Evaluation of the Belgian FRAMES pilots

AN ANALYSIS THROUGH THREE PERSPECTIVES

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Evaluation of the Belgian FRAMES project: an analysis through three perspectives

The Centre for Mobility and Spatial Planning (AMRP) of Ghent University has conducted an evaluation of the different Belgian FRAMES pilots. Its purpose is to identify the progress made during the project's activities in regard to flood resilience, the challenges encountered and lessons learnt. The AMRP used three theoretical perspectives based on its experience and past research on planning theories. This report first presents the geo-physical and institutional context of the Dender Basin, the area of focus. It subsequently explains the different theoretical perspectives, the multi-layered water safety concept, flood resilience and the actors' relational approach, that formed the basis for the set-up of the project's four cases: resilient citizens, areas, businesses and education. Each case is then evaluated following the theoretical perspectives.

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1. Context

1.1. History of the Dender

The Dender river springs in the Ath municipality, Wallonia, where the West- and East-Dender flow together. The Dender runs 18 km before reaching the Flemish Region in Geraardsbergen. The Flemish part of the Dender is 51 km long and mouths in the Scheldt river at Dendermonde (CIW, 2016). The topography of the Dender catchment area in Flanders ranges in height from 116 meters to 3 meters above sea level. Most of the soil in the Dender catchment area is made of loam or close variations of it. The combination of the relatively steep relief and the loam soil –which has a low infiltration capacity- makes the Dender very sensitive to intense rainfall events, which can cause high discharge rates and sometimes natural floods (CIW, 2016).

Throughout history, rivers have been a source of wealth and a majority of historical urban areas are located along relatively large river streams for transportation means (Mees, 2017). The Dender catchment is no exception with its oldest municipalities being located along the river: Dendermonde, Aalst, Denderleeuw, Ninove and Geraardsbergen. These urban cores were connected by roads with higher located villages centred on agriculture. Along the 20th century and especially in its second half, linear urban sprawl has spread spectacularly in Flanders with urbanisation occurring along the road networks (Verbeek *et al.*, 2014). Nowadays, about 70% of the land use of the Dender catchment in Flanders is made up of crop- and rangeland. The built-up area (18%) is concentrated around the urban areas along the river. From these urbanised centres, the urbanisation and the consequent impervious surface is connected through the ribbon development (*lintbebouwing*). Big industrial and SME zones are also located along the river in the vicinity of the urban areas (CIW, 2016). This urbanisation trend increases the discharge of water during intense rainfall. Nevertheless new building parcels were and are still being settled in flood prone areas. The combination of the natural features of the Dender catchment, with the past and current rate of urbanisation and the ongoing climate change, leads to a situation of problematic floods (CIW, 2016; Kellens *et al.,* 2013; Mees, 2017; Tempels, 2016).

The Dender is at the moment one of the most frequently flooded areas in Flanders, with the most recent floods occurring in 2002, 2003, 2010, 2011 and 2014 (Tempels, 2016). The issue of floods in the Dender catchment area, is regularly subject to social and political debate about how to reduce floods and its damage. The most mentioned problems are the increasing impervious land surface due to urbanisation, the age-old flood protection infrastructure and the lack of coordination between the Walloon and Flemish region (CIW, 2011). Moreover, the upscaling of agricultural activity has decreased in many locations the infiltration capacity and the use of drainage infrastructure has reduced the water conservation capacity of the soil (CIW, 2016).

1.2. Recent problems and (failed) solutions

In the 20th century, the biggest floods in Flanders were caused by storm surges along the coastline. The most recent floods, however, have a fluvial and pluvial cause (Kellens et al., 2013). Floods caused by storm surges along the coastline and tidal waves rolling upstream the Scheldt river in 1953 and 1976, initiated the Sigma-plan in the early 1980s. The plan followed a flood control approach, proposing high-scale protective measures such as storm surge barriers and the heightening of the Scheldt river dikes. The storm surge barrier was eventually never constructed due to a lack of economic justification (Broekx *et al.*, 2011). Gradually, with forecasts of sea level rise and economic developments, the assumption grew that flood risks will increase significantly in the 21st century. Following this, the

Flemish Government changed its flood management strategy in the early 2000s from a flood control to a risk-based approach. This led to a focal shift from a protection focus against a certain flood level, towards a protection against flood damage (Kellens et al., 2013). It led to the evaluation of the best applicable solutions using cost-benefit analysis, which includes the definition of zones with different priority levels depending on population density and the level of economic importance (Broekx *et al.*, 2011). These simulations generally put in balance the cost of the implementation and maintenance against the cost of damage in case a flood occurs. Although this method has proved a useful tool, it has also shown its limits. The results of such simulations generally propose hydrologically quantifiable measures such as dykes and the reinstallation of floodplains (Nolf, 2014). The solutions proposed by the calculations vary strongly, changing the temporal or spatial scales of analysis. Also issues such as social justice relating to the implementation of these measures, additional benefits -including public safety, added ecological or amenity value- and future economic development- remain difficult to include in the calculations (Brouwer & van Ek, 2004; Broekx *et al*., 2011; Turner *et al.*, 2007).

Traditional technical measures, that focus on hydrologically quantifiable results, thus carry inextricably uncertain facets, due to their dependency on the scale of observation and their (in)direct influence on other socio-ecological issues. On top of that, Flanders, in particular, has a dense and hybrid territory. Each square kilometre is subject to the interest of a large and diverse set of landowners whose interests can be influenced by the implementation of the measures (Nolf, 2014). The perception grows since the 2000s that the engineering approach is not sufficient anymore to answer the problem. FRM requires a new approach that includes the support of other actors, such as the business and civic society itself (Bubeck *et al*., 2013; Hegger *et al*., 2016; Mees *et al.*, 2016a).

1.3. Go beyond traditional planning/measures

Therewith, the idea came up that FRM needs to go beyond the traditional planning and infrastructural measures. The Commission for Integral Water management (CIW) stressed in 2003 to organise an integrated water strategy amongst the different governmental entities (Mees *et al.,* 2016a). Moreover, following the European Flood Directive 2007/60/EC, in 2007 more emphasize was put on the development of flood risk maps for information dissemination and increasing awareness. This led to the modelling of different flood risk maps in Flanders. The Directive also underlines the importance of a diversification of measures and to put more emphasize on the incorporation and quantification of intangible damage effects such as health and environmental effects or cultural heritage. However, quantifying such effects remains challenging and still relies on precise calculations that can differ depending on how far we look in the future, which areas are taken into account or due to unexpected societal changes (Kellens *et al*., 2013).

In accordance with the EU Flood Directive, the Flemish Region also tends to apply the Multi-Layered Water Safety (MLWS) concept, which categorizes measures in three layers: prevention, protection and preparedness (VMM, 2014). Each layer addresses a specific aspect of floods increasing the diversity of measures and the number of potentially involved stakeholders from the public, private and civic sectors. In doing so, this MLWS-concept tries to cope with the expected increasing frequency, intensity and adjoining vulnerabilities of floods due to the climate change (Van den Brink et al., 2011). The MLWS concept recognises that governments can't guarantee a sufficient flood protection with its traditional engineering instruments. Instead, MLWS focuses on a shared responsibility between water managers, spatial planners, emergency planners, the insurance sector, the building sector and the population Tempels, 2016).

