsch pilot in Germany), and establishing shelter criteria and potential locations (Sloe area pilot in the Netherlands) (table 3). In order to support emergency planning, fostering social capital (table 3) requires time and patience to motivate, engage and empower local community groups (Alblasserwaard – Vijfheerenlanden pilot in the Netherlands, United Kingdom. However, it is important to involve local government when engaging with citizens in FRM actions (Ninove pilot in Belgium). Furthermore, a clear communication strategy is required in case of emergency response (Sloe area, Alblasserwaard – Vijfheerenlanden pilot in the Netherlands, Wesermarsch pilot in Germany). Horizontal evacuation (using roads) and vertical evacuation (move to higher buildings) were examined in the Sloe pilot and guidelines for cattle evacuation have been developed for the Wesermarsch Germany.

Flood preparedness measures are highly dependent on the local context, which makes **broadening** lessons learned a challenging pilot strategy. However, several FRM actions are relevant to replicate and adjust in another context, e.g. assessment of social capital in relation to emergency planning, identification of shelter locations and balancing between preventive evacuation and shelter in place (Alblasserwaard – Vijfheerenlanden and Sloe area pilots in the Netherlands). Additionally, flood risk awareness was increased beyond the experimental pilot phase since the developed informative materials (flyers, brochures, booklet, and webpages) will remain openly accessible to the general public. Likewise, community resilience was strengthened by involving local farmers and landowners in the implementation of NFM measures on their farm. Other farmers increased their flood risk awareness by visiting the farms where these measures were implemented (Medway, Lustrum Beck and Southwell pilots in the United Kingdom). Besides, agreements were signed among local water management authorities and local community groups to define responsibilities in FRM. E.g. local community groups such as inhabitants and schools, installed water storage devices to reduce flood risk and they agreed to be responsible for the operation and maintenance of the devices. This could be seen as formalization of the broadening mechanism.

Upscaling or embedding of preparedness by inhabitants into a fully integrated FRM strategy seems a bridge too far for areas with a low probability of flooding. Nevertheless, continuously learning and reframing are needed to adjust measures according to the social interests and behavior of people and connect them to the overall FRM regime. Certainly for communities living in flood prone areas, their needs should be included in local action plans (Medway, Southwell pilots in the United Kingdom). A communication strategy to provide regular information and exercises regarding flood preparedness will support embeddedness of emergency planning and response among local communities (all pilots in the United Kingdom, Sloe area pilot in the Netherlands, Wesermarsch pilot in Germany).

Recovery

Within FRAMES, few pilot projects focused on this flood strategy, thus more empirical evidence is needed. However, some **lessons** were drawn from pilots that implemented preparedness and emergency management actions that also support recovery in the long term (Southwell, Medway, Lustrum Beck pilots in the United Kingdom). E.g., local communities engaged in the pilots are now more aware of the local flood risk and know who to contact and what to do after a flood event to support recovery. Therefore, in case of flooding, they know what to do during the recovery process. Thus, changing the way of doing things can result in multiple benefits. Likewise, learning from past flood events (table 3) and their recovery process is relevant to foster recovery capacity of communities and authorities for potential new flood events (Roskilde pilot in Denmark). Regarding **broadening**, the knowledge about flood recovery should be combined with awareness raising campaigns to deepen this knowledge beyond the lifespan of FRAMES (Roskilde pilot in Denmark). Furthermore, in relation to

scaling-up, few pilot projects went a step further trying to embed pilot results into a wider governance setting. In Denmark, the lessons learned about recovery were translated into guidelines and integrated into the local flood management plans of Roskilde. In addition, these guidelines were shared and recommended to other municipalities in Denmark.

Conclusions

In FRAMES, pilot projects experimented with diverse MLS actions. Pilots combined mitigation via spatial planning, preparedness and recovery measures with protection strategies to enhance flood resilience in five EU countries. This paper aimed to gain insight in how these pilot projects contribute in practice to a transition towards integrated FRM. In order to do so, pilot outcomes were analysed via three transition mechanisms: deepening or learning, broadening or adjusting and upscaling. These three mechanisms are presented and discussed for each layer of the MLS approach.

Firstly, pilots experimenting with mitigation via spatial planning have deepened their knowledge and understanding with regards to the need for more integration between spatial planning and FRM. This study shows that broadening of mitigation via spatial planning is facilitated by adjusting pilot results to the local conditions, investing in continuous monitoring and linking FRM to other domains such as critical infrastructure. For embeddedness of mitigation via spatial planning, translation of pilot results about the vulnerability of critical infrastructure in more generic conditions is needed to induce wider structural change in regional or national policies.

Secondly, pilot projects have deepened a preparedness strategy through raising flood risk awareness, fostering social capital and developing clear evacuation and emergency planning actions. Moreover, to broaden results of preparedness pilots, the local conditions such as physical, administrative and political characteristics should be taken into account when replicating pilots in other contexts. Potential upscaling of emergency planning and evacuation is limited, although lessons learned about communication processes and new evacuation strategies for instance, can affect the dominant regime. Due to the high dependency on local context, it is however unlikely that pilot projects will result in structural changes of a preparedness strategy in FRM.

Thirdly, emergency planning and response can benefit recovery, but more insight is needed in the potential effects. Therefore recovery should be considered and deepened as a post-disaster strategy. The Roskilde pilot taught us that learning from previous flood events can shorten and smoothen the recovery process when all responsible authorities are aware of their responsibilities. These lessons learned about recovery should be further disseminated and embedded in existing FRM plans to support flood resilience. This means that deepening will be an important transition mechanism for recovery. Besides the local flood risk governance context, also the specific circumstances of a flood event will result in limitations for broadening and upscaling as transitions mechanisms for a recovery strategy.

Considering the transition towards more integrated FRM, pilot projects within FRAMES have experimented with three MLS strategies: mitigation via spatial planning, preparedness, and recovery. The analysis shows each MLS strategy requires a different set of transition mechanisms to foster the transition towards more integrated FRM. Overall, it seems that the higher the dependency on local context (political, administrative, physical) and integral character of a FRM strategy, the more importance needs to be given to deepening as transition mechanism. Preparedness and recovery as strategy not only depend on the physical aspects, but also are highly dependent on a diversity of societal aspects in the flood risk governance context. This makes broadening and especially upscaling as transition mechamisms more challenging, if possible at all. This can imply relevant considerations for the design of pilot projects and the potential of their outcomes in transition processes. Therefore, more empirical research is required to further understand the deepening, broadening and upscaling mechanisms of pilot outcomes in a transition towards integrated FRM.

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ABSTRACT

The Interreg North Sea region project FRAMES, Flood Resilience by Multi-LayerEd Safety, addressed the shared territorial challenge of climate change impacts, specifically the physical, economic and social effects of floods. To deal with future climate uncertainties, alternative options need to be considered for the future of flood risk management (FRM), including spatial planning and emergency management. This has been framed as a multi-layered safety (MLS) approach. In FRAMES, 16 pilot projects have experimented with diverse MLS measures in a transition from a protection dominated approach towards more integrated FRM strategies. In this article, the pilot results are analysed through the transition management mechanisms of deepening, broadening, and upscaling. We found that pilots provide relevant understanding about shifts in thinking, perspectives and practices of mitigation via spatial planning, preparedness and recovery. The results show that each of these MLS strategies apply a different combination of transition mechanisms.

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