Mosan Initiative for Climate Change Action

CREATING A COOPERATION SPACE FOR ADAPTING THE INTERNATIONAL MEUSE CATCHMENT TO CLIMATE CHANGE IMPACTS INCLUDING SUPPORTING THE FIRST EUROPEAN PROJECT PROPOSAL (AS LIFE OR INTERREG) OF THIS COOPERATION SPACE

Final report

Mission 3 – MOVING ON TO ACTION AT EUROPEAN LEVEL: ASSESSMENT OF COMMON POINTS AND POSSIBLE SYNERGIES BETWEEN THE EXISTING ADAPTATION PLANS

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1. Introduction

This report is part of the Mission 3 of the MICCA project: Moving on to Action at European level. This mission aims at identifying, making coherent and structuring an action plan for adaptation to climate change whose scope and dimensioning will allow the submission of the European project (Mission 4).

One of the first step consist in reviewing the initiatives related to water, ecosystems and climate change that have been already carried out on the Meuse basin territory. Those master plans/ strategies/ operational programs or projects, that were identified in the first phase "gaining support and structuring" were assessed based on a multi-criteria analysis presented below.

The main objectives of this assessment are as follow:

- Identify common points and possible synergies between the existing adaptation plans, operational programs and projects
- Assess gaps and identify missing measures

The value of this analysis is twofold:

1. The starting point is the lack of current governance of adaptation in the Meuse River basin. The International Meuse Commission (IMC) is a place for political discussions and coordination, but its mandate covers only the water framework directive and does not address climate change as such (or only on the lens of floods and droughts directives). Then, when it comes to cross border coordination, there is a need to facilitate discussions on how each country implements their strategies and understand the scope of the main project/ measures carried out. This is especially true since, depending on the adaptation strategies/measures taken in one country, there may be knock-on effects on another segment of the basin.
2. Several adaptation plans/ projects were implemented out by national and regional stakeholders through the countries of the catchment area (France, Belgium, Luxembourg, Germany and the Netherlands). One the main lever of action identified by the GRCC think tank to move forward on the cross-border adaptation governance is to work on what brings us together, not what separates us. In this respect, the analysis of the commonalities between the strategies/ actions carried out is particularly useful.

Beyond this report, a database of actions as an Excel tool offering a documented vision of the existing (already carried out/ in progress/ planned) adaptation actions was provided. This tool can be further developed but will serve as a shared knowledge base, understood and accepted by all stakeholders.

The whole of this assessment should result in the definition of the strategic vision and its related catalogue of operational actions.

2. Approach to assessing adaptation plans

2.1. Identification of sources and scope of the analysis

Previous research project documents, territorial and national adaptation plans, sectoral plans (water, biodiversity, agriculture, energy) potentially contributing to adaptation were analysed. All master plans / operational programs and projects identified during the phase 1 have been included as well as the desk-based review done to build the database of actions. The assessment of the type of adaptation actions is directly linked to the findings of the catalogue of actions.

The figures 1 and 2 allows us to see the distribution and the scale of plans and projects across the countries of the Meuse catchment.

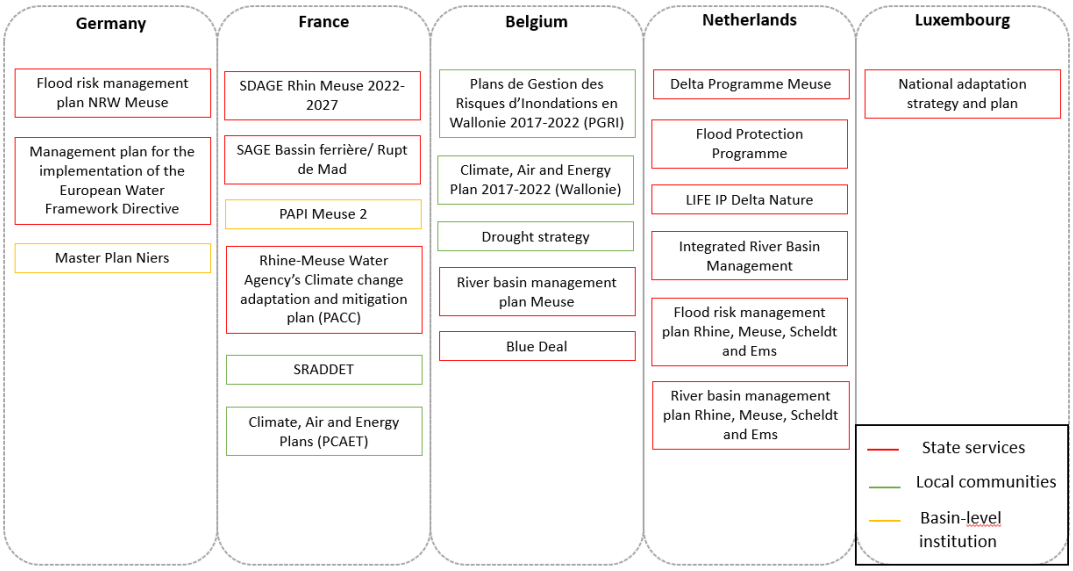

Figure 1: Adaptation-relative plans and programmes carried out on the Meuse catchment.