The concept of a shared responsibility, however, is not easy to grasp and cannot be implemented in one day. As the traditional approach using infrastructural and engineering measures has been common practice for decades, the Flemish institutional structure and *modus operandi* are designed according to this approach (Nolf, 2014). Subsequently a low willingness to act or participate in FRM is still noticeable amongst non-traditional actors such as stakeholders from the private sector or citizens (Mees *et al.*, 2016a). Concretely, the MLWS concept is used as the general approach of the Flemish FRM (VMM, 2014). This general approach is in line with the advocacy of a shared responsibility where each actor can contribute to flood resilience. However, the shift from general approach towards its practical implementation remains challenging.

1.4. The FRAMES project

The MLWS concept is not solely used in the Flemish Region. An increasing amount of authorities and practitioners across the North Sea Region (NSR) start to acknowledge and use the concept. In that context, an Interreg North Sea Region project -FRAMES- was set-up to increase the resilience of areas and communities prone to flooding in the different regions around the North Sea by using MLWS and explore its applicability. FRAMES has three aims (Interreg, 2019):

- Flood resilient areas: improving infrastructure and spatial planning
- Flood resilient communities: making the population and stakeholders better prepared
- Flood resilient authorities: reducing recovery time and improve response capacity

Partners from the UK, Denmark, Belgium, Germany and the Netherlands joined the project and 15 pilot sites were selected where the MLWS concept would be applied. The experiences, challenges and lessons learnt along the projects' development would be exchanged between partners. The project ran from October 2016 until April 2020 (Interreg, 2019).

The three aims are more precisely translated in three objectives. The first objective is to improve the applicability of the MLWS concept through the development of (e-)tools that will support the integration of resilience measures. These tools will also benefit the integration of cross-sector interests and benefits (resilient communities). The second objective is to develop more flood resilient areas by demonstrating MLS in pilot sites around the NSR. These pilots allow to test spatial solutions, emergency response and deploying recovery for the better (resilient areas). The third objective is to improve the ability of authorities, stakeholders and practitioners in the NSR for enhancing climate change resilience (resilient authorities; UGent, 2016).

The FRAMES-project in Belgium were conducted by a collaboration between the Province of East-Flanders (POV) and Ghent University (UGent). The cities of Denderleeuw and Ninove were originally selected as the pilot projects with Geraardsbergen being added to the list in November 2019.

2. Theoretical perspectives

2.1. Introduction

The FRAMES project focuses on the implementation of MLWS measures to achieve three types of resilience: resilient areas, resilient communities and resilient authorities. As mentioned above, the MLWS concept underlines the importance of sharing the responsibility of FRM amongst the different public, civic and private actors. Many studies have already indicated the importance of a multi-actor involvement in FRM (Adger et al., 2006; Bell & Rowe, 2012; Loux, 2011; Mees, 2017; Nolf, 2014). This involvement is not only emphasized by new approaches in water management, but also by the recent theoretical concepts in spatial planning. This set of concepts -such as the actors networks theory, the actor's relational approach or the co-evolutionary theory to name a few- have been used increasingly in the last 30 years in the development of planning strategies and research around governance (Balducci et al., 2011; Boelens & de Roo, 2016; Rammel et al., 2007; Tempels, 2016).

The Department of Mobility and Spatial Planning of Ghent University (AMRP in Dutch) has explored the challenges related to the translation of these new theoretical concepts into water management practices and the Flemish FRM (Boelens, 2018a; Tempels, 2016). These researches tend to analyse different water management practices through different types of resilience (Tempels, 2016) or from an actor-relational perspective (Boelens, 2018a). They point out the difficulties for the implementation and the "putting into practice" of these new concepts in the current practices. Concordant with many spatial developments, FRM issues have become a-linear and dynamic involving many actors (Boelens, 2018a). However, as mentioned before, most actors' *modus operandi* remains traditional with regard to floods (Mees et al, 2016a; Nolf, 2014; Pahl-Wostl et al., 2011). Evaluating FRM projects along with other spatial planning projects becomes thus challenging. How to evaluate a project when the context is highly dynamic, constantly co-evolving and a diverse set of actors must be involved? To answer this question, the AMRP tested different theoretical concepts for the evaluation of the FRAMES pilot projects.

The evaluation of the Belgian FRAMES-pilot projects is done through three perspectives. The first perspective is the MLWS. AMRP analyses to which level the Belgian FRAMES project has implemented measures from the different layers. The second perspective implies the different types of resilience identified by Tempels (2016). It explores mainly which kind of resilience the project has been addressing. Finally, the Belgian FRAMES project is examined through the theoretical approach presented by Boelens (2018a), which focuses on the actors' involvement.

2.2. Multi-Level Water Safety Concept

The MLWS concept was first introduced in the Netherlands in the National Water plan of 2009-2015 as a possible method to manage the flood risks. The concept originated from reflexions about alternatives to preventive flood measures (Hoss et al., 2011). The first step of MLWS is to compile all the existing measures that potentially might ease the impact of flooding and categorizes them in three layers: protection, prevention, and preparedness. While protection measures tend to prevent large amounts of water to get to inhabited areas (dikes, flood retention zones,…), prevention stands for spatial and structural measures decreasing the damage due to flooding (spatial planning, water proof building,…) and preparedness represents measures when a flood is actually threatening build up areas (distribution sand bags, evacuation plans,…). Traditionally, the majority of the investments in the Netherlands are focused on the protection layer, which can become very costly through the building

and maintenance of the measures. Other measures from the second and third layer were thus presented as being more cost-efficient (Hamer *et al.,* 2015; Hoss, 2010).

The Region of Flanders started to use the Dutch MLWS concept in 2013 (Mees, 2017). The Flemish interpretation of the MLWS is slightly different from the Dutch with discrepancies between the three layers. The original concept and purpose of each layer, however, stays the same. The CIW defines the first layer as encompassing all measures that protect the urbanised areas from floods through collecting (green roofs, rainwater storage tanks), retaining (water retention ponds) and draining the excess of water (dikes, pumps). The second layer focuses on reducing the potential damage from floods by safeguarding, avoiding (no building in flood zones) and reducing potential damage (water proof building). The third layer focuses on preparation when a flood actually occurs through prediction, increasing awareness and emergency services (CIW, 2015). Overall, despite the differences in the institutional structures between the two countries, the MLWS concept is recognized as being a useful tool for the development of FRM, because it offers a new view and a diversification of measures. It allows broader scope for the risk reduction and the cost-benefit analysis. However, concrete flood resilient actions resulting from a MLWS strategy remain difficult to implement in both countries (Kaufmann et al, 2016). There still seems to be a bias for the traditional and technical measures

