

Lessons learnt about multi-layered safety to support decision making for flood resilience

Transnational monitoring
and evaluation report of FRAMES



Preface

This report brings together the deliverables 3.5 (Transnational monitor and evaluation of Resilient Areas), 4.7 (Transnational monitor and evaluation of Resilient Communities), 5.1 (Transnational Focus Groups) and 5.2 (Decision Support System) of the Interreg North Sea region project FRAMES (www.frameswiki.eu). FRAMES focused on how multi-layer safety could improve the overall resilience of areas, communities and authorities in sixteen pilot areas in five countries in the North Sea Region: Belgium, Denmark, Germany, the Netherlands and the United Kingdom.

The knowledge institutes (HZ University of Applied Sciences, Ghent University, Oldenburg University and Jade University of Applied Sciences) have used a learning evaluation approach to compare the pilots and developed and implemented a transnational monitoring and evaluation framework (chapter 2). The report has been authored by HZ University of Applied Sciences with input from project partners (Appendix A). The learning evaluation resulted in new flood risk management insights, support for future decision making and innovative solutions to improve society's ability to cope with flooding.

The current document includes the assessment and analysis of the development of adaptive capacities in all pilot projects as well as all the lessons learnt through these pilot projects. The lessons learnt are divided in three chapters: general multi-layer safety lessons learnt in chapters 3, lessons learnt of resilient areas in chapter 4 and lessons learnt of resilient communities are in chapter 5.

It is expected that the pilot project outcomes will have a further impact at the regional and national flood risk management practices and policies (see chapter 8) within each of the North Sea region countries. This report is addressed to practitioners who are interested in the applicability of the MLS approach and policy makers who are involved in decision making of flood risk management strategies.

Enjoy the reading!

On behalf of the HZ team and all contributors,

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Abbreviations

ACW:	Adaptive Capacity Wheel
BE:	Belgium
DAPP:	Dynamic Adaptation Policy Pathways
DE:	Germany
DK:	Denmark
DSS:	Decision Support System
FRM:	Flood Risk Management
MLS:	Multi-Layer Safety
NAP:	National Adaptation Plans
NAS:	National Adaptation Strategy
NFM:	Natural Flood Management
NGO:	Non-Governmental Organisation
NL:	the Netherlands
NSR:	North Sea Region
TFG:	Transnational Focus Groups
UK:	the United Kingdom

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1. Introduction: climate change, floods and multi-layer safety

Climate change will result in increased sea level rise and extreme weather rainfall causing flooding and damage to infrastructure and societies in the North Sea Region (NSR) countries. Hard infrastructure measures may not be sufficient to protect citizens and prevent the consequences of future flooding, thus additional measures should be taken. The Multi-Layer Safety (MLS) approach is a Dutch risk-based approach to manage the consequences and probability of a flood through several types of measures (see figure 1): (1) prevention through dikes, levees and dams; (2) mitigation via spatial planning; (3) crisis management through preparedness and emergency response (Kaufmann *et al.* 2016). While the principles of MLS are being acknowledged by more and more authorities and practitioners across the NSR, the approach has not been developed in a transnational way. The EU Interreg project FRAMES, Flood Resilient Areas by Multi-layered Safety, added a fourth layer to this approach (4) resilient recovery. Flood recovery is usually managed separately from flood risk mitigation and focuses on immediate effects of a flood and short-term actions for recovery. However, FRAMES recognises that 'adaptive recovery' gives the opportunity to reduce the impact of a future event on society in the long term. FRAMES applied the MLS concept focusing particularly spatial adaptation, emergency response and resilient recovery actions, which are respectively layer 2, 3 and 4 from MLS, to limit the consequences flood events and enhance resilient recovery. Specifically FRAMES will demonstrate the benefits of applying layer 2 (spatial planning) and layer 4 (recovery and resilience) where traditional (level 1) measures are not sufficient on their own or appropriate, cost effective or sustainable to achieve more sustainable solutions to increasing flood risk.

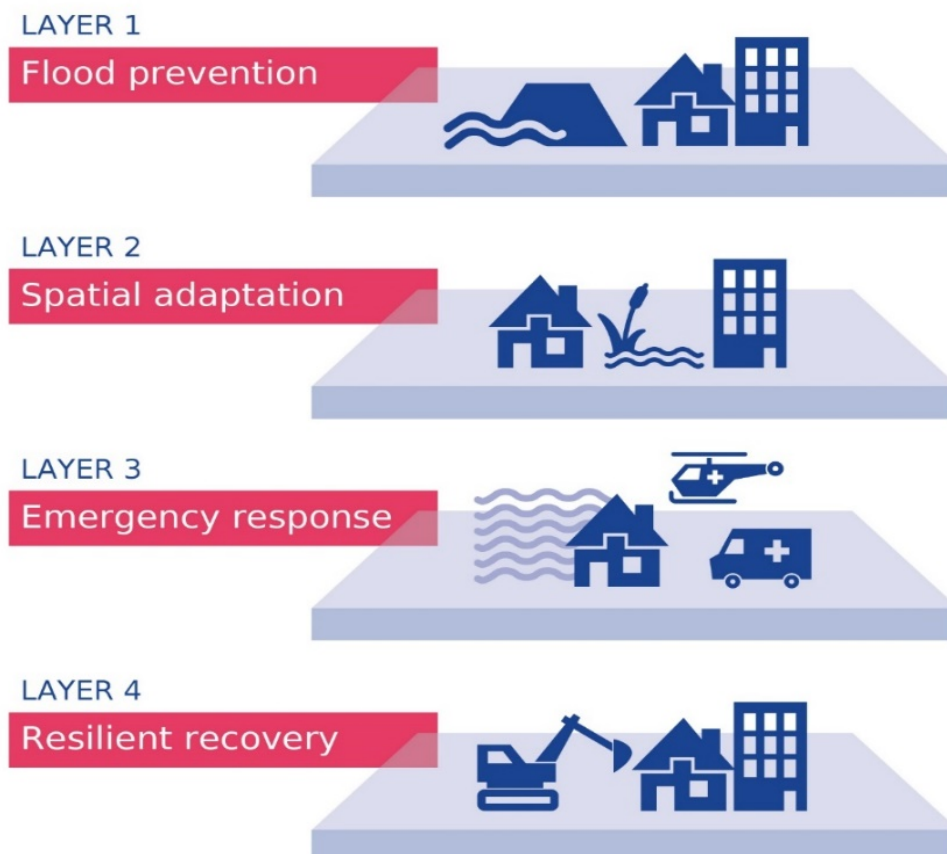


Figure 1. The Multi-Layer Safety approach applied in the FRAMES project

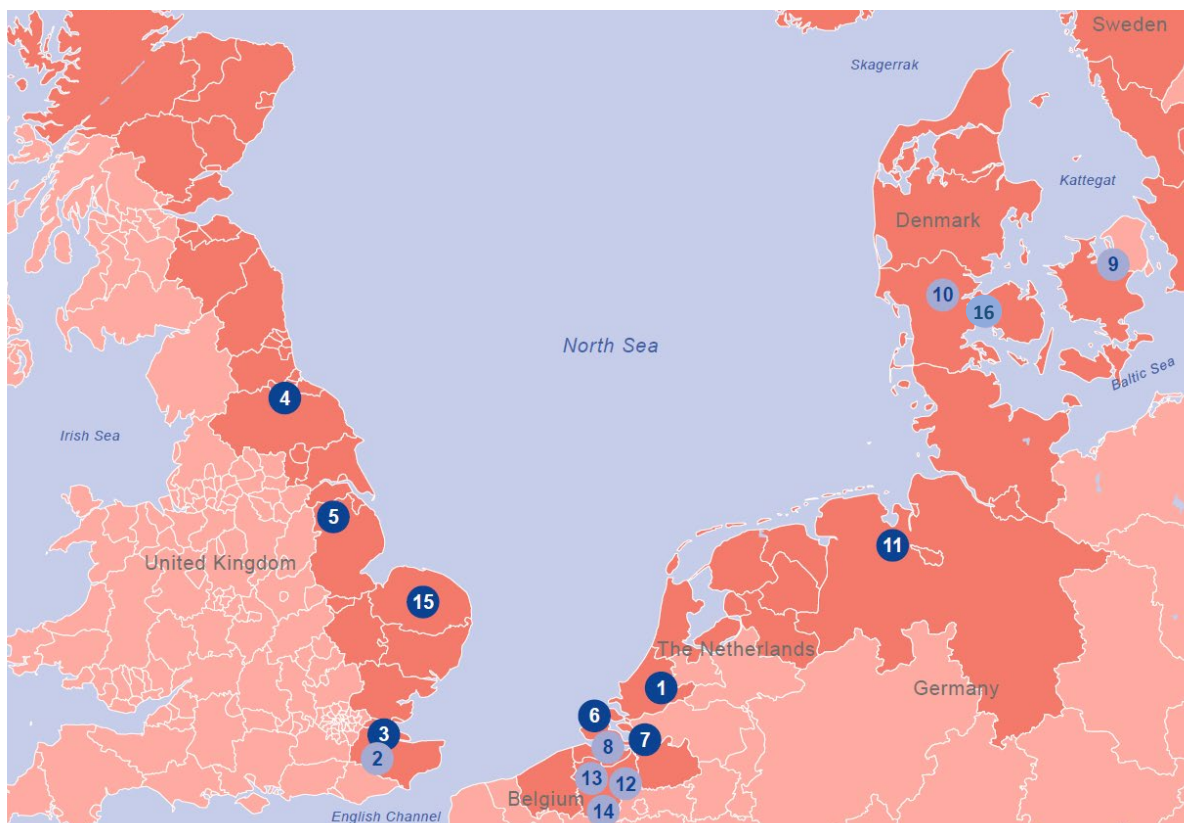


Figure 2. FRAMES' 16 pilot locations in five NSR countries.

- 1: Alblasserwaard-Vijfheerenlanden; 2: Kent; 3: Medway Catchment; 4: Lustrum Beck; 5: Southwell;
 6: Floodproof electricity grid Zeeland; 7: Reimerswaal; 8: Sloe area; 9: Roskilde; 10: Vejle; 11: Wesermarsch;
 12: Ninove; 13: Denderleeuw; 14: Geraardsbergen; 15: Butt Green Shield; 16: Assens.

Box 1. The FRAMES project in a nutshell

Partners: Province of Zuid-Holland (Lead Beneficiary), Province of Zeeland, Rijkswaterstaat Zee en Delta, HZ University of Applied Sciences, Veiligheidsregio Zeeland, Kent County Council, The Rivers Trust, Tees Rivers Trust, Trent Rivers Trust, National Flood Forum, Carl von Ossietzky University Oldenburg, Jade Hochschule, Oldenburgisch-Ostfriesischer Wasserverband, Province of Oost Vlaanderen, Ghent University, Danish Coastal Authority.
Project duration: 1 October 2016 – July 2020
Total budget € 6.924.911,-- [ERDF contribution € 3.462.455,--]
Websites: <http://www.northsearegion.eu/frames> and <http://www.frameswiki.eu>

In FRAMES, sixteen pilot projects in five countries, Belgium (BE), Denmark (DK), Germany (DE), the Netherlands (NL) and the United Kingdom (UK), experimented with the MLS-concepts in order to improve the overall resilience of areas, communities and authorities. The pilot projects that focused on flood resilient areas looked at spatial adaptation (flood proof design and planning, resilience of critical infrastructure and adaptive planning) and catchment management measures in the form of natural flood management (NFM). The pilot projects that focused on flood resilient communities looked at ways to empower citizens and social stakeholders to increase flood preparedness and emergency response (increase flood risk awareness, improve risk communication). In Denmark, one pilot focused on learning about Recovery planning.

This report presents the results from the transnational monitor and learning evaluations about resilient areas and communities in five countries in the NSR . It provides insight in the lessons learnt in the pilot projects and the adaptive capacities that were applied and developed to implement diverse MLS measures. This report is addressed to practitioners working on FRM issues in all its forms and shapes.

Box 2 Key terms used in FRAMES.

Multi-Layer Safety Approach: The Multi-Layer Safety (MLS) approach is a risk-based approach to manage the consequences and probability of a flood through three types of measures (see figure 1): (1) prevention through dikes, levees and dams; (2) mitigation via spatial planning; (3) crisis management through preparedness and emergency response (Kaufmann *et al.* 2016).

Flood resilience goes beyond the ability to 'resist' when exposed to high water levels, towards the ability to 'recover' from a flood and to 'adapt' or to 'transform' the existing approach considering the future climate change uncertainties. Resilience in flood risk management (FRM) embraces the deployment of measures reducing flood risk through a combination of protection, prevention and preparedness to reduce the flood hazard and associated consequences (Zevenbergen, Gersonius, & Radhakrishan, 2020). In FRAMES, the aim is to enhance the resilience of areas, through flood proof design and planning, resilience of communities via increase self-efficacy and capacity of authorities through transnational learning.

2. Framework and data collection

This chapter includes a brief description of the theoretical concepts used to develop the monitoring and evaluation framework. It includes an overview of the application of this framework to collect data and learn from the pilot projects.

2.1 FRAMES' integrated monitoring and evaluation framework

Using FRAMES' joint theoretical framework (figure 3), we have assessed, evaluated and learnt from the pilot projects regarding the main outcomes and the capacity development during the implementation of diverse Multi-Layer Safety (MLS) measures. This theoretical framework integrates three components: the Adaptive Capacity Wheel (ACW, see Appendix B) (Gupta et al., 2010) the Triple Loop Learning approach (Pahl-Wostl, 2009) and the Pilot Paradox (van Buuren, Vreugdenhil, Van Popering Verkerk, et al., 2018). Each pilot project was set up in a different flood governance context which in turn determined the characteristics of the pilot's goal, stakeholders involved, selected measures for implementation and final pilot outcomes (see table 1).

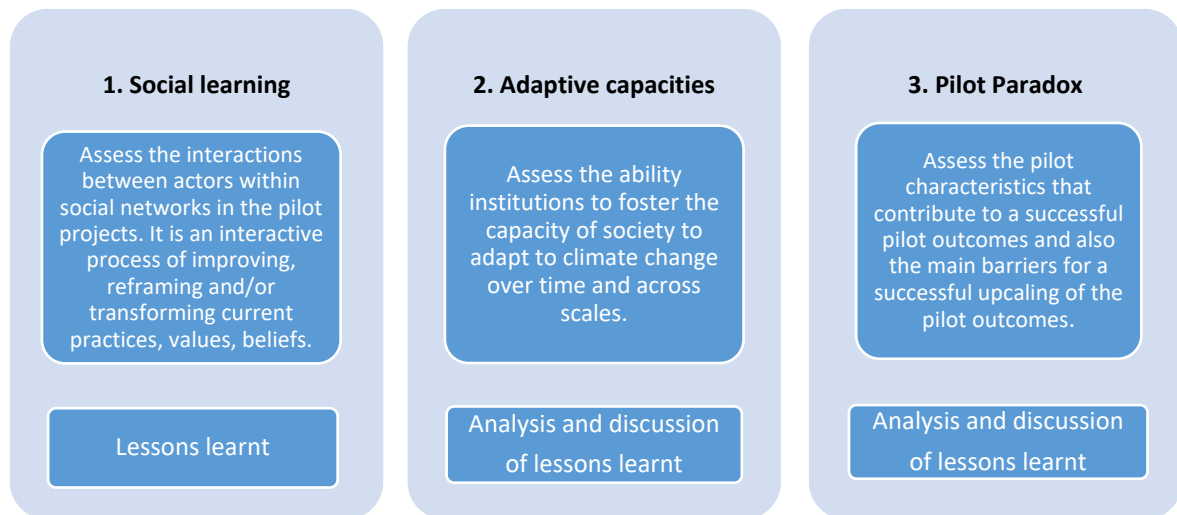


Figure 3. FRAMES' integrated monitoring and evaluation framework

The framework has been used to identify the insufficient, employed and developed capacities before, during and after a pilot project. Insufficient capacities refer to capacities that are not present, or present but not applied. Employed capacities refer to the capacities present and applied throughout the pilot projects. Developed capacities refer to the capacities improved or emerged in the governance context as a result of the pilot projects. 'Before' refers to the situation at the time the pilot project started – this is taken into account because it can determine the character of the implementation process and pilot outcomes. 'During' refers to implementation of MLS measures during the pilot project and what can be learnt from this implementation process. 'After' refers to outcomes of the pilot projects and potential upscaling of outcomes in order to change or transform current the FRM policies (see figure 4).

FRAMES' integrated monitoring and evaluation framework thus supports transnational learning from pilots; the outcomes were used to summarize lessons learnt regarding capacity development in pilot projects when implementing diverse MLS measures to improve flood resilience in flood prone areas and vulnerable communities. Additionally, the lessons learnt were used to shape policy recommendations for the local, regional, national and European level.

Table 1. Flood risk governance in countries of pilot studies. Based on Matczak et al. (2016: 72)

Characteristics of governance	Belgium	United Kingdom	The Netherlands	Germany	Denmark
Diversification & dominance	Moderately diversified, defence still important	Highly diversified, quite balanced	Low diversification, defence dominant	High diversified, focus on defence	Highly diversified, focus on defence
Multi-sector	Water sector and spatial planning gaining equal importance; water sector still important	Multi-sector involvement integrated by spatial planning	Water sector dominant	Multi-sector involvement integrated by spatial planning	Multi-sector involvement (landowners and farmers have a say; landowners do not pay)
Multi-actor	Public (state dominant)	Public and private	Public (state dominant)	Public (state and federal states) dominant	Public & private
Multi-level	Decentralised, tendency towards centralisation	Central and local level	Both central and regional level	Central guidance Decentralization to federal state local level	Central guidance Ongoing decentralization to local level

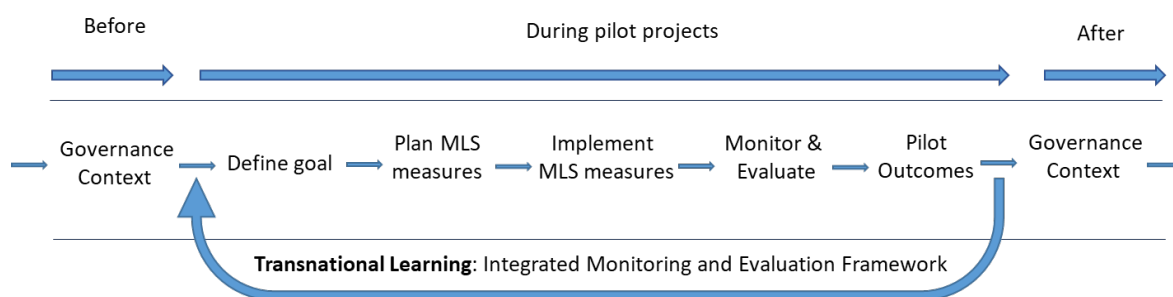


Figure 4. Transnational learning from pilot projects

2.2 Data collection

Data was collected from all the pilot project using surveys, semi-structured interviews, transnational focus groups, site visits and workshops. This all was complemented with additional information from FRAMES project meetings and documents (internal reports and presentations) to make the findings more robust.

2.2.1 Baseline and final monitoring surveys

For each pilot project, a baseline and a final monitoring survey (Appendices C1 and C2) was completed by the pilot managers in consultation with key pilot stakeholders. The actors filled out the baseline monitoring survey prior to the start of the pilot project, (October 2017) and at the end of the pilot project (March 2020). This allowed us to identify the current situation – before the pilot started – but also obtain a description of the future situation,

not only the expectation after the pilot project, but also the situation five years after the pilot had finished. The main questions evolved around the level of implementation of Flood risk management (FRM) actions (flood protection/prevention, protection/ defence, mitigation, preparation and recovery) and the perceived current and future level of flood resilience among authorities and communities. Pilot managers were also asked to reflect on what will happen with the lessons learnt at the end of the project.

2.2.2 Semi-structured interviews

Based on the theoretical framework, a comprehensive interview guideline was developed (Appendix D). The purpose of the interviews was to get insight into the process of decision-making while implementing (elements of) the MLS approach in the pilot areas. This included views on the regional capacities for flood resilience, drivers and barriers for change and the impact of the expected outcomes for the pilot region. All pilot managers were interviewed face to face (figure 5), and the recordings were transcribed and checked by the pilot managers. Data analysis was performed using systematic coloured coding (Fereday & Muir-Cochrane, 2006) to determine the insufficient, employed and developed capacities before, during and after the pilot project.



Figure 5. Interviews with pilot manager (Denmark, 2019)

2.2.3 Transnational Focus Groups

The activities of all pilot projects have been inventoried and categorized into eleven MLS actions and grouped into seven main actions for resilient areas and communities taking into account the similarities of the pilot projects goals (see table 2). Six out of eleven actions were selected as point of departure for six transnational focus groups (TFGs) (see *italics* in table 2, figure 6). These topics were selected for the TFG because pilots in several countries were working on these actions and/or related activities. This allowed the participants to bring forward experience and knowledge from their own pilot activities during the transnational exchange. Since there was only one pilot project focused on resilient recovery, this was not selected as point of departure for a TFG. The purpose of the TFGs was to gain insight into the characteristics that have enabled capacity development for flood mitigation, preparedness and response actions in the pilot projects (see table 3 and figure 6). The final column in table 2 shows the relevant layers of MLS for each action, starting with the main layer for each action.

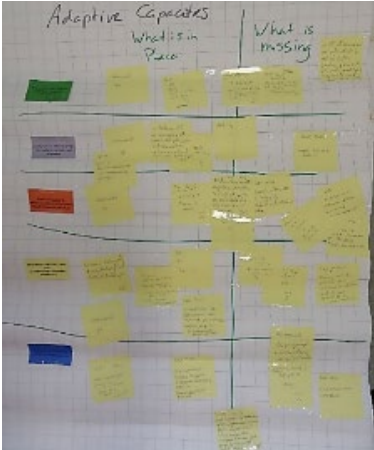


Figure 6. Transnational focus groups workshop, FRAMES partner meeting Kent (UK), November 2019

Table 2. Combination of MLS actions and TFG themes in FRAMES' pilot projects

Theme	Pilots	#	MLS Actions	#	Main actions	MLS Layers
RESILIENT AREAS	Ninove, Geraardsbergen, Denderleeuw (BE)	1	<i>Improving zoning of developments in flood prone areas (TFG1)</i>	1	Flood proof design and planning	2, 1
	Butt Green Shield (UK), Ninove (BE)	2	Reducing surface flood risk from extreme rainfall via increasing storage capacity in private and public space			2, 3
	Medway, Lustrum Beck, Southwell (UK)	3	<i>Lowering flood risk for communities via nature based solutions upstream (TFG4)</i>	2	Natural Flood Management (NFM)	2, 1, 3
	Reimerswaal, Flood Proof Electricity Grid Zeeland (NL), Kent (UK)	4	<i>Realizing a flood proof critical infrastructure (and cascading effects) (TFG5)</i>	3	Critical infrastructure	2, 1, 3,4
RESILIENT COMMUNITIES	Alblasserwaard-Vijfheerenlanden (NL), Wesermarsch (DE), Kent, Sloe area (NL)	5	<i>Integrate emergency response planning in FRM (and vice versa) (TFG2)</i>	4	Preparedness and emergency planning	3, 2,1,4
	Alblasserwaard-Vijfheerenlanden, Reimerswaal, Sloe area (NL), Wesermarsch (DE)	6	Improve evacuation strategies (preventive evacuation, safe haven, shelters, vertical evacuation)			3, 4,2,1
	Medway, Lustrum Beck, Southwell, Butt Green Shield, Kent (UK), Ninove, Geraardsbergen, Denderleeuw (BE), Wesermarsch (DE), Sloe area, Alblasserwaard-Vijfheerenlanden (NL)	7	Raising awareness for flood resilience measures			3, 4
	Ninove, Geraardsbergen, Denderleeuw (BE), Sloe area, Alblasserwaard-Vijfheerenlanden (NL), Wesermarsch (DE)	8	Involving community groups (citizens, farmers, business, schools) in flood resilience measures			3
	Medway, Lustrum Beck, Southwell, Butt Green Shield, Kent (UK), Ninove (DE)	9	<i>Empowering communities to take action for local flood resilience measures (TFG3)</i>	5	Community resilience	3, 4
	Roskilde (DK)	10	Improving flood recovery learning from previous flood recovery process	6	Resilient recovery	4, 3
Adaptive planning	Assens, Vejle (DK)	11	<i>Apply adaptive planning to look for tipping points in FRM strategies and to explore synergetic combinations of strategies (TFG6)</i>	7	Adaptive planning	4, 3,2,1

The seven main MLS actions within FRAMES were discussed within Transnational Focus Groups during FRAMES partner meetings in Oldenburg and Kent.

- Oldenburg (DE), 27 March, 2020: Flood proof design and planning, Emergency response, Community resilience and Recovery
- Kent (UK), 12 November, 2019: NFM, Critical infrastructure and Adaptive planning.

2.2.4 Workshops

Several interactive workshops were organized during the transnational project meetings to share knowledge and collect data related to the transnational learning process of pilot projects.

- Knowledge institutes meeting to discuss approaches and activity planning (Utrecht (NL) 26 January 2017; Ghent (BE), 27 June 2017; Oldenburg (DE), 28 June 2017);
- Transnational focus groups to gain insight on the governance context of each pilot project (see table 1) and the intended actions, Kings Mill (UK), 8 November 2017); see figure 7;
- Transnational focus groups to inventory tools and approaches used in pilot projects, Aalst (BE), 17 May 2018; see figure 8;
- Two workshops to discuss the application of Adaptive planning in relation to MLS Actions (Lemvig (DK), 5-6 February 2018; Aalst (BE), 14 May 2018);
- Knowledge institutes meeting to finish the transnational monitoring and evaluation framework, The Hague (NL), 21-22 November 2018); see figure 9;
- Workshop for development of policy recommendations for MLS actions, in addition to TFGs (Oldenburg (DE), 27 March 2018);
- Workshop to get an overview into the lessons learnt and the upscaling of the pilot outcomes beyond the project (Kent (UK), 13 November 2019, see also Appendix E); see figure 10.

Box 3. Key terms used, continued

Flood governance: a process of - more or less institutionalized – interaction between public and private entities ultimately aiming at the realization of collective goals (Lange et al., 2013).

Adaptive capacities: inherent characteristics of institutions that empower social actors to respond to short and long-term impacts either through planned measures or through allowing and encouraging creative responses from society both *ex ante* and *ex post*. Adaptive capacity is promoted if institutions (1) encourage the involvement of a variety of perspectives, actors and solutions; (2) enable social actors to continuously learn and improve their institutions; (3) allow and motivate social actors to adjust their behavior; (4) can mobilize leadership qualities; (5) can mobilize resources for implementing adaptation measures; and (6) support principles of fair governance (Gupta et al., 2010).

Adaptive planning: Adaptive planning processes like Dynamic Adaptation Policy Pathways (DAPP) affect the development of climate adaptation strategies and how they deal with uncertainties (Buijs et al., 2018). The DAPP is a method for decision making under deep uncertainties future arising from social, political, technological, economic, and climate changes. This method combines two approaches for designing adaptive planning: ‘adaptive policymaking’ and ‘adaptive pathways’ (Haasnoot et al., 2013). In FRAMES, the DAPP approach was adjusted (from ten to six steps) to the Danish context to develop a robust urban development plan to make Assens and Vejle flood proof cities.