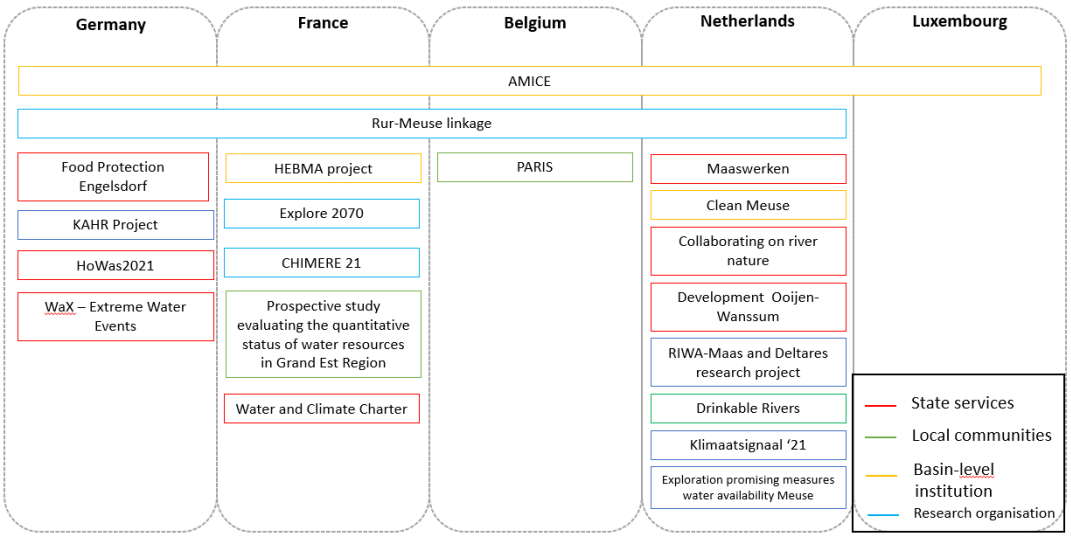

Figure 2: Adaptation-relative projects carried out on the Meuse catchment

As expected, several plans and programmes have been formulated on the segments of the Meuse basin in Germany, France, Belgium and Netherlands. In Luxembourg, no plan deals specifically with their Meuse section, which is consistent with the low level of participation of Luxembourg stakeholders in the AMICE or Rur-meuse linkage projects.

In terms of spatial scale, main adaptation-relative plans and programmes have been formulated at regional level especially in Germany, France and Belgium such as the German flood risk management plan NRW Meuse or the Climate, Air and Energy Plan of Wallonia. In Netherlands, only large programmes at national level were developed. A small proportion of local plans address water resources and climate change issues. In France, two recent Climate, Air and Energy Plans (PCAETs) (Ardenne and Vosges) include measures in this perspective.

Further to the scales as described in Figures 1 to 2, it is important to determine the scope of the various plans and projects. For this, all plans and projects are described using the 4 Ws: Who, Where, When and Why.

In order to facilitate comparison between the revised documents and to quickly identify what the documents refer to, a colour categorisation has been made.

Regarding the adaptation – relative plans, three types of documents have been assessed:

- Water resource management document that refers to a plan or strategy dedicated exclusively to the management of water resources (flood management strategy, qualitative or quantitative management of water resources). Climate change is often considered as a section of this document or as a chapeau component.
- Climate documents that refers to the strategy or plan whose focus is the fight against climate change. In this category are considered adaptation plans for water resource or regional/ local climate plans integrating water section.
- Territorial planning document which can integrate climate change consideration as a cross-cutting issue and a section dedicated to water and urbanism.

Concerning the projects, a discrimination was made between projects corresponding to operational actions and studies. When the project includes both studies and operational actions, this is specified.

Table 1: 4 Ws of the past and present adaptation plans (row color signifies type of document: blue = Water resource management document, green = Climate document, yellow = Territorial planning document)

Country of implementation	Adaptation-relative plan/ strategy	Type of document	Who: responsible organization	Where: geographical level	When: current status	Why: main climate hazard addressed
France	SDAGE Rhin Meuse 2022-2027	Water resource management document	Regional authority	Regional	In progress	Mean air temperature/mean precipitation/ heavy precipitation and river flood/ drought
	SAGE Bassin Ferrrière/ Rupt de Mad	Water resource management document	Regional authority	Regional	In progress	River flood
	PAPI Meuse 2	Water resource management document	Local authority	Local	Not yet published	River flood
	Rhine-Meuse Water Agency's Climate change adaptation and mitigation plan (PACC)	Climate document	Local authority	Regional	In progress	Mean air temperature/mean precipitation/ heavy precipitation and river flood/ drought
	PCAET CC Mirecourt/Dompaire	Climate document	Local government	Local	In progress	Water scarcity; river flood
	SRADDET	Territorial planning document	Regional government	Regional	In progress	River flood; drought
Belgium	Plan de Gestion des Risques Inondations en Wallonie 2022-2027	Water resource management document	Regional government	Regional/subnational	In progress	Heavy precipitation and river flood
	Plan Air Climat Energie Wallonie 2016-2022	Climate document	Regional government	Regional/ subnational	In progress	River flood; soil erosion
	Integral Drought Strategy	Climate document	Regional government	Regional/ subnational	Not yet published	Drought
	River basin management plan Meuse	Water resource management document	Regional government	Regional	In progress	Increased precipitation and river flood; Droughts
	Blue Deal	Climate document	Regional government	Regional	In progress	Mean air temperature ; droughts; water scarcity
Luxembourg	Stratégie et Plan d'Action pour l'Adaptation aux effets du changement climatique au Luxembourg	Climate document	National government	National	In progress	Heavy precipitation and river flood; drought
The Netherlands	Delta Programme Meuse	Water resource management document	National government	National	In progress	Increased precipitation and river flood
	Flood Protection Programme	Territorial planning document	National government	National	In progress	Increased precipitation and river flood

Country of implementation	Adaptation-relative plan/ strategy	Type of document	Who: responsible organization	Where: geographical level	When: current status	Why: main climate hazard addressed
	LIFE IP Delta Nature	Climate document	National government	National	In progress	Increased precipitation and river flood; Droughts
	Integrated River Basin Management	Water resource management document	National government	National	In progress	Increased precipitation and river flood; Droughts
	Flood risk management plan Rhine, Meuse, Scheldt and Ems	Water resource management document	National government	National	In progress	Increased precipitation and river flood
	River basin management plan Rhine, Meuse, Scheldt and Ems	Water resource management document	National government	National	In progress	Droughts
Germany	Flood risk management plan NRW Meuse	Water resource management document	Regional government	Regional	In progress	Increased precipitation and river flood
	Management plan for the implementation of the European Water Framework Directive	Water resource management document	Regional government	Regional	In progress	Droughts
	Master Plan Niers	Water resource management document	Regional government	Regional	In progress	Increased precipitation and river flood. Droughts

Table 2: 4 Ws of the past and present adaptation-relative projects (row color signifies type of project: blue = action, white = study)

Country of implementation	Adaptation-relative project	Type of project	Who: responsible organization	Where: geographical level	When: current status	Why: main climate hazard addressed
Transnational	AMICE	Study/Action	Local authority	Transnational	Completed	Mean air temperature/mean precipitation/ heavy precipitation and river flood/ drought
	Rur-Meuse linkage	Study	Local authority	Transnational	Completed	Mean precipitation/ heavy precipitation/ drought
France	Explore 2070	Study	Research	National	Completed	Mean air temperature/mean precipitation
	CHIMERE 21	Study	Research	French Meuse	Completed	Mean air temperature/mean precipitation
	Prospective study evaluating the quantitative status of water resources in Grand Est Region	Study	Regional government	Regional	Completed	Mean air temperature/mean precipitation/ heavy precipitation and river flood/ drought
	HEBMA project	Action	Local authority	French Meuse	In progress	Increased precipitation and river flood