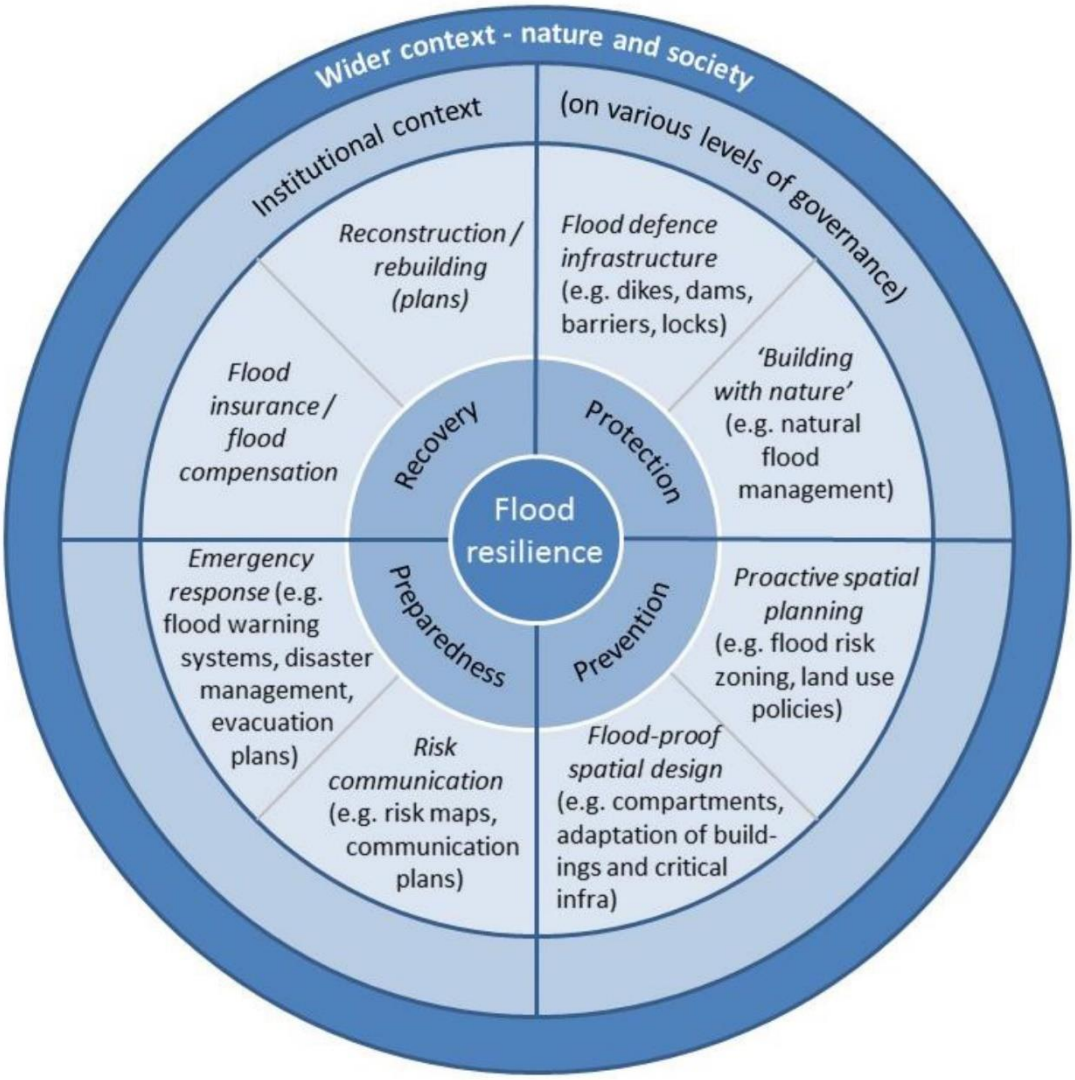

Figure 1: The Flood Resilient Rose categorizing flood resilient measures in four layers (Restemeyer, 2018).

(Tempels, 2016). As mentioned, the involvement of a broad range of actors in concrete flood resilience measures are generally not part of the institutional *modus operandi* (Nolf, 2014). All the involved actors have acquired the needed awareness concerning the status of a certain area of interest. Furthermore, such multi-actors' decision-making process requires a mutual respect of their different values and a consideration of the local circumstances in order to find the most balanced and sustainable solutions (Sophronides et al., 2016). The main challenge of the operational aspects of the MLWS is thus related to the low willingness and capacity of non-traditional actors to participate in the concrete implementation of measures. In addition, such participation in implementation broadens the range of the measures and must be established in the *modus operandi* of the involved actors.

In order to evaluate the FRAMES project from a MLWS perspective, without mixing the different approaches and definitions, a framework had been proposed by Restemeyer (2018). In addition to MLWS this proposal adds a layer to the concept: recovery. The 1st layer is defined as implying measures impeding water to get to a certain area, the 2nd layer are measures decreasing damage when a flood occurs, the 3rd layer entails reactive measures if a flood went through and the 4th imply recovery measures in case of flood damage. The enhanced concept is represented as a *Flood Resilient Rose* (figure 1).

2.3. Flood resilience

Tempels (2016) discussed the evolution and different interpretations of the resilience concept, in reference to the introduction by Holling in 1973. The concept finds its origins in the behaviour of ecological systems to change. Holling (1973) identified two kinds of properties. The first is stability, which refers to the ability of a system to come back to its original state or equilibrium. The second, resilience, is defined as a measure of a systems' persistence and ability to absorb change by maintaining the relationships between its populations and state variables. The novelty in the concept presented by Holling (1973) is the perspective that a system can cope with hazards or changing external factors, not only by returning to its original state, but also by evolving with these changes towards a new kind of equilibrium. Since the introduction of that perspective, the concept of resilience has been further elaborated. This led to the distinction between engineering, ecological and socio-ecological resilience. Tempels (2016) has compared these different types of resilience in terms of the described system state, definition of resilience, and how resilience can be assessed in the context of FRM (figure 2).

Engineering resilience corresponds to Holling's (1973) definition of stability; hence, the ability of a system to return to its original state. This type of resilience assumes a pre-determined stable state to which all systems come back after a hazard. The level of resilience of the system is thus solely measured by assessing the time needed to return to its original state. This conceptualisation is useful to describe moments where hazards have a small impact and a system can return to its original state, through the use of engineering or technical measures. Such representation relies strongly on determinism and predictability. However, when a hazard is too strong, bouncing back to its original state might cost more than it saves. Comparably, when floods become too strong, technical measures can become more expensive than the damage it causes (Tempels, 2016).

The ecological resilience concept goes beyond the idea of a pre-determined stable state. It acknowledges the dynamism of systems through the potential of multiple stable states. A system can thus merge into an alternative equilibrium after a hazard. This alternative state has different

characteristics and will react differently to new hazards, making any return to the previous state extremely difficult. The transition from one state to another is generally marked by a threshold. When the hazard becomes too strong, it will inherently merge the system into a new state. Tempels (2016) represents such resilience system as moving within the boundaries of its threshold. In terms of FRM, ecological flood measures, such as retention basins, allow the system to be dynamically in balance within the thresholds. The shift of one state to another means that a flood occurred in such magnitude that the original threshold was reached and that the basin changed its structure.