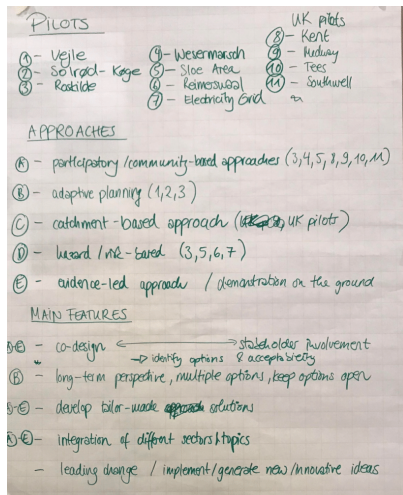


Figure 9. Toolkit workshop in BE, 2018



Figure 8. Governance context workshop in UK, 2017



Figure 7. Workshop focussing on the framework in NL, 2018



Figure 10. Workshop discussing lessons learnt in UK, 2019

2.2.5 Site visits

Besides interviews, TFGs and workshops, the transnational project meetings were complemented with site visits (figures 11 and 12) to get a deeper understanding of each pilot project. During the visits, all project partners could visualize how the prevention and preparedness measures were implemented and how they work in practice. Meanwhile, they could exchange experiences and learning related to FRM practices implemented in their home country.



Figure 12. Site visit Medway pilot (UK), 2019



Figure 11. Site visit Wesermarsch pilot (DE), 2019

3. General lessons learnt and transnational FRAMES products

This section provides an overview of products developed during FRAMES, based on the results of the transnational monitoring and evaluation. Hence we will discuss overall lessons learnt.

3.1 Decision Support System, policy recommendations and toolkit

The transnational monitor and evaluation of the pilot projects has resulted in the Decision Support System, or DSS, of FRAMES. This DSS presents the main actions in the different layers of Multi-Layer Safety (MLS) in a coherent framework, showing the interrelations between all MLS actions. Each of the actions is described on a separately, showing the interrelations with other actions, lessons learnt in FRAMES, adaptive capacities needed and relevant tools to implement this action. The [Decision Support System](#) is available on the FRAMES wiki and further explained in chapter 7.

Based on the lessons learnt of the transnational monitor and evaluation, the FRAMES partnership has compiled [Policy recommendations](#) for the MLS strategies, Tools & instruments, Policies & programmes, and Stakeholder involvement & support.

The [Toolkit](#) provides an overview of relevant tools per MLS layer, including descriptions and available links for the further information to apply specific tools.

3.2 General lessons learnt

By combining the findings of the transnational monitoring and evaluation with the pilot findings, general and specific lessons learnt for each MLS core action (see tables 2 and 3) were distilled. Since there was no TFG on resilient recovery, lessons learnt for this layer were derived directly from the analysis of the pilot project focussing on this topic.

Table 3. Action themes of MLS approach for resilient areas and resilient communities

Themes	#	Main MLS actions	Layer
Resilient areas	1	Flood proof zoning	Spatial adaptation measures, layer 2
	2	Natural Flood Management (NFM)	
	3	Critical infrastructure	
Resilient communities	4	Preparedness and emergency planning	Emergency response, layer 3
	5	Community resilience	Resilient recovery, layer 4
	6	Resilient recovery	
Adaptive planning	7	Adaptive planning	All layers

We have included the lessons learnt about Adaptive planning in the general lessons learnt, since this action is not directly linked to Resilient areas and Resilient communities, but rather about the planning process that links the different MLS actions.

The following lessons learnt are derived from all pilot projects - they refer to the MLS approach in general, beyond specific actions taken in one of the layers.

An integrated MLS approach requires high level participation of multiple actors

Multiple organisations with different responsibilities in flood risk management (FRM) and crisis management often work independently from each other. However, during FRAMES, diverse water and crisis management organisations were involved in the pilot projects sharing responsibilities in FRM. Local stakeholders were involved early on in the process because they could share concrete knowledge relevant for the implementation of MLS measures in the area. During FRAMES, stakeholders were open to share their needs and were willing to work towards increased flood resilience. This collaboration process helped to reach a common understanding of the problems and solutions, share information and implement actions in a more efficient manner. This has led to a higher commitment and engagement among all stakeholders involved. Therefore, collaboration among stakeholders is key to diversify FRM strategies.

"... you need integration of different topics... we have to assume that 100% [safety] doesn't exist and how to deal with this remaining risk due to floods...for this purpose we need spatial measures, we need emergency measures and ...bring people together who work on these different topics". [Helge Bormann, Jade University, pilot manager for the Wesermarsch pilot project, Germany, 23 January 2019]

"... choose an integral approach so you can achieve multiple goals. As Province we don't have a specific role in layer 3 (emergency response) but helping the Safety Region with the third layer improves the MLS approach to get a better solution. Cooperation and collaboration is the key to the solution because you all need each other. Everyone has a part of the solution and combining them will create a broader and better solution." [Lucy Smeets, Province of Zuid-Holland, pilot manager for the Alblasserwaard-Vijfheerenlanden pilot project, the Netherlands, 28 February 2019]

Continuous communication is crucial

Collaboration among stakeholders is key when diversifying FRM strategies. However, collaboration cannot exist without clear communication among all stakeholders in a pilot area. Communication is a first step towards clearly identifying the responsibilities of each actor in FRM, and to get a shared understanding of the needs and solutions to avoid unnecessary redundancy of FRM measures. In all pilot projects, pilot managers kept communication lines with all stakeholders (authorities, NGOs, citizens, schools, farmers) open and flowing and explained the purposes and the effects of MLS actions. The way the message was worded and sent, including the channel (e.g. newspapers, face to face, see below) used to communicate with local communities, turned out to be crucial when trying to motivate and engage stakeholders. Pilot managers used different ways to communicate with stakeholders: information materials (brochures, flyers, booklets), community events (sport events, coffee evenings), face-to-face discussions, local social media (newsletters, magazines, newspapers, Facebook, Twitter, email).

" ... communication, getting to know all the stakeholders, building relationship with the residents and the businesses...understanding that they need to get out of this project...what message and method of communication works best for each individual". [Michelle Steel, National Flood Forum, pilot manager for the Butt Green Shield pilot project, the United Kingdom (UK), 8 March 2019]

"Communication and engagement, make sure that you are engaging with the right people in the right place... get them the message you want them to get." [Mark Smith, Kent County Council, pilot manager for Kent pilot project (UK), 6 March 2019]

Flood risk awareness needs to be increased

Pilot outcomes clearly showed that, even though responsibilities in crisis and water management are clear in the FRAMES countries, flood risk awareness among the involved stakeholders is low. Stakeholders, especially citizens, do not know what to do or who to contact in case of a disaster. As a result of the pilot projects, informative materials such as flyers, brochures, booklet, and webpages, were developed to increase flood risk awareness, and thus preparedness, of citizens. The informative materials include clear information for citizens

about the authorities responsible for disaster management. Furthermore, the involvement of water and crisis management organisations, local authorities and citizens through workshops and participatory meetings resulted in awareness increase of the local flood risks in their pilot areas: the need for preparedness, response actions, shelter locations, and clarification of their own responsibilities in FRM. Nevertheless, raising flood risk awareness should not stop when a project is finished – it should be a continuous effort.

“Take [your] time because awareness takes time. People also need time to get aware that they are part of the solution.” [Lucy Smeets, Province of Zuid-Holland, pilot manager for the Alblasserwaard - Vijfheerenlanden pilot project, the Netherlands, 28 February 2019]

You should take your time. You won’t change people’s attitudes and minds just in one day. It takes a lot of time to build up a new approach to flooding and you should respect and accept that.”[Hannelore Mees, Province of East Flanders, pilot manager for the Belgian pilot projects 25 January 2019]

Improve local flood risk maps for tailor made solutions

FRM actions, such as spatial planning, evacuation routes, and response actions, will improve when the local flood risk maps are updated according to the most current area risk analyses. Most of the FRAMES pilot projects conducted modelling to update their flood risk maps to improve the FRM actions. E.g. in the Wesermarsch (DE) and Alblasserwaard-Vijfheerenlanden (NL) pilot projects, the evacuation route maps were improved and in the Belgian and British pilots, the location of the water retention measures were selected using updated flood risk maps.

“... very important to invest in a very good relationship with all stakeholders. ...reach a certain amount of trust base because...there is a lot of confidential information... and make a good agreement with (electricity grid) owners.” [Erik Schumacher, Province of Zeeland, pilot manager for the Floodproof Electricity grid Zeeland pilot project, the Netherlands, 16 January 2019]

Change takes time, a lot of time

It takes time to understand what to do in each stage of the pilot project in order to meet the project objective. Likewise, it takes time to build trust, to engage with local community groups, to increase flood risk awareness. Time also plays a role to continue motivating and engaging stakeholders for next steps such as new projects, and policy changes. Motivating actors, gathering information and planning events is challenging and takes time. Overall, in all pilot projects, stakeholders needed the lifespan of the project, four years, to increase flood risk awareness and create a sense of urgency to take preparedness measures. Therefore, time is key to deliver useful pilot outcomes for all those involved.

FRM everyone’s responsibility, but a bottom-up approach results in more engagement

When FRM is traditionally a government’s responsibility, it will take time, energy and commitment to go from a single responsibility perspective to a collective responsibilities’ perspective. More commitment and engagement can be achieved by starting from the local level: what are the local needs, what do stakeholders expect from you, and what would they like to achieve and/or what can they contribute. However, citizens often do not have enough knowledge about flood risk measures related to planning and legislation. Next to that, awareness might also be low (or non-existent) in areas where flood events have not happened for a while. Once they are awareness of the flood risk in their area, they start to feel responsible. They have the knowledge of the local area, they know which are the main problems and what would be the most suitable solutions. Therefore, local government should support citizens’ needs and share with them responsibilities of FRM actions at local level.

Draw lessons learnt to enhance replication in other areas

Communication and dissemination of pilot projects' results are a way to spread the message and motivate actors from other regions or countries to replicate the findings. In the United Kingdom, the NFM interventions used in FRAMES will also be applied in other river catchments because new implementation techniques have been developed in FRAMES. The farmers and landowners have more knowledge about their role to reduce flood risk locally and farmers from another catchment visited the areas where NFM were implemented in the Lustrum Beck catchment. Another example can be found in Denmark where the Danish Coastal Authority sent the recovery guidelines resulting from their pilot projects, to all the municipalities in Denmark and included some of the findings into the FRM plans that the municipalities can use. As a result, another municipality, not part of the FRAMES consortium, is currently using the Dynamic Adaptive Policy Pathways (DAPP) approach for their urban development planning.

Develop a strategy to connect and mainstream the pilot outcomes into current FRM policies

Pilot projects are perceived as an easy and safe manner to experiment with new solutions that deal with the consequences of climate change. Innovative ideas or solutions are tested in pilot projects and actors learn from this process. However, due to the flexibility that actors have in the process, pilot projects tend to take too much distance from the (flood) governance system (van Buuren, Vreugdenhil, van Popering-Verkerk, et al., 2018). It is therefore essential to develop strategies to connect pilot project outcomes to the relevant policies at local, regional, national and European level as a way forward. In most of the FRAMES pilot projects, the lessons learnt were translated into input for policy making or policy advise. The lessons learnt were also disseminated via social media, conferences, and international academic journals to wider regional and national audiences. Communication of lessons learnt to political representatives can also be considered as an upscaling strategy. Several examples have been observed of linking pilot projects to policy making at the regional and national level . In the Kent pilot project (UK) the FRAMES team from the Kent County Council has a good relation with the policy makers within the Council and good connections with other governmental bodies to ensure the uptake and mainstreaming of the lessons learnt. Moreover, the pilot project findings were also integrated into other EU project such as [STAR2Cs](#), [C5a](#), [Cool Towns](#) and [H2O](#) to promote the FRAMES results widely across Europe. In the pilots of Alblasserwaard-Vijfheerenlanden (NL), Ninove and Geeraardsbergen (BE), public officials and political representatives were intensely involved in the pilot projects' process and communication became a strategy for mainstreaming the pilot results.

3.3 Adaptive planning: lessons learnt

Adaptive planning processes like Dynamic Adaptation Policy Pathways (DAPP) affect the development of climate adaptation strategies and how they deal with uncertainties (Buijs et al., 2018). The DAPP is a method for decision making under deep uncertainties future arising from social, political, technological, economic, and climate changes. This method combines two approaches for designing adaptive planning: 'adaptive policymaking' and 'adaptive pathways' (Haasnoot et al., 2013). In FRAMES, Assens and Vejle pilot projects (DK) worked with adaptive planning to plan and prioritize MLS actions, for layer 1, layer 2 and layer 3, in order to make both cities flood proof.

"... it is beneficial to work with long term planning and include measures from each of the 4 layers. That will make the planning more robust, more stronger...try to combine the measures, look not only at prevention but also at spatial planning and also consider where recovery will fit in to your long term planning. ...have a clear vision on how you would like your community area, city, country....measures...don't clash..." [Mie Thomsen, Danish Coastal Authority, pilot manager for the pilot projects of Vejle, Assens and Roskilde, Denmark, 4 April 2019]

Combining MLS with adaptive planning creates robust long term visions

The DAPP approach was combined with the MLS approach to make long term development plans towards flood proof cities. This process helped both Danish municipalities to define and prioritize diverse FRM decisions related

to flood protection, flood prevention via spatial planning and preparation and emergency planning. By combining the approaches, it was possible to figure out the benefits for long term planning since the synergetic combination of FRM measures from each of the MLS layers will make the planning more robust in the long term. For this to work though, the DAPP should be adjusted to the local context first before developing action plans. The Danish pilot projects did this by, amongst others, preparing a baseline study of the local challenges and performing a multi-criteria analysis of the chosen adaptation pathways.

Criteria needed to consider when applying the DAPP approach

The DAPP approach (a) needs the collaboration between stakeholder; between the municipalities and the Danish Coastal Authority, as well as between the different departments of each municipality, climate adaptation, urban planning, water safety departments); (b) the DAPP needs to be adjusted to the local context in terms of landscape, hydrology; (c) the soft measures such as emergency planning, need to be included in the action plan because the DAPP map does not show a direct impact; (d) the DAPP needs to refer only to one flooding sources, river or storm surge, but not both; and (e) the DAPP maps need to be explained by someone with knowledge about the DAPP approach.

A clear and shared vision is imperative

Adaptive planning needs a clear vision for the community area, city or country in question. At first, the municipalities had different ideas, but developed a shared vision via discussions that enabled the prioritization of measures. This increased the resilience of municipalities because there is now a more clear planning and better understanding of the constraints, the options and what decisions have to be made in the long term. Additionally, after FRAMES the local communities will be involved in decision-makings on how to decrease the flood risk for the municipalities.

Integrate adaptive planning into FRM plans

Municipalities should get ownership of this approach and engage on flood risk issues with their local politicians. The most efficient way to accomplish this, would be to integrate the DAPP method into the current FRM plans. In Vejle and Assens (DK), it was therefore recommended to use the DAPP approach when the municipalities have to adjust their FRM plans as issued by the European Floods Directive. This in turn, requires expertise of both, the DAPP approach and MLS concept to guide municipalities through the process.

4. Resilient areas: lessons learnt

Several pilot projects focussed on spatial adaptation actions, layer 3 of the MLS approach. Three pilot projects, Ninove, Geraardsbergen, Denderleeuw, Belgium (BE) aimed to improve flood zoning developments in flood prone areas. Two pilots, Ninove (BE) and Butt Green Shield, the United Kingdom (UK) aimed to reduce surface flood risk from extreme rainfall via increasing storage capacity in private and public spaces. The following lessons learnt from these four pilot projects are described on the following pages.

4.1 Flood proof design and planning

In layer 2, the spatial adaptation layer, preventive measures taken reduce consequences and damage of flood events by keeping water away from people and flood prone areas. Preventive measures require spatial planning and flood-proof spatial design. Spatial planning refers to removal of measures or relocation of construction in flood prone areas and appropriate land use (flood risk modeling, assessment, flood risk zoning). Flood-proof spatial design implies the adaptation of existing and future constructions (adjustments of existing houses and infrastructure). A total of four pilots focused on improving flood proof zoning design at property and neighbourhood level. The Belgian pilots (Ninove, Geraardsbergen and Denderleeuw) aimed to enhance the design and planning of urban developments in flood prone areas. The Butt Green Shield (UK) and Ninove pilot (BE) focused on reducing surface flood risk from extreme rainfall via increasing storage capacity in private and public space.

Look for synergies and use existing networks

Areas frequently affected by floods might have already a network or organisation focusing on FRM actions. If the area does not flood frequently, it can be helpful to try and build on already existing social networks in the area such as drinking water companies, road management agencies, and social housing companies. For example, in Ninove pilot project (BE), the Flemish Government worked together with social housing and citizens to design and plan a Vision and Action Plans with specific spatial adaptation measures for a flood proof neighbourhood. As a result, the water element was integrated at every level of the spatial management planning and specific responsibilities were defined among the public, civic and private actors depending on their location in the water system.

Take the flood risk governance context into account

The political (in)stability of the flood risk governance context and the actors' agenda should be carefully considered when starting up a pilot project and/or implementing MLS measures. For instance, the start of the pilot project in Ninove (BE) was conditioned by the instability of the political local context resulting in awareness raising of the political representatives of the city of Ninove;. considering that MLS actions are depending on different levels or scale (local, regional, national, European) ,many actors and context, the stakeholder analysis needs to have a multilevel and multi-actor focus.

Include local knowledge when making a flood risk assessment of the area

All risks and issues should be considered in the development of the project scope. The pilot projects implementing water retention measures in the form of natural flood management (NFM) water butts or raised flower beds conducted flood risk assessments by combining modelling and discussions with local authorities and communities. The purpose was not only to find out where the risk areas were, but also getting support and incorporating local knowledge in deciding about the location to install water retention measures. In the Geraardsbergen pilot project (BE), for instance, the neighbourhood committees provided information about flood risk mitigation at property level. In the Ninove pilot project (BE), the local authorities, social housing company and citizens worked closely together to inform all those involved about MLS and get input from stakeholders on flood mitigation actions for their property.

Demonstrate the added value of using water storage measures in flood risk management (FRM)

In FRAMES, pilot projects provided sufficient evidence about the effectiveness of water storage measures in FRM to reduce surface flood impacts resulting from extreme rainfall. Water butts or raised flower beds at household level or NFM at catchment level, can also reduce flood impacts for people and areas when implemented at a wider scale, either catchment or neighbourhood level. The use of these solutions at a wider scale is a new strategy in the United Kingdom.

4.2 Natural flood management: lessons learnt

NFM interventions are used as preventive measures looking beyond managing floods at household or town level to manage floods at catchment level. A total of three pilot projects (Medway, Southwell and Lustrum Beck) implemented NFM measures to lower flood risk in different catchments in the United Kingdom: Medway, Lustrum Beck and Southwell. The following lessons learnt were derived from these three pilot projects.

Work in partnerships to create a shared understanding of problems and solutions

Taking measures in a catchment requires the involvement of several parties such as environmental agencies, nature organisations, local authorities and communities. Working in partnership allows to develop a shared understanding of the problems and solutions, to narrow down the scope of the project while having a long term vision, and match plans and interests to reduce flood risk in a catchment. In these pilots, the partnerships for instance facilitated the decision making of the location for the implementation of the NFM interventions. The partnerships also improved the communication between authorities and local communities which in turn resulted in better collaboration among the stakeholders involved in the partnerships.

Working within a catchment means crossing political and administrative boundaries

To implement NFM measures at catchment level requires the collaboration among stakeholders across different governance layers. This means crossing boundaries, political or administrative, to avoid hitting barriers within a catchment, such as conflict of interests between landowners and environmental agencies. In the NFM pilot projects in the United Kingdom, stakeholders from every layer of governance collaborated: from knowledge institutes, local and regional governments, and drinking water and sewage organisations, to road management organisations, nature conservation agencies, flood action groups and NGOs. New collaboration groups resulted from the pilot project with: the riparian owners, the landowners and the local councils.

Understand and combine the political, hydrological, geological and social context of a catchment

Before implementing NFM measures to reduce flood consequences, it is important to understand the geology, hydrology and social system of the catchment where NFM will be applied. The FRAMES pilot projects used flood risk assessments to determine flood risk areas combined with modelling, visual observations, knowledge of local communities to select sub-catchments for NFM interventions.

Continue monitoring NFM measures to demonstrate (additional ecological) benefits

By monitoring the NFM interventions beyond the lifespan of the pilot project, it will be possible to show the effectiveness of NFM. This knowledge should also be passed to other stakeholders in other catchments to increase flood resilience there as well. E.g. as a result of the Medway pilot project (UK), a methodology was developed to identify priority areas, to better target measures for further work in the Medway Catchment. The evidence base will continue to improve as a result of the planned long-term monitoring of the NFM measures.

Dissemination is key to ensure the implementation of the NFM interventions

In the Southwell pilot (UK), the Trent Rivers Trust worked together with the Southwell Flood Forum to raise awareness among communities that have been flooded and communities that have never been flooded. They provided a flood warden (volunteers) network with an infrastructure and communication hub to disseminate information. This has allowed stakeholders to implement NFM in the Trent river area as well as other catchments.

Integrate a catchment based-approach into flood action plans

NFM interventions are used as preventive measures looking beyond managing floods at property/ town level to manage floods at catchment level. In order to implement NFM wider in the catchment, the strategic flood action plan should improve. In Lustrum Beck pilot (UK), the pilot manager will integrate the wider catchment management planning into infrastructure development plans.

4.3 Critical infrastructure: lessons learnt

Three pilot projects, Reimerswaal, Flood Proof Electricity Grid Zeeland(NL) and Kent (UK) focused on assessing the vulnerability of critical infrastructure to flood events. The following lessons learnt were drawn from these three pilot projects.

A thorough flood risk analysis of the area is essential

It is important to conduct a solid flood risk analysis of the area in order to get a realistic view on what happens with critical infrastructure (electricity grids, health centres, roads, railways, harbours, drinking water supply, among others) when an area floods. This impact was unknown in the Netherlands, and therefore, a vulnerability study was carried out to identify the cascading effects of electricity grid failure in case of a flooding. In the Kent pilot project (UK), risk assessment tools and models were used to accurately study the vulnerability of critical infrastructure and communities to floods.

Increase awareness about the vulnerability of critical infrastructure

Generally, there is a lack of knowledge and research done about the vulnerability of critical infrastructure to floods. As a result of these FRAMES pilots, new knowledge was developed about the vulnerability of critical infrastructure such as electricity grid networks, health care institutions, roads. In the Netherlands, the organisations managing these infrastructure became aware of the flood risk and their responsibility of taking actions to become more resilient. The owners of the health care institutions in the Flood proof electricity grid pilot project for instance, now realize that they have to acquire their own power generators in case of an electricity failure. A next step for them is to include flood safety in their management asset plans.

Transform knowledge about impacts of floods on critical infrastructure into policy advice

The increase of knowledge on how cascading effects can be prevented, were translated into policy advice for the Dutch national government, and could be integrated into the asset management plans for electricity grids and/or to develop similar vulnerability studies for other vital services (telecom, gas) and other climate change effects (droughts, heat stress). In the United Kingdom, the knowledge developed has been used to engage with decision makers in Kent County Council and update flood response plans. They will continue to engage with planners and water managers to strengthen physical resilience of new build developments, increase consideration of flood risk in planning policy and will incorporate this into future projects of Kent County Council about resilience to climate change.

Find out who should be involved in the project

In the Dutch pilot projects, the first step was to investigate the stakeholders of the study area, because it is extremely important to get the right people (and hence the right power, the right knowledge and the right networks) actively involved before the pilot project starts. For the Dutch pilot projects, this resulted in bringing together people that never before cooperated: flood risk professionals from local and regional authorities together with the asset and quality managers of critical infrastructure. It is important to realize that not all stakeholders realize themselves that they have a stake in the issue at hand, and it might be necessary to pro-actively involve parties, and clarify their stake for them. Likewise, for the Kent pilot (UK), flood risk and crisis management authorities (the Kent County Council, Kent fire and rescue, Kent police among other) never met before with service providers.

Trust equals success

In the Netherlands, pilot managers had to build a relationship with the owners of critical infrastructure. An agreement was signed with the owners of the electricity grid to ensure that confidential information (such as the exact location of the electricity grid assets) will not be published. As a result, trust was created among project partners, and the group as a whole was motivated to work on this together.

Have a clear and understandable message

In all three pilot projects (Reimerswaal, Flood Proof Electricity Grid Zeeland (NL) and Kent (UK)), it proved difficult to communicate the exact meaning and consequences of the low probabilities of flooding, or the cascading effects of electricity failures. Flood risk maps were therefore used to assess flood consequences and to communicate the low possibilities of flooding. In the Kent pilot, a set of guidance documents for businesses was produced to overcome this gap.

4.4 Preparedness and emergency planning: lessons learnt

Most pilots aimed to improve flood preparedness in their countries. Four pilot projects (the Alblasserwaard-Vijfheerenlanden and the Sloe area pilots in the Netherlands, the Kent pilot project in the United Kingdom and the Wesermarsch pilot in Germany) focused on integrating emergency response planning in FRM. Four pilot projects (the Alblasserwaard-Vijfheerenlanden, the Reimerswaal and Sloe area pilots in the Netherlands and the Wesermarsch pilot project in Germany) focused on improving evacuation strategies (preventive evacuation, safe haven, shelters, vertical evacuation). These are the lessons learnt taken from those pilots.

Share knowledge, insights and perspectives

In Germany, regional fora were organized with water and crisis management organisations to share knowledge and information regarding their perspective on FRM and to improve flood preparedness in the region. In the Alblasserwaard-Vijfheerenlanden pilot project (NL), it was difficult to engage municipalities but the project opened the eyes of the mayors for the necessary links between water and spatial planning for evacuation. As a result, collaboration among authorities responsible for water, crisis management and spatial planning was greatly enhanced.

Find out how much social capital in case of emergency planning is available

In the Alblasserwaard-Vijfheerenlanden pilot project (NL), an assessment was carried out to identify which local groups can act as volunteers in case of evacuation (for instance churches, sport clubs, local businesses, and retired firefighters). Knowing how many volunteers are present in the area is extremely valuable in case of an emergency.

Identify criteria for potential shelter location

It is important to identify which buildings in a city fulfil the requirements of a shelter that can be used in case of a disaster such as flooding. These requirements are: high building to keep dry during a flooding; accommodate a large number of inhabitants from the area; be easily accessible by road; have facilities such as toilets, drinking water, heating; be water proof. In the Sloe area pilot project (NL), the harbor facilities were assessed to find out if it can be used as a 'safe haven' or shelter for the people living in the area. The outcome was that while it could be used as an emergency response hub, it cannot be used as shelter location, because it does not fulfill the requirements.

Develop a clear communication strategy in case of emergency response

In the Netherlands, the chance for flooding due to dyke breaching is very low (1 in 4000 years) and it has proven difficult to communicate such low probabilities of flooding to authorities responsible of spatial adaptation measures to ensure safe evacuation via roads or railways in case of flooding. Communication with citizens about flood risk is also very important. In the Sloe area pilot project, a communication strategy was therefore developed

to instruct citizens what to do before, during and after a flood in the area. This strategy also supports local authorities to improve their planning for emergency response and preparedness of communities.

Consider options and prepare an evacuation strategy in case of emergency

In the Sloe area pilot project (NL), an evacuation strategy with two options was developed: plan A is to evacuate people from high risk areas followed by the others, or horizontal evacuation via roads and waterways. Plan B is vertical evacuation: shelter people on the highest buildings in the area and evacuate them after few days. In the Wesermarsch pilot project (DE), there was no strategy on how to evacuate livestock in case of electricity failure due to flooding. Thanks to FRAMES, the farmers received a booklet with steps on how to increase flood preparedness of their farms.