Country of implementation	Adaptation-relative project	Type of project	Who: responsible organization	Where: geographical level	When: current status	Why: main climate hazard addressed
	Water and Climate Charter	Action	Local authority	French Meuse	In progress	Increased precipitation and river flood, water scarcity
Belgium	PARIS	Action	Regional government	Wallonia Meuse	In progress	Increased precipitation and river flood
The Netherlands	Maaswerken	Action	National government	Regional	In progress	Increased precipitation and river flood
	Clean Meuse	Action	Regional governments	Regional	In progress	Droughts
	Collaborating on river nature	Action	National government	National	In progress	Droughts
	Development Ooijen-Wanssum	Action	Local government	Local	Completed	Increased precipitation and river flood
	RIWA-Maas and Deltares research project	Study	Other	Regional	Completed	Droughts
	Drinkable Rivers	Action	Other	Regional	In progress	Droughts
	Klimaatsignaal '21	Study	Research	National	Completed	Mean air temperature/mean precipitation/ increased precipitation and river flood/drought
	Exploration promising measures water availability Meuse	Study	Research	National	Completed	Mean precipitation/drought
Germany	Flood protection Engelsdorf	Action	Regional government	Local	Completed	Increased precipitation and river flood
	KAHR Project	Study	National government	Regional	In progress	Increased precipitation and river flood
	Flood protection Vicht	Action	Local government	Local	In progress	Increased precipitation and river flood
	HoWas2021	Study	National government	National	In progress	Increased precipitation and river flood
	WaX – Extreme Water Events	Study	National government	National	In progress	Mean precipitation/ increased precipitation and river flood/drought

2.2. Assessment of sources and structuring of information

Information from both Climate Change Adaptation strategies and projects were assessed and categorised into:

- Strategic axes and structuring axes of intervention included in the plans and strategies reviewed that address water, ecosystems and climate change.
- Type of adaptation intervention proposed (structural, institutional, social) in those plans
- Water, ecosystems and climate change related topics covered in the plans and projects
- Types of adaptation measures executed/planned to address impacts of climate change on water resources in both plans and projects

A definition of structural, institutional, and social interventions and the categorisation of adaptation actions can be viewed in the tables below.

Sub-categories were also further developed on the basis of the data collected to identify which structuring axes, and types of adaptation measures were most commonly included.

ADAPTATION INTERVENTION: DEFINITIONS APPLIED

Adaptation interventions can be categorised in different ways from the type of the measure to the scale of their implementation. IPCC in its Working Group II (Assessment report 5) proposes a classification into 3 sub-categories:

Institutional intervention

Institutional policy interventions refer to laws, regulations, and planning measures (such as protected areas, building codes, and re-zoning) that can improve the safety of hazard-prone communities by designating land use to support resilience. Institutional options are also relative to economic instruments as well as effective governance and programs serving capacity building in terms of planning tools and risk management. This may include the development of new working groups or ministerial departments.

Structural/ physical intervention

Structural interventions refer to discrete adaptation options, with clear outputs and outcomes that are well defined in scope, space, and time. They refer to "concrete activities" including structural and engineering options; the application of discrete technologies; the use of ecosystems and their services to serve adaptation needs; and the delivery of specific services at the national, regional, and local levels.

Social intervention

Social policy interventions aim to reduce vulnerability of disadvantaged groups and tackle social inequities through educational, informational, and behavioural interventions. Adaptation is described as a social learning process and awareness raising, outreach, community meeting and educational programs are important for disseminating knowledge about adaptation options.

ADAPTATION ACTION: DEFINITIONS APPLIED

In 2020, the European Environment Agency (EEA) developed a categorisation system of Key Type Measures (KTM) to classify adaptation measures and actions. The concept of KTMs was initially developed in 2012 for the Water Framework Directive (WFD) to simplify reporting, and later developed under the EU Floods Directive. One of the main advantages of this approach is to be able to benefit from a comparative framework between policy documents that are highly heterogeneous in the way they are organized and described across countries, territories, etc. Examples of this heterogeneity can be found, for example, in the use of terms and taxonomies, their approach to impacts and vulnerabilities, structure, level of detail and prescriptiveness, the scope and definition of sectors, targets, and the governance levels and actor groups addressed as responsible for implementation. Categorizing the diversity of measures and actions in each country by means of a common and straightforward taxonomic framework is a necessary pre-condition for being able to map, capture and appraise the state of play of adaptation action on the Meuse territory as well as for learning from what others are doing.

In the KTM approach, adaptation options can be divided into five main categories:
A: Governance and Institutional
B: Economic and Finance
C: Physical and Technological
D: Nature Based Solutions and Ecosystem-based Approaches
E: Knowledge and Behavioural change

The categories are summarized in the table below:

Adaptation categories		**Specification (linked to adaptation categories)**
KTM	**Sub KTM**	
A: Governance and Institutional	A1: Policy instruments	Creation / revision of policies Creation / revision of (implementing regulations
	A2: Management and planning	Mainstreaming adaptation into other sectors Creation / revision of technical rules, codes and standards
	A3: Coordination cooperation and networks	Creation / revision of ministerial coordination formats Creation / revision of stakeholder networks
B: Economic and Finance	B1: Financing and incentive instruments	Creation / revision of incentive mechanisms Creation / revision of funding schemes
	B2: Insurance and risk sharing instruments	Creation / revision of insurance schemes and products Creation / revision of contingency funds for emergencies
C: Physical and Technological	C1: Grey options	New physical infrastructure(s) Rehabilitation, upgrade and / or replacement of physical infrastructure(s)
	C2: Technological options	Early warning systems Hazard / risk mapping Service / process applications
D: Nature Based Solutions and	D1: Green options	Creation of new / improvement of exiting green infrastructure Natural and/or semi-natural land-use management

Ecosystem-based Approaches	D2: Blue options	Creation of new / improvement of existing blue infrastructure Natural and / or semi-natural water and marine areas management
E: Knowledge and Behavioural change	E1: Information and awareness raising	Research and innovation Communication and dissemination Decision support tools and databases
	E2: Capacity building, empowering and lifestyle practices	Identification and sharing of good practices Training and knowledge transfer Reporting on lifestyle practices and behaviours

3. Common points and possible synergies between the existing adaptation plans

3.1. Principles and structuring axes of intervention

Table 3 summarized the main Water and Climate Change axes of intervention mentioned in the adaptation plans or strategies elaborated on the Meuse catchment. In the adaptation plans, the strategic axes and global orientations are the declination of political priorities which are then broken down into objectives, projects and action plans. On the Meuse territory, due to the variety of the plans assessed (scale, scope and type of plan, etc.), in some cases, the areas of adaptation intervention were not clearly defined, but the general ideas/ strategic axes were taken up. A differentiation by colour has been introduced to facilitate the identification of the major issues per basin section (country).