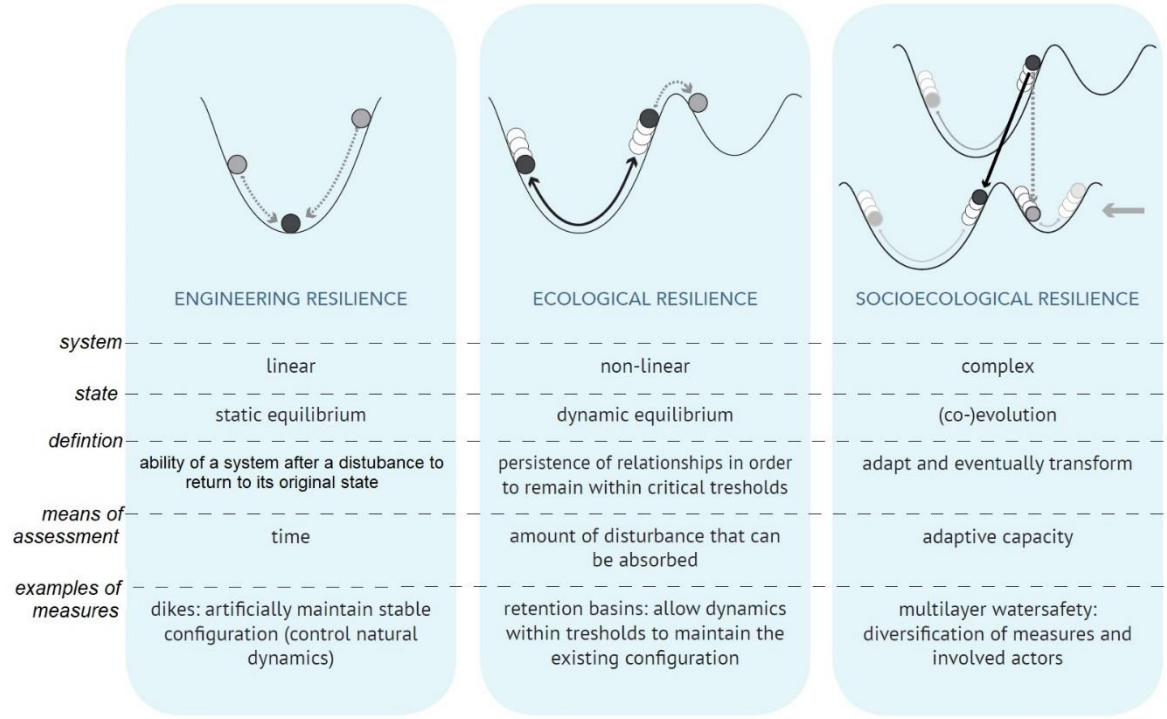

Figure 2: Schematic representation of engineering, ecological and socio-ecological resilience. Resilience is represented by the position (state) of a ball (system) in a basin (conditions/landscape) [retrieved from Tempels (2016)].

The socio-ecological resilience received growing interest through the study of social and ecological relationships and behaviour. This resilience concept emerged from the observation that changes in social behaviour and its surrounding environment are interlinked and co-evolve with one another. In such worlds, the state of a system is not only influenced by the surroundings and its position to the threshold, but also by their mutual relationships. This concept implies that not only the environment will change when a hazard makes a system reach a certain threshold, but also the people and actors involved as well. The system's behaviour co-evolves with its changing physical and social environment and they mutually influence each other. If a significantly strong flood occurs, a change in the social system's behaviour could lead to more resilience in the new basin. In those case, the conservation of a certain state through engineering solutions could ultimately even lead to a loss of resilience (Tempels, 2016).

Concretely, socio-ecological resilience does not regard natural and social systems as fixed realms with robust characteristics. Moreover, socio-ecological resilience can be regarded as a concept encompassing the engineering and ecological resilience. Tempels (2016) presents engineering or ecological resilience as applicable in case of small disturbances in order to return to a stable equilibrium. Engineering resilience focuses on infrastructural measures such as dikes, sewer systems

or drainage systems to maintain a stable equilibrium in case of small hazards. Ecological resilience can be linked with natural flood management measures (retention basins, floodable areas,…) that allow a certain moulding of the landscape, when floods are getting too strong. Finally, socio-ecological resilience adds social measures to the list, which entails behavioural changes of different societal actors. Such changes in a social system could imply cultural modifications if they become embedded.

2.4. Actor Relational Approach

In summary, the MLWS concept categorizes flood resilient measures in function of the impact they can have on floods: reduce the likelihood of occurrence (1st layer), reduce the potential damage if a flood occurs (2nd layer), reduce the impact when a flood occurs (3rd layer) and increase the recovery potential (4th layer). The different concepts of resilience presented by Tempels (2016) discusses perspectives of resilience that allow to broaden the possibilities for more adaptive systems through infrastructural, ecological and sociological changes. Both concepts offer interesting perspectives for flood measures or the needed adaptive changes. However, it remains unclear how these measures or changes are to be implemented. For that we can return to the Actor Relational Approach (ARA) of Boelens (2010), which is also derived from a relational co-evolutionary perspective as the very ground for the resilience and the co-evolutionary evaluating approach. In this respect ARA proposes a more operational mind-set for the setting-up of planning projects focused on the relation and characteristics of actors in a specific spatial and temporal context. The ARA offers a method for planning practices that adapts to actors' relation and that co-evolves in function of specific themes, new insights and alternating surroundings (Boelens, 2010). The approach can be regarded as a flat ontology to planning practices. It implies neither a top-down nor a bottom-up point of view. It sees the efficiency of rules, norms or contracts as always being the outcome of interactions between involved and conscious actors in specific locations within their own dynamic settings (Boelens, 2018a). Because these dynamics and relations are different in alternating locations and for various intentions or objects of planning, it becomes essential to analyse the different actors, the relations between them and the economic, cultural, political and geographical characteristics of the context on a case-by-case basis.

One of the common characteristics of the MLWS and the flood resilience concepts presented above is the importance given to the implementation of diverse measures and, consequently, the involvement of different actors in the FRM (without explaining precisely *how* to implement the measures or involve the actors). In that sense, the ARA could give some guidelines how to deal with planning in complex adaptive situations. Thus, the ontological scheme presented by Boelens (2018b) was used as a major inspiration scheme to evaluate involvement of actors in the Belgian FRAMES pilot projects (figure 3). The scheme represents a subsystem with the different public, civic and private actors and their interactions within a specific environmental and institutional context. This context is characterised by geo-physical, cultural, economic, political and infrastructural features inherent to the geographical or thematic scale of observation. The focused subsystem is interdependent with other subsystems and can thus influence each other. The interactions between actors are in co-evolution with its institutional and environmental context. From that perspective, one could traditionally try to improve FRM by setting up new decrees and laws (for instance with regard to flood prone areas) to improve the resilience of a certain area with regard to floods (the institutional approach). One could also try to improve the physical conditions (for instance with regard to prevention or protection measures) in order to save a specific area for further damages. That was traditionally done under the regime of the so-called 'condition planning' (the factor approach). But especially in times of ongoing climate change, both traditional strategies are no longer sufficient or (cost-benefit) effective in itself anymore.

Therewith the focus changes to the third corner of the triangle; e.g. the leading actors. That is consistent with the MLWS shift in FRM. But here ARA does not only focus on new, more adaptive approaches of governments and/or public servants (the public society), neither on only the support of the inhabitants and leading actors in the civic society as well, but also on the involvement of the business sector. It is especially the interaction between representatives of these three societies (the public sector with regard to subsidies and legal restraints, the civic with regard to the needed support and change in attitude and the business sector with regard to the necessary funds for implementation and maintenance) which could enhance the robustness or resilience against repetitive and ongoing floods. Planners could play a mediating role over here, opening up new alliances between leading actors of each of these three societies, or an intermediating role, by making prominent representatives more aware of the ongoing or expected impact of climate change, and the need collaborate in order to come up with more resilient solutions for the very future. Moreover, how these new alliances could also change the environmental conditions (the factors of importance) and not only the formal (legal), but also the informal (moral, custom) institutional settings is pivotal over here.

As such the scheme could be used in retrospect (for analytical means), but also in prospect (for operational uses) and give recommendations for improvement. Therewith we will use this schema to also evaluate the various FRAMES projects of East-Flanders.