5. Resilient communities: lessons learnt

Multiple pilot projects focused on preparedness and emergency planning, community resilient and resilient recovery actions (see Table 2). In this chapter, the lessons learnt are given for each these Multi-Layer Safety (MLS) actions.

5.1 Preparedness and emergency planning: lessons learnt

Four pilots projects (Alblasserwaard-Vijfheerenlanden, Reimerswaal, and Sloe in the Netherlands (NL), and the Wesermarsch in Germany (DE)) took actions to increase flood preparedness and emergency response to improve evacuation strategies. Additionally, many pilot projects took actions to increase flood risk awareness of communities: five pilots in the United Kingdom (UK) such as Medway, Lustrum Beck, Southwell, Butt Green Shield, Kent, three pilots in Belgium BE such as Ninove, Geraardsbergen, Denderleeuw, the Wesermarsch pilot project in Germany (DE) (and two pilots in the Netherlands NL such as Sloe area and Alblasewaard-Vijfheerenlanden. The following lessons learnt are related to these pilot projects.

Share knowledge, insights and perspectives about flood risk management (FRM)

In Germany, regional fora were organized with water and crisis management organisations to share knowledge and information regarding their perspective in FRM and to improve flood preparedness in the region. In the Alblasserwaard-Vijfheerenlanden pilot project (NL), it was difficult to engage municipalities but the project made the mayors aware of the necessary links between water and spatial planning for evacuation. In Belgium, participatory workshops were organized to inform with citizens, schools and business about MLS and to get input from them on needed actions in their area. As a result, collaboration among authorities responsible for water, crisis management and spatial planning was greatly enhanced.

Raise flood risk awareness

FRAMES pilot projects provided access to information to increase the flood risk awareness among involved or interested stakeholders: a flood preparedness manual for communities and awareness-raising brochure 'Water zonder overlast' (Water without nuisance) were produced in the Belgian pilot project, a brochure for farmers preparedness and their livestock was written and regional fora were organized to discuss 'Flood partnerships' in the Wesermarsch pilot project (DE). In the Lustrum Beck catchment (UK), annual community flood training events will be held to maintain awareness among communities. In the Ninove and Geraardsbergen pilot projects (BE), several workshops were organised with citizens, local authorities and a social housing company to present the MLS approach and decide upon FRM actions required to increase flood resilience. In the Denderleeuw pilot (BE), workshops were held with schools about climate change adaptation and local climate change issues (floods, droughts, heat island effects) and it was recommended to include these topics in the curricula of the schools.

Find out how much social capital in case of emergency planning is available

In the Alblasserwaard-Vijfheerenlanden pilot project (NL), an assessment was carried out to identify which local groups can act as volunteers in case of evacuation (for instance churches, sport clubs, local businesses, and retired firefighters). Knowing how much volunteers are present in the area is extremely valuable in case of an emergency.

Train volunteers who can help in a flood event

It is important to train volunteers who are interested to assist and prepare local communities at risk of flooding. They play an important role in preparing a community flood plan and putting it into practice. They are also a link between the local community and the agencies responsible for flood response. In the Southwell pilot project (UK), the Trent River Trust and Southwell Flood Forum developed a training for flood wardens (volunteers) on the use of telemetric water level data as well as basic hydrology.

Identify criteria for potential shelter locations

It is important to identify which buildings in a city fulfil the requirements of a shelter that can be used in case of a disaster such as flooding. These requirements are: high building to keep dry during a flooding; accommodate a large number of inhabitants from the area; be easily accessible by road; have facilities such as toilets, drinking water, heating; be water proof. In the Sloe area pilot (NL), the harbor facilities were assessed to find out if it can be used as a 'safe haven' or shelter for the people living in the area. The outcome was that while it could be used as an emergency response hub, it cannot be used as shelter location, because it does not fulfill the requirements.

Develop a clear communication strategy in case of emergency response

In the Netherlands, the chance for flooding due to dyke breaching is very low (1 in 4000 years) and it has proven difficult to communicate such low probabilities of flooding to authorities responsible of spatial adaptation measures to ensure safe evacuation (roads, railways) in case of flooding. Communication with citizens about flood risk is also very important. In the Sloe area pilot (NL), a communication strategy was therefore developed to instruct citizens what to do before, during and after a flood in the area. This strategy also supports local authorities to improve their planning for emergency response and preparedness of communities.

Prepare an evacuation strategy in case of emergency

In the Sloe area pilot (NL), an evacuation strategy with two options was developed: plan A is to evacuate people from high risk areas followed by the others, or horizontal evacuation via roads and waterways. Plan B is vertical evacuation: shelter people on the highest buildings in the area. In the German pilot Wesermarsch, there was no strategy on how to evacuate livestock in case of electricity failure due to flooding. Thanks to FRAMES, the farmers received a booklet with steps on how to increase flood preparedness of their farms.

Prepare tailor made solutions for flood response

The needs of each community should be considered rather than the broad community approach. Thus, the response actions and the resource allocation taken should be tailored according to the local needs. In the Kent pilot project (UK), socio-spatial analysis conducted by Kent County Council has allowed for local tailoring of plans to ensure that local needs are being met and resources are allocated according to local needs.

5.2 Community resilience: lessons learnt

In FRAMES, six pilot projects (Ninove, Geraardsbergen and Denderleeuw in Belgium, the Sloe area and Alblasterwaard-Vijfheerenlanden in the Netherlands and Wesermarsch in Germany) were focused on involving community groups (citizens, farmers, business, schools) in flood resilience measures. Likewise, six pilot projects (Medway, Lustrum Beck, Southwell, Butt Green Shield and Kent in the United Kingdom and Ninove in Belgium) aimed to empower communities by taking the lead and implement local flood resilience measures. The following lessons are drawn from these pilots.

Involve the community and be patient

During all three pilots in Belgium, community resilience workshops were organized with local groups (citizens, schools and local authorities). Participants were able to openly discuss needs, interests and what measures they are willing to practice. Project partners experienced that the implementation of preparedness measures requires changes which depend on perceptions, socio-cultural and economic background of the communities. However, changing people's attitudes and mind-sets takes time and patience.

Involve the local government when engaging citizens in FRM actions

In a diversified flood governance context but still defence dominant like Belgium (table 1), responsibility of FRM relies mainly on national government. Local government plays a key role in communicating with citizens and activating them. E.g. in the Geraardsbergen pilot (BE), meetings with emergency planners took place to engage citizens into emergency planning.

Changing minds, perceptions and attitudes takes time

In Belgium, the leading authority of the pilot projects experienced that it takes a long time to change the attitudes and the perception of stakeholders regarding new approaches or strategies for FRM. The leading authority was confronted with disbelief when applying MLS approach procedures (e.g. community resilience workshops) in the state dominated flood governance context of BE. Likewise, in the United Kingdom, FRM is still based on top-down management. Thus, communities depend mainly on the national government for flood safety. It can be extremely difficult to change the perspectives of communities about their role in flood management at the local level. Therefore, the Butt Green Shield pilot project in the United Kingdom embedded the narrative "we all have a role in managing water, what's yours?" into the local networks and partners. Overall, it takes a lot of time and it is very challenging to switch from a top-down to bottom-up approach.

Working within a catchment means crossing political and administrative boundaries

To implement natural flood management (NFM) measures at catchment level requires the collaboration among stakeholders across different governance layers. This means crossing boundaries, political or administrative, to avoid hitting barriers within a catchment, such as conflict of interests between landowners and environmental agencies. In the NFM pilot projects in United Kingdom, stakeholders from every layer of governance collaborated: from knowledge institutes, local and regional governments, and drinking water and sewage organisations, to road management organisations, nature conservation agencies, flood action groups and NGOs. New collaboration groups resulted from the pilot project with: the riparian owners, the landowners and the local councils.

Work in partnerships to create a shared understanding of problems and solutions

Taking measures in a large catchment, such as the Medway or Lustrum Beck catchments (UK), requires the involvement of several parties such as environmental agencies, nature organisations, local authorities and communities. Working in partnership allows to have a shared understanding of the problems and solutions, to narrow down the scope of the project while having a long term vision, and match plans and interests to reduce flood risk in the catchment. In these pilots, the partnerships for instance facilitated the decision making of the location for the implementation of the NFM interventions. It also improved the communication between authorities and local communities which in turn resulted in better collaboration among the stakeholders involved in the partnership. In the Medway pilot (UK) for instance, all the relevant local and governmental agencies came together with representatives of flood affected communities to form the 'Medway Flood Partnership'. This has enabled improved strategic planning and coordination among project partners such as National Flood Forum, Environment Agency, Kent County Council and many others. The capacity of these organisations to plan for, to respond to, and to recover from flood events has increased.

Continuous communication is crucial during and beyond the project

Collaboration among stakeholders is key when diversifying FRM strategies. However, collaboration cannot exist without clear communication among all stakeholders in a pilot area. Communication is a first step towards clearly identifying the responsibilities of each actor in FRM, and to get a shared understanding of the needs and solutions to avoid unnecessary redundancy of what?. In all pilots, pilot managers kept communication lines with all stakeholders (authorities, NGOs, citizens, schools, farmers) open and flowing and explained the purposes and the effects of MLS actions. The way the message was worded and sent, including the channel (e.g. door to door, community events) used to communicate with local communities, turned out to be crucial when trying to motivate and engage stakeholders. Pilot managers used different ways to communicate with stakeholders: information materials (brochures, flyers, booklets), community events (sport events, coffee evenings), face-to-face discussions, local social media (newsletters, magazines, newspapers, Facebook, Twitter, email). In the NFM pilot projects (Southwell, Lustrum Beck and Medway), the communication improved between the crisis management agencies (fire department, police, environmental agency and local authority) which have been engaged in developing the local flood action plans.

Understand and combine the political, hydrological, geological and social context of a catchment

Before implementing NFM measures to reduce flood consequences, it is important to understand the geology, hydrology and social system of the catchment where NFM will be applied. The FRAMES pilots used flood risk assessments to determine flood risk areas combined with modelling, visual observations and, knowledge of local communities to select sub-catchments for NFM interventions.

Involve local communities and get their support

It is highly recommended to engage and get the support of communities to increase flood resilience of individual households. It is crucial to start upfront to investigate the needs of communities and start building up a relationship with them to gain their trust. In the FRAMES pilot projects, communities were approached using surveys, community events, door to door visits (homes, business), face to face discussions, community events, and information materials. In the United Kingdom (Medway, Southwell and Lustrum Beck pilots), an agreement was signed with the landowners to define the responsibilities of landowners or farmers in the maintenance of the NFM interventions in the long term. Additionally, in the Lustrum Beck catchment (UK), farmers or landowners were motivated and engaged with economic incentives of improving their business following a business model outputs. In another pilot project in United Kingdom, Green Water Butt, a contract was signed with households to make them responsible of the maintenance of the water butts. In Belgium, citizens were intensely involved into the design process for a flood proof neighbourhood.

Build social capital to empower communities

Changing the traditional way of working with communities can empower these communities; teach the communities at risk and not at risk, for instance, how to create an adaptive framework thinking in terms of climate change. Communities can take the lead and build up a relationship management process between them and the relevant partners. If communities take the lead, a second step can be to engage with key stakeholders to take actions (e.g. create emergency plans) for reducing flood risk. This all starts with explaining to citizens what flood risk is, and what the related impacts are. This will raise their awareness and make them feel part of the process. Raising awareness among a wider community and providing them with information they turn into a communication and dissemination hub themselves. As a result, communities become self-sufficient and their preparedness and recovery will enhance in the long term. For example, in the Southwell pilot project (UK), the Southwell Flood Forum has a team of flood wardens who can close roads during floods. This will continue into the future. Likewise, in the Medway pilot project (UK), the local communities increased their capacity to identify sources of flooding in their area, and to press for actions to address their flooding issues. The community network can support recovery (taking actions) and lobby for policy changes at national level. In Kent (UK), residents have formed flood action groups and are supported by the Kent County Council to take actions to mitigate flood risk.

Continue monitoring NFM measures to demonstrate (additional ecological) benefits

By monitoring the NFM interventions beyond the lifespan of the pilot project, it will be possible to show the effectiveness of NFM. This knowledge should also be passed to other stakeholders in other catchments to increase flood resilience there as well. E.g. as a result of the Medway pilot project (UK), a methodology was developed to identify priority areas, to better target measures for further work in the Medway Catchment. The evidence base will continue to improve as a result of the planned long-term monitoring of the NFM measures.

Word of mouth is priceless when it comes to dissemination

The demonstration of NFM in FRM is an important part of the legacy of the pilot projects (Medway, Southwell and Lustrum Beck in United Kingdom) that focussed on this. The farmers who implemented NFM, experienced the effects of these measures on their land. Afterwards, farmers talked to each other and other farmers and shared their experiences. Moreover, interested farmers could also visit the areas where NFM interventions were implemented. This is a very effective way to visualise and disseminate the results of a pilot project. In time, farmers gain knowledge about NFM and build trust with the responsible organisation.

Sign agreements to define responsibilities

In the United Kingdom, agreements were signed between the leading authority of the pilot projects (Medway, Southwell, Lustrum Beck) and the landowners or farmers. The purpose of this was to give them ownership and make them responsible for the maintenance of the NFM measures beyond the lifespan of FRAMES. Likewise, the leading authority of another pilot project, Green Water Butt (UK), signed a contract with the household to ensure that inhabitants are responsible of the water butts implemented in their gardens to reduce surface flooding. These agreements strengthen the bond between local communities and local authorities leading to build social capital.

5.3 Resilient recovery: lessons learnt

One pilot project in Denmark, Roskilde, focused on improving flood recovery by learning from a recent flood event. The following lessons learnt refer only to this pilot project but it also applies to other areas and countries where there is a need to improve flood recovery. In addition, the pilot projects that focused on preparedness and emergency planning actions also support recovery.

Learn from past flood events

In the Jyllinge Nordmarke, Roskilde municipality (DK), communities are still recovering after a flood event that took place in 2013, because there were no protection and preparedness measures in place at the time. Authorities and communities did not know what to do, who to contact and volunteers did not know how to help. The Danes therefore selected this community to learn from the past and be prepared for a future flood event.

Integrate new knowledge in new guidelines and spread the word

The pilot project in Roskilde (DK) clarified a lot of unknowns during the recovery phase of the 2013 flood. The experiences of citizens and local organisations affected by the flood recovery process resulted in new knowledge that was integrated into guidelines for communities, insurance companies and citizens. These guidelines include clear steps on how to prepare before a flood event, who to contact and what to do during a recovery process after a flood event. These guidelines will increase resilience for especially the municipalities but also for the other authorities, organisations and citizens. Likewise, other communities will also be made part of this new knowledge to ensure they too will be better prepared for future events.

Increase flood risk awareness beyond FRAMES

Because floods do not occur regularly in Denmark, flood risk awareness and preparedness is low, if not absent, and emergency management plans for floods are insufficient. Moreover, there is still a lack of coordination between different actors and a lack of clear understanding of who is performing which tasks. The FRAMES pilot clearly shows the necessity for such plans and thus increased flood risk awareness of stakeholders. The lessons learnt from FRAMES have been translated into guidelines to increase the awareness of citizens and local organisations. However, people forget quickly, so an awareness raising campaign should be initiated beyond the lifespan of FRAMES.

Increase the capacity of communities to support recovery

The capacity of wider communities increases when raising awareness and providing them with information. Communities become self-sufficient and are able to identify flood sources in their areas and lobby for actions at the responsible agencies. Therefore, communities are better prepared to take their own immediate responses to flooding. In the Roskilde pilot project, citizens of Jyllinge Nordmark became more aware of flood risk and they have been engaged by the local authorities (municipality and emergency services) to deal with this challenge. FRAMES pilot projects that took preparedness and emergency management actions (Table 2) also support recovery in the long term. So for instance in the Medway catchment UK), communities can take immediate response to flooding by having equipment and material available to close the affected roads.

6. Adaptive capacities and MLS actions in pilot projects

Based on the FRAMES' integrated monitoring and evaluation framework, we have analysed the learning processes during pilot processes, taking into account the situation before, during and after the pilot projects. To support transnational learning of pilot projects about Multi-Layer Safety (MLS), we have analysed the development of adaptive capacities of pilot projects when implementing the main MLS actions. Adaptive capacities provides insight in the ability of institutions to foster the capacity of society to adapt to climate change over time and across scales (Gupta et al., 2010). The numbered adaptive capacities in the spider graphs refer to the six dimensions of 22 adaptive capacities (see also Appendix B): (1) Variety; (2) Learning capacity; (3) Room for autonomous change; (4) Leadership; (5) Resources; and (6) Fair governance.

In the analysis presented in this chapter, we have brought together the results of pilot projects which have focused on specific MLS actions. In the spiderweb graphs we have visualised:

- Numbers representing the amount of pilot projects in relation to a specific MLS action;
- Adaptive capacities considered to be insufficient before the pilot project started (yellow lines in negative numbers in the spider web);
- Adaptive capacities considered to have been employed and/or developed during the pilot project (green lines in the positive numbers in the spider web);
- Red boxes highlight the capacities that are developed in more than half of the pilot projects which applied a specific action (e.g. if one action is applied in twelve pilot projects and the capacity is identified in six pilots or more is highlighted with red colour).

This adaptive capacity analysis provides insight in capacities that are considered relevant by the FRAMES pilot manager for the implementation of specific MLS actions. The results of this analysis are discussed subsequently for the main actions related to resilient areas, resilient communities and for adaptive planning. The latter is discussed as distinctive process oriented action, covering both areas and communities.

The transnational evaluation analysis revealed that certain adaptive capacities were more developed or employed than others – see figures 14-20 of spiderwebs. We focus on those capacities that show a relevant increase compared to the situation prior to implementation of the specific FRAMES pilot project addressing this action (red boxes around adaptive capacities in outer ring). In the discussion, relevant insights from the TFG discussions are also brought forward.

6.1 Developing more flood resilient areas

In this section, we analyse and discuss the adaptive capacities employed and developed in pilot projects focused on actions to enhance the resilience of areas to flooding: flood proof design and planning, critical infrastructure and natural flood management (NFM).

6.1.1. Flood proof design and planning

In the application of the FRM cycle, most NSR countries have paid limited attention to mitigation via spatial adaptation in past decades. Strong protection via flood defences act as a 'front door' which make any investments in the area behind this redundant. Until recently, there has been little urgency to consider climate change challenges in FRM strategies, such as soil subsidence and sea level rise. Thus, it is difficult to find cost-effective spatial planning measures (Linde et al., 2018; van Berchum et al., 2018). However, integrating spatial planning in FRM requires reframing the current FRM policy and practice. The shift from a traditional way of managing floods to an integrated FRM is a very slow process taking place with small wins (Termeer & Dewulf, 2019). In the Netherlands, such reframing has partly taken place with the adoption of the multi-layered safety concept in FRM policy (Ministry of Transport, 2009). In FRAMES, new steps have been taken to put this in practice

via this approach. In the Belgian pilot project (Ninove), spatial planners are involving citizens from flood prone areas to develop a vision and an action plan to make their neighbourhood flood proof.

The [adaptive capacities](#) that were employed and developed during the pilot projects working on flood proof design and planning are shown in the spiderweb below (figure 13). We will provide more detail for those capacities that significantly increased during the pilot projects:

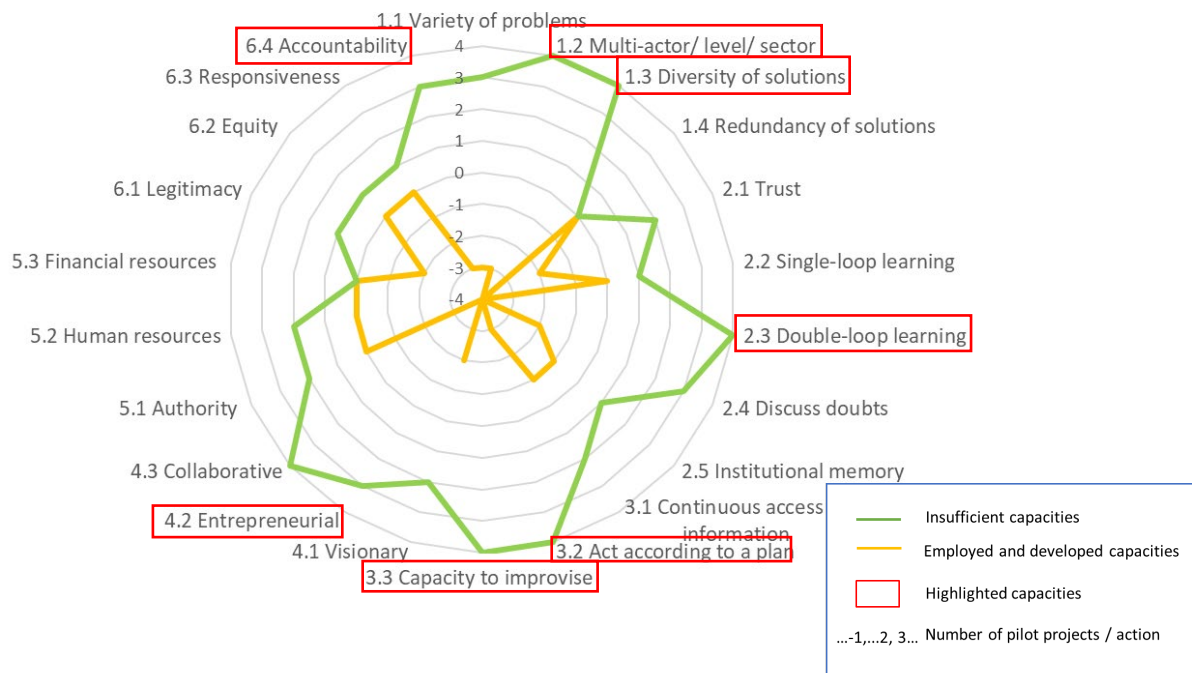


Figure 13. Development of adaptive capacities in flood proof design and planning projects

- Diversity of solutions: think outside the box. When it is tradition to manage flood risk looking at hard infrastructure, you can pay more attention to ways to diversify FRM using spatial adaptation measures.
- Multi-actor/sector/level: involve all stakeholders from all levels. In the Ninove pilot project (BE), spatial planners and water managers involved citizens from flood prone areas.
- Double loop learning: considering the large investments and high impact on land-use there remains a clear need to embed spatial planning in policies and regulations.
- Act according to plan: develop a vision and an action plan, as the stakeholders did in the Ninove pilot project (BE).
- Capacity to improvise: involve local communities. The involvement local communities leads to an increase in their social capital to deal with floods as well as an increase of flood risk awareness.
- Collaborative leadership is indispensable when it comes to integrating spatial planning in FRM. Flood risk management (FRM) experts, spatial planners and land-users need to work together to develop new frames for adaptive co-management. Even though the graph does not show it, leadership for flood proof design and planning requires also long term planning e.g. to decide about not building in flood prone areas and safeguarding this.
- Accountability is considered relative important for fair governance: large investments demand clear accountability procedures.

6.1.2 Critical infrastructure

Critical infrastructure has a pivotal role in limiting consequences of floods, which makes it a specific issue in multi-layered safety. Climate proof building of new critical infrastructure relies heavily on a sustainable spatial planning. Failure of critical infrastructure as a result of flooding has high impact on the capacity for emergency response (evacuation/rescue, crisis communication) and the ability to recover the economy and society within an area. However, a lot is unknown about the vulnerability of critical infrastructure, such as electricity grid network, health/social care homes, transportation and telecom, towards floods.

The [adaptive capacities](#) that were employed and developed during the pilot projects working on critical infrastructure are shown in the spiderweb below (figure 14). We will provide more detail for those capacities that significantly increased during the pilot projects:

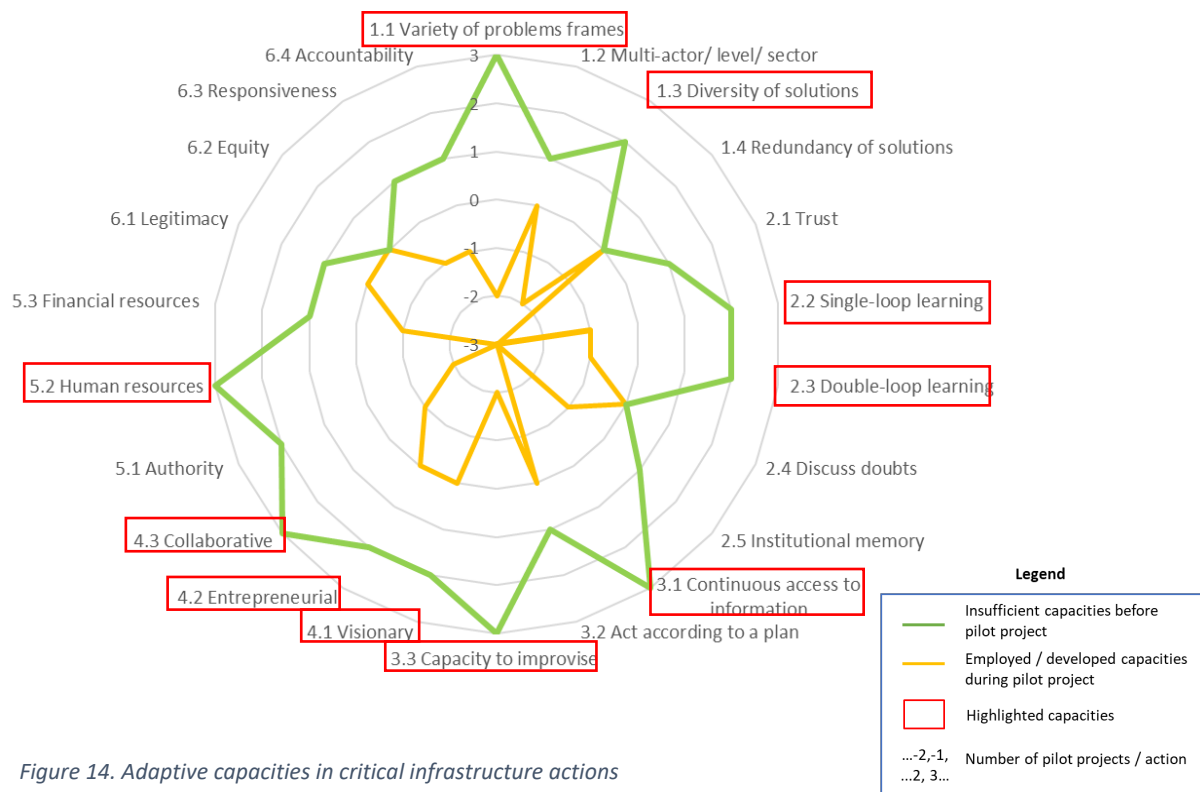


Figure 14. Adaptive capacities in critical infrastructure actions

- Variety of problem frames: prepare an in-depth analysis of the problem. A flood directly causes failure of the electricity grid network but also has indirect, or cascading effects on vital services such as transportation and telecom services. Therefore, an in depth problem analysis is required to consider the perspective of all stakeholders involved in the management of critical infrastructure.
- Diversity of solutions: consider multiple measures. The knowledge generated in the pilot projects provide diverse solutions in FRM (e.g. spatial adaptation and preparedness measures).
- Single loop learning. In the Netherlands, the knowledge developed about vulnerability of critical infrastructure (electricity grid network) resulted in the improvement of the current asset management plans of the critical infrastructure. In the United Kingdom, the knowledge develop about the vulnerability of health/ social care homes improved the emergency response in case of calamities.
- Double loop learning: integrate new knowledge into policy. This knowledge was also translated into policy advice to start up a discussion with policy makers and include this topic into the political agenda. For instance, in the Electricity grid network Zeeland and Reimerswaal (NL) flood risk assessments of critical infrastructure and importance for layer 3 (emergency response) has been put on the agenda (Nationale Omgevingvisie 2021).