Table 3: Main axes of intervention identified in the adaptation plans (row color signifies type of document: blue = Water resource management document, green = Climate document, yellow = Territorial planning document)

Country	Adaptation plan	Preserving ecosystems	Improving water quality	Building a water-saving society	Reducing floods vulnerability	Improve knowledge	Virtuous management of the territory's flows and resources	Water eco-resilience	Water demand analysis and management	Resource enhancement and mobilization	Cross borders and strengthen cohesion at EU level
FR	SDAGE Rhin Meuse 2022-2027	X	X	X	X		X				X
	Sage Bassin Ferrière/ Rupt de Mad	X	X		X		X				
	PAPI Meuse 2				X	X		X			
	Rhine-Meuse Water Agency's Climate change adaptation and mitigation plan (PACC)	X	X	X	X	X					
	PCAET CC Mirecourt/Dompaire			X	X		X				
	SRADDET						X				X
BL	Plan de Gestion des Risques Inondations en Wallonie 2022-2027				X						
	Plan Air Climat Energie Wallonie 2016-2022	X	X		X	X					
	Drought Strategy							X	X	X	
	River basin management plan Meuse	X	X		X		X			X	X
	Blue Deal			X		X	X		X	X	
LUX	Stratégie et Plan d'Action pour l'Adaptation aux effets du				X		X		X		

Country	Adaptation plan	Preserving ecosystems	Improving water quality	Building a water-saving society	Reducing floods vulnerability	Improve knowledge	Virtuous management of the territory's flows and resources	Water eco-resilience	Water demand analysis and management	Resource enhancement and mobilization	Cross borders and strengthen cohesion at EU level
	changement climatique au Luxembourg										
NL	Delta Programme Meuse				X	X	X	X			
	Flood Protection Programme				X	X					
	LIFE IP Delta Nature	X	X		X	X		X			X
	Integrated River Basin Management	X	X		X	X	X	X			
	Flood risk management plan Rhine, Meuse, Scheldt and Ems				X	X					
	River basin management plan Rhine, Meuse, Scheldt and Ems	X	X			X	X		X		
DE	Flood risk management plan NRW Meuse				X	X					
	Management plan for the implementation of the European Water Framework Directive	X	X			X					
	Master Plan Niers	X	X		X						

A first assessment of the axes of intervention of the adaptation-relative plans shows that the reduction of flood vulnerability, the qualitative and quantitative management of water resources and the preservation of the ecosystems are the main "Water and Climate Change" strategic issues shared on the Meuse catchment. In particular, the reduction of flood vulnerability is covered in almost all the plans analysed. Several flood risk management plans or programmes considering future impacts due to climate change were also implemented. This priority is in line with the Floods Directive and reflect the recent 2021 floods in Germany and Belgium.

Table 3 further highlights the varying diversity of intervention areas per country. The respective plans in France and Belgium seem to have a wider focus, whereas the Netherlands and Germany tend to have a relatively strong focus on flood vulnerability and water quality. While this could give an indication of the countries' priority points with respect to water management, it should be noted that only plans applicable to the Meuse river basin or its tributaries were included. In this context, Germany only holds a limited share of the river basin in comparison to, for example, France. As a result, the scale of potential challenges varies per country and consequently, it is to be expected that the axes of intervention also vary by country.

Some plans (particularly in the Netherlands) include cross-cutting areas of intervention such the Delta Programme Meuse. Ambitions incorporated in this plan include strengthening the Meuse as a natural river landscape, the development of economically prosperous regions and the reinforcement of recreational landscapes in villages, dikes and flood plains. The same multidisciplinary approach holds for the overarching Delta Programme, which is based on three pillars: protection against flooding, ensuring freshwater availability and spatial adaptation to account for flooding, heat and droughts.

Connecting territories across borders is a strategic issue that is rarely addressed in the water resource management plans but more in climate plans or territorial planning documents. SRADDET, the Belgian river basin management plan Meuse, LIFE Delta in particular highlight this stake. Nevertheless, it's interesting to note that this emerging issue is gradually taking its place in the strategies.

Apart from adaptation plans that focus exclusively on water resources, some regional or local adaptation-relative plans address water more as a cross-cutting or integrated issue among the other "natural resources" or "flows" in the territory. Examples include the SRADDET and the PCAETs in France which are respectively a territorial planning document and climate document.

The wording of some of the axes may vary but refer to the same final issue. For example, the issue of resource sharing can be described under the axis of building a more water-saving society, virtuous management of the territory's flows and resources or water demand analysis and management. It makes sense as moving towards more water-efficient uses means avoiding consuming water, as a priority in vulnerable sectors, reducing water consumption for all uses, reusing water when it's possible.

The Rhine-Meuse Water Agency's Climate change adaptation and mitigation plan (PACC) is a very good model of plan that could be replicated on other portions of the international Meuse basin and can serve as a basis for plans and programmes that will guide the implementation of public policies. The philosophy of the plan and the main principles are clear (track down maladaptation, favour sober, no-regrets and integrated actions, share the resource) while the strategic axes clearly summarise the main issues and entry points and the state of knowledge associated. Furthermore, the value of developing a mixed adaptation-attenuation strategy facilitates a direct understanding of the associated co-benefits.

Finally, it's interesting to note that some documents that focused exclusively on water resource management now include adaptation to climate change as a cross-cutting concept or as an umbrella component to all the structural axes and principles. In the French part of the basin, the new 2022-2027 version of the Rhine-Meuse SDAGE is a good example of this new approach.