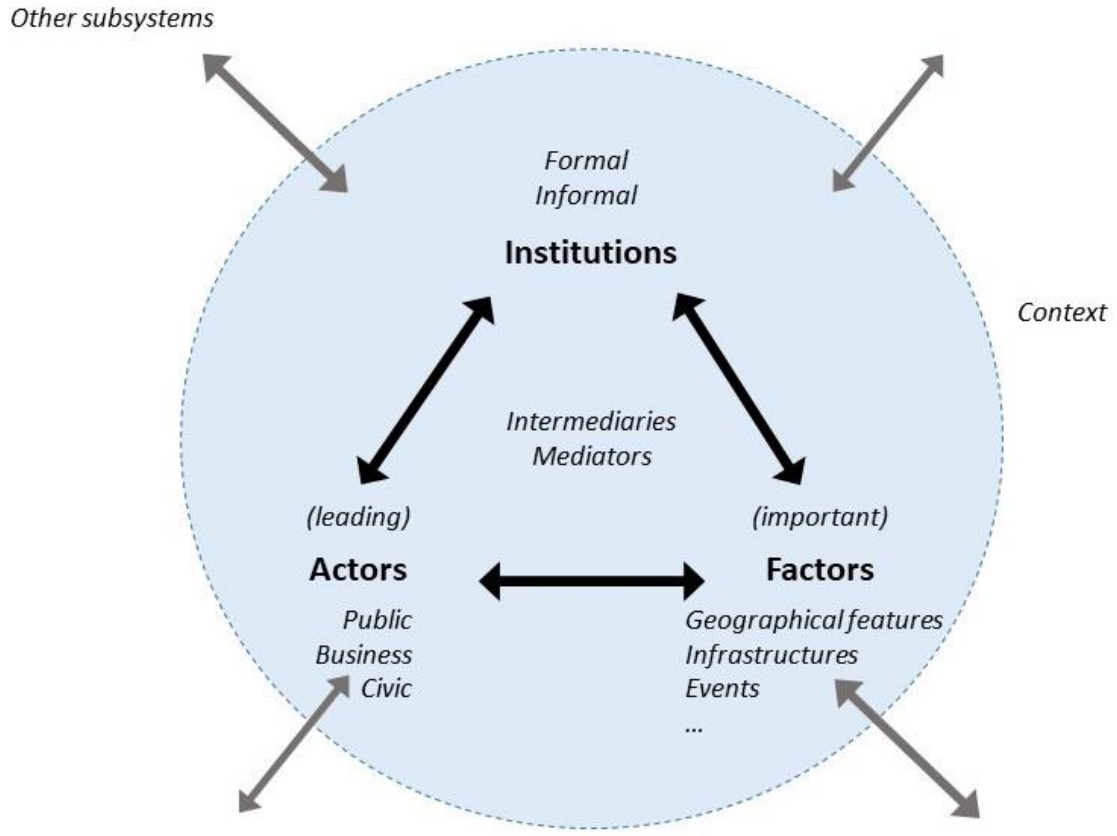

Figure 3: Schematic representation of ARA used as frame of analysis for the Belgian FRAMES pilots (Boelens, 2018b).

3. Four focus points: a literature review

The setting of the Belgian FRAMES projects has been strongly influenced by these theoretical concepts and have thus been divided in four subprojects with each a specific focus on the actors involved and the context in which they were set-up: resilient citizens, resilient areas, resilient businesses and resilient education. In this chapter, we will discuss the findings from previous researches around these focus points.

3.1. Resilient citizens

The involvement of citizens in FRM decision has been the subject of several studies exploring it from the perspective of co-production (Mees, 2016b), vulnerability to floods (Coninx & Bachus, 2008; Sayers et al., 2017), social justice and fairness (Adger *et al.,* 2006; Bell *et al.*, 2012) or a co-evolutionary approach (Tempels, 2016).

The input of citizens can logistically take different forms. They can be delivered by individuals or by group, they can be complementary or substituting to the existing governmental measures. Citizens can contribute through knowledge, financial, material or even human resources input. Such involvement can be beneficial to improve the resilience of individuals or the community as a whole, it can reduce the cost of FRM and potentially enhance the democratic capacity by empowering marginalized individuals or groups (Mees *et al.*, 2016b). From the perspective of MLWS, citizens can contribute in increasing the permeability of their garden, or they can install a green roof in order to reduce the chances of floods (1st layer). But they can also transform their houses into flood proof ones, which will reduce the damage caused by floods (2nd layer). Furthermore, they can volunteer in the local emergency services in order to increase the preparation of a community (3rd layer) or even help in the recovery efforts, such as clean-up activities (4th layer). These various contributions of each citizens or community are, however, strongly dependent on their socio-economic characteristics. The age, health, family status, income, education, social capital and nationalities are all characteristics that influence the amount of contribution citizens can bring in flood resilient measures, but are also indications to which degree they are vulnerable to these hazards (Coninx & Bachus, 2008; Sayers et al., 2017). Socio-economic inequalities exist amongst the population. Thus, the type of vulnerability of the flood exposed population groups will depend on the area of focus. From the perspective of social justice and legitimacy, FRM and the citizens' involvement need to be drafted in function of the socio-economic specificities of the specific area.

Tempels (2016) noticed a dismissive attitude towards flood responsibility in the population of the Dender basin. A strong factor contributing to this attitude was attributed to the very rigid and inert Belgian institutions of spatial planning. The zoning plans adopted in the 1970's allowed to keep some open space areas free of construction, but also implied a de facto right to build in areas that were not defined as build zones without a thorough reflection. Moreover, this rigid institutionalisation induced a strong governmental emphasis on technical protective measures, which has proven counterproductive for the idea of a shared responsibility to floods. From a co-evolutionary perspective, the FRM should adapt and install feedback mechanisms to changing situations and the way other actors deal with floods (Tempels, 2016).

3.2. Resilient areas

From a spatial point of view, water is an integral element of any landscape. A local change in spatial features can alter the water cycle and bring unexpected response in another area (Mahaut, 2009). In order to have a deep understanding of the processes causing floods and explore solutions, one cannot confine the problem to the area of occurrence. There has been an increasing advocacy towards water management that does not enclose the subsystems of the water cycle individually (rivers, tributaries, channels, springs, groundwater or rainwater,) but rather analyses the water cycle in its totality.

New paradigms have proposed in recent years new water management approaches that emphasize the complexity of the water system and the interdependency of its subsystems with human activities (Pahl-Wostl *et al.*, 2011). For instance, the Integrated Water Resource Management proposes watersheds as spatial organizing units. It represents watersheds as social-ecological systems where the social and ecological systems are interdependent and coevolving (Grigg, 2016; Ostrom, 2009; Wells *et al*., 2019). Another example, the Adaptive Management, focuses more on the fact that both the human and ecologic systems are inherently unpredictable and underlines the importance of learning from the interactions between the two systems. Setting aside the interesting perspectives they offer, both approaches have been criticised for their struggle in implementation. A common characteristic of these two approaches, however, is their acknowledgement of communication between actors with different backgrounds (Pahl-Wostl *et al.*, 2011). Loux (2011) identified multiple benefits in multi-actors' engagement in water management: innovative and unexpected solutions can come out of it. It enhances the relationship between actors or can activate resources opportunities.

Coming back to Flanders, the gradual confinement of water in a closed network has shown its limits. Droughts and floods start to have a larger impact than a closed network approach can deal with. Also in MLWS, it is recognised that this process of organising spatial water solutions cannot be done without the involvement of other actors and stakeholders (Nolf, 2014).