- Continuous access to information: make information available for all stakeholders. An important issue in this it to organize access to (geo-)information about critical infrastructure assets. This knowledge and information is made available for organisations involved in managing critical infrastructure, but also municipalities and policy makers.
- Capacity to improvise: be more flexible when it comes to actions and solutions. Moreover, critical infrastructure owners increased their capacity to deal with flood risk in the long term.
- Visionary leadership: let all stakeholders share their insights. All stakeholders together discussed challenges and shared a common vision for the long term planning of critical infrastructure in relation to climate change.
- Entrepreneurial leadership do something with the new knowledge to make improvements. Critical infrastructure owners are motivated and interested to integrate the gained knowledge gained to improve the current asset management plans of the critical infrastructure.
- Collaborative leadership: authorities of all levels work together on the same issue. As a result of these pilot projects, collaboration between crisis management organisations, critical infrastructure owners and local authorities (local and regional) improved.
- Human resources: create new knowledge. The pilot projects resulted in new knowledge gained about the vulnerability of critical infrastructure in relation to flood scenarios.

6.1.3 Natural flood management

Traditionally, flood risk was managed only with hard infrastructure. However, learning from the past events and experiences is useful to improve FRM in the area. This is one of the main reasons to implement NFM besides reinforce current dikes. NFM considers the hydrological processes across the whole catchment of a river or along a stretch of coast to identify where measures can best be applied, with a focus on increasing water retention capacities. NFM interventions are protection measures (layer 1) to increase flood resilience using non-structure measures or engineering such as building with nature (leaky wooden barriers, ponds, earth bunds, revegetation). Moreover, NFM can also be regarded as prevention measures (layer 2) because they reduce flood consequences and damage by keeping water away from people in flood prone areas.

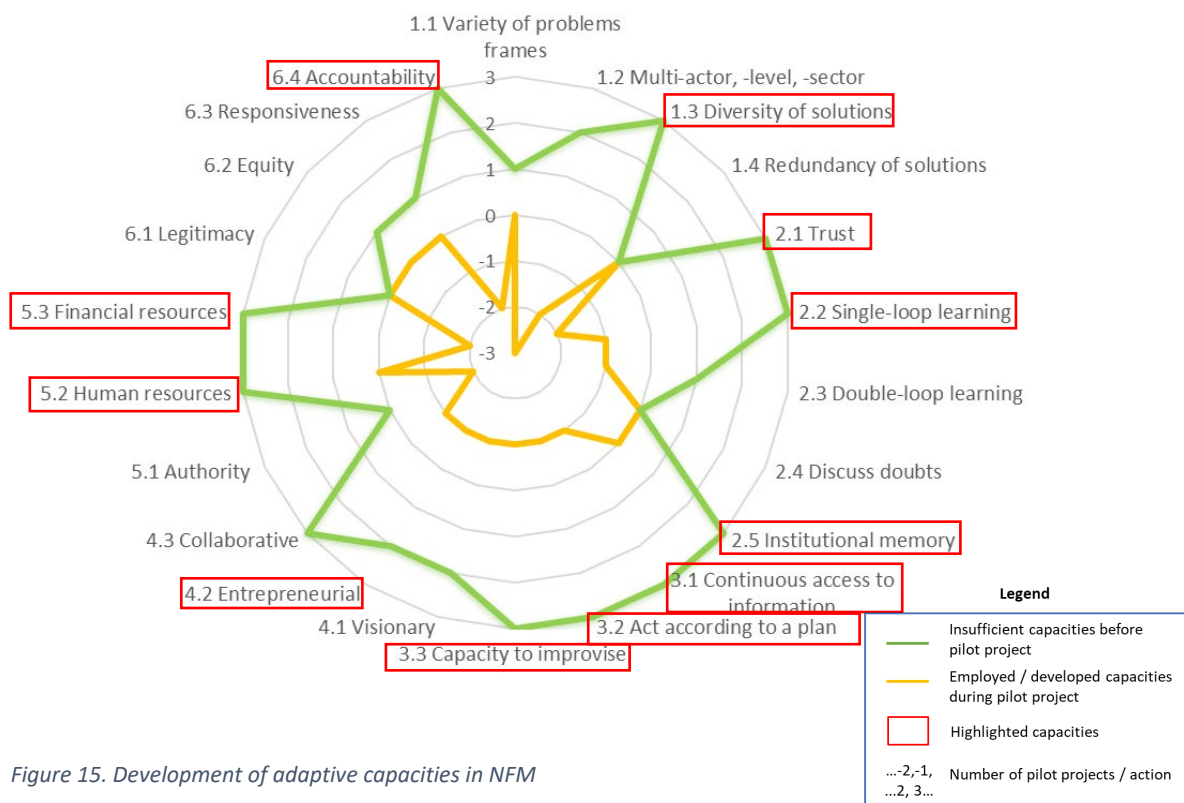


Figure 15. Development of adaptive capacities in NFM

The [adaptive capacities](#) that were employed and developed during the pilot projects working on NFM are shown in the spiderweb below (figure 15). We will provide more detail for those capacities that significantly increased during the pilot projects:

- Diversity of measures: combine, combine, combine. In FRAMES pilot projects, a combination of several NFM measures was applied to increase flood resilience at catchment level.
- Trust: nothing happens without trust. When implementing NFM at a catchment level, local authorities need to build trust with local communities (farmers/landowners).
- Single loop learning: learn from the past. Traditionally, flood risk was managed only with hard infrastructure in these pilots. However, learning from past events and experiences proved useful for improvement of FRM in the areas.
- Continuous access to information: share what you know. Local authorities provided the community with flood risk information and established an increase of their flood risk awareness.
- Accountability and institutional memory: clarify, maintain and monitor agreed upon responsibilities. In this example, the agreement states that farmers or landowners are responsible for maintaining and monitoring the NFM interventions. The monitoring of the NFM is indispensable to prove their effectiveness as alternative measures in FRM.
- Act according to plan: stick to what you intended to do. An agreement was signed with farmers and landowners – they are now obliged to maintain the NFM beyond the lifespan of the pilot project.
- Capacity to improvise: be flexible. The communities in these pilots increased their social capacity to deal with floods. They have more knowledge on what kind of measures they can take to reduce flood risk at property level.
- Human and financial resources: add when needed. The agreements in these pilot projects also state that communities receive an economic incentive to maintain the NFM interventions for the coming five years. Moreover, communities can also lobby via the supporting organisations (national flood forum, regional authorities) for investments by national government.
- Collaborative leadership: do not exclude anyone. The collaboration between local authorities and vulnerable communities improved as result of the partnerships created.

6.2 Enhancing flood resilient communities

In this section, we analyse and discuss the adaptive capacities employed and developed in pilot projects focused on actions to enhance the resilience of communities to flooding: preparedness and emergency planning, community resilience and recovery learning.

6.2.1 Preparedness and emergency planning

Preparedness and emergency planning aims to support vulnerable people and areas susceptible to flood damage. This implies active risk communication by increased public awareness and preparedness and emergency response via contingency planning. Preparedness and response have been in competition with flood protection measures; this has resulted in low flood awareness among inhabitants in most NSR countries. This causes also problems for preparedness and emergency planning strategies. Local citizens do not know what the flood risk of their property is, how to prepare in case of flooding, what kind of measures to implement, who is responsible of what and where they can find this information. This has also an effect on evacuation planning. By integration of preparedness and emergency planning in FRM new frames for evacuation and emergency response be developed, taking into account risk analysis (flood scenarios), spatial analysis and adaptation of evacuation routes and behavioural studies.

The [adaptive capacities](#) that were employed and developed during the pilot projects working on preparedness and emergency planning are shown in the spiderweb below (figure 16). We will provide more detail for those capacities that significantly increased during the pilot projects:

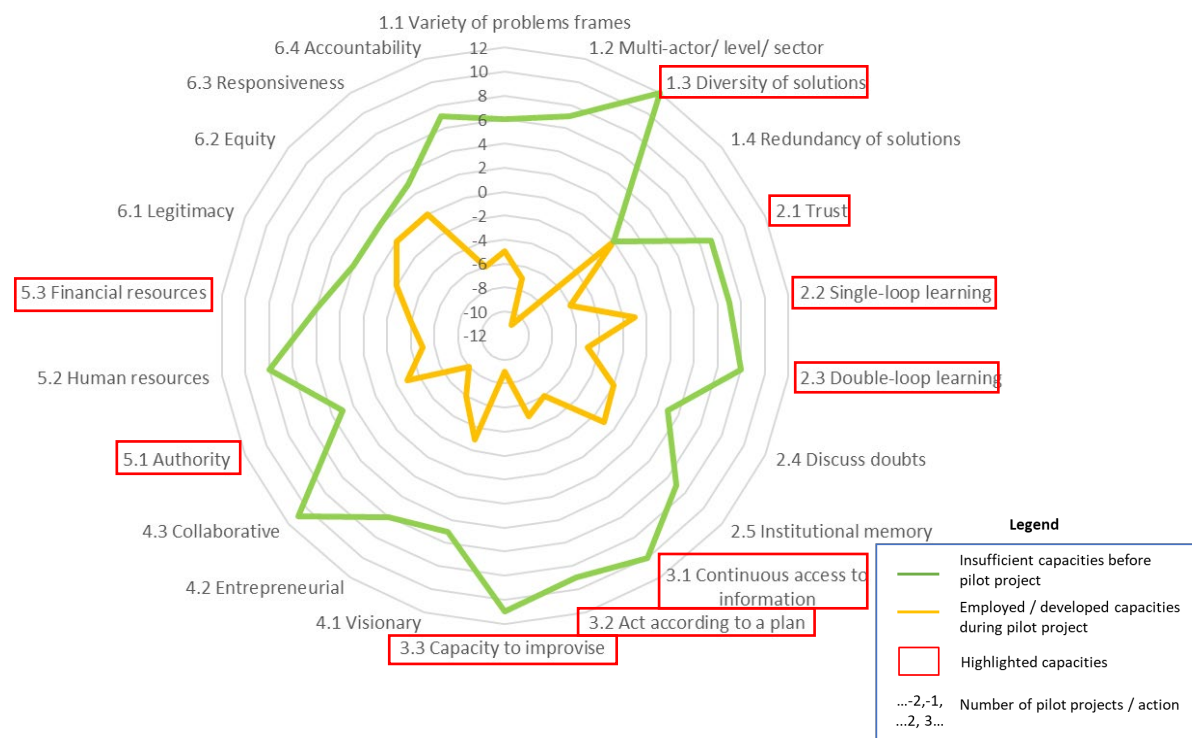


Figure 16. Development of adaptive capacities in preparedness and emergency planning actions

- Diversity of measures: combine actions. Low flood risk awareness causes problems for preparedness and emergency planning strategies. By combining several preparedness and emergency planning actions, flood resilience will increase.
- Trust: creating trust is the first step towards success. In the FRAMES pilot projects, the local authorities built trust with local community groups involved, such as citizens, schools, farmers and landowners.
- Single loop learning: combination of measures improves FRM. In the pilot projects, combining emergency planning with spatial planning and water management improved FRM overall. In the Alblasserwaard-Vijfheerenlanden pilot (NL), municipalities and safety region joint responsibilities to improve flood safety.
- Double loop learning: integrate the layers. In several pilot projects (Alblasserwaard-Vijfheerenlanden and Sloe area in the Netherlands, Wesermarsch in Germany) crisis management has been combined with flood protection and spatial planning. Risk analysis (flood scenarios) and spatial analysis about evacuation strategies, and shelter locations, has been combined with behavioral studies to develop new frames for evacuation planning. In short, provide new ways to improve local evacuation strategies.
- Access to information: raise awareness. Stakeholders who are not directly involved in FRM might also have low(er) risk awareness. By giving them access to local flood risk information, awareness should increase. New innovative approaches have been developed to raise awareness of many different types of stakeholders: specific information leaflets for farmers and landowners (Wesermarsch pilot in Germany, NFM pilot projects in the United Kingdom), school programs (Denderleeuw pilot project in Belgium) and risk assessments for businesses (Alblasserwaard-Vijfheerenlanden, Sloe area pilot projects in the Netherlands). Communication initiatives for the public, including articles in [newspapers](#) and [magazines](#), items for [television](#) and radio, [stop motion film](#) about Multi-Layer Safety (MLS) and [regional FRM days](#), and [exchange meetings](#) between project partners.
- Capacity to improvise: by raising awareness about flood risks among citizens and other stakeholders, social capacity have also increased.
- Act according to plan: ensure leaflets, manuals and leaflets are clear enough so citizens can actually follow the advice given and be better prepared in case of a flooding event.

- Collaborative leadership: share experiences and knowledge. The collaboration improved between water and crisis management authorities, plus local community groups. The stakeholders of Alblaserswaard-Vijfheerenlanden (NL) and Wesermarsch (DE) pilot projects visited each other (Netherlands, 22 February 2019; Germany, 28–29 March 2019) to share knowledge and experiences on emergency management strategies.
- Human resources: successful projects will increase knowledge. Pilot projects generated new knowledge and increased social capacity; both are expected to last beyond the lifetimes of the projects.

6.2.2 Community resilience

Increasing awareness starts from the perspective of FRM authorities providing more and better information about flood risk. Community resilience is both a function of the collection of individuals who comprise it and emergent properties that are dependent on social capital, social/cultural values, and practices, including duties to family members, the role of authorities within the community, trust, level of engagement and ethical norms (Etkin, 2016). Nine core elements determine community resilience as it applies to disasters: local knowledge, community networks and relationships, communication, health, governance and leadership, resources, economic investment, preparedness, and mental outlook (Patel et al., 2017)). The extent of applicability of community resilience in FRM depends highly of the type of flood hazard, potential consequences and effectiveness of other FRM strategies. E.g. applicability for coastal floods with impact beyond local level will be less effective than for local river floods. However, empowering local communities will provide them with the capacity to prepare for flood events and know what to do after a flood event. When flood preparedness and response is low, community based approaches can be developed to increase resilience of communities towards floods.

The adaptive capacities that were employed and developed during the pilot projects working on community resilience are shown in the spiderweb below (figure 17). We will provide more detail for those capacities that significantly increased during the pilot projects:

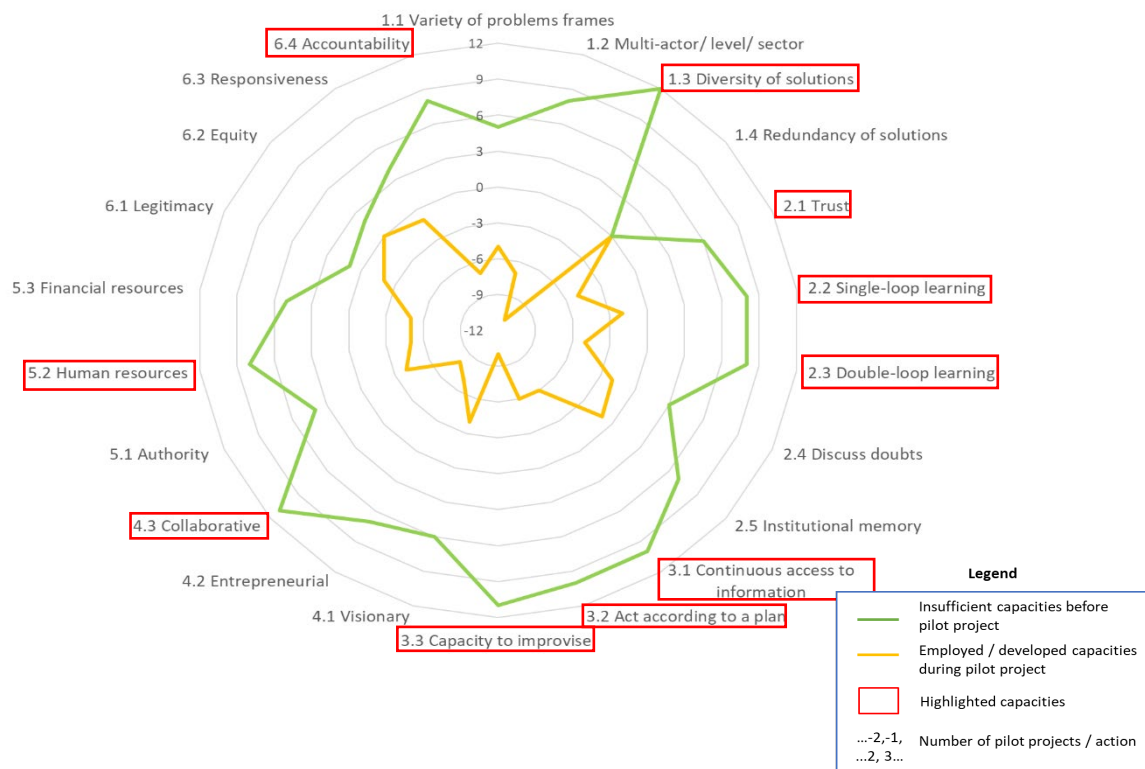


Figure 17. Development of adaptive capacities in community resilience

- Diversity of solutions: think outside the box. Community groups in these pilots implemented a variety of solutions at different scales to increase their flood resilience: from NFM interventions such as pond to and water storage devices such as water butts and raised flower beds. Community resilience starts with changing the perspective of citizens towards flood risk and make them feel they have a role to play. Changing the narrative around flood risk to a message like “Everyone has a role in managing water. What’s yours?” or “Are you interested in helping your neighbours installing a water butt?” In this way, local communities change their perception and awareness about flood risk, their role and over time they develop abilities to take the lead to improved flood preparedness and response at local level. E.g. in BE the East Flanders government is also developing a participatory procedure to involve more local communities (schools, local neighbourhoods and organisations) together with other parties (water management agencies, local municipalities) in FRM.
- Trust: built relationships based on trust. Generally, inhabitants trust government to take action in FRM. However, local communities (such as farmers, landowners, riparian owners, inhabitants) do not trust local organisations responsible of community resilience. Thus, these organisations promoted conversation about flood risk, flood preparedness and response and the potential of implementing NFM on their land. The way of approaching local communities and the message communicated to them is key in building relationships and gaining trust. It is important to communicate the message in a clear way to the stakeholders in order to get their interest and engage with them. In FRAMES, e.g. inhabitants were suspicious about the word ‘free’ water butt. Instead, inhabitants became interested when they were asked to have a role in decreasing surface flooding by implementing water butts. Once there is trust, stakeholders are more open to discuss and engage in the project.
- Single loop learning: FRAMES outcomes show that that where flood preparedness and response are low, community based approaches improves the resilience of communities towards floods.
- Double loop learning: integrate new knowledge into local policies. Integration will ensure long term flood resilience. In Kent for instance, the knowledge generated about the vulnerability of health and social care homes was integrated into the actions plans at District level.
- Continuous access to information: continuous and personal communication will strengthen all that is mentioned above. Ask all involved or affected about their individual needs, and clearly explain their role in FRM.
- Act according to plan: prepare plans and stick to them. In Germany (Wesermarsch) flood preparedness manuals were developed for farmers to increase their self-capacity to deal with floods. In the United Kingdom , landowners and farmers needed to follow the signed agreements to take care of the NFM solutions.
- Capacity to improvise: the more you know, the more you can do. Empowering local communities will provide them with the capacity to prepare for flood events and know what to do after a flood event.
- Collaborative leadership: increasing community resilience means involving multiple actors, such as representatives from the spatial planning and water management. The actors need to have an open mind and share their own interests and perspectives about a certain problem. This could lead to higher commitment and engagement between authorities and citizens. The extent of applicability of this type of action depends highly of the type of flood hazard potential consequences and effectiveness of other FRM strategies. E.g. applicability for coastal floods with impact beyond local level will be less effective than for local river flood.
- Human resources and accountability: increasing community resilience is a participatory process and requires takes time, energy and switching from a single to a shared responsibility.

6.2.3 Learning about recovery planning

Flood events can be devastating causing large impacts associated with high economic costs and slow recovery afterwards. It is important to learn from previous flood events to improve flood recovery. Recovery, in this context, aims to reduce the vulnerability of people and areas susceptible to damage by reducing social and

economic impacts. Recovery actions implies flood insurance, compensation and/or reconstruction of individual, societal and environmental assets. Resilient, in this context, refers to the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions”(UNDRR, 2020). It is related to enhancing disaster preparedness for effective response, and to build back better” in recovery, rehabilitation and reconstruction (UNDRR, 2015). For a resilient recovery process it is important to address the long term needs of communities (physical and social) (Colten et al., 2008) and cope with possibly conflicting goals of rapid recovery to familiar built environment and socio-economic activities, and aspiration to reconstruct in a safer, better, and sometimes more equitable way.

In FRAMES, only one pilot project (Roskilde, Denmark) focused on recovery. As a result, the lessons learnt should be considered as being context specific.

The [adaptive capacities](#) that were employed and developed during the pilot projects working on recovery are shown in the spiderweb below (figure 18). We will provide more detail for those capacities that significantly increased during this pilot:

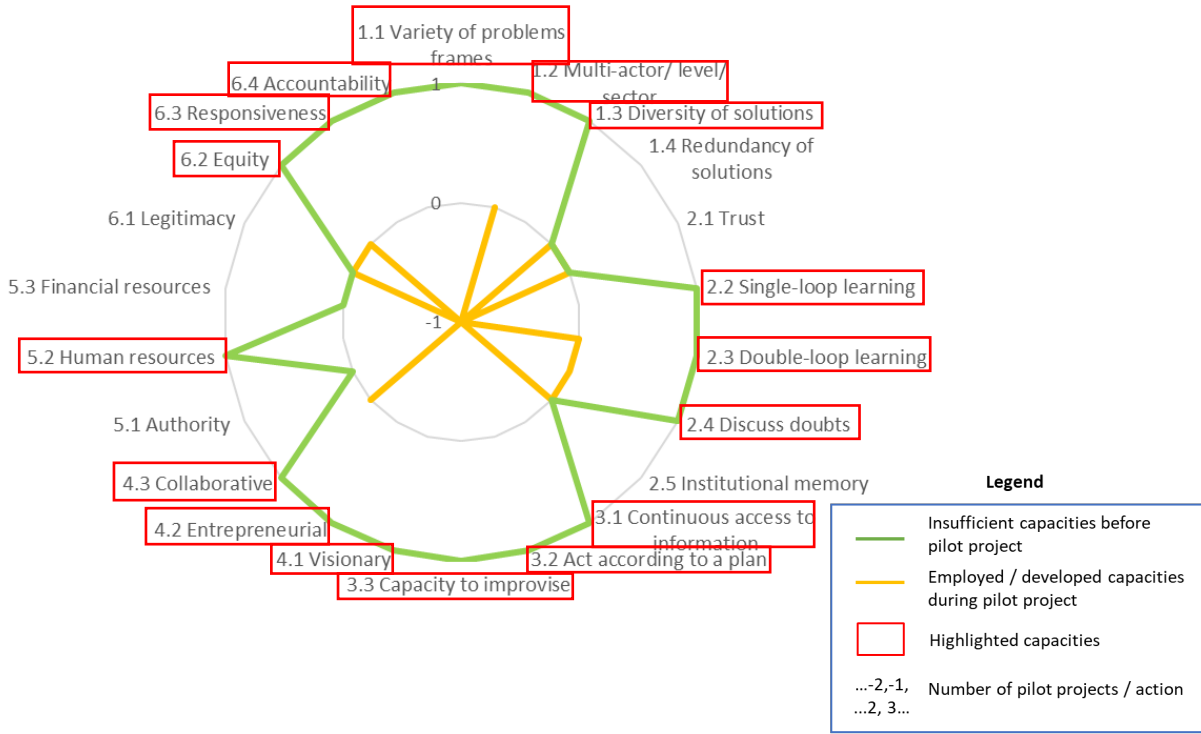


Figure 18. Development of adaptive capacities in learning about recovery

- Variety of problem frames: the perspective of all actors are important. In the assessment of the recovery capacity in Jyllinge Nordmark town, municipality of Roskilde, the perspective and the experiences of multiple actors were considered: the citizens, and the crisis management organisations (municipalities, Danish Storm Council, Red Cross). Each stakeholder has a different role and perception about the same problem: slow recovery process about the flooding in 2013.
- Multi-actor, multi-level, multi-sector: floods are not a one-dimensional event. Involve all relevant stakeholders when looking at FRM. In this case the insurance companies, municipalities, coastal management authority, citizens, knowledge institutes and crisis management authorities were involved to assess the recovery process in Roskilde area. With the input from all, a step-by-step guide was developed to better understand the entire process of FRM and inform citizens about what to do and who to contact in each phase of a flooding event.

- Diversity of solutions: combine the layers. The guidelines prepared for this pilot looked at not only the recovery process but also at flood preparedness.
- Single loop learning: learn from the past. This pilot analysed what happened, recovery wise, after the last flood event. The findings were used to improve FRM by taking non-structural measures in the form of guidelines to improve recovery and drafting up flood emergency plans.
- Double loop learning: integrate new knowledge into policy. The findings from this pilot for instance, were included in the Danish Floods Directive Risk Assessment Plans.
- Continuous access to information: share what you know with all involved. Regular meeting were information was shared with the stakeholders were an essential part of this pilot and the guidelines are available for everyone who is interested.
- Act according to a plan: provide clear information for every level. The guidelines resulting from this pilot for instance, include clear steps on what to do and who to contact in case of a flood event. The guidelines also clarify what authorities have responsibilities in a FRM process.
- Capacity to improvise: increase flood risk awareness. The knowledge developed translated into guidelines are targeted to municipalities, insurance companies, Danish Storm Council and citizens. The citizens who experienced the recovery process in Roskilde are learning from the Danish Red Cross how to be self-sufficient and take measures themselves.
- Leadership: visionary, collaborative and entrepreneurial. The guidelines provide the knowledge to allow the organisations responsible for flood recovery to independently response when it is needed in the long term. The implementation of the guidelines will result in a better collaboration between the responsible authorities for crisis management. The collaboration between the municipalities and Danish Coastal Authority is very good, but not so much with the local communities. The collaboration between the local communities and the Danish Red Cross improved as a result of the pilot project.
- Equity: consider the needs of all stakes. In the development of the guidelines, the needs and experiences of all organisations and citizens (affected or not by the floods) were taken into account.
- Responsiveness. The guidelines will be available for everyone, but it will primarily cater the needs of institutions (municipalities, The Danish Storm Council) insurance companies et cetera.
- Accountability. The guidelines state clearly who are the responsible organisations and actors and what they should do to improve their capacity to help in a similar situation.

6.3 Adaptive planning

The future predictions of climate change and the uncertainties of future flood events increase the flood risk in urban areas. The spatial adaptation of urban areas to make a city flood proof can become a challenge for municipalities. The use of adaptive planning tools such as the DAPP approach in combination with the MLS approach can facilitate the adaptation development plan and prioritize the FRM measures for making a city flood proof. In FRAMES, the municipalities of Assens and Vejle in Denmark, used the DAPP and the MLS to prioritize and take decisions on which FRM measures are best to implement. They classified the measures based on the MLS approach: protection; spatial adaptation measures; preparedness and response / response plans. Adaptive planning is a process that helps to reconsider effective combinations of FRM perspectives, by taking future scenarios into account. The impact of FRM measures can be visualized in maps, developed into an action plan to communicate with non-experts such as inhabitants and decision makers.