3.2. Modes of action / intervention proposed to promote adaptation to climate change

To assess how different plans approach climate adaptation, an assessment of the different modes of action is performed (refer to Table 4). To this end, a distinction is made between institutional, structural and social interventions. Institutional interventions are related to the policy aspect and can include revision of policies or the incorporation of climate adaptation strategies in governmental programmes. Structural interventions are related to the physical aspect and might include the construction of grey, green or blue infrastructure and the implementation of technical solutions (e.g. warning or communication systems). Social interventions are, as the name implies, related to social aspects. These include interventions with respect to communication, awareness raising but also encouraging (international) collaborations.

Table 4: Modes of action proposed in the adaptation relative plans (row color signifies type of document: blue = Water resource management document, green = Climate document, yellow = Territorial planning document)

Country	Adaptation plan	Institutional intervention	Structural intervention	Social intervention
FR	SDAGE Rhin Meuse 2022-2027			
	SAGE Bassin Ferrière/ Rupt de Mad	X	X	
	PAPI Meuse 2	X	X	X
	Rhine-Meuse Water Agency's Climate change adaptation and mitigation plan (PACC)	X	X	X
	PCAET CC Mirecourt/Dompaire		X	X
	SRADDET	X	X	X
BL	Plan de Gestion des Risques Inondations en Wallonie 2022-2027	X	X	X
	Plan Air Climat Energie Wallonie 2017-2022	X		X
	Drought Strategy	X	X	
	River basin management plan Meuse	X	X	X
	Blue Deal	X	X	X
LUX	Stratégie et Plan d'Action pour l'Adaptation aux effets du changement climatique au Luxembourg	X	X	
NL	Delta Programme Meuse	X	X	
	Flood Protection Programme		X	
	LIFE IP Delta Nature	X	X	X
	Integrated River Basin Management	X	X	
	Flood risk management plan Rhine, Meuse, Scheldt and Ems	X	X	X
	River basin management plan Rhine, Meuse, Scheldt and Ems	X	X	
DE	Flood risk management plan NRW Meuse	X	X	X
	Management plan for the implementation of the European Water Framework Directive	X	X	X

Country	Adaptation plan	Institutional intervention	Structural intervention	Social intervention
	Master plan Niers	X	X	

Based on the analysis performed in Table 4, it is concluded that adaptation plans tend to focus on institutional and structural interventions. Social interventions are included, but to a lesser extent. Plans comprise of varying types of interventions, such as policies for adapting to increased river run-off combined with the construction of physical infrastructure. In this sense, the Dutch Flood Protection Programme (Dutch: Hoogwaterbeschermingsprogramma) seems to be relatively unique in its design, as it is a large national programme that almost exclusively focuses on structural interventions (i.e., the strengthening of dikes). Other than the aforementioned plan, there seem to be no other relevant plans that focus on a specific mode of action.

Social interventions are predominantly related to improving collaboration between stakeholders and increasing awareness. An example of the latter is the website 'overstroomik.nl', a Dutch website that allows people to find out if flooding poses a risk to their home and how to prepare for flood situations. In another extent, the Belgian River basin management plan Meuse specifically mentions the issue of cross-national water sharing. Both generic and water body specific actions are reported to have been formulated.

However, social intervention can also refer to outreach activities on the links between climate change, water and territory including better monitoring of the territory's parameters. Several studies and programmes have been already carried in that extent in the past few years.

Overall, it is concluded that plans tend to cover a combination of institutional, structural and social interventions. Some options can also cut across several categories or are interrelated. For instance, institutions and information are prerequisites for effective flood risk management tool.

3.3. Water, ecosystems and climate change topics

Another point of analysis concerns the main "Water, ecosystems and climate change" topics addressed. In that case, both plans/ programs and projects carried out on the Meuse catchment have been assessed. The scope of the MICCA project is labelled "water & climate change", covering all water management topics that are connected to the negative impacts of climate change: floods, low-flows, water temperature, water share, aquatic pollutions, drinking water, freshwater ecosystems, sediments, rainwater, landscape legacy. Table 5 summarized the main topics addressed in each plan while Table summarized those considered in the main research initiatives and operational projects carried out on the Meuse basin.

Table 5: Main "Water and Biodiversity" topics addressed in each plan (row color signifies type of document: blue = Water resource management document, green = Climate document, yellow = Territorial planning document)

Country	Adaptation plan	Floods	Low flows	Water temperature	Water share	Aquatic pollutions	Drinking water	Freshwater ecosystems	Sediments	Rainwater	Landscape legacy
FR	SDAGE Rhin Meuse 2022-2027	X			X	X	X	X			
	SAGE Bassin Ferrière/Rupt de Mad	X				X	X	X			
	PAPI Meuse 2	X									
	Rhine-Meuse Water Agency's Climate change adaptation and mitigation plan (PACC)	X			X	X		X	X		X
	PCAET CC Mirecourt/Dompaire	X			X		X				
	SRADDET	X			X	X	X	X			X
BL	Plan de Gestion des Risques Inondations en Wallonie 2022-2027	X									
	Plan Air Climat Energie Wallonie 2017-2022	X	X	X	X	X	X	X			X
	Drought Strategy		X		X		X				
	River basin management plan Meuse	X	X	X	X	X	X	X	X	X	
	Blue Deal		X		X		X			X	
LUX	Stratégie et Plan d'Action pour l'Adaptation aux effets du changement climatique au Luxembourg	X	X	X	X		X				
NL	Delta Programme Meuse	X			X						X

Country	Adaptation plan	Floods	Low flows	Water temperature	Water share	Aquatic pollutions	Drinking water	Freshwater ecosystems	Sediments	Rainwater	Landscape legacy
	Flood Protection Programme	X									
	LIFE IP Delta Nature	X			X			X			X
	Integrated River Basin Management	X	X		X	X		X	X		X
	Flood risk management plan Rhine, Meuse, Scheldt and Ems	X									
	River basin management plan Rhine, Meuse, Scheldt and Ems		X		X	X	X	X	X		
DE	Flood risk management plan NRW Meuse	X			X					X	
	Management plan for the implementation of the European Water Framework Directive		X	X	X	X		X			
	Master plan Niers	X				X		X			

Large-scale adaptation plans (national and regional) address more issues by connecting with the full range of climate change impacts. National and regional adaptation plans such as the SRADDET, the Regional Climate Plan of Wallonia, the river basin management plan Meuse of Flanders and the national adaptation strategy and plan of the Luxembourg address the full range of water and biodiversity topics. It is interesting to note that the Flemish river basin management plan Meuse encompasses both the Floods Directive and the Water Framework Directive. In other regions, the implementation of both directives is generally separated.