3.3. Resilient businesses

Within planning this idea is already recognized and applied for a long time. Already from the mid 1980's onwards several British, and especially American scholars pointed out towards a new entrepreneurial style of planning, in which a mutual dependence of the public and private sector was promoted (Fainsteins, 1983; Stone, 1989, Mossberger/Stoker 2003). Soon this kind of planning also moved over the Atlantic to the UK and the continent in the form of public-private-partnerships in order to gain momentum for at first complex inner-city redevelopments, but later also for brownfields. However, this kind of urban regime and entrepreneurial style of planning were often too hastily translated into regimes, in which 'the public' still had to deal with the deficits, while 'the private' would go for the profits. Moreover, they appeared to promote non-transparent, non-democratic decision-making in back rooms, to deliver selective distribution of material incentives, and a fragmentary contextualism (Sartori 1991, Imbroscio 1998, Davies 2002). There was a call for 'place entrepreneurs' who would enhance more engagement with a long-term investment in the region (Logan/Molotch 1987). In addition collaborative, smart growth or integrated development regimes entered the scene, which focused on public-private-people partnerships, and later on also a Triple Helix and even a Quadruple Helix model (Healy 1998, 2006, Janssen-Jansen 2006), therewith including not only businesses, but also the inhabitants and academics based on a kind of trade off system between these parties towards robust place-based alliances.

However, within the context of FRM these regime or entrepreneurial partnership ideas hardly got any foothold. Often integrated water management is still regarded a prominent public activity, since it would be focused on the general protection and well-being. The predominant profit focus of entrepreneurs would only enforce a selective flood protection, and cherry picking resulting in weaker links in an integrated water chain (Ruijten 2015). Nevertheless, here one often forgets that the birth of an integrated water management, especially in Delta-areas, evolved from an intensive collaboration between free spirited serfs, emerging farmers and entrepreneurial monasteries, under the aegis of an ambitious local governor (Boelens, 2018b). In order to restore such a more entrepreneurial, but also sustainable and responsible undertaking, one needs to move from a predominant inside-out ppp-approach, towards a more promising outside-in relational approach, with governments in a facilitating and coordinating role (Boelens 2009).

3.4. Resilient education

Finally, and as Pahl-Wostl *et al.* (2011) pointed out, individuals do not pay the same attention or give the same value to details when coping with a problem. Disciplinary background, education, cultural heritage and experience are major aspects that influence the mental models of people in regard to a specific issue. This could lead to a variety of frames or conceptions and ultimately to different solutions. Actors sharing the same mental map will more likely work together, reinforcing their viewpoints. A change in people's mental maps are most likely triggered by either a crisis or by communication with actors, who have different backgrounds (Termeer & Koppenjan, 1997). Such reframing does not happen automatically when communicating with other actors. Being aware of its own frame and having the capacity to reflect on it, are basic preconditions for an active reframing. Studies have shown that such processes are the most effective when experiences are shared and supported by relational practices (Pahl-Wostl *et al.*, 2011).

The basic precondition of the actors' awareness of their own frame and the capacity to reflect on it can be influenced through the aspects mentioned above (disciplinary background, education, cultural heritage and experience). Amongst these aspects, public education has been recognized as an important tool of influence the development of a population's perception towards certain issues and how to deal with them (Alexander, 2010). Education thus provides an opportunity to act at two different levels. Firstly, as it influences the mental model of a population, education could enhance the perception in regard to the integral aspects of water in a landscape and that the water system could be improved in every sector of human activity. Secondly, education could play a role in raising people's awareness of their own frame and develop their capacity to reflect on it.

Against these theoretical and operational backdrops, we have evaluated the four Belgian FRAMES cases, with regard to Resilient Citizens (Ninove), Resilient Areas (Geraardsbergen), Resilient Businesses (Liedekerke/Denderleeuw) and Resilient Education (on several schools in the area).

4. Case resilient citizens

4.1. Introduction of Ninove

Ninove was set as the focus area at the beginning of the FRAMES project. Ninove is located half-way of the Dender along the river. Historically, Ninove's development was therewith strongly related to the river. Locks were constructed to control the flow rate of the river and assured a good connection with other cities. However, in the last 150 years, the territorial development became less influenced by the surrounding landscape and more by the development of regional railways of Brussels, Ghent and Aalst, which lead to a more sprawly urbanisation. After the Second World War, the sprawl of residential urbanisation intensified with the motorisation of mobility and expanded towards natural flood areas. Residency was not the only type of settlements that established in these areas, but also industrial areas flourished along the river (PlusOffice, 2020). This urban sprawl in Ninove lead to the establishment of various building activities within natural flood areas, which ultimately endured significant damage of floods, amongst which and most severely the one of November 2010.

Flanders is characterized as a very hybrid territory with a high diversity of actors being established on a small area (Nolf, 2014). Ninove is no exception to that. Hence, the first objective of the Belgian FRAMES pilot project was to focus on the involved citizens, based on rrevious research that had been conducted for the whole Dender (Mees *et al.*, 2016a; Tempels, 2016). From here the Ninove pilot progressed.

4.2. Problem statement

Concurring with the FRAMES objective of resilient communities, the purpose of the Ninove pilot project was to increase the resilience of citizens living in flood areas. In the institutional context, the involvement of citizens in the delivery of FRM has triggered the interest of the Flemish authorities in order to enhance its effectiveness and efficiency. However, Mees (2017) noticed a significant gap between the viewpoints of governmental water managers and citizens living in flood prone areas. This is congruent with the findings of Tempels (2016) who observed a low awareness of those citizens to flood risks, as well as a low willingness to take measures themselves. Citizens in the Dender basin consider FRM mainly as the responsibility of the public authorities. In that matter, the boundary between public and private responsibilities to FRM are not defined explicitly by law. The responsibility of the authorities is broadly assumed in an informal way (Mees, 2017).

A first step towards the implementation of flood resilient measures by citizens, is to increase citizens resilience through public participation in decision-making (Mees, 2017). Both approaches can be rather tricky as a large portion of the citizens considers FRM solely a governmental responsibility. This dismissive attitude can be explained by the rigid and inert Belgian regional zoning plans. Construction land was defined in the 1970's providing legal certainty and the right to build residential infrastructure. This definition of zones was done without a thorough consideration of the natural flood plains. Nowadays, a number of these construction lands are located in flood-prone areas, since the residents assume they are living in flood-free zones (Tempels, 2016). In that context, a shift of responsibility of living on flood prone areas could be perceived as a frustrating experience.

Nevertheless, it is now acknowledged that public authorities do not have the necessary means to cope with floods by themselves. However, the picture is not exclusively negative. Tempels (2016) noted a relatively high satisfaction rate amongst the citizens to live in these areas; and therewith to improve

their housing conditions. The purpose of this pilot was thus to explore the possibility to increase the flood resilience of communities in the city of Ninove.

4.3. Contact with local authorities and communities

The FRAMES project started in February 2017. During the first year of the project exploratory research was conducted and meetings were held with the local authorities, stakeholders and community groups. During this period, information was gathered concerning the existing organizations and how win-win situations could be triggered through co-creative activities with communities. A similar phase was also conducted for the Denderleeuw municipality during that year. However, this resulted in an absence of approval from the local authority due to the sensitivity of the subject in the upcoming pollical elections.