“it is beneficial to work with long term planning and include measures from each of the 4 layers. That will make the planning more robust, more stronger...try to combine the measures, look not only at prevention but also at spatial planning and also consider where recovery will fit in to your long term planning. ...have a clear vision on how you would like your community area, city, country...measures...don’t clash.... ” [Mie Thomsen, Danish Coastal Authority, pilot manager for Vejle, Assens and Roskilde pilot projects (DK), 4 April 2019]

The [adaptive capacities](#) that were employed and developed during the pilot projects working on adaptive planning are shown in the spiderweb below (figure 19). We will provide more detail for those capacities that significantly increased during the pilot projects:

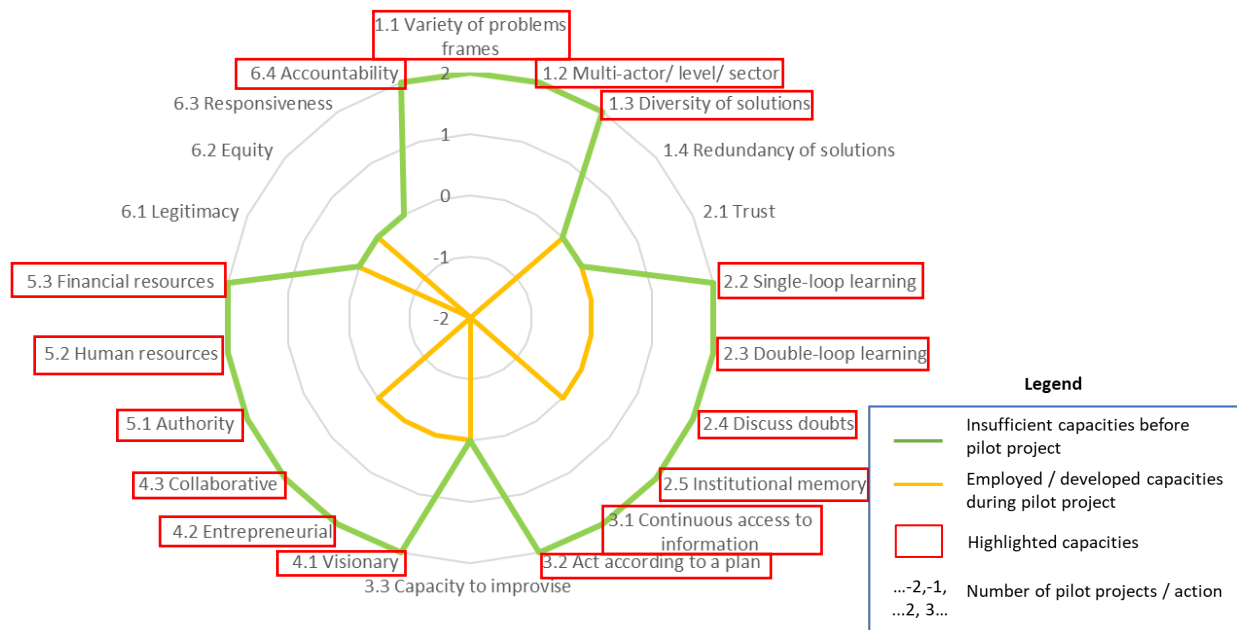


Figure 19. Development of adaptive capacities in adaptive planning

- **Variety of problems:** there is not just one type of flood. Multiple flood risk issues were considered in the Danish pilots (storm surges and river flooding); make sure to consider all relevant types of floods in your area.
- **Multi-actor,-sector,-level:** involve all relevant stakeholders. Multiple stakeholders were involved in the pilot process such as urban planners, water managers and crisis management authorities.
- **Diversity of solutions:** a diversity of FRM measures were integrated in the adaptive planning for each layer of the MLS approach: protection; spatial adaptation measures; preparedness and response / response plans.
- **Single loop learning:** combining the DAPP and MLS approach allows for learning and improvement of FRM practices. Both municipalities took decisions about future FRM measures (storm surge barrier in Vejle and a dune in Assens) and developed a clear and action plans.
- **Double loop learning:** integrate new knowledge into policy. Single loop learning supports the reframing of FRM strategies and developing a new planning approach for long term FRM planning. The Danish Coastal Authority developed guidelines for municipalities to recommend the integration of the DAPP approach into their FRM plans.
- **Discuss doubts:** nobody knows what the future looks like. Adaptive planning is a process that helps to reconsider effective combinations of FRM perspectives by taking future scenarios into account. In the Assens pilot project, the municipality and the harbour representative had very different views and discussions about the FRM solutions and climate adaptation during the process of working with the DAPP.
- **Institutional memory:** reflect. Having a clear vision also means reflection is allowed, including consideration of the feedback loop of the adaptive pathways and their impact in the long term.
- **Continuous access to information:** make maps available to all. The visualization of the impact of FRM measures can be developed into maps and an action to communicate with non-experts such as inhabitants and decision makers.
- **Act according to plan:** stick to what was planned. The municipalities developed a guide with clear steps on who to apply the DAPP approach in Denmark. One of this steps is an action plan that municipalities need to follow in short/medium/ long term when implementing the adaptation measures of the future vision for the both cities.

- Leadership: visionary, entrepreneurial and collaborative. It is key to have a clear vision in urban development planning to make a city flood proof in the future. This promotes sharing information between stakeholders and enhances collaboration between the stakeholders involved in FRM. Assens and Vejle had clear that it was required to build a storm surge barrier to protect the cities from future flooding. After the discussion and collaboration between stakeholders, it was agreed that a storm surge barrier will be built in Vejle and a dune in Assens to protect the west coast from flooding.
- Human resources: create the knowledge and expertise needed. Currently, both municipalities have the knowledge and the expertise to use a new tool for developing an adaptation development plan for flood proof cities. However, these municipalities cannot guide other municipalities which may be interested in applying DAPP approach in the future.
- Authority and accountability: even when it clear who is responsible for FRM, it is still important to involve the appropriate level of authority. In Denmark, it was found that for instance, the municipality is the authority responsible of the urban development and spatial adaptation.

7. FRAMES' decision support system for multi-layer safety

The uncertainty of climate change is a major challenge for flood managers to make robust decisions about flood management options in the North Sea Region (NSR) countries. In addition, the governance settings of each country adds to the complexity of joint decision making for climate change adaptation to increase flood resilience. A so-called decision support system, or DSS, can assist authorities to identify the best options to increase flood resilience in their region.

[FRAMES' DSS](#) is an integrated framework developed to support authorities in their decision-making process concerning FRM in their region (figure 20). The DSS supports authorities in identifying and selecting Multi-layer Safety (MLS) options for more diversified and balanced strategies.

The DSS has been jointly developed by the FRAMES consortium as a learning evaluation of the pilot activities; the experiences from all pilots have been integrated in the framework and local and regional contexts, climate, socio-economic, hydraulic drivers) were considered. Via the learning evaluation in FRAMES relevant target groups for the DSS have been involved in the development: local/ regional/ national authorities from involved regions, infrastructure and (public) service providers, interest groups (NGOs) and higher education and research centres. Based on the interviews with pilot managers, transnational focus groups and monitoring of pilot outcomes, the DSS brings together the transnational learning and knowledge from sixteen FRAMES pilots into the MLS approach. The lessons learnt were also translated into [policy recommendations](#).

In the online version of the DSS, available on www.frameswiki.eu, each of the MLS actions and layers can be clicked to learn more about each of the layers and in particular the actions as applied in FRAMES. For each action the following support has been provided:

- Description of the action
- The application of this action in FRAMES
- Interdependencies with other MLS actions
- Lessons learnt in FRAMES
- Relevant adaptive capacities
- Tools applied in FRAMES

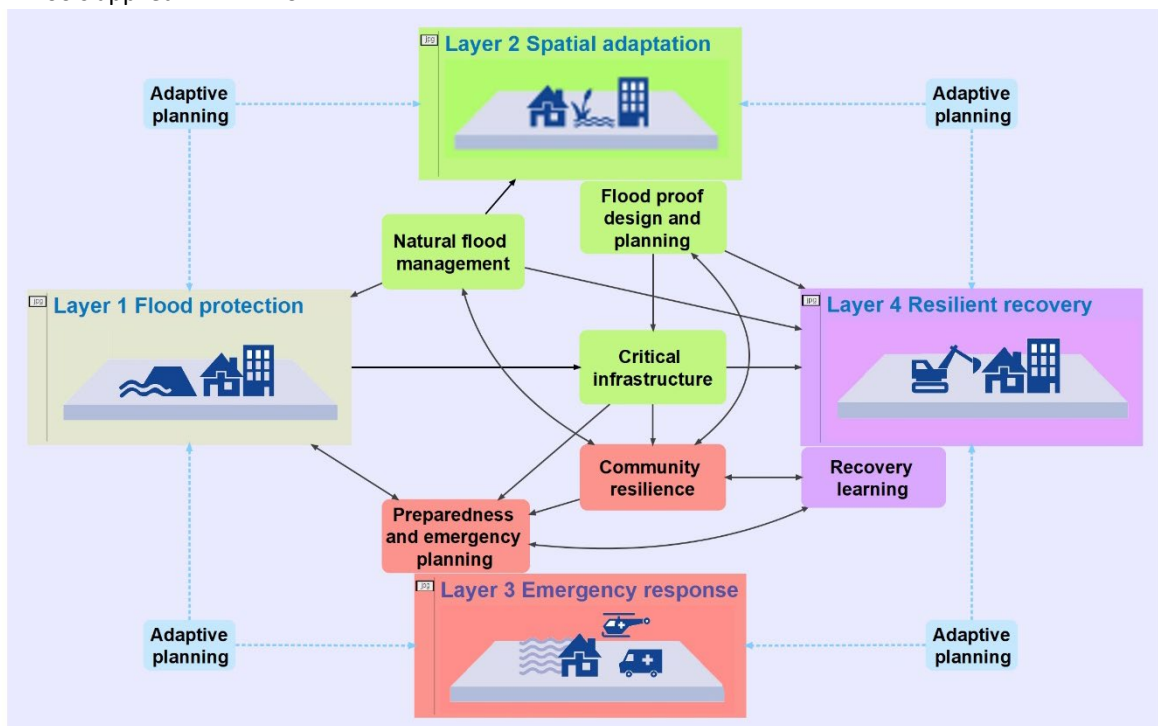


Figure 20. Decision support system of MLS actions

Based on the experience in FRAMES, the highlighted actions in the DSS framework provide:

- Authorities responsible for flood resilience: an overview and relevant knowledge in exploring a variety of MLS actions for enhancing FRM strategies.
- National/regional authorities: support for regional/local authorities in the adaptive planning of their area, taking into account climate change uncertainties and flood proof design and planning of spatial investments.
- Local and regional authorities: the possibility to conduct area based studies and explore additional actions to fine tune FRM strategies in their area or catchment.
- NGOs involved in natural flood management (NFM) and community resilience: the possibility to align their activities with mainstream FRM strategies
- NGOs and interest groups: strategies and tools to empower local communities to have a voice in FRM.
- Infrastructure and service providers: a position in the field of flood resilience.
- Higher education and research centres: available knowledge and cases on diversification of FRM and flood resilience.

This DSS provides options for authorities in the NSR to enhance flood resilience via a multi-layered safety approach, based on the actions as explored and implemented within the FRAMES project. These actions, links and insights are the outcome of the pilot projects of the specific regions selected for FRAMES. This DSS provides more insights into the possibilities and linkages of the MLS approach in the NSR, but the exact recipe for successfully implementing MLS measures in other regions requires additional information about governance context, current flood risk management (FRM) strategies, current and future flood scenarios and socio-economic developments.

Table 4 provides an overview of the actions in the DSS framework that are specifically mentioned in the National Adaptation Strategies (NAS), National Adaptation Plans (NAP) and the European Floods Directive. A more detailed description of the harmonization between FRAMES actions and the NASs and NAPs in each country can be found in Appendix G.

Based on this overview it becomes clear that all main actions of the FRAMES' DSS are present in the European Flood Directive, except for Adaptive planning. Within FRAMES, this process oriented action has been explicitly addressed by pilot projects in Denmark (DK). However, in the transnational learning process also regions in the United Kingdom (UK) (in particular Kent County Council), Belgium (BE) (Province of Oost Vlaanderen) and the Netherlands (NL) (Province of Zuid Holland) showed interest in this approach and see similarities in the challenges they are working on in times of uncertainties about the extent of climate change effects.

Within each of the countries, the implemented pilot projects fit within their NAS. For the Netherlands, the involvement of communities in FRM is rather new and not yet fully integrated in the NAS. Likewise in Germany (DE), where this applies to the action of flexible evacuation strategies. In the United Kingdom, the issue of critical infrastructure has been brought forward in FRAMES by Kent County Council, although it was not yet present in the NAS.

Table 4. Harmonization of FRAMES DSS with National Adaptation Strategies / Programmes

MLS actions	Specific actions	EU Floods Directive	Netherlands		Belgium		Germany		United Kingdom		Denmark	
			FRA- MES	NAS NAP	FRA- MES	NAS NAP	FRA- MES	NAS NAP	FRA- MES	NAS NAP	FRA- MES	NAS NAP
Flood proof design and planning	<i>Improving zoning of development in flood prone areas</i>	v		v	v	v		v				v
	<i>Reducing surface flood risk from extreme rainfall via increasing storage capacity</i>			v	v	v		v	v	v		
Preparedness and response	<i>Integrate emergency response planning in FRM</i>	v	v	v			v	v	v	v		
	<i>Improve flexible evacuation strategies</i>		v	v			v					
	<i>Raising awareness for flood resilience measures</i>		v	v	v	v	v	v	v	v		
Critical infrastructure	<i>Realizing a flood proof critical infrastructure</i>	v	v	v				v	v			v
Natural flood management	<i>Lower flood risk for communities via NBS</i>	v						v	v	v		
Community resilience	<i>Involving community groups in flood resilience measures</i>	v	v		v	v	v	v				
	<i>Empowering communities to take action for local flood resilience</i>				v	v	v	v	v	v		v
Adaptive planning	<i>Apply adaptive planning to look for tipping points in FRMS and explore synergetic combinations of strategies</i>			v							v	v

8. Impact of pilot projects on flood risk management strategies

8.1 Result of baseline and final monitors

In the transnational learning evaluation process, all pilot projects experimented with multi-layer safety (MLS) actions and developed the capacity of authorities and society to cope with flooding. To measure the impact of FRAMES on improving the flood resilience of pilot areas, communities and authorities both a baseline and final monitoring survey have been conducted (see chapter 2). As explained in chapter 2, the surveys were completed by pilot managers in consultation with key pilot stakeholders. The baseline survey included questions about the actual situation in 2017 and expectations for 2020. The final survey contained similar questions, but about the actual situation in 2020 and expected situation for 2025, five years after the pilot projects are finished. All the scores for both surveys can be found in Appendix H.

8.1.1 Resilient communities

Six pilot projects (Ninove, Geraardsbergen and Denderleeuw in Belgium, the Sloe area and Alblasterwaard-Vijfheerenlanden in the Netherlands and Wesermarsch in Germany) were focused on involving community groups (citizens, farmers, business, schools) in flood resilience measures. Likewise, six pilot projects (Medway, Lustrum Beck, Southwell, Butt Green Shield and Kent in the United Kingdom and Ninove in Belgium) aimed to empower communities by taking the lead and implement local flood resilience measures. With an average score of 6, the results of final survey clearly show that overall, the resilience of authorities and stakeholders has increased as a result of FRAMES. The level of self-efficacy of local communities has also improved slightly – the average score of 5 is a higher than anticipated result since this was not the core focus of the pilots focusing on resilient communities. When asked about thoughts on the level of embeddedness of the three strategies (mitigation, preparation and recovery) five years after FRAMES has ended, the results indicate that the stakeholders who filled out the survey have become more realistic after having worked with the MLS approach, realizing it takes more time and effort than thought prior to FRAMES: scores in the baseline are higher than in the final survey, but still mildly optimistic. The context specificity of the approaches and hence future embeddedness can also clearly be deducted from the surveys – the scores vary, for all strategies, between 1 and 10.

8.1.2 Resilient area

In both the baseline and final survey, the pilot managers and stakeholders were asked to what extent the strategies were a strong characteristic of their pilot area, not only prior to the start of FRAMES, but also at the end of FRAMES, and five years after FRAMES has ended. The result show a slight increase of this extent (from 5.2 to 5.9), with almost all pilots showing an increase when comparing the situation at the beginning of FRAMES. The context specificity of the pilots clearly surfaces when looking at the individual scores; scores range from 1 to 10. See Appendix H for the detailed scores of all pilot areas.

8.1.3 Resilient authorities

In both the baseline and final survey, the pilot managers and stakeholders were asked to what extent the strategies were embedded in the policy and practice of the resilient authorities. We clearly see an increase – pilot managers as well as stakeholders indicate that the extent of embeddedness has increased as a result of FRAMES and will continue to stay embedded five years after FRAMES. While the score range again from the minimum to the maximum, indicating the context-specificity of the pilots and associated governance structures, the overall picture is positive with a score that increased with half a point to 5.1. See Appendix H for the detailed score per pilot project.

Next, the meaning for diversification of flood risk management strategies is discussed in 8.2 and paragraph 8.3 elaborates further on the results per strategy and their embedding in authorities and communities.

8.2 Diversification of flood risk management strategies

Pilot projects provide important opportunities for experimenting and learning (van Buuren et al., 2018; van Popering-Verkerk & van Buuren, 2017) in working towards transformations in flood risk management (FRM) (Cosoveanu et al., 2019). Knowledge and experiences acquired from pilot projects are often valuable lessons for upscaling of pilot project results (Driessen et al., 2018; van Buuren, Vreugdenhil, Van Popering Verkerk, et al., 2018). Moreover, by learning from new insights and experiences, actors foster their capacities in governance networks to cope with uncertainty and change (Pahl-Wostl et al., 2007). However, there is also a paradox in the success of pilot projects: ‘pilots never fail, but they never scale’ (van Buuren, Vreugdenhil, van Popering-Verkerk, et al., 2018). This means that pilots often meet conditions for successful completion, based on the internal conditions for a pilot, but face difficulties with wider uptake in new policies and strategies. Interestingly, the pilot paradox argues that the same conditions that make pilots successful often hamper their uptake. In order to upscale the lessons learnt from pilot projects, improvement and changes in current FRM practices and policies are needed (Van Buuren et al., 2018). Based on this perspective we reconsider the lessons learnt in FRAMES and discuss if and how the pilot projects have resulted in working practice change.

The further analysis of the final and baseline surveys show the impact of pilot projects on flood resilience via different aspects of the FRM cycle and MLS. The FRAMES project focused mainly on mitigation via spatial planning, emergency response and recovery, layers 2, 3 and 4 of MLS respectively. Figure 21 presents the overview of the current impact and expected impact of all pilot projects for the different FRM strategies.

Based on the point of departure and focus of FRAMES, the assumption was that the pilot projects would result in a more diversified and balanced FRM strategies (Interreg, 2016). Pilot managers were asked about the current and the expected level of FRM strategies in their pilot area. E.g. *To what extent is pro-action/ protection/ mitigation/ preparation/ recovery a strong characteristics of the pilot area? Currently and (five years) after FRAMES.* Considering the focus in FRAMES on the three red circled strategies, it is not surprising that overall minor changes are observed in the strategies pro-action and protection (figures 21). Expectations for these strategies were limited before FRAMES and also for next five years, since they were not part of FRAMES’ focus. FRM experts do not have that much influence on taking away cause, as promoted by the pro-action strategy. The average of a protection strategy for the pilot project areas part of FRAMES is already at a high level.

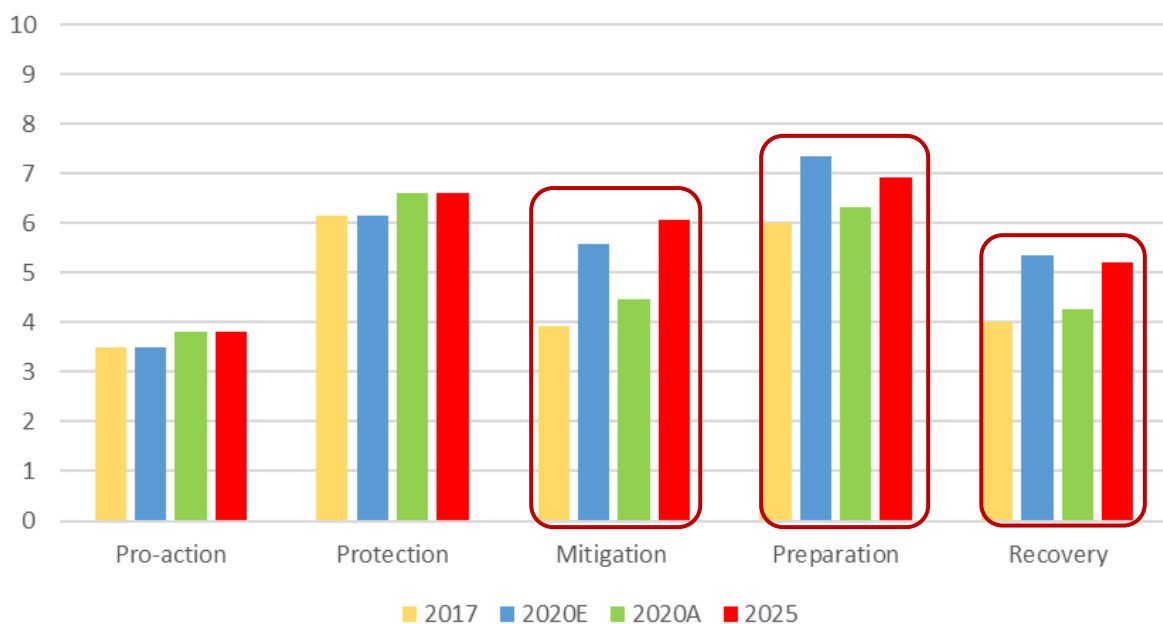


Figure 21. Extent to which different FRM strategies are considered a strong characteristic of all pilot areas, including actual baseline 2017, 2020 expectations (E), 2020 Actual (A) and 2025 expectations

More balance was expected in particular by an improvement of mitigation via spatial planning and recovery. If we look at the average of the actual increase between 2017 and 2020 (yellow and green bars) small wins (Termeer & Dewulf, 2019) have been realized to improve strategies which can limit the consequences of flooding and enhance recovery. As concluded in Cosoveanu et al. (2019), the pilot projects studied are examples of incremental change in the diversification of FRM. This results in following mix of MLS strategies (figure 22). It needs to be emphasized that this figure provides a generic overview of all pilot project areas. In practice each pilot project region has its own configuration of FRM strategies. For the aggregated results of all pilot areas it can be concluded that the actual situation in 2020 is slightly more balanced than the situation in 2017.

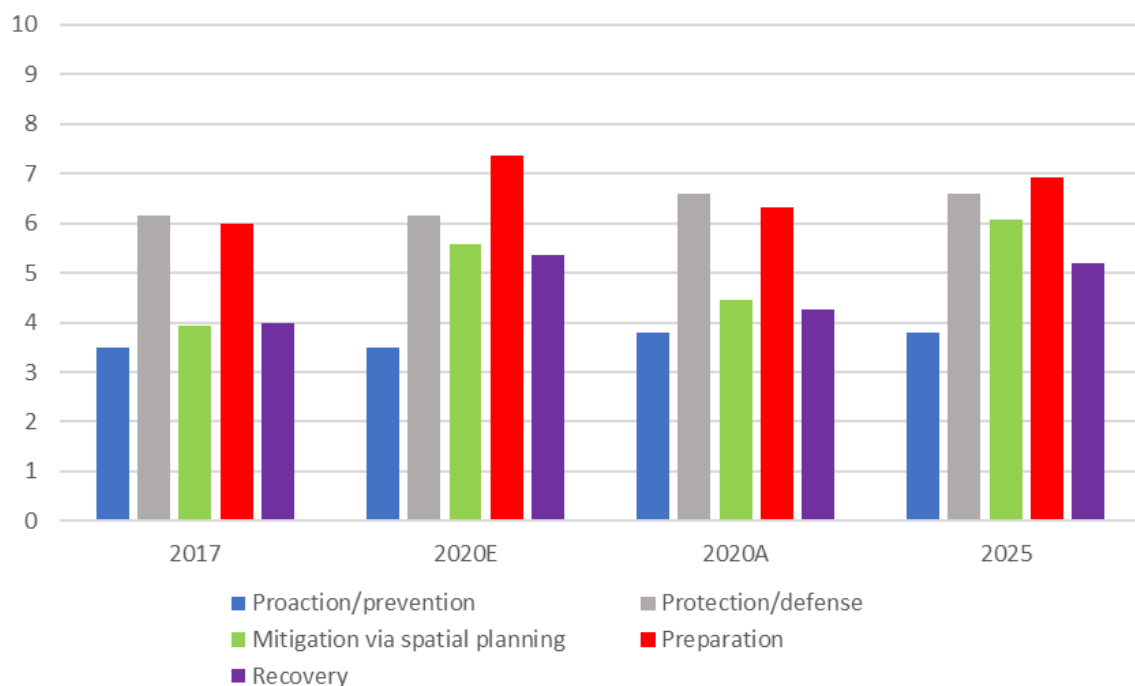


Figure 22. Overview of MLS strategies for the aggregation of all pilot regions, including actual baseline 2017, 2020 expectations (E), 2020 Actual (A) and 2025 expectations

8.3 Results per strategy

In this section we elaborate on the results per strategy and link this to actual results of the pilot projects. In addition, regarding FRM actions the expectations before and five years after FRAMES are included (figure 22). Pilot managers were asked their opinion about the embeddedness of FRM strategies in their pilot areas. E.g. *to what extend is flood mitigation/preparation/recovery embedded in... policy and practice of these organisations... in the behaviour of these communities? Currently and (five years) after FRAMES*. In section 8.3 it will discuss the approaches applied in pilot regions to upscale and mainstream the lessons learnt from FRAMES.

8.3.1 Mitigation via spatial adaptation

The monitoring and evaluation surveys show that before the project, mitigation via spatial planning had an average low score of approximately 4. The actual score has increased to almost 4.5 in 2020 (figure 22). This increase was in particular a result of higher scores for pilot areas in the United Kingdom, Wesermarsch (DE) and Denderleeuw (BE).

The following actions taken in the pilot projects support the improvement of this strategy:

- Flood proof design and planning in the Ninove, Geraardsbergen, Denderleeuw pilot projects (BE) to develop a flood proof neighbourhood.
- Flood risk analysis was done in most of the pilot projects to update the local flood risk maps. E.g., in the United Kingdom, flood risk maps were analysed to identify the best areas where to implement NFM to reduce flood consequences in Medway, Lustrum Beck and Southwell catchments. This resulted into a new

methodology developed for the identification of the target sites where to implement NFM solutions. Likewise, Butt Green Shield pilot project (UK) and Ninove pilot project (BE) conducted flood risk analysis to reduce surface flood risk from extreme rainfall via increase storage capacity in private and public space. In the Kent pilot project (UK) a social and physical analysis was done to assess the vulnerability of care homes in the Kent County. In the Reimerswaal and Flood proof electricity grid pilots (NL) also conducted GIS modelling to identify the most vulnerable electricity grid assets in Zeeland.

- Combine DAPP approach with MLS measures to improve the urban development plans for Assens and Vejle (DK) to make both city flood proof.