The main themes addressed in the adaptation plans coincide with the main challenges and vulnerabilities of each territory to climate change and axes of interventions mentioned before:

- Flood is a major hazard on the Meuse catchment and this issue is widely shared across plans and territories. Risk seems to be well known all over the basin which coincide with the number of flood crisis management strategies developed in the last years. However, recent impacting events of 2021 in Belgium and Germany have shown the necessity to better integrate climate projections into disaster risk management considering extreme events or to reconsider the role of water and vegetation in urban environments by integrating them into development strategies. Such is the case for the new Flood Risk Management Plan in Wallonia 2022-2027 which focuses on the consideration of climate change and territorial development in the long term. Climate change is considered through the choice of the extreme scenario to identify future flooding events. Long-term development is integrated by considering the potential consequences of these future events on the urbanisable areas. The PACC also links with the flood risk management plans developed on the Rhine and the Meuse and emphasises the need for a relevant organisation of the stakeholders, particularly those involved in spatial planning. In addition, whereas the 2021 flood events have highlighted the importance of these strategies, they have also shown that the climate models and projections at the basis of many of these strategies may have to be revisited.

- Water sharing is also one of the main questions addressed in the adaptation-relative plans and strategies. It is covered in relation to the multiple uses on the basin or in relation to drought priorities.

- In a lower extent, low-flow and drinking water topics seems to be interconnected in some plans but rather as a new concern posed by the Water Directive and by the evolution of the water demand in the context of probable water scarcity.

- Aquatic pollutions and Freshwater ecosystems topics seem also interconnected as macro and micro pollutants have consequences for the ecosystems. Within the framework of this analysis, there is no evidence of a more marked occurrence of these two topics in any specific section (country) of the Meuse basin.

Table 6: Main "Water and Biodiversity" topics addressed in relevant research initiatives and projects (row color signifies type of project: blue = action, white = study)

Country	Adaptation project	Floods	Low flows	Water temperature	Water share	Aquatic pollutions	Drinking water	Freshwater ecosystems	Sediments	Rainwater	Landscape legacy
TN	AMICE	X	X	X		X	X	X			X
	Rur-Meuse linkage		X	X	X	X					
FR	Explore 2070		X								
	CHIMERE 21	X	X								
	Prospective study evaluating the quantitative status of water resources in Grand Est Region	X	X							X	
	HEBMA project	X			X						
BL	PARIS	X									
NL	Maaswerken	X			X			X			
	Clean Meuse					X	X	X			
	Collaborating on river nature		X			X		X			
	Development Ooijen-Wanssum	X	X		X					X	X
	RIWA-Maas and Deltares research project		X								
	Drinkable Rivers					X	X	X			
	Klimaatsignaal '21	X	X								
	Exploration promising measures water availability Meuse		X		X		X			X	
DE	Flood protection Engelsdorf	X									
	KAHR Project	X									
	Flood protection Vicht	X									
	HoWas2021	X									
	WaX – Extreme Water Events	X	X		X	X	X	X		X	

Regarding the topics addressed in the research initiatives (studies) or operational projects (actions) carried out on the Meuse basin, results are rather different. Floods and low flows have been the main thematic covered. This is mainly due to the type of projects carried out (several studies, research initiatives, pilot projects aiming to understand future climate or hydrological scenarios for the Meuse). An interesting research project is the WaX – Extreme Water Events research initiative. Led by the German Ministry of Education and Research, the initiative funds 12 research projects on water-related natural hazards such as heavy rain, floods and droughts across disciplines and sectors. In addition, the initiative has a strong focus on networking and knowledge transfer between projects and to business, practice, politics and the general public.

Aquatic pollutions and freshwater ecosystems topics are interrelated within the projects such as Collaborating on river nature, Clean Meuse or Drinkable rivers. These projects aim at improving river water quality through a variety of measures. Although the projects communicate different goals (i.e. improving ecological quality versus achieving drinkable river water quality), reduction of aquatic pollutions is – to varying extents – inherent to all these goals.

An evaluation of the projects has shown that especially larger projects aim at combining goals. For example, the Development Ooijen-Wanssum aims to reduce flooding, develop nature, improve quality of live and boost the economy in the project area. This multidisciplinary approach can also be found in other projects, such as the Maaswerken and the flood protection Engelsdorf. Consequently, measures and the related investments tackle multiple climate hazards simultaneously, which makes them more attractive from an economical point of view.

3.4. Measures to address CC impacts on the basin

In Table 7 andTable 8, the types of measures incorporated in the adaptation plans and projects are highlighted. Measures were organised according to the Key Type Measure Approach presented in Section 2.2. They largely correspond to the modes of actions as described in Section 3.2, but give a more in-depth description of the actions that are undertaken. Similar to the approach of Section 3.3, both plans and relevant research initiatives and projects are considered in this stage.

Table 7: Main type of measures proposed in each plan/strategy (row color signifies type of document: blue = Water resource management document, green = Climate document, yellow = Territorial planning document)

	KTM	Governance and Institutional		Physical and Technological		Nature Based Solutions and Ecosystem-based Approaches		Knowledge and Behavioural change			Economic and Finance	
	Sub KTM	Policy instrument/ management planning	Coordination cooperation and networks	Grey options	Technological options	Green options	Blue options	Information and awareness raising		Capacity building	Financing and incentive instruments	Insurance and risk sharing instruments
	Plan/ strategy	**Revision of policies, rules**	**Networking**	**Grey infrastructure**	**Technological options**	**NBS Green infrastructure**	**NBS Blue infrastructure**	**Research and innovation (modelling, climate projections)**	**Communication dissemination, decision support tool**	**Sharing of good practices, training**	**Incentive mechanisms and funding schemes**	**Insurance schemas/ contingency funds for emergency**
FR	SDAGE Rhin Meuse 2022-2027											
	SAGE Bassin Ferrière/ Rupt de Mad											
	PAPI Meuse 2											
	Rhine-Meuse Water Agency's Climate change adaptation and mitigation plan (PACC)		X	X	X	X	X	X	X		X	
	PCAET CC Mirecourt/Dompaire	X							X	X		
	SRADDET											
BL	Plan de Gestion des Risques Inondations en Wallonie 2022-2027	X			X				X			
	Plan Air Climat Energie Wallonie 2017-2022	X	X		X				X			