A first meeting was held with the public administration of Ninove on 2nd of June 2017 during which the FRAMES project was presented; including a list of stakeholders and community groups. The FRAMES team attended several participative working sessions for the development of the *Overstromingsbeheersplan* (the Flood risk management plan, FRMP) and the flood management plan (the 27th of July, 12th and 19th of October and the 6th, 16th and 22nd of November 2017). Also a meeting was organised with *Ninove Welzijn*, a local Social Housing Cooperative, the 17th of January 2018. In addition several meetings were organised along the year 2017 with the *buurtinformatienetwerken* (BIN) of several districts of Ninove. These community groups are neighbourhood networks for information exchange. Their purpose was to increase security, social cohesion, criminal prevention and enhance collaboration between citizens and the local police. These groups were subsequently used as contact platforms for inviting citizens for co-creative activities. Finally, a meeting with the public servant for emergency planning and the fire department on the 16th of January 2018 triggered the development of a Community Resilience Workshop, during which possible preparedness measures (3rd layer) would be elaborated with citizens. Information was also be gathered during the workshops to explore what kind of protection and prevention measures would be well-received by the local population. A last meeting and official approval of the local authorities on the 28th of February 2018 gave the final green light to organize these co-creative activities.

4.4. The Community Resilience Workshops

Five Community Resilience Workshops were organized in the following year. The purpose of these workshops was to explore the possibilities for the implementation of community based flood resilient measures. Citizens were invited at these workshops, but also the local authorities and the Flemish navigable courses management agency, *De Vlaamse Waterweg*. The municipality of Ninove participated also in the development efforts of these measures, while the latter was invited to present their progress in terms of FRM.

The first workshop was held the 25th of April 2018 in the main hall of the fire station. The inhabitants living in flood prone areas were invited by means of door-to-door visits that served an ex-ante survey. The purpose of this first workshop was to increase the awareness of the flood risks in their neighbourhood, including the possible role of citizens in FRM with regard to what measures citizens could take to protect themselves against floods. Approximately 20 citizens were present at the first workshop and the local mayor as well as the public servant for emergency planning. After the first workshop, it became clear that two themes had to be set: resilient citizens and resilient areas. This distinction was made to clearly differentiate the type of measures and the role of each actor in their implementation. Moreover, a significant dissatisfaction of the inhabitants was noticed concerning the FRM of the public authorities. It was thus acknowledged that adding citizen's participation in the FRM

measures of the local authority would be a motivating factor for the elaboration of preparedness measures.

Following the first workshop, a research-by-design project was started. A public call for application was launched shortly after the first workshop (see "5. Case resilient areas"). The Tractebel company was selected for the assignment to ultimately finish its assignment in September 2018. The second workshop was held the 11th of June 2018 also at the fire station and had two objectives. The first objective was to define what kind competences were needed for and look at the applicability of several preparedness measures. The second objective was to inspire and receive feedback from the inhabitants for structural FRM measures. Again, about 20 inhabitants were present during that workshop. In conclusion, the willingness of citizens was limited and especially geographically fragmented. Moreover, the formal and informal social network in the focus areas seemed weak for preparedness measures. The results were presented to the public authorities of Ninove on the 12th of September 2018 in order to discuss additional collaboration proposals for the structural measures.

The third workshop was organised on the 13th of November 2018 at the Belleman Café, a local pub. The number of attendees raised to 28 at this workshop and two themes were discussed: the possible collaborations between citizens and the fire department and the adaption of a preparedness manual for the new inhabitants of Ninove. Several proposals came up during the discussion concerning how citizens could enhance emergency services. Still, a great portion of the discussions were primarily focused on the lack of trust from the inhabitants in the public authorities to tackle the problem. This was sometimes used as an argument to demonstrate the illegitimacy of citizens to take measures.

With the information of the third workshop, a fourth one was organized to take place the 13th of December 2018 at the local sport complex. The purpose was to finalize the content of the preparedness manual with the residents. However, only one citizen arrived that evening. The original lack of interest of the citizens to participate was the main reason. Other contributing factors were the significantly cold weather and the distance of the sport complex, the coming of the Christmas days and finally, the occurrence of an important football match that evening. Unfortunately, other attempts for organising such workshop were launched but did not conclude due to the explicit unwillingness of the citizens.

A last workshop was organized in collaboration with the BIN of a sub-district of Ninove, Okegem. A total 18 residents attended the workshop. The workshop introduced the public strategy for FRM and started discussions with citizens about which role they could have in contributing for FRM. Still a large portion of the residents expressed a dismissive stance towards such participation considering their views about the public authorities as the main responsible for floods

In conclusion, the participation process which involved citizens in the implementing FRM measures did not result satisfactory. The inherent perspective amongst citizens to attribute the responsibility of FRM to the public authorities constrained strongly the development of citizens preparedness.

4.5. House-to-house advices

Based on the observations made during the first Community Resilience Workshop, it seemed that the majority of citizens did not have the necessary knowledge to perform basic structural changes to their houses to increase its resilience to floods. Since 2004, the Province of East-Flanders has a consultancy service for sustainable housing and building (DUWOBO). While DUWOBO originally focused on energetic efficiency, it has the ambition to widen its services to flood resilience. However, the service

has yet to build-up its experience on this subject. Using the FRAMES project as opportunity to further develop expertise on giving flood resilience advice to citizens, the Province of East-Flanders launched a public call for application. The purpose was to hire the services of a private consultancy bureau expert in giving flood resilient renovation advices at housing scale and offer free advices to the citizens attending the workshops. The bureaus Hydroscan and *MilieuAdviesWinkel* were selected for the assignment. Based on the citizens reactions and the advice presented by the bureaus, DUWOBO of the Province of East-Flanders would build up its expertise.

The citizens who expressed their interest in receiving advice were contacted during the summer of 2019 in order to plan an advice event. Furthermore, flyers were sent to 400 addresses in flood prone areas of the municipality of Ninove and a call was sent through the website and facebook page of the municipality. 8 citizens registered for the service but after a phone contact and availability check, 5 addresses finally received advice in flood resilience. Unfortunately, this represents about 1,25% of the target group. This means, statistically speaking, that the findings of that experiment concerning the citizens living in flood prone areas cannot be considered representative of the total population. Nevertheless, it gave insights in the role that the Province of East-Flanders could play in advising its citizens in flood resilient measures and the added value of such advices. These insights were compiled during a roundtable organised on the 27th of November 2019 between different stakeholders: Hydroscan, *MilieuAdviesWinkel*, the VMM and the departments of Spatial Planning, Integrated Water Management, and DUWOBO of the Province of East-Flanders.

The majority of attendees argued that the Province of East-Flanders' initial and official role in FRM is to implement collective protective measures. A deep-rooted broadening of this role to the scale of housing did not seem appropriate due to the limited results of the experiment and the lack of support for a further institutionalisation. Furthermore, fully integrate flood resilience advice into the DUWOBO consultancy service seemed not on schedule due to the already extensive amount of information that the advice entail.

4.6. Results and discussion

4.6.1. Multi-Layered Water Safety

From the perspective of the MLWS concept during the Community Resilience Workshops, various measures and possibilities were discussed. While the dissatisfaction and the dismissive stance of a large part of the citizens concerning *"taking matters in their own hands"* did not result in implementation, the workshops did indeed increase the citizens' awareness about the diversity of measures that are possible in order to enhance flood resilience.