To gain more insight in the embedding of the Mitigation via spatial adaptation, we have analysed the scores of all pilots to see to what extent respondents consider this strategy embedded in their area, organisations and communities (see figure 23).

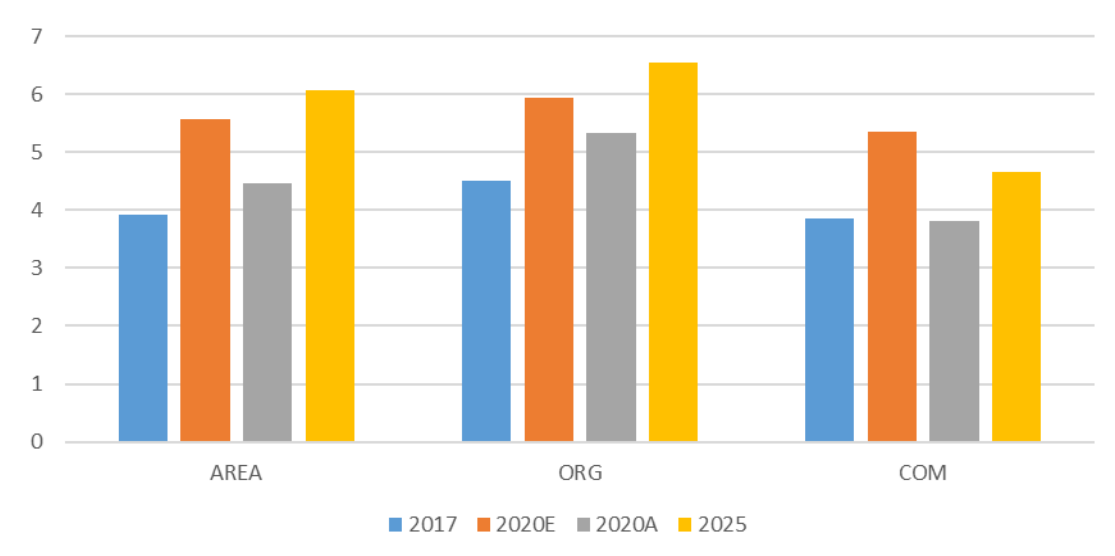


Figure 23. Mitigation strategies embedded in areas (AREA), organisations (ORG) and communities (COM), based on all pilot including baseline 2017, 2020 Expectations (E), 2020 Actual (A) and 2025

Even though the mitigation strategies increased during the FRAMES project, it has become clear that not all expectations have been met. The analysis of the embeddedness shows that progress has been made in further embedding this strategy in the involved organisations (see figure 23). E.g. in UK the implemented NFM will continue to store water in the coming years and farmers/ landowners will maintain them. In the Medway pilot project, flood mitigation was already embedded in the policies and practices of the organisations involved in the pilot project. Nevertheless, the formation of Medway Flood Partnership and FRAMES improved the mitigation practices. In Denmark, municipalities need to include mitigation measures in their planning and it is expected that the municipalities of Assens and Vejle pilot projects will update their planning based on the FRAMES results.

Embedding the strategy of mitigation via spatial planning into communities appears to be more difficult, despite successful practices within FRAMES. For example in the United Kingdom, the engaged communities supported South East Rivers Trust to identify the best locations for the NFM interventions to decrease flood risk at household level. The methodology developed to identify the target areas for NFM is being extended to other catchments in the United Kingdom but it could also be applied in other NSR countries. Likewise, the monitoring of the NFM interventions provides a valuable evidence for local communities and organisations to lobby for policy changes. In the Ninove pilot project (BE), the local municipality will develop a climate adaptation plan in 2021 taking as a starting point the FRAMES results. Moreover, shifts in discourses are taking place regarding subsidies for green roofs, street gardens, rain pits among others. These measures were presented to inhabitants during project workshops and it is expected that they will implement them measures in the coming five years.

8.3.2 Preparedness

Preparedness was considered relative high and has slightly increased as a result of small wins in many pilots (figure 22). A high variety of activities in the pilot projects have contributed to enhancing this strategy:

- Integration of emergency planning into FRM. Preparedness was already embedded into policies, pilot projects in FRAMES supported to embed this more into practice. E.g. the socio-spatial analysis conducted by Kent County Council has allowed for local tailoring of plans to ensure that resources are allocated according to local needs. In the Wesermarch pilot project (DE), a regional warning system was developed and a new digital elevation model has been applied for evacuation planning.
- Improvement of evacuation strategies (preventive evacuation, safe haven, shelters, vertical evacuation). In the Netherlands a regional survey and local focus groups have been conducted to improve understanding of the motivations and intentions by inhabitants. Also potential shelter locations have been studied.
- Emergency response (warning systems, emergency services). In the Medway pilot project (UK), the collaboration with the Kent County Council and Medway Flood Partnership improved thanks to FRAMES. Now, there is better coordination between partners to provide effective response.
- Raise awareness for flood resilience measures among communities and authorities. In most of the pilot projects, flood risk awareness towards preparedness has increased among authorities and communities (figure 25) E.g. in the Netherlands (Alblasserwaard-Vijfheerenlanden pilot project), the municipalities and the Safety Region are more aware that flooding requires a different approach than other hazards and more open to share responsibilities in water safety. In the Reimerswaal and Flood proof electricity grid pilot projects (NL), critical infrastructure manager have become more aware of flood risks in the pilot area. In Denmark (Wesermarsch pilot project), awareness among crisis management authorities has been raised via regional events (flood risk awareness day). In Belgium, workshops with citizens and local government (Ninove and Geraardsbergen pilot project) and school programs (Denderleeuw pilot project) supported awareness raising. In Denmark (Roskilde pilot project), the University College Copenhagen and Aalborg University have made a manual for locals by applying the experiences from Jyllinge Nordmark town (Roskilde municipality).
- Involve and empower communities. Kent County Council is responsible of flood response plans and emergency services. As a result of FRAMES, there is more support from communities in Kent County Council due to the collaboration with National Flood Forum in the Medway pilot. More communities are managing their own flood risk in cooperation with Kent County Council. Moreover, more communities have greater capacity to self-organise and manage floods by themselves (Lustrum Beck, Southwell, Kent, Butt Green Shield (UK) and Ninove in (BE)).

To gain more insight in the embedding of Preparedness, we have analysed the scores of all pilots to see to which extent respondents consider this strategy embedded in their area, organisations and communities (see figure 24). From this analysis it becomes clear that most progress has been made by embedding Preparedness as a strategy in the involved organisations. Respondents expect that this further increase after FRAMES. For example, in the Netherlands (Reimerswaal pilot project), it is expected that critical infrastructure managers will include flood safety in their future plans. In Belgium (Ninove pilot project), the new emergency planner, with knowledge and expertise about flood risk, showed high interest on FRAMES results. Thus, he could influence follow up actions after FRAMES (e.g. inclusion of citizens in emergency planning).

As we have discussed many activities have been conducted to improve preparedness of communities. For the embedding of these activities within communities small wins (Termeer & Dewulf, 2019) have been made. It is however also striking that expectations to embed preparedness within communities were higher before FRAMES for 2020 than the current expectations for 2025. This means, that we have not only learnt in FRAMES about relevant activities, but also how complex it is to actually to embed preparedness as a strategy within communities.

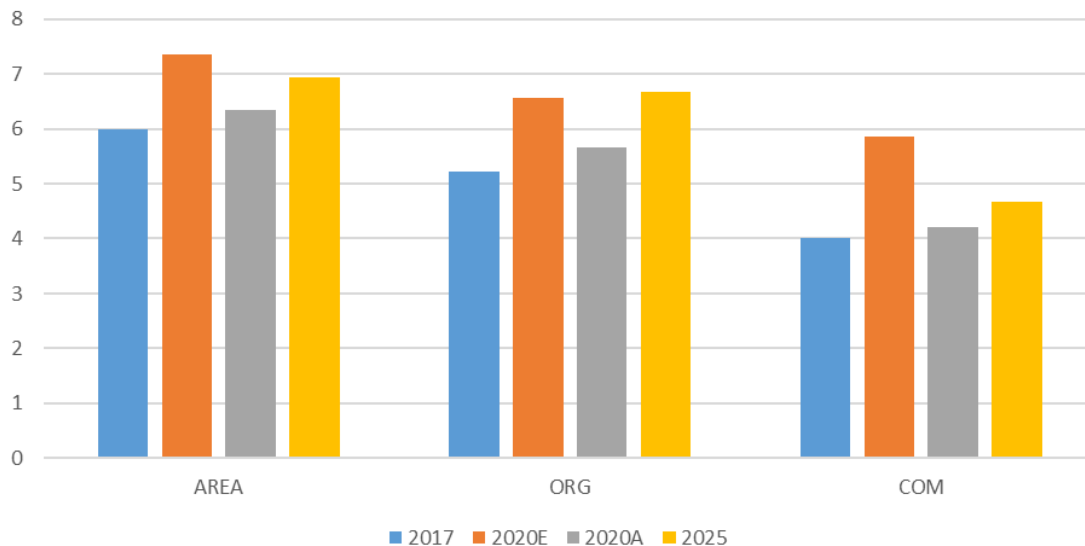


Figure 24. Preparedness strategies embedded in areas (AREA), organisations (ORG) and communities (COM), based on all pilot including baseline 2017, 2020 Expectations (E), 2020 Actual (A) and 2025

8.3.3 Recovery

A limited increase in flood recovery is observed as a result of FRAMES (figure 22). For many pilot projects small wins (Termeer & Dewulf, 2019) or losses have been reported. A major increase has been reported for the Southwell (UK), Sloe area (NL) and Roskilde (DK) pilots. Since Roskilde was the only pilot project directly focused on this strategy, this supports the relevance of interconnectedness of strategies as visualized in the Decision support system (DSS).

- Since the flooding in 2013 the word ‘recovery’ was not present in the vocabulary of FRM in Roskilde municipality. In this pilot project, the authorities and society have learned from the recovery process of the flooding in Jyllinge Normark. The Danish Coastal Authority developed guidelines based on the experiences of local organisations and citizens interviewed. The guidelines were developed for the municipalities with the focus on the role of local organisations in the recovery process and encourage municipalities to include these organisations in the planning. As a result, the municipality, the Storm Surge Council and the insurance companies have changed procedures and are more aware of the recovery phase. The Danish Coastal Authority integrated the lessons learnt from FRAMES into the guidelines for developing FRM plans (European Floods Directive). Moreover, the developed guidelines will also be disseminated to all municipalities in Denmark and present the results to the Storm Surge Council.
- In Southwell (UK), recovery from previous events has been a focus of the Southwell Flood Forum. Based on the activities in FRAMES, the involved organisations consider themselves better in place to inform and advise the community helping with flood recovery. Communication to offer advice and coordination of incidents has been improved.
- In the Sloe area (NL), one of the outcomes of the pilot project was that the industrial Sloe area cannot be used as a safe haven for inhabitants of the Badkuip (bathtub) of Ritthem, but could be used as a hub for transport for recovery materials. The conclusions of this pilot are used for recommendations for flood recovery by the authorities. One of the outcomes of the Sloe area pilot is that the involved organisations are now aware of this. Flood recovery policy and practices are next steps.

To gain more insight in the embedding of Preparedness, we have analysed the scores of all pilots to see to which extent respondents consider this strategy embedded in their area, organisations and communities (see figure 25). Just like the results for Preparedness, also for Recovery it is striking that respondents consider this more embedded in their organisations than in communities. Despite the limited pilots directly focused on recovery, many of the involved organisations in FRAMES have learned about recovery as aspect of flood resilience.

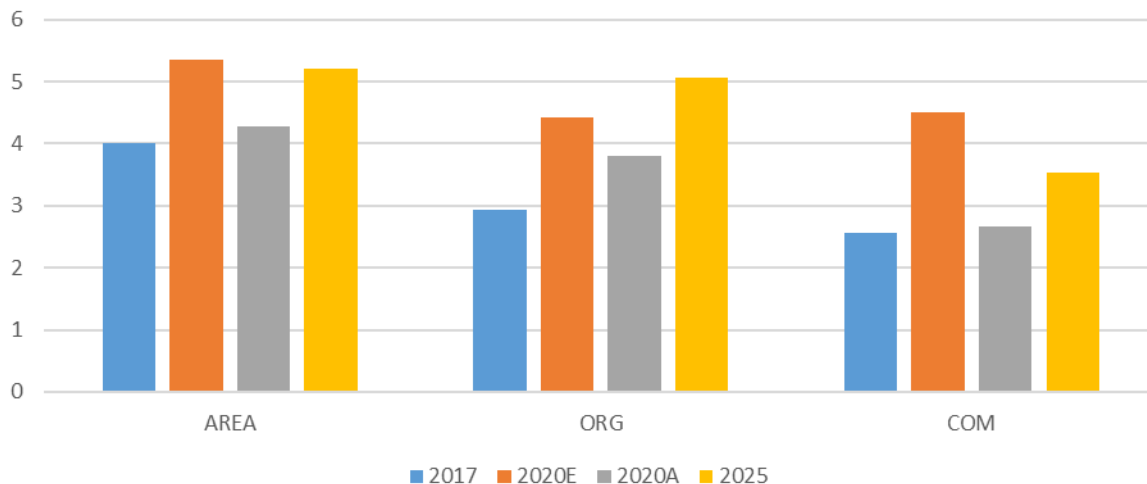


Figure 25. Recovery strategies embedded in areas (AREA), organisations (ORG) and communities (COM), based on all pilot including baseline 2017, 2020 Expectations (E), 2020 Actual (A) and 2025

It is expected that for the embedding of recovery as strategy in organisations more progress can be made. However, implementation in communities is a major challenge in the light of more diversified and balanced FRM strategies. With an average score around 2,6 this aspect has the lowest score of the embeddedness of strategies. For the Sloe area (NL) it has been explained that an increase is expected. “After adaptation of flood safety policy by the local, regional and/or national government, this new policy will be communicated with communities and awareness of the importance of flood recovery measures will grow.” (Final survey Sloe area, 2020)

In Denmark, it is expected that all the municipalities will incorporate recovery in their FRM plans since the Danish Coastal Authority already included the lessons learnt in the guides to the municipalities (including Vejle and Assens). The recovery guidelines will be shared with all municipalities in Denmark in the coming years. Comparing Denmark with other NSR countries, recovery also improved due to more attention given to preparedness. In the United Kingdom, a large part of the responsibility for recovery falls upon the national government and insurance companies through the ‘Flood Re’ insurance scheme. However, FRAMES partners such as the National Flood Forum, Kent County Council and Environment Agency all have some responsibilities in these areas and have embedded policy and practice into their organisations thanks to the raising of awareness through the Medway Flood Partnership. The communities have an important role to play in lobbying for policy changes and investments (NFM), and this is coordinated through the National Flood Forum. In Southwell (UK), the regional and local authorities, Nottinghamshire County Council, the Southwell Flood Forum and the National Flood Forum, will continue to help residents recover after floods. Moreover, the Southwell Flood Forum is focused on recovery and they will continue leading on emergency response (road closure scheme, flood wardens and as communications hub).

8.4 Upscaling and mainstreaming after FRAMES

In section 8.2 each of the strategies has been discussed separately. In FRAMES, the pilot regions have been working on combinations of MLS measures towards more diversified and balanced FRM strategies. In section 8.3 we will present how the pilot regions will continue after FRAMES.

Upscaling and mainstreaming of pilot project results (Figure 26) can take place via different paths: replication of pilots (B), evolve in a small or full scale projects (C or D) or changes in policies (E) (Vreugdenhil et al., 2012).

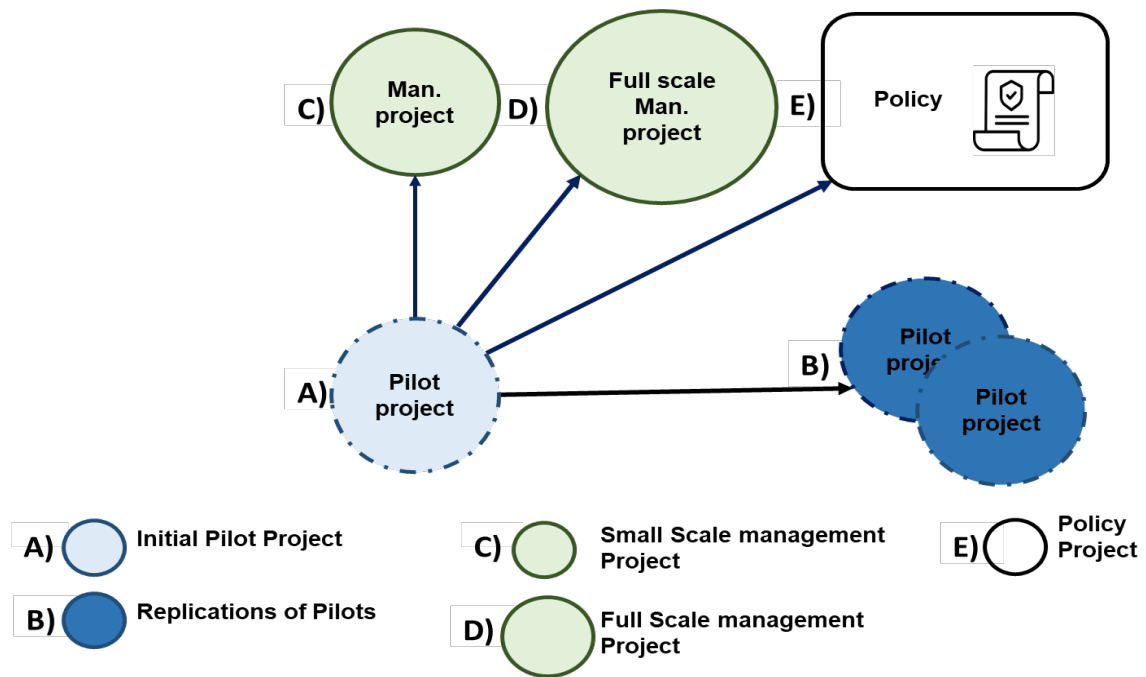


Figure 26. Different ways of disseminating lessons learnt from pilot project

The following graph (figure 27) shows that pilot managers have high expectations (score >6) regarding the upscaling of the pilot project results (see also lessons learnt about upscaling in 3.2). Most pilot managers foresee that the pilot results will be replicated in another region or country, according to the figure, thirteen pilots score 7 and higher. Likewise, they also expect the lessons learnt (12/16 pilots with a score >7) are very valuable to influence decision makers about the importance of making changes in FRM policies to strengthen flood resilience of areas and communities.

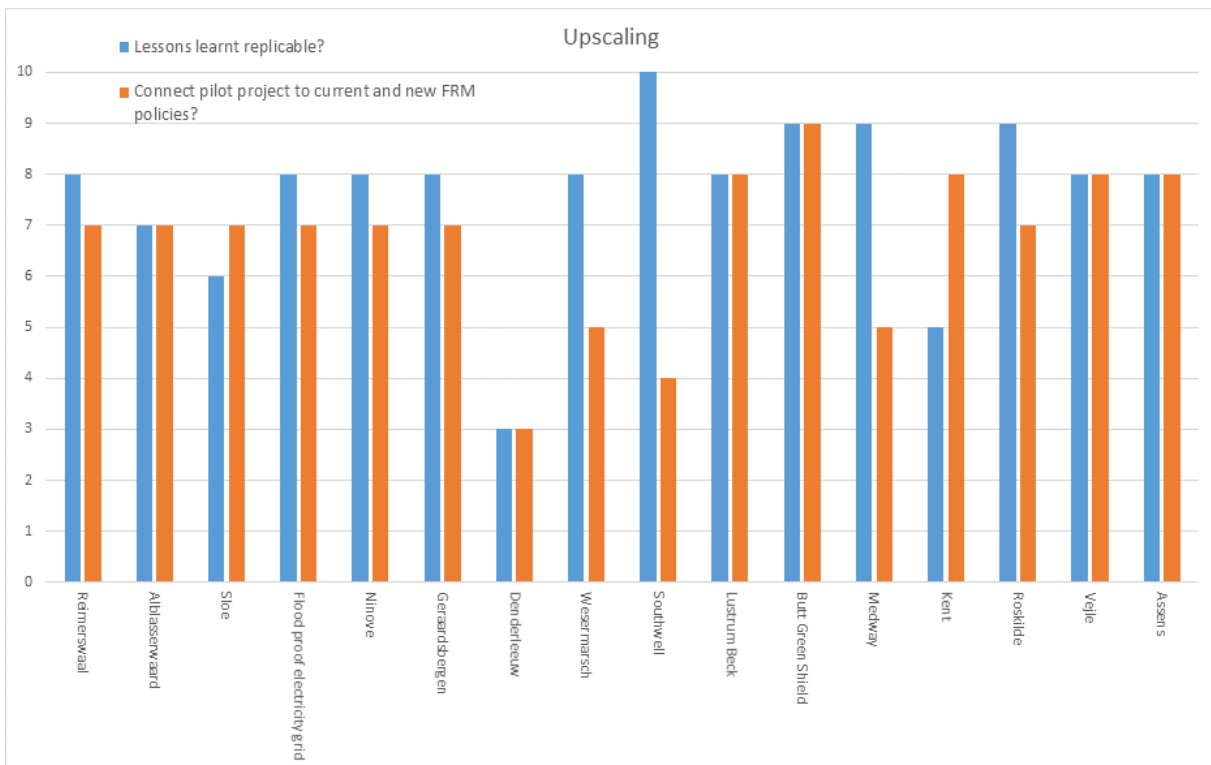


Figure 27. Expected upscaling of pilot projects' outcomes. In blue expected replication of the lessons learned and in yellow the existence of an upscaling strategy to connect the lessons learned to the current and future FRM policies

9. Conclusions

9.1 FRAMES as unique learning opportunity about diversified flood risk management

In this report, the lessons learnt have brought together resulted from the evaluation and monitoring of sixteen pilot projects in FRAMES. Following the European Flood Directive, North Sea Region (NSR) areas aim to reduce the negative consequences of flooding by working towards a transition for more diversified and balanced flood risk management (FRM) strategies.

In FRM, protection remains a main strategy to reduce flood risk in many areas within the NSR. However, taking into account the uncertainties of climate change, competition for land-use, the need to protect ecological values, long term planning of infrastructural investments, and socio-economic developments, such as urbanization, it becomes clear that other aspects of FRM are needed to cope with flood hazards. In response to the increasing risks, European countries are making efforts to diversify their FRM strategies by combining flood risk measures spanning the whole disaster management cycle (pro-action, protection, mitigation, preparation, and recovery). In FRAMES, the Multi-layered safety (MLS) approach have been adopted, already applied in the Netherlands and Belgium. Relevant frameworks and concepts to integrate diverse aspects of the disaster management cycle can also be found in Germany (the LAWA approach Bund/Länder-Arbeitsgemeinschaft Wasser in German), in the United Kingdom (a flood resilience approach) and most recently in Denmark (an adaptive planning approach). As argued in the introduction of this report, the principles of these integrated FRM approaches are being acknowledged by more and more authorities and practitioners across the NSR, but the approach has not been developed in a transnational way. The FRAMES project provided a unique opportunity for transnational learning from the implementation of MLS pilot projects.

9.2 Multi-layered safety actions supporting flood resilience

The transnational learning as described above has resulted in a broad and in-depth insight of seven MLS-actions: (1) Flood proof design and planning; (2) Natural flood management (NFM); (3) Critical infrastructure; (4) Preparedness and emergency planning; (5) Community resilience; (6) Resilient Recovery; and (7) Adaptive planning.

In the Decision Support System, the DSS (chapter 7), we have seen that these actions are highly interdependent and it is clear that **MLS is not a hierarchic approach, but rather a complex network of actions**. For instance, adaptive planning as process-oriented action can support the unravelling of relevant actions in relation to time and changing conditions within the local or regional context.

While there was just one pilot specifically focused on recovery, many of the other actions contribute to resilient recovery as well. Based on the lessons learnt in FRAMES, it is perceived that MLS is not only about a shift from managing safety (focus on flood protection to lower probability) towards FRM (focus on probability x consequences), but about managing flood resilience, by **taking into account probability, consequences and recovery**. The identified MLS actions are relevant conditions for a flood resilient society.

Considering the low awareness of flood risk in many countries in the NRS, this emphasizes also the need to **reconnect flood risk management with society**. The lessons learnt about community resilience provide relevant insights from the pilot projects within FRAMES. An overarching insight is that community resilience is a relevant strategy to work on flood resilience starting from local interests and needs. In FRAMES, relevant demonstrations are provided in the design and planning of flood proof neighbourhoods and the implementation of NFM.

For reconnecting flood risk with society, the role of professionals in preparedness and emergency planning is indispensable. Both the **knowledge and expertise about flood probability and human behaviour** are needed to assess the consequences for human activities and to provide coping strategies for resilient communities.

Critical infrastructure has also a pivotal role for flood resilient societies, since the functioning of critical infrastructure is both an important condition for emergency response and resilient recovery. Communities in the NSR depend highly on critical infrastructure. Interdependencies between several networks can also result in cascading effects for society. On the other hand, the planning of critical infrastructure depends on spatial planning and requires long term investments. While the pilot projects focused directly on critical infrastructure, awareness was also raised by studying the vulnerability of critical infrastructure in flood prone areas.

Working on flood resilient areas also provide **opportunities for coalignment of flood risk management with enhancing ecological values**, by implementing NFM. This also applies to the flood proof design and planning in flood prone areas. These approaches are most relevant in the context of river flooding and/or of extreme rainfall.

9.3 Pilot projects enhance development of adaptive capacities

In order to support flood resilient decision making in the next decades, it is needed to take interdependencies between different aspects of flood resilience into account. All pilot areas in the NSR have their own geographical, hydrological and physical characteristics, local community cultures and governance contexts, resulting in a unique mix of FRM approaches. The potential for diversification of strategies in response to climate change depends on the adaptation space and capacity of institutions (Berkhout et al., 2006). In working towards diversified FRM, there is a shared need for the capacity development of authorities to foster the capacity of society to deal with floods.

The MLS pilots have significantly contributed to that capacity development of authorities, stakeholders and practitioners in the NSR. In the evaluation it has become clear that for diversification of flood risk management there is a need for a high variety of solutions, but also that there are many solutions available. Decision making and implementation of diversification of FRM also ask for the involvement of **multi-actor, multi-level and multi-sector setting** which makes the applicability of MLS approach a complex challenge. This capacity has been emphasized by FRAMES partners that is essential for all types of actions in FRAMES (see chapter 6). MLS needs **collaborative leadership** which encourages and enables collaboration between different actors in order to implement MLS actions. Responsibilities for FRM are dispersed over many different authorities, such as water, crisis management and spatial planning. Thus, the implementation of MLS actions requires collaboration among different actors to **share knowledge and experiences, discuss problems** and look for solutions to further develop FRM strategies e.g. preparedness plans and community resilience. **A clear division of responsibilities among the actors** was also needed to facilitate the implementation of MLS actions. As a result of FRAMES pilot projects, new collaborations (e.g. new networks or partnerships) were developed built up on **trust** (e.g. community resilience or critical infrastructure actions).

Bringing actors together at the same table enables **knowledge exchange, sharing information and learning** from each other. In FRAMES, the learning process was mainly focused on looking back to FRM actions applied previously related to flooding events and improve these through the pilot projects in FRAMES. Moreover, few pilot projects went a step further questioning and rethinking the current FRM strategies to reach the political agenda. As a result, actors and more specifically **citizens increased their awareness about flood risk**. (e.g. preparedness and community resilience actions). To raise awareness among stakeholders, who are not directly involved in FRM, the **right information should be made accessible as a continuous effort**. This is a first step towards **engaging and empowering citizens** to take an **active role** in FRM within their community or region. For certain actions such as emergency planning, it is important to invest in **joint capacity development**, via collaborative planning and contingency exercises. Looking long term, depending on the potential flood hazards for a region it is important to **develop plans together with stakeholders who need to act** to mitigate the consequences of floods.