	KTM	Governance and Institutional		Physical and Technological		Nature Based Solutions and Ecosystem-based Approaches		Knowledge and Behavioural change			Economic and Finance	
	Sub KTM	Policy instrument/ management planning	Coordination cooperation and networks	Grey options	Technological options	Green options	Blue options	Information and awareness raising		Capacity building	Financing and incentive instruments	Insurance and risk sharing instruments
	Plan/ strategy	**Revision of policies, rules**	**Networking**	**Grey infrastructure**	**Technological options**	**NBS Green infrastructure**	**NBS Blue infrastructure**	**Research and innovation (modelling, climate projections)**	**Communication dissemination, decision support tool**	**Sharing of good practices, training**	**Incentive mechanisms and funding schemes**	**Insurance schemas/ contingency funds for emergency**
	Drought Strategy	X			X							
	River basin management plan Meuse	X		X	X	X	X		X		X	
	Blue Deal	X			X			X	X	X	X	
LUX	Stratégie et Plan d'Action pour l'Adaptation aux effets du changement climatique au Luxembourg	X		X	X		X		X			
	Delta Programme Meuse			X		X	X	X				
	Flood Protection Programme			X		X	X					
	LIFE IP Delta Nature		X			X	X		X	X		
NL	Integrated River Basin Management	X	X	X	X	X	X	X				
	Flood risk management plan Rhine, Meuse, Scheldt and Ems	X		X	X	X	X		X	X		
	River basin management plan Rhine, Meuse, Scheldt and Ems	X		X	X	X	X				X	
	Flood risk management plan NRW Meuse	X		X	X	X	X	X	X			
DE	Management plan for the implementation of the European Water Framework Directive			X	X				X	X	X	
	Master plan Niers					X	X					

As shown in Table 7, measures related to research and innovation (including modelling, climate projections etc.), capacity building and networking tend to be less of a focal point in the studied plans. In a general manner, economic and finance measures are not frequent measures in the plans. In contrast, institutional measures (revision of policies), physical and technological and nature-based solutions measures are strongly represented in almost all cases. In addition, there seem to be national differences between approaches towards climate adaptation. Whereas Belgium is relatively heavily focused on the incorporation of technological options and the mobilisation of policy instruments, the Netherlands and Germany tend to include more blue and green nature-based solutions (NBS) and grey infrastructure.

With respect to the approach, it is interesting to note that in the German Flood risk management plan NRW Meuse, a clear distinction is made between the phases of the flood management cycle as described in the EU Floods Directive (i.e., protection, prevention, precautions, and recovery). Consequently, measures are defined for each of the four categories and range from flood-adapted construction and renovation to the planning and optimization of crisis and resource management. This distinction by category is less evident in the other reviewed plans. For example, measures defined in the Delta Programme Meuse and the Flood Protection Programme tend to focus on the protection against flooding (mostly using structural interventions). In general, measures focused on the prevention of flooding include the expansion of discharge capacities, for example through the construction of high-water channels or flood plains. Traditional methods such as dike heightening no longer seem to be the preferred option (with some exceptions).

An interesting plan is the so-called 'Blue Deal' by the Flemish government. While the plan is not specifically focused on the Meuse River basin, it aims to tackle water scarcity and droughts in the Flemish region in a systematic manner. Approaches include changes in regulations, stimulation of circular water use, stimulation of private infiltration measures, active inclusion of agriculture, protection of water resources and investments in smarter, more robust and more sustainable water systems.

Regarding the technological options, main measures aim to support stakeholders against flooding at different phase of the disaster risk management. It can include the creation of flood hazard or risk mapping tool (Flooding application - Wallonia), the establishment or improvement of municipal warning and information systems (EWS – Germany) or a tool to support crisis management (Osiris – France).

Institutional options are often options relative to management planning regarding flood-areas and include building regulation, land-use planning measures.

Some interesting decision support tool at local level can also be highlighted. One example is the Adapt ta commune approach, which results from the Walloon Air Climate and Energy Plan. This tool, although its scope is not focused on the Meuse, aims to support municipalities in the assessment and understanding of current and future climate risks for their territory and the identification and implementation of targeted adaptation strategies to address them. A web interface includes information and tools such as impact maps and risk indicators, action sheets and examples of achievements. It's a good example of integrating vulnerability diagnosis into development making process at municipal level that could be replicate in other territories on the Meuse basin.

With respect to spatial scale, plans that are part of national programmes comprise a wider variety of adaptation measures than local plans, such as the master plan Niers. This is in line with expectations, given that national plans have to account for a larger set of boundary conditions.

Table 8: Main types of measures conducted in relevant research initiatives and projects (row color signifies type of project: blue = action, white = study)

Country	KTM	Governance and Institutional		Physical and Technological		Nature Based Solutions and Ecosystem-based Approaches		Knowledge and Behavioural change			Economic and Finance	
	Sub KTM	Policy instrument/ management planning	Coordination cooperation and networks	Grey options	Technological options	Green option	Blue options	Information and awareness-raising		Capacity building	Financing and incentive instruments	Insurance and risk sharing instruments
	Project	Revision of policies, rules	Networking	Grey infrastructure	Technological options	NBS Green infrastructure	NBS Blue infrastructure	Research and innovation (Modelling, climate projections, etc.)	Communication and dissemination	Sharing of good practices, training	Incentive mechanisms and funding schemes	Insurance schemas and contingency funds for emergency
TN	AMICE		X	X		X	X	X	X	X		
	Rur-Meuse linkage		X					X				
FR	Explore 2070							X				
	CHIMERE 21							X				
	Prospective study evaluating the quantitative status of water resources in Grand Est Region							X				
	HEBMA project		X	X		X	X		X			
	Water and Climate charter		X						X			
BL	PARIS		X		X				X			
NL	Maaswerken			X		X	X					
	Clean Meuse		X		X				X	X		
	Collaborating on river nature					X	X					
	Development Ooijen-Wanssum			X		X	X					
	RIWA-Maas and Deltares research project				X			X				
	Drinkable Rivers		X						X	X		
	Klimaatsignaal '21							X	X			
	Exploration promising measures water availability Meuse	X						X	X			
DE	Flood protection Engelsdorf					X	X					

KAHR Project					X	X	X
Flood protection Vicht			X	X			
HoWas2021					X	X	X
WaX – Extreme Water Events	X				X	X	X

Table 8 summarizes the types of measures associated with the different relevant research initiatives and projects. It is evident that research and innovation measures that include modelling and climate projections are more heavily represented in these types of projects, especially in France where several studies have been carried out. In addition, the projects tend to put more focus on social initiatives, including raising awareness, capacity building and networking. Projects such as Clean Meuse and Drinkable Rivers are good examples of projects that do not have physical measures as their focal points but lean towards strengthening social responsibility.