Overall, the **knowledge gained**, the new **collaboration** emerged and the **raised flood risk awareness** are key ingredients to mainstream the lessons learnt beyond FRAMES. Each of the MLS-actions has specific adaptive capacities which need to be developed for successful implementation. However, it needs taken into account that the development and presence of adaptive capacities also depends on the local government context. This results in **a need for adaptive capacity assessment in the development of more diversified flood risk management strategies**. (see examples of MLS actions and specific adaptive capacities in chapter 6).

9.4 Small wins in transition towards flood resilience

FRAMES clearly showed that the implementation of MLS approaches contributes to more diversified and balanced flood risk management measures. FRAMES further demonstrated how the implementation of combined MLS actions resulted in 'small wins' (Termeer & Dewulf, 2019) (Chapter 8) or incremental changes in FRM practices at local and regional level. The general lessons learnt (Chapter 3) are valuable and available for replication in other contexts or locations across the NSR countries. The specific lesson learnt per action (Chapter 4 and 5) are relevant to take into account to learn from barriers and successes in the implementation of these actions. Pilot managers expect that the pilot results will also be mainstreamed into the FRM practices and policies (Chapter 8). It is expected that authorities will make use of the knowledge gained to reframe the underlying FRM values, beliefs and norms. In order to support and facilitate the decision makers or practitioners, in FRM measures or practice changes, we strongly advise them to consider these lessons learnt and the general recommendations. This is the legacy of the transnational evaluation and monitor of pilots in FRAMES project to transitions towards flood resilience.

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Appendix A: Project partners contribution to report and wiki

Name	Function	Organisation	Type of contribution				
			Frame work	Inter-viewer	Inter-viewee	TFG	Wiki
Flavia Simona Cosoveanu	Researcher and lecturer	HZ University of Applied Sciences	x	x		x	x
Marloes Bakker	Researcher		x			x	x
Jean-Marie Buijs	Senior researcher and lecturer		x	x		x	x
Teun Terpstra	Professor		x			x	x
Lukas Papenburg	Researcher and lecturer		x				x
Tom van der Voorn	Researcher		x			x	
Jasper van den Heuvel	Researcher and lecturer						x
Paul Vader	Senior Researcher and lecturer						x
Jethro Waanders	Application manager and web developer						x
Tom Goosse	Researcher		Ghent University	x	x		x
Barbara Tempels	Researcher	x				x	
Luuk Boelens	Professor	x					
Britta Restemeyer	Researcher and lecturer	Oldenburg University	x	x		x	x
Leena Karrasch	Researcher and lecturer		x			x	
Thomas Klenke	Professor		x			x	
Malo Feldmann	Master student					x	
Helge Bormann	Professor Pilot manager Wesermarsch	Jade University of Applied Sciences	x		x	x	x
Jenny Kepschull	Researcher Pilot manager Wesermarsch		x		x	x	x
Ruben Akkermans	Pilot manager Reimerswaal and Sloe area	Province of Zeeland			x	x	x
Ingrid de Kubber	Pilot manager Reimerswaal and Sloe area				x	x	x
Erik Schumacher	Pilot manager Flood proof Electricity grid Zeeland				x		x
Arjen Bastiaanse	Finance manager					x	
Eva den Boer	Intern					x	
Lucy Smeets	Pilot manager Alblasserwaard-Vijfheerenlanden				x	x	x
Bianca Groot	Communication advisor	Province of South Holland	x			x	
Steven Krol	Lead beneficiary of FRAMES		x			x	
Edward Sterenberg	Communication manager					x	
Hannelore Mees	Pilot manager Denderleeuw, Geraardsbergen and Ninove	Province of East Flanders			x	x	x

Brendan de Baets	Policy advisor	Province of East Flanders				X	
Mark Smith	Pilot manager Kent	Kent County Council			X	X	X
Christine Wissink	Pilot manager Kent					X	X
Dean Morrison	Pilot manager of Medway	Southeast Rivers Trust			X	X	X
Bella Davies	Trust Director					X	
Michelle Steel	Pilot manager Butt Green Shield	National Flood Forum			X	X	X
Paul Cobbing	Pilot manager Butt Green Shield				X	X	X
Sanjay Johal	Sr. flood risk officer					X	
Amanda Davies	Operation coordinator					X	
Shani Lambert	Pilot manager Southwell				X	X	X
Ben Lamb	Pilot manager Lustrum Beck	Tees Rivers Trust			X	X	X
Richard Holmes	Operations coordinator					X	
Josh Wells	Pilot manager Southwell				X	X	X
Mie Thomsen	Pilot manager Assens and Vejle	Danish Coastal Authority			X	X	
Martin Jebens	Pilot manager Roskilde				X		
Kaija Jumppanen Andersen	Coastal engineer					X	
Mie Dall Azan	Project assistant					X	
Laura Storm Henriksen	Pilot manager Roskilde					X	X
Julia Oberdörfer	Manager	OOWV				X	
Frank Ahlhorn	Consultant	Küste & Raum				X	
Pieter Ton	Sub pilot manager	Rijkswaterstaat				X	
Vijay Gayadien	Advisor European subsidies					X	
Martijn Warmerdam	Finance manager	Reeleaf				X	
Kim Jennings	Senior catchment manager	The Rivers Trust				X	
Chloe Palmer	Director					X	
Alistair Maltby	Operations Director					X	
Jayne Mann	Marketing and communication manager					X	
Jenn Yearling	Finance manager					X	
Lucy Butler	GIS Manager					X	
Arlin Rickard	Chief policy advisor					X	

Appendix B: Adaptive capacities

Table A1. Dimensions and adaptive capacities definitions (Gupta et al., 2010)

Adaptive capacities	Definitions
1. Variety	
1.1 Variety of problem frames	Room for multiple frames of references, opinions and problem definitions
1.2 Multi-actor, multi-level, multi-sector (stakeholders)	Involvement of different actors, levels and sectors in the governance process
1.3 Diversity of solutions	Availability of a wide range of different solutions/pathways/actions to tackle a problem
1.4 Redundancy (duplication)	Presence of overlapping solutions/measures and back-up systems; not cost-effective. Redundancy in the short-term to promote the best solutions in the long-term
2. Learning capacity	
2.1 Trust	Presence of authorities patterns that promote mutual respect and trust
2.2 Single loop learning	Ability of authorities patterns to learn from past experiences and improve their routines
2.3 Double loop learning	Evidence of changes in assumptions underlying authorities patterns (re-evaluates and reframes goals, values, etc.)
2.4 Discuss doubts	Authorities openness towards uncertainties (deal with uncertainties)
2.5 Institutional memory	Authorities provision of monitoring and evaluation processes of pathways/actions experiences
3. Room for autonomous change	
3.1 Continuous access to information	Accessibility of data within authorities memory and early warning systems to individuals
3.2 Act according to a plan	Increasing the ability of individuals to act by providing plans and scripts for action, especially in case of disasters
3.3 Capacity to improvise	Increasing the capacity of individuals to self-organize and innovate; foster social capital
4. Leadership	
4.1 Visionary	Room for long-term visions and reformist leaders
4.2 Entrepreneurial	Room for leaders that stimulate actions and undertakings; leadership by example
4.3 Collaborative	Room for leaders who encourage collaboration between different actors; adaptive co-management
5. Resource	
5.1 Authority	Provision of accepted or legitimate forms of power; whether or not authorities rules/procedures are embedded in constitutional laws
5.2 Human resources	Availability of expertise, knowledge and human labour
5.3 Financial resources	Availability of financial resources to support measures and financial incentives
6. Fair governance	
6.1 Legitimacy	Whether there is public support for a specific authority
6.2 Equity	Whether or not authorities rules/procedures are fair
6.3 Responsiveness	Whether or not authorities patterns show response to society
6.3 Accountability	Whether or not authorities patterns provide accountability procedures

Appendix C: Transnational Monitoring Surveys FRAMES

C1: Baseline monitoring survey

Pilot:

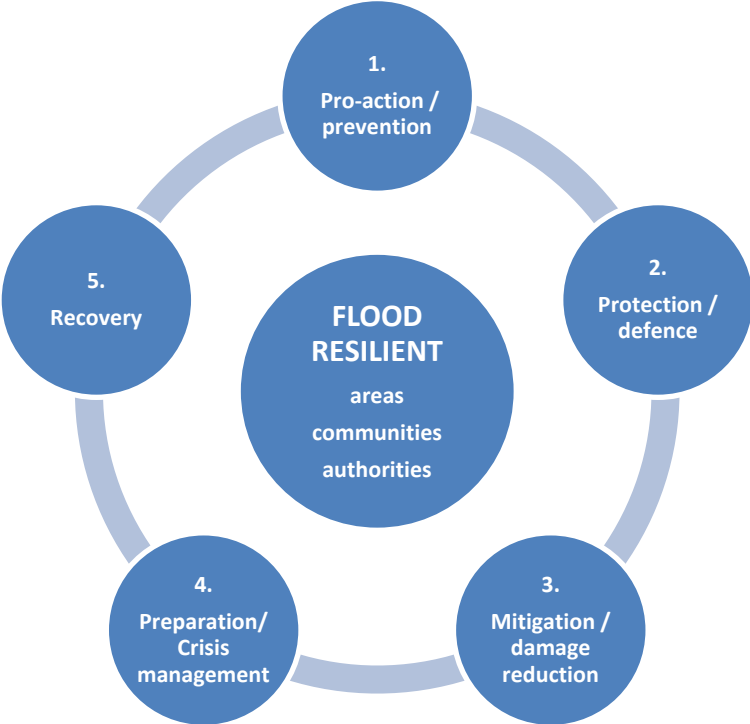
Important:
 We kindly ask the pilot manager to complete this questionnaire in consultation **with relevant experts/stakeholders in the pilot/region**. The pilot manager can send this questionnaire and ask these experts/stakeholders to complete (certain) questions, or ask them to review answers. **Per pilot we would like to have 1 questionnaire returned.**

Who contributed to completing this questionnaire? Please provide names of persons and their organisations:

Person	Organisation
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Short explanation

FRAMES is about improving flood resilience by taking different types of actions. A common and well known typology in flood risk management (FRM) is the disaster management cycle, as shown in the diagram below. This survey first focuses on the flood resilience of areas by considering the five elements proaction (1), protection (2), mitigation (3), preparation (4) and recovery (5). Hereafter, a few questions will be asked with regard to the flood resilience of communities and authorities.



1. Pro-action/prevention

Negative consequences of flooding can be avoided by pro-active spatial planning or land use policies (“keeping people away from water”), aimed at building only outside areas that are prone to flooding.

To what extent is proaction/prevention currently a strong characteristic of the pilot area?

<i>Not at all</i>											<i>To a great extent</i>
1	2	3	4	5	6	7	8	9	10		

Please shortly explain your answer:

2. Flood protection/defence

Keeping water away from people by (combinations of) hard infrastructural works (dikes, dams, etc.) or softer (nature based) solutions (dunes, retention in nature areas, etc.).

To what extent is flood protection/defence currently a strong characteristic of the pilot area?

<i>Not at all</i>											<i>To a great extent</i>
1	2	3	4	5	6	7	8	9	10		

Please shortly explain your answer:

3. Flood risk mitigation

Consequences of floods can be mitigated by a smart design of the flood-prone area including spatial orders, constructing flood compartments, or (regulations for) flood-proof building.

To what extent is flood risk mitigation a strong characteristic of the pilot area?

	<i>Not at all</i>										<i>To a great extent</i>
Currently	1	2	3	4	5	6	7	8	9	10	
Expectation after Frames	1	2	3	4	5	6	7	8	9	10	

What will be done in FRAMES with regard to flood risk mitigation, that improves the

... physical resilience in the pilot area?

... capacities of local organisations / institutions in the pilot area?

... capacities of local communities (citizens, businesses) in the pilot area?

4. Flood preparation

Consequences of floods can be mitigated by preparing for adequate response to a flood event. Measures include flood warning systems, disaster management and evacuation/rescue plans, and managing a flood when it occurs by taking last call emergency measures (e.g. sand bags).

To what extent is flood preparation a strong characteristic of the pilot area?

	<i>Not at all</i>									<i>To a great extent</i>
	1	2	3	4	5	6	7	8	9	10
Currently										
Expectation after Frames										

What will be done in FRAMES with regard to flood preparation, that improves the ... physical resilience in the pilot area?

... capacities of local organisations / institutions in the pilot area?

... capacities of local communities (citizens, businesses) in the pilot area?

5. Flood recovery

Facilitates a good and fast recovery after a flood event. Includes plans for draining / pumping away flood water and restoring safety and security, plans for reconstruction or rebuilding critical infrastructure, damage compensation/insurance systems, return of evacuated communities and social-psychological support.

To what extent is flood recovery a strong characteristic of the pilot area?

	<i>Not at all</i>									<i>To a great extent</i>
	1	2	3	4	5	6	7	8	9	10
Currently										
Expectation after Frames										

What will be done in FRAMES with regard to flood recovery, that improves the ... physical resilience in the pilot area?

... capacities of local organisations / institutions in the pilot area?

... capacities of local communities (citizens, businesses) in the pilot area?

Flood resilience of authorities

Please name the organisations / stakeholders that will be involved in your pilot:

Organisation
1
2
3
4
5
6
7
8
9
10

In general, to what extent is flood risk mitigation embedded in policy and practice of these organisations, in your opinion?

	<i>Not at all</i>									<i>To a great extent</i>
	1	2	3	4	5	6	7	8	9	10
Currently										
Expectation after Frames										

Please shortly explain your answer:

In general, to what extent is flood preparation embedded in policy and practice of these organisations, in your opinion?

	<i>Not at all</i>									<i>To a great extent</i>
	1	2	3	4	5	6	7	8	9	10
Currently										
Expectation after Frames										

Please shortly explain your answer:

In general, to what extent is flood recovery embedded in policy and practice of these organisations, in your opinion?

	<i>Not at all</i>									<i>To a great extent</i>
	1	2	3	4	5	6	7	8	9	10
Currently										
Expectation after Frames										

Please shortly explain your answer:

Flood resilience of local communities

Please name the communities (e.g., neighbourhoods, municipalities) that will be involved in / informed about your pilot(s), and how many citizens they consist of:

Community	Number of citizens (approximately)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

In general, to what extent is flood risk mitigation embedded in the behaviour of these communities, in your opinion?

	<i>Not at all</i>									<i>To a great extent</i>
	1	2	3	4	5	6	7	8	9	10
Currently										
Expectation after Frames										

Please shortly explain your answer:

In general, to what extent is flood preparation embedded in the behaviour of these communities, in your opinion?

	<i>Not at all</i>									<i>To a great extent</i>
	1	2	3	4	5	6	7	8	9	10
Currently										
Expectation after Frames										

Please shortly explain your answer:

From our current understanding of Kent as a whole these are our opinions.

In general, to what extent is flood recovery embedded in the behaviour of these communities, in your opinion?

	<i>Not at all</i>									<i>To a great extent</i>
	1	2	3	4	5	6	7	8	9	10
Currently										
Expectation after Frames										

Please shortly explain your answer:

C2: Final monitoring survey

Pilot name:

Important:

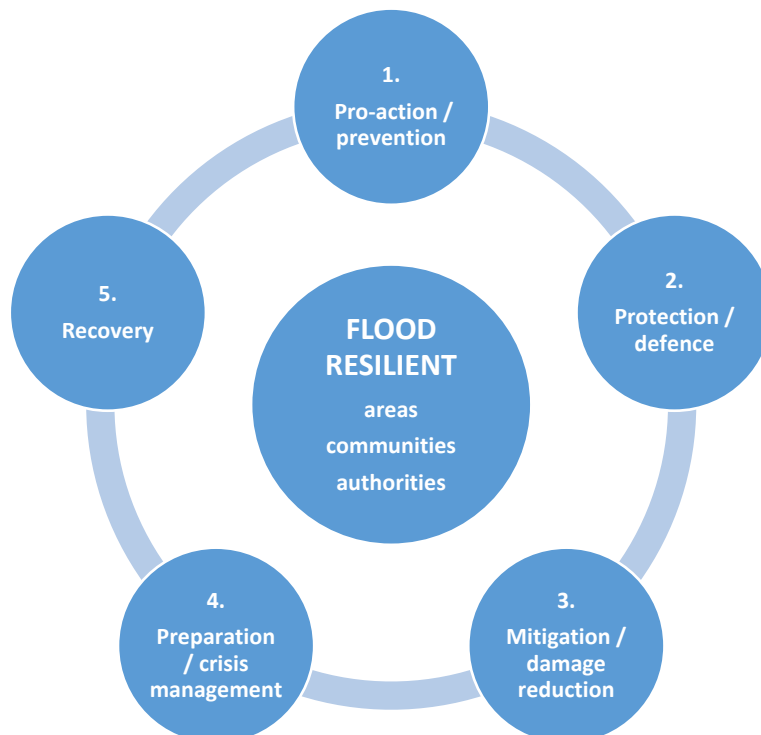
We kindly ask the pilot manager to complete this questionnaire in consultation **with relevant experts/stakeholders in the pilot/region**. The pilot manager can send this questionnaire and ask these experts/stakeholders to complete (certain) questions, ask them to review answers, or organize a group meeting. **Per pilot, we would like to have 1 questionnaire returned with the average score for the pilot and all individual scores and input from stakeholders in the explanations.**

Who contributed to completing this questionnaire? Please provide names of persons and their organisations:

Person	Organisation
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Short explanation

FRAMES is about improving flood resilience by taking different types of actions. A common and well known typology in FRM is the disaster management cycle, as shown in the diagram below. This survey first focuses on the flood resilience of areas by considering the five elements proaction (1), protection (2), mitigation (3), preparation (4) and recovery (5). Hereafter, a few questions will be asked with regard to the flood resilience of communities and authorities. Finally, a couple of questions with regards to upscaling are listed.



1. Pro-action/prevention

Negative consequences of flooding can be avoided by pro-active spatial planning or land use policies (“keeping people away from water”), aimed at building only outside areas that are prone to flooding.

To what extent is proaction/prevention currently a strong characteristic of the pilot area?

Not at all

To a great extent

1 2 3 4 5 6 7 8 9 10

Please shortly explain your answer:

2. Flood protection/defence

Keeping water away from people by (combinations of) hard infrastructural works (dikes, dams, etc.) or softer (nature based) solutions (dunes, retention in nature areas, etc.).

To what extent is flood protection/defence currently a strong characteristic of your pilot area?

Not at all

To a great extent

1 2 3 4 5 6 7 8 9 10

Please shortly explain your answer:

3. Flood risk mitigation

Consequences of floods can be mitigated by a smart design of the flood-prone area including spatial orders, constructing flood compartments, or (regulations for) flood-proof building.

To what extent is flood risk mitigation a strong characteristic of your pilot area?

Currently (after) FRAMES:

Not at all

To a great extent

1 2 3 4 5 6 7 8 9 10

Please shortly explain your answer:

Expectation 5 years after FRAMES:

Not at all

To a great extent

1 2 3 4 5 6 7 8 9 10

Please shortly explain your answer:

What *has been* done in FRAMES with regard to flood risk mitigation, that improved the...

... physical resilience in your pilot area?

... capacities of local organisations / institutions in your pilot area?

... capacities of local communities (citizens, businesses) in your pilot area?

What *will be* done after FRAMES with regard to flood risk mitigation, that will improve the...

... physical resilience in your pilot area?

... capacities of local organisations / institutions in your pilot area?

... capacities of local communities (citizens, businesses) in your pilot area?

4.Flood preparation

Consequences of floods can be mitigated by preparing for adequate response to a flood event. Measures include flood warning systems, disaster management and evacuation/rescue plans, and managing a flood when it occurs by taking last call emergency measures (e.g. sand bags).

To what extent is flood preparation a strong characteristic of your pilot area?

Currently (after) FRAMES:

Not at all

To a great extent

1 2 3 4 5 6 7 8 9 10

Please shortly explain your answer:

Expectation 5 years after FRAMES:

Not at all

To a great extent

1 2 3 4 5 6 7 8 9 10

Please shortly explain your answer:

What *has been* done in FRAMES with regard to flood preparation, that improved the...

... physical resilience in your pilot area?

... capacities of local organisations / institutions in your pilot area?

... capacities of local communities (citizens, businesses) in your pilot area?

What will be done after FRAMES with regard to flood preparation, that improves the...

... physical resilience in your pilot area?

... capacities of local organisations / institutions in your pilot area?

... capacities of local communities (citizens, businesses) in your pilot area?

5.Flood recovery

Facilitates a good and fast recovery after a flood event. Includes plans for draining / pumping away flood water and restoring safety and security, plans for reconstruction or rebuilding critical infrastructure, damage compensation/insurance systems, return of evacuated communities and social-psychological support.

To what extent is flood recovery a strong characteristic of your pilot area?

Currently (after) FRAMES:

Not at all

To a great extent

1 2 3 4 5 6 7 8 9 10

Please shortly explain your answer:

Expectation 5 years after FRAMES:

Not at all

To a great extent

1 2 3 4 5 6 7 8 9 10

Please shortly explain your answer:

What has been done in FRAMES with regard to flood recovery, that improved the...

... physical resilience in your pilot area?

... capacities of local organisations / institutions in your pilot area?

... capacities of local communities (citizens, businesses) in your pilot area?

What will be done after FRAMES with regard to flood recovery, that improves the...

... physical resilience in your pilot area?

... capacities of local organisations / institutions in your pilot area?

... capacities of local communities (citizens, businesses) in your pilot area?

Flood resilience of authorities

Please name the organisations / stakeholders that were involved in your pilot:

Organisation

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10

In general, to what extent is flood risk mitigation embedded in the policy and practices of these organisations, in your opinion?

Currently (after) FRAMES:

Not at all

To a great extent

1 2 3 4 5 6 7 8 9 10

Please shortly explain your answer:

Expectation 5 years after FRAMES:

Not at all

To a great extent

1 2 3 4 5 6 7 8 9 10

Please shortly explain your answer:

In general, to what extent is flood preparation embedded in the policy and practices of these organisations, in your opinion?

Currently (after) FRAMES:

Not at all

To a great extent

1 2 3 4 5 6 7 8 9 10

Please shortly explain your answer:

Expectation 5 years after FRAMES:

Not at all

To a great extent

1 2 3 4 5 6 7 8 9 10

Please shortly explain your answer:

In general, to what extent is flood recovery embedded in the policy and practices of these organisations, in your opinion?

Currently (after) FRAMES:

Not at all

To a great extent

1 2 3 4 5 6 7 8 9 10

Please shortly explain your answer:

Expectation 5 years after FRAMES:

Not at all

To a great extent

1 2 3 4 5 6 7 8 9 10

Please shortly explain your answer:

Flood resilience of local communities

Please name the communities (e.g., neighbourhoods, municipalities) that were involved in / informed about your pilot(s), and how many citizens they consist of:

Community	Number of citizens (approximately)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

In general, to what extent is flood risk mitigation embedded in the behaviour of these communities, in your opinion?

Currently (after) FRAMES:

Not at all

To a great extent

1 2 3 4 5 6 7 8 9 10

Please shortly explain your answer:

Expectation 5 years after FRAMES:

Not at all

To a great extent

1 2 3 4 5 6 7 8 9 10

Please shortly explain your answer:

In general, to what extent is flood preparation embedded in the behaviour of these communities, in your opinion?

Currently (after) FRAMES:

Not at all

To a great extent

1 2 3 4 5 6 7 8 9 10

Please shortly explain your answer:

Expectation 5 years after FRAMES:

Not at all

To a great extent

1 2 3 4 5 6 7 8 9 10

Please shortly explain your answer:

In general, to what extent is flood recovery embedded in the behaviour of these communities, in your opinion?

Currently (after) FRAMES:

Not at all

To a great extent

1 2 3 4 5 6 7 8 9 10

Please shortly explain your answer:

Expectation 5 years after FRAMES:

Not at all

To a great extent

1 2 3 4 5 6 7 8 9 10

Please shortly explain your answer:

Up-scaling of pilots

“ Pilots never fail, but also never scale” – the conditions that make pilots successful, often hamper their uptake in policy.

To what extent do you expect that the lessons learnt of your pilot are going to be replicated or applied in other locations in your country or other countries?

Not at all

1

2

3

4

5

6

7

8

9

10

To a great extent

Please shortly explain your answer – please explicitly refer to barriers and success factors for replication:

To what extent, in your opinion, is/are there...

... a strategy in place to support policy makers in connecting your pilot project with current and new FRM policies to mainstream the pilot outcomes

Not at all

1

2

3

4

5

6

7

8

9

10

To a great extent

Please shortly explain your answers – please explicitly refer to barriers and success factors for upscaling:

Appendix D: Interview guideline

The interview guideline was developed between December 2018 and January 2019 by 7 project partners from the knowledge institutes: 4 from HZ Delta Academy, 1 from Oldenburg University and 2 from Ghent University.

General information

Pilot area:

Name of the pilot manager:

Organisation:

Interviewers:

Date:

Objective:

This interview consists of 14 semi-structured questions to facilitate/guide an open discussion with the pilot coordinators/managers about the implementation process of the Multi-Layer Safety (MLS) approach in the pilot area and the impact/influence of the expected outcomes in the pilot region. This input will be used for the development of the FRAMES Decision Support System (DSS) and resilience toolkit. The bullet lists relevant aspects to follow and bring into the discussion if they are mentioned by the pilot manager.

Introductory questions:

1. Which were/are the most relevant flood risk management (FRM) measures taken in the pilot area and in the pilot region (*before* FRAMES)?
2. How did you get involved in setting up this pilot and what was your main motivation?

Key questions:

3. Main goals/MLS: What are the main goal(s) in the pilot in relation to the MLS layers (protection/prevention/preparation/recovery)?
 - ✓ Specify if the goal(s) is/are for short/medium/long term (<5/5–25/>25 years)
 - ✓ Reason of the pilot, was it completely new compared to the region's FRM approach?
4. Pilot process and decision making: Throughout the implementation process of MLS, which were/are
 - ✓ Follow up steps towards new/improved strategies in FRM
 - ✓ Tools/methods used to perform and monitor these steps/decisions
 - ✓ Current and missing actors (level, sector)
 - ✓ Tools/methods to involved and keep actors engaged (special attention of local communities)
5. Interaction of layers/hierarchy of layers: Have you encountered any interaction of activities between several layers of MLS? If yes, how have you coordinated activities when they take place on different layers? Could you give any examples?
6. Struggles/hurdles: Which were/are the main struggles that you have faced in implementing and reaching the goal(s) in relation to the MLS approach? What would you never do again? How have you overcome these struggles?
 - ✓ Drivers/barriers of change: stakeholders, time, resources, uncertainties of climate change, power
7. Accomplishments: What did it go well? Would you do again the same thing? If not, what would you change?
8. (Expected) Outcomes: Which are the outcomes or expected outcomes of implementing the MLS in the pilot area and in the pilot region?
 - ✓ Concrete outputs/products (new or not?)
 - ✓ Share information/communicate outcomes
9. Embedding/upscaling of MLS approach. Based on the pilot (expected) outcomes, what are the potential/opportunities to embed/upscale the MLS approach in the region after FRAMES? For example, community resilience, spatial planning/infrastructure, FRM policies/strategies.

10. Role of pilot coordinator: How do you see your role as pilot manager in facilitating the implementation of the MLS approach during the pilot project and embedding/upscaling the project outcomes *afterwards*?
11. Role of key actors: How do you see the role of the key actors in facilitating the implementation of the MLS approach *during* the pilot project and embedding/upscaling the project outcomes *afterwards*?
12. What do you think will be the main drivers/barriers for the embedding/upscaling of the expected outcomes after FRAMES?
13. What is needed to make use of these drivers and to overcome these barriers?

Ending questions:

14. Do you recommend to talk with the key actors that will have a role in enabling/facilitating the implementation of MLS approach further, after FRAMES, at regional/national level?
15. Do you have any comments related to this interview? (additional questions or ideas).

Thanks so much for your time and contribution in this interview

Appendix E: Plenary discussion statements pilot paradox

Name of pilot:

Name of pilot manager and organisation:

Pilot projects are perceived as easy and safe manner to experiment with new solutions that deal with the consequences of climate change. The same characteristics that facilitate the development and implementation of a pilot project may cause a tension in the wider mainstream of the pilot outcomes (van Buuren, 2018).

Please read, reflect and score from 1-5 the following pilot project aspects providing a clear explanation of your answer. (1 very low, 2 low, 3 not high or low, 4 high, 5 very high present). Additionally, provide an explanation of the answer (3-4 lines) to the statements of internal (A) and external (B) pilot process in relation to the current coastal zone, flood risk or urban planning policies in your country.

	Conditions for internal process	Conditions for external process
1. Position of the pilot <i>Explain briefly</i>	A. In these pilots, actors have the possibility to experiment with new FRM solutions as part of Multi-Layer Safety (MLS) that would not fit in the current flood risk management (FRM) policies. 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/>	B. A strategy is in place to support policy makers in connecting the pilot project with current FRM policies to mainstream the pilot outcomes/results 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/>
2. Resources distribution <i>Explain briefly</i>	A. Sufficient resources are available to experiment, learn and complete a full test and demonstrate the added value of MLS approach in the current FRM policies. 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/>	B. There are enough resources to replicate the pilot project in the existing policy regime 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/>
3. Stakeholder participation <i>Explain briefly</i>	A. The actors involved in the pilot can be considered as a coalition of boundary spanners: a diversity of perspectives and a creative process leads to innovative approaches in the design and implementation of the new FRM strategies as part of the MLS approach. 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/>	B. The actors involved in our pilot represent all relevant disciplines and stakes of the future implementation arena, and are capable to connect pilot outcomes to the relevant policy regimes. 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/>
4. Process design <i>Explain briefly</i>	A. The pilot process is tailor-made and set up as a collaborative learning environment. 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/>	B. In the pilot process there is continuous focus on where the results have to land, so after completion results are ready for mainstreaming and broader embedding. 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/>
5. Project design <i>Explain briefly</i>	A. The time and space scale of the pilot project is small to reduce risks and obtain high quality results for its specific location. 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/>	B. As a result of the pilot project, actors gained a full understanding of MLS and its applicability in other locations and longer time scales. 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/>

Appendix F: Overview of FRAMES pilot projects

Pilot projects	Pilot objective	Pilot outcomes per layer of MLS		
		Layer 2, Spatial adaptation	Layer 3, Emergency response	Layer 4, Resilient recovery
BELGIUM				
1 Ninove 2 Geraardsbergen 3 Denderleeuw	Involve and empower citizens to take an active role in flood risk management (FRM) at local and regional levels	The creation of a vision and an action plan including spatial adaptation measures for flood proof a neighbourhood for citizens living in flood prone areas the development of flood risk zoning based on the flood risk label method	An increase of flood risk awareness by providing access to information about flood risk to local community groups (citizens, schools and local authorities) The improvement of risk communication by providing citizens with a flood preparedness manual	
DENMARK				
4 Assens 5 Vejle 6 Roskilde	Adjust and apply the Dynamic Adaptation Policy Pathways approach, or DAPP, in combination with Multi-Layer Safety (MLS) measures to create adaptation development plans to make a city flood proof. Assess the stakeholders recovery capacity after the severe flooding event that took place in 2013		An increase in flood risk awareness by municipalities about the importance of combining multi-layered safety measures to reduce flood risk	The realization that recovery capacity can be improved and recovery time can be reduced by developing guidelines with concrete information, such as what to do and who to contact when a flood event occurs
GERMANY				
7 Wesermarsch	Achieve a more balanced FRM by improving layer 2 and 3 of the MLS approach	The development of flood risk zoning based on identified flood prone areas in the region and the integration of rural-urban drainage into the management plans	An increase of flood risk awareness by citizens, water and crisis management authorities by developing information materials (such as leaflets, booklets, and brochures) about flood risk and flood preparedness The improvement of risk communication (for instance the evacuation procedure) by using updated flood risk maps	

Pilot projects		Pilot objective	Pilot outcomes per layer of MLS		
			Layer 2, Spatial adaptation	Layer 3, Emergency response	Layer 4, Resilient recovery
THE NETHERLANDS					
8	Alblasserwaard - Vijfheerenlanden	Improve emergency response management, layer 3 of Multi Layered Safety approach		Increase of flood risk awareness and collaboration by Safety Region, Water board and local municipalities by working together on combining evacuation and spatial development Improvement of evacuation routes and risk communication using updated flood risk maps	
9	Flood proof electricity grid Zeeland	Assess the vulnerability of the electricity grid network to flooding in Zeeland	The development of an 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 the Safety Region, Water board and local municipalities and critical infrastructure owners to provide more information about flood vulnerability of critical infrastructure Improvement of evacuation routes and risk communication using risk label method Improvement of evacuation routes and risk communication using risk label method	
10	Reimerswaal	Assess the vulnerability of the electricity grid network to flooding in Zeeland.	The development of an inventory of spatial adaptation measures (e.g. increase height, location) for the most vulnerable electricity grid assets	Increase of flood risk awareness by the Safety Region, Water board and local municipalities and critical infrastructure owners by providing more information about the flood vulnerability of critical infrastructure The improvement of asset management plans using updated flood risk maps The improvement of evacuation routes and risk communication using updated flood risk maps	
11	Sloe area	Study the suitability of the Sloe harbour as a temporary shelter location for residents of the Ritthem area		The development of risk communication and evacuation strategies for citizens when the area faces a flood event	

Pilot projects	Pilot objective	Pilot outcomes per layer of MLS		
		Layer 2, Spatial adaptation	Layer 3, Emergency response	Layer 4, Resilient recovery
THE UNITED KINGDOM				
12 Butt Green Shield	Reduce surface flooding by implementing water storage devices at household level in Gorleston, Bradwell, Great Yarmouth towns	The improvement of flood proof zoning by implementing water storage devices, such as water butts or raised flower beds, at household level	An increase of flood risk awareness by local citizens and businesses by having regular discussions and meetings about this topic	
13 Lustrum Beck 14 Medway	Test and implement Natural Flood Management (NFM) measures in the Lustrum Beck catchment and improve community resilience	The improvement of flood proof zoning by implementing NFM measures such as leaky barriers and water ponds, to reduce flood damage at farm level.	An increase of flood risk awareness by local communities, local and regional authorities and nature conservation organisations through demonstrating the effectiveness of NFM measures in FRM The development of social capital through engaging local communities and making them responsible for FRM actions	
15 Southwell	Test and implement NFM measures in the Trent river catchment and improve community resilience	The improvement of flood proof zoning by implementing NFM measures such as leaky barriers, water ponds, to reduce flood damage at farm level	An increase of flood risk awareness by local communities, state agents, local and regional authorities through demonstrating the effectiveness of NFM measures in FRM the development of social capital by engaging local communities and making them responsible of FRM actions	
16 Kent	Study the vulnerability of the health and social care sectors in Kent County	The improvement of spatial planning of health and social care infrastructure using updated flood risk maps	an increase of flood risk awareness by Kent County Council and care homes owners by providing more information about the vulnerability of communities, health and social care infrastructure The improvement of flood action plans at District Council level by using updated flood risk maps	

Appendix G: Harmonisation of FRAMES lessons learnt with the national adaptation strategies

The most recent national adaptation plans and national adaptation strategies of the FRAMES countries were checked for inclusions of flood, flooding and other key words from the selected policy actions. Below, the relevant texts are pasted, organized per country. Also the EU Floods Directive has been included.

European Floods Directive

The purpose of this Directive (European Union, 2007) is to establish a framework for the assessment and management of flood risks, aiming at the reduction of the adverse consequences for human health, the environment, cultural heritage and economic activity associated with floods in the Community.

- Flood risk management (FRM) plans shall take into account relevant aspects such as costs and benefits, flood extent and flood conveyance routes and areas which have the potential to retain flood water, such as natural floodplains, the environmental objectives of Article 4 of Directive 2000/60/EC, soil and water management, spatial planning, land use, nature conservation, navigation and port infrastructure.
- FRM plans shall address all aspects of FRM focusing on prevention, protection, preparedness, including flood forecasts and early warning systems and taking into account the characteristics of the particular river basin or sub-basin.
- FRM plans may also include the promotion of sustainable land use practices, improvement of water retention as well as the controlled flooding of certain areas in the case of a flood event.
- It is feasible and desirable to reduce the risk of adverse consequences, especially for human health and life, the environment, cultural heritage, economic activity and infrastructure associated with floods.

Belgium

National Climate Change Adaptation Strategy (National Climate Commission, 2010):

- Adaptation actions on a sectoral level - Biodiversity, ecosystems and water
 - As far as inland floods are concerned, regional prevention plans already exist. All regional plans aim to improve knowledge of the risk of flooding, reduce and decelerate the run-off of water on slopes, protect, restore and establish flood zones, improve the management of rivers, decrease vulnerability in zones liable to flooding and improve crisis management. Rules banning the construction of buildings in areas prone to flooding have also been imposed.
 - In Flanders, building plans, as well as any other plans that might have consequences for water, are checked for their hydrological consequences (a procedure called “watertoets”, within the framework of the Coordination Commission Integrated Water Policy). It applies in particular to zones prone to flooding, important for infiltration, or close to a drinking water catchment area. The objective is to avoid negative impacts on the water system, but also to reduce the risk and consequences of flooding. Flood risk maps have been prepared to facilitate the implementation of these measures.
 - At the federal level, new legislative changes deal with flooding and other natural hazards in the form of an obligatory annex to housing fire insurance policies.
- Adaptation actions on a sectoral level – coastal, marine and tidal areas
 - Sigma plan: controlled flooding zones

- Water management is a cross cutting issue, therefore adaptive measures in this sector will also influence activities in other areas. For instance, some of the measures mentioned above within the framework of flood prevention will also contribute to water availability.

National Adaptation Plan (National Climate Commission, 2010)

Most adaptation initiatives will be undertaken by local, regional or federal authorities in the context of their own climate policy. National measures aim to complement these measures by promoting greater coordination and information-sharing between the authorities. The National Adaptation Plan describes national measures for the next few years, covering the period 2017-2020.

- At Brussels level: a new regional water management plan for the period 2017-2021 (which follows its first plan from 2012). This plan includes an integrated and global approach to all the challenges related to water management. It provides, inter alia, measures to stimulate sustainable water use and to restore the Region's hydrographic water network. This plan also includes measures to prevent and manage flood risks.
- Measure 3: To create a national database to share and give access to all the information available dealing with climate change impacts, vulnerability assessments and adaptation in BE (research projects, best practice, guidance, plans and programmes). As stated in the National Adaptation Strategy (NAS) "making the information available for end users through a climate information system is an important consideration".
- Measure 4: Strengthening sectoral coordination at national level. Setting up of an integrated vertical and horizontal coordination structure. Inter-sector taskforces exist at regional and federal levels (or are being created). Coordination also exists between regional and federal institutions. It seems useful to strengthen horizontal and vertical coordination by bringing together sectoral experts from the local, regional and federal entities to exchange expertise, projects in development, etc. This coordination may take the form of thematic round tables. Every year, a specific will be addressed and the relevant actors (involved at federal, regional, provincial and local levels) will be invited. Sectoral coordination in terms of adaptation to climate change may be strengthened on the following themes in particular: transport, disaster management, health, energy, agriculture, etc.
- Measure 6: Evaluate the impact of climate change on the security of the energy supply and the energy transport and distribution infrastructures
- Measure 7: Evaluation of the socio-economic impacts of climate change in BE
- Measure 10: Promote transnational cooperation on adaptation. To facilitate transnational cooperation on adaptation, covering both international cooperation between (neighbouring) countries and cross-border cooperation among countries with shared cross-border resources (e.g. water, protected areas) or other shared interests.
- Measure 11: Coordination of preventative, planning and management measures in the event of emergency climate change situations. In the short term, the aim is to achieve greater consistency between the management and prevention measures for climate-related action/emergency (and response) plans and their coordination, at federal, regional, provincial and local level, by involving the competent authorities for preventative measures in preparatory working groups from the beginning. In the medium term, the aim is to ensure that climate-related incidents and disasters such as wildfires and floods occur less frequently. If these incidents do occur, the aim is to reduce the damage to people, the environment and infrastructures by taking preventative measures and ensuring good crisis management.

National Adaptation Strategy (The Danish Government, 2008)

Coastal management: generally speaking, it is individual land owners' own choice to protect themselves from flooding and erosion. Therefore, there are no general laws or regulations stipulating protection, or to what degree owners must protect themselves. However, the Danish Coastal Authority will recommend minimum heights for building footings and dike heights upon request. These figures are determined in consultation with the Storm Council, and compliance with them is one of the prerequisites for compensation for flooding losses from the Council. The recommended heights now include an addition for future sea-level rise.

- Buildings and infrastructure: Individual municipalities may implement information campaigns to inform residents and businesses of the precautions they should take to minimise the extent of damage in the event of flooding. The Danish Environmental Protection Agency published guidelines in 2007 giving municipalities some new tools for thinking across the usual municipal sectors when climate change must be taken into account in connection with construction and operation of sewage systems and sewer renovation. During heavy precipitation events municipalities must issue warnings and information concerning deterioration of bathing water quality.
- Land use planning:
 - More powerful storms, especially in winter, can increase risks for people, buildings and installations, and can also increase the risk of flooding in low-lying areas. In general climate change can create both problems and possibilities that in the longer term can best be solved/exploited by conscientious planning of land use, for example by exempting certain areas from residences and other installations.
 - Many municipalities are already underway with adapting their planning to the expected climate changes. This work should be supported and followed centrally, since it cannot be expected that municipalities, businesses and citizens themselves will be able to obtain and interpret relevant information on climate change as a matter of course. Private and public building owners will to a certain extent be able to adapt their decisions about building and construction work to the altered risks and possibilities that climate change will bring, if the relevant information is available. An important source of information is municipal planning, which should therefore always reflect and adapt to the risks and possibilities brought on by climate change.
 - An important aim of national measures under planning legislation could be to limit building and construction in high-risk areas, where they could incur significant extra expenses for remedies, for example, coastal protection, dike construction, infrastructure protection or water pumping.
 - There should be measures to ensure that updated information on climate developments and relevant risk analyses – for example, illustrated on maps – reaches the municipalities at all times for use in their planning. Information should also be made available for citizens and businesses. The EU Directive on the Assessment and Management of Flood Risks, which took effect in 2007, stipulates that this type of information must be provided.
 - Member States must by the end of 2011 indicate those areas thought to be at risk of flooding. The designation will be based on an interim estimate of flood risks, including as a result of climate change. For every designated area, maps must be made by the end of 2013 showing the flooding extent and the potential number of inhabitants that would be affected, potential environmental and economic damage, etc. On the basis of these maps Member States must draft by the end of 2015 risk management plans for flooding and set adequate targets for managing flood risks.
- Rescue preparedness
 - Ongoing adaptation of rescue preparedness is already underway, for example, as a result of the hurricane in 1999 and the storm surges and floods of recent years. This development will continue on

the basis of observed weather events, experience from efforts undertaken and expectations for the future.

- Cross sectoral initiatives
 - There is a need for a more general and at the same time goal-oriented information campaign, partly to inspire the stakeholders faced with climate challenges and partly to get citizens to change their behaviour.
 - Targeted information campaign: The focal point of the information effort will be the establishment of a web portal for climate change adaptation. To provide Danish society the possibility of timely adaptation to climate change, it is important that easily accessible information concerning the expected changes is available.

Germany

National Adaptation Strategy (Bundesregierung, 2008) *in German only*

Adaptation Action Plan II (APA II) of the German Strategy for Adaptation to Climate Change (The Federal Environment Agency, 2015)

The German Strategy for Adaptation to Climate Change (DAS) provides the political framework for climate change adaptation in DE. In order to support this strategy with concrete measures, the Adaptation Action Plan (APA) was adopted in 2011.

- The actors in charge need reliable data and tools in order to initiate the adaptation measures necessary.
- Cluster Water: comprises the fields of action water resources, water management, coastal and marine protection and fishery: Water Resources/Water Management: the measures referred to in the [APA II](#) are primarily supposed to improve the management of and prearrangement for flood risks as well as the handling of heavy rainfalls and flash floods. Among other things the renaturation of water courses and water meadows is to be advanced and natural floodplains are to be created.
- Cluster Infrastructure: Measures from the cluster “Water” are particularly relevant for the construction industry in order to avoid or minimize flood damage to buildings and infrastructures.

The Netherlands

National Adaptation Strategy (Ministry of Infrastructure and Water Management, 2016):

The National Climate Adaptation Strategy (Ministry of Infrastructure and Water Management, 2016) *seeks to raise awareness and promote action across the full breadth of all sectors. The practical adaptation tasks which seek to reduce the risks associated with flooding, heat and drought fall within the Delta Decision on Spatial Adaptation.*

- It is essential that climate adaptation permeates all sections of society and that all citizens are aware of the joint responsibility they bear for its success.
- The NAS encourages public sector authorities, knowledge institutes, private sector companies, societal organisations and engaged individuals to play their part in offsetting the negative effects of climate change and taking advantage of the opportunities it brings.
- An important component of the strategy is the desire to unite all parties and promote a joint approach.
- Responsibilities are clear and well organized; the necessary resources have been reserved. Flood safety policy is based on a multi-level risk management approach. In practice, there are three levels. Prevention (Level 1) is the most important. Prevention is always better – and less expensive – than cure. Disaster

response (Level 3) forms the final safety net, regardless of the nature of the crisis: floods, extreme weather, an outbreak of some infectious disease or the failure of vital functions due to heat or drought. It is possible to achieve the necessary level of protection by replacing certain Level 1 measures by measures at Level 2 (spatial design) or Level 3. A good spatial structure will provide physical protection to the vital and vulnerable functions. This is an important component of the Delta Programme on Spatial Adaptation. Similarly, good crisis management will limit the impact of a flood. This responsibility has been assigned to the Water Crisis and Flood Management Taskforce (*Stuurgroep Management Watercrises en Overstromingen*), which includes representatives of all relevant parties, including ministries, water management authorities and the security regions.

- Flooding in the urban area: Municipal authorities and water management authorities are jointly responsible for reducing the risk of flooding.
- Flood prevention is of course a component of the Delta Programme on Spatial Adaptation.
- Aspects demanding special attention
 - *Vital and vulnerable functions*: Although the vulnerability of certain vital functions has prompted the revision of policy and the implementation of measures, it could be claimed that too little attention has been given to the likely impact of flooding. The urgency of effective measures is partly due to the long life-cycle of the infrastructure that supports vital functions such as energy provision and transport. There is limited flexibility and it will be difficult to adapt the infrastructure to cope with climate change at a later date. The choices and investments made today will do much to determine the form and function of the networks for decades to come. This applies to a far lesser extent to the IT and telecommunications infrastructure which is, for the time being at least, more flexible.
 - *Coherent policy*: It is becoming increasingly clear that climate adaptation is a particularly broad undertaking. It goes beyond flood safety and water provision to touch on many other societal domains, including the physical environment, health and nature. The call for a fully coherent and cohesive policy is therefore being heard ever more clearly from a wide range of actors, including those who are directly involved in the design and upkeep of the physical environment.
- Capacity building in the public sector: For provincial and municipal authorities, climate adaptation is a relatively new area of attention. Given the integrated nature of climate adaptation and the various policy domains of which it forms part (water management, spatial development, economic policy, health, safety and environment), it is difficult to assign responsibility to any particular department. It is important that all public sector authorities develop the necessary knowledge and resources: there must be a process of capacity building. A central point of contact is required. Cooperation between the smaller municipalities is likely to be of value. A number of meetings have been held further to the National Safety and Security Strategy, at which public and private stakeholders were invited to discuss topics such as heat and drought, flooding, extreme weather conditions and (forest) fires. An ongoing study (the National Threats and Capacities Programme) will determine the extent to which NLIs prepared to counter various risks to public safety. The NAS complements this process by recommending measures which will help to climate-proof our country.
- Crossover¹: water-Spatial Planning-Public Spaces-Housing-Infrastructure: Tackling potential flooding within the spatial structure is cheaper than doing so within the water system.

¹ At the regional and local levels of scale, it is often necessary to address various problems – in several sectors – simultaneously. It is worthwhile examining whether a single solution can be found which will address multiple issues, particularly if all are evident at the same location. Such solutions are termed ‘crossovers’.

The United Kingdom

National adaptation strategy: Climate Change Act (gov.uk, 2008)(2008)

One of the provisions in the Climate Act is “The government must publish regular reports on the risks to the UK from climate change and programmes for adaptation to respond to the risk identified.”

National adaptation programme (Department for Environment Food & Rural Affairs (Defra), 2018)

This report sets out what government and others will be doing over the next 5 years to be ready for the challenges of climate change.

- Flooding and coastal change risks to communities, businesses and infrastructure is a high risk now and is expected to remain a high risk in the future. In this NAP we set out the objectives and actions that will be taken to:
 - make sure everyone is able to access the information they need to assess any risk to their lives, livelihoods, health and prosperity posed by flooding and coastal erosion;
 - bring the public, private and third sectors together to work with communities and individuals to reduce the risk of harm – particularly those in vulnerable areas;
 - make sure that decisions on land use, including development, reflect the level of current and future flood risk;
 - boost the long-term resilience of our homes, businesses and infrastructure;
 - take action to reduce the risk of harm from flooding and coastal erosion including greater use of natural flood management (NFM) solutions; and
 - include flood risk as a key
- Natural flood management and protection of coastal habitats:
 - Our objective in the first NAP was to work with individuals, communities and organisations to reduce the threat of flooding and coastal erosion, encouraging NFM solutions, including that resulting from climate change, by understanding the risks of flooding and coastal erosion, working together to put in place long term plans to manage these risks and making sure that other plans take account of them.
 - As set out in the 25 Year Environment Plan we aim to: Explore greater use of NFM techniques where these are appropriate
 - NFM approaches and/or working with natural processes can, in the right place, provide opportunities to manage water flow, potentially reducing the risk of flooding to our communities. NFM measures alone will not offer protection to areas of greatest risk or in the face of the most significant flood events. Good integrated flood management will see these incorporated alongside conventional defences.
 - As we continue to explore and refine the role of NFM schemes, we will monitor and evaluate their effectiveness, allowing us to improve future programmes.
- Cross sectoral: The Cabinet Office has established a National Infrastructure Resilience Council (NIRC) to bring together utilities companies to share information about the locations of their assets and to take a coordinated approach to flood resilience.
- 25YEP Goal: to reduce the risk of harm to people, the environment and the economy from natural hazards including flooding and coastal erosion by taking appropriate action. We will achieve this by:
 - Making sure everyone is able to access the information they need to assess any risk to their lives and livelihoods, health and prosperity posed by flooding and coastal erosion;
 - bringing the public, private, and third sectors together to work with communities and individuals to reduce the risk of harm – particularly those in vulnerable areas;
 - making sure that decisions on land use, including development, reflect the level of current and future flood risk;

- boosting the long-term resilience of our homes, business and infrastructure; and
- Taking action to reduce the risk of harm from flooding and coastal erosion including greater use of NFM solutions.

We have a holistic approach to flood and coastal erosion risk management, addressing the aspects of prevention, protection, adaptation, response, and acceptance:

- Prevention: minimise new building in areas at high flood and erosion
- Protection: Supporting increased protection from flooding and erosion where appropriate by investing in defences such as flood walls, sea defences, and embankments and in soft engineering which works with natural and erosion processes to manage the volume, timing and speed of water flowing through particular areas.
- Adaptation: Supporting adaptation which reduces the damage to homes, infrastructure and local services so that costs to government, industry (including insurers), and individuals are reduced and recovery is quicker. This includes designing properties, infrastructure, and communities to withstand flooding when it happens and speed recovery where it does. These can be simple measures such as installing flood gates or air brick covers or more substantial works such as fitting a pump, having solid floors or raising electrics in buildings.
- Response: We are working with partners to ensure there are robust arrangements in place to forecast and respond to a flooding incident. This includes warning and informing communities and local responders so that they are in a position to take appropriate preventive action whilst also having robust incident management arrangements in place in the event of a flood occurring.
- Acceptance: Flood plains managed well can provide temporary flood storage areas for rivers and the sea at times of high flow or tide, minimising the risk elsewhere.

RESILIENT AUTHORITIES MONITOR		Abl. waard	Kent	Medway	Lustrum Beck	BG Shield	South well	Elgrid	R'waal	Sloe area	Roskilde	Velje	Assens	Weser marsch	Ninove	D'leeuw	G'bergen	
<i>In general, to what extent is...</i>		B	F	B	F	B	F	B	F	B	F	B	F	B	F	B	F	
...	flood risk mitigation embedded in policy and practice of these organisations, in your opinion? Currently	4	3	4	7	3	6	6	6	6	6	5	1	4	5	7	6	6
...	flood risk mitigation embedded in policy and practice of these organisations, in your opinion? After Frames	5	3	7	7	8	8	8	7	7	6	1	7	1	6	7	8	7
...	flood preparation embedded in policy and practice of these organisations, in your opinion? Currently	7	6	5	7	6	8	7	5	6	6	4	1	2	6	7	7	5
...	flood preparation embedded in policy and practice of these organisations, in your opinion? After Frames	8	7	7	7	8	9	9	7	7	7	6	1	3	7	8	8	7
...	flood recovery embedded in policy and practice of these organisations, in your opinion? Currently	2	2	5	6	6	7	6	5	2	6	2	3	1	2	1	4	4
...	flood recovery embedded in policy and practice of these organisations, in your opinion? After Frames	3	2	7	7	8	8	6	6	7	7	1	4	1	3	1	5	4
...	flood risk mitigation embedded in the behaviour of these communities, in your opinion? Currently	4	4	2	5	5	6	6	4	6	4	3	1	1	3	6	3	1
...	flood risk mitigation embedded in the behaviour of these communities, in your opinion? After Frames	5	5	5	5	8	8	7	8	7	6	3	1	1	4	6	3	6
...	is flood preparation embedded in the behaviour of these communities, in your opinion? Currently	6	6	2	5	4	7	4	5	6	2	4	1	1	6	6	3	2
...	flood preparation embedded in the behaviour of these communities, in your opinion? After Frames	7	7	5	5	7	8	7	7	6	7	4	5	1	7	6	7	3
...	flood recovery embedded in policy and practice of these organisations, in your opinion? After Frames	2	2	5	4	6	6	7	6	7	5	7	1	1	1	6	1	6
Average per pilot		4,6	4,1	4,6	5,8	5,8	7,3	6,8	5,9	5,8	5,2	4,7	1,0	2,2	4,0	4,7	5,6	4,0
Total average baseline		4,6																
Total average final		5,1																

Colophon

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