It is further noted that measures related to policy instrument or management planning are generally not incorporated in the studied projects, with the exception of the Dutch exploration promising measures water availability Meuse. This exploration serves as a basis for the Delta Programme fresh water 2022-2027. Other research initiatives and operational programmes are generally less focused on providing input to specific programmes, but recommendations can result from these projects.

An evaluation of the projects mentioned in Table 8 has shown that projects related to the reduction of flood risks, mainly do this by the implementation of physical infrastructure. For example, the Maaswerken, development Ooijen-Wanssum and flood protection Engelsdorf all provide increased discharge capacity through measures such as high-water channels or retention basins. In contrast, projects related to water quality mainly aim at increasing awareness and capacity building. This can be attributed to the fact that especially in the field of emerging contaminants, a lot of research is still to be done. As described by the Clean Meuse initiative, studies and pilot projects are currently being performed by companies, (local) governments and wastewater treatment plants. These are then translated into measures at the source or down the line (i.e., wastewater treatment plants).

Technological options seem to be more frequently implemented in Belgium and in the Netherlands, while nature-based solutions were found in projects in France (HEBMA), Belgium (AMICE), the Netherlands (Collaborating on river nature, development Ooijen-Wanssum, etc.) and Germany (flood protection Engelsdorf and Vicht). Regarding the last category, we can point out actions of river restoration, flood management in low area without dikes, integrated management of flood plains, measures to improve infiltration, creating riparian buffer zones among others.

Apart from the European AMICE project carried out a few years ago, there is little evidence of projects that included both a research component and an implementation component for operational actions.

4. Gap analysis

In chapters 2 and 3, the scope of the adaptation plans and research initiatives and projects has been assessed. In addition, the programmes were evaluated according to the criteria 'principles and structuring axes', 'modes of action', 'water and biodiversity topics' and 'measures to address CC impacts'. This has given an overview of synergies between programmes, but also allowed for the highlighting of potential gaps. The following conclusions are drawn per subtopic:

- With respect to spatial scale, most of the plans and projects act on a regional and national level. This is to be expected, given that the Meuse basin covers multiple countries and regions. It is noted, however, that the drafted catalogue does not provide a comprehensive overview of all local projects in the Meuse basin. The reason for this is twofold: a) MICCA is intended to be a transnational cooperation platform and as such, very local projects are not within the scope, and b) public information on local projects is relatively scarce.
- With respect to identified CC hazards, general focus seems to be on increased precipitation and mean air temperature. Items like droughts and water scarcity are relatively underrepresented. In the cases that droughts are within the scope of the plans/projects, this is usually linked to water quality (and predominantly associated with the EU Water Framework Directive).
- For the criteria of 'principles and structuring axes', the topic of 'cross borders and strengthen cohesion at EU level' is a strategic issue that is rarely addressed in the plans or not directly linked to water resource issues. In addition, the principle of saving water resources is not included as a focal point in many of the plans.
- For the criteria of 'modes of action', it was found that social interventions are less of a focal point in many of the plans. Plans generally focus on institutional or structural interventions (e.g., policies or physical infrastructure).
- For the criteria of 'water and biodiversity topics', it was found that floods tend to be the major point covered in the plans and projects. In contrast, topics such as water temperature, sediment and rainwater management are not often focus of the programmes. While they are well covered in the adaptation plans, drinking water and water share topics are finally very little included in the operational programs and projects.
- For the criteria of 'measures to address CC impacts', significant gap is observed regarding the economic and finance options such as financing and incentive instruments or insurance and risk sharing instruments that are not frequently covered by the plans or projects. In addition, social intervention such as networking and capacity building are less covered in the plans.

Overall, it has been found that opportunities are present with respect to transnational plans and/or projects. These can be linked to various CC hazards, but a major point which has not been extensively addressed is the topic of transnational water-share (in combination with droughts). Virtual meetings with MICCA stakeholders have also indicated that the topic of water-share is deemed controversial and has not been covered to a great extent in present programmes.

5. Key messages

Principles and strategic axes of intervention

- The reduction of flood vulnerability, the qualitative and quantitative management of water resources and the preservation of the ecosystems are the main "Water and Climate Change" strategic issues shared on the Meuse catchment.
- Apart from adaptation plans that focus exclusively on water resources, some regional or local adaptation-relative plans address water more as a cross-cutting or integrated issue among the other "natural resources" or "flows" in the territory.
- The topic of 'cross borders and strengthen cohesion at EU level' is a strategic issue that is rarely addressed in the plans or not directly linked to water resource issues.

Modes of actions

- Plans tend to cover a combination of institutional, structural, and social interventions. Some options can also cut across several categories or are interrelated. Social interventions are included to a lesser extent.

Water, ecosystems, and climate change topics addressed

- Flood topic is widely shared across plans, projects of the territories. Risk seems to be well known all over the basin which coincide with the number of flood crisis management strategies developed in the last years. The 2021 flood events have highlighted the importance of these strategies but have also shown that the climate models and projections at the basis of many of these strategies may have to be revisited.
- Plans seem to better integrate climate projections into disaster risk management considering extreme events or to reconsider the role of water and vegetation in urban environments
- The question of water-sharing is addressed in many adaptation-relative plans (multiple uses, droughts) but this issue is covered in a little extent in the projects.
- Topics such as water temperature, sediment and rainwater management are rarely a focus of the plans and programmes

Adaptation measures

- Physical, technological, and nature-based solutions measures are strongly represented in almost all cases.
- There seem to be national differences between approaches towards climate adaptation. Whereas Belgium is relatively heavily focused on the incorporation of technological options and the mobilisation of policy instruments, the Netherlands and Germany tend to include more blue and green nature-based solutions (NBS) and grey infrastructure.
- In general, measures focused on the prevention of flooding include the expansion of discharge capacities, for example through the construction of high-water channels or flood plains. Traditional methods such as dike heightening no longer seem to be the preferred option.
- Economic and finance measures are rarely if ever selected measures in the adaptation-relative plans and projects assessed.