After the introductory workshop, the feasibility of a list of measures were discussed through the use of an illustrated booklet developed by the Province of East-Flanders. Compiled over the four workshops, these measures addressed all layers of MLWS:

1. Green roofs and reducing the imperviousness at household level were mentioned as feasible measures for residents to be taken.
2. The installation of flood barriers at household level and renovate households into flood-proof ones were also put forward as a possibility.
3. Volunteering and helping in the coordination of the relief efforts, filling, distributing sandbags and put valuable appliances at higher floors.
4. Help cleaning after and organise release efforts through neighbourhood groups.

All these measures were overall discussed during the Community Resilience Workshops. However, the perceived inaction and passive attitude of the public authorities to the problem was a regularly occurring subject of discussion during the workshops. According to a majority of the attendees, the public authority did not fulfil its responsibility by a lack of river dredging, locks improvement, dikes instalment and drainage enhancement. Moreover, most of the citizens'-based measures could not be implemented according to the attendees due to the lack of active efforts and legislation from the public authorities to motivate citizens in doing so. For instance, subsidies and an available expertise would expectedly greatly enhance the motivation of citizens to implement such measures. Therewith it became clear that in order to enhance citizens preparedness, it needs to be presented as part of a bigger picture. Here all efforts and measures, also from other stakeholders (especially public authorities), need to be exploited too.

4.6.2. Flood resilience

The objective of the Community Resilience Workshops was to enhance the flood resilience of citizens through increasing the awareness of the communities and their responsiveness or behaviour. From the perspective of flood resilience concept presented by Tempels (2016), this objective can clearly be categorized as socio-ecological resilience. However, due to the low willingness of the citizens to actively be involved in FRM, we have to conclude that the objective was not fulfilled at the end of the workshop. The idea that citizens could play a role in enhancing the flood resilience of a neighbourhood seemed understandable but not acceptable from the viewpoint of the workshop attendees.

Already noticed by previous literature on the matter (Mees, 2017; Tempels, 2016), there exists a strongly established perception of attributing the responsibility of floods to public authorities. This perception is not only shared by citizens but also by the local public authorities themselves, that still tend traditionally to rely on engineering resilient measures and measures to be taken by higher level authorities.. Dredging the rivers, improved locks, dikes construction and drainage enhancement were the foremost and most often mentioned flood resilient measures to be taken; despite the fact that it is known that these measures are not sufficient. Ecological resilient measures such as retention basins or enhanced infiltration efforts were discussed but in a much lesser degree. In general, public authorities are officially open and show interest in alternatives or new approaches. However, they still lack expertise and their method relies strongly on path dependent models that do cope with these alternatives. The idea that citizens could play a role in enhancing the flood resilience of a neighbourhood was not recognized as a way to move forward.

4.6.3. Actor's Relational Approach

From a multi-actor relational perspective (figure 4), a lot of effort was put on the interaction between public and civic actors. The mediators (the Province of East-Flanders and AMRP) tend to increase the collaboration between the local community and the municipal authorities of Ninove and the Flemish waterways agency, *De Vlaamse Waterweg*. Furthermore, they explored the possibility to widen its consultancy service for individual housings towards expertise on flood resilience. Firstly, the mediation between the local public authority with its citizens, had the objective of implementing citizen centred flood resilient measures. On the other hand, the endeavour of putting the Flemish waterways into contact with the local citizens had the objective of enhancing communication between those two actors and increase the understanding of the local communities to the FRM strategy and process.

In the end, the workshops did not result in the implementation of community-based measures. Several remarks from citizens to the public authorities were not followed by an active response from the local

authority to build up a multi-actor flood resilient strategy. It thus resulted in a single direction exchange. The second objective was fulfilled thanks to the willingness of the Flemish Waterways to present the progress made in the elaboration of a FRM strategy at their responsibility domain and based on their specific expertise. But they focused their efforts solely to the Dender river itself strengthening their expertise on hydrological and cost-efficiency calculations of infrastructural measures. Such focus implied a very technical and engineering approach beyond participation of local communities. Consequently, the focus remained predominant in a classic, traditional linear approach and can be evaluated as such. The institutionalised engineering approach and the informal assumption of the authorities' responsibility over floods, remained a too dominant element influencing the interaction between the public and civic actors.

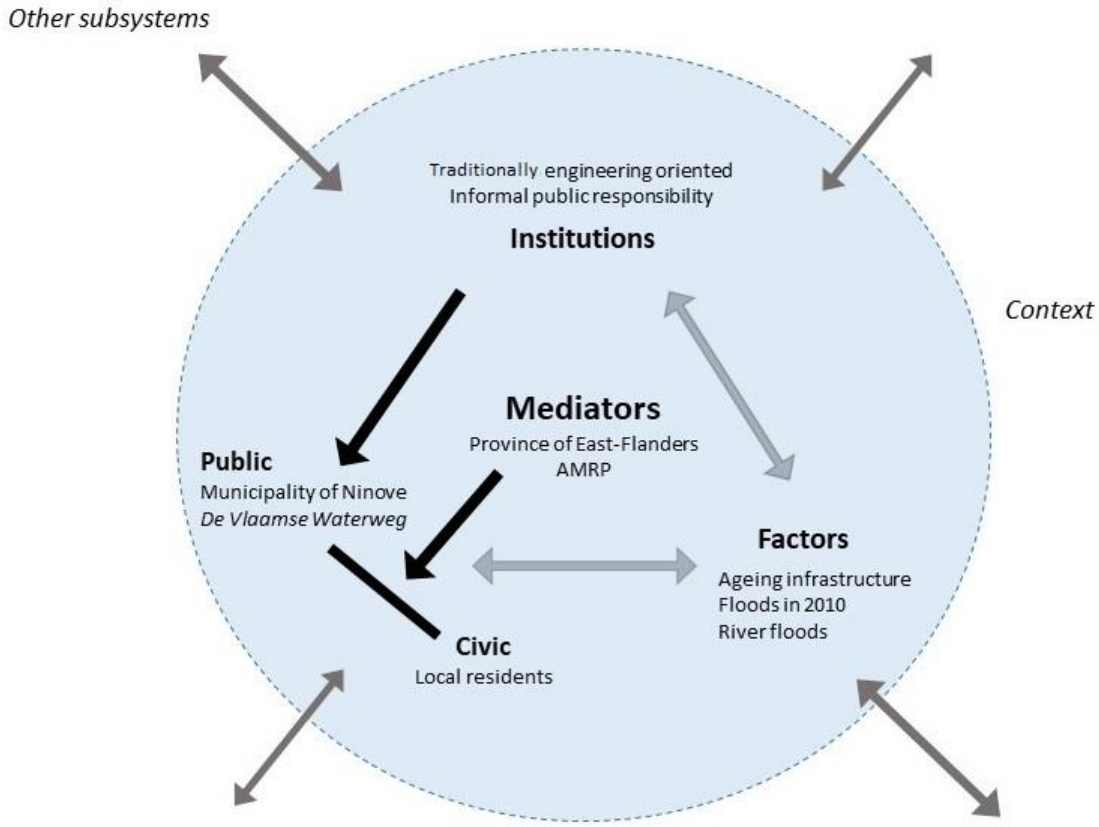

Figure 4: Evaluation Resilient Citizens according to ARA

5. Case resilient areas

5.1. Introduction

After the first workshop the 25th of April 2018, it became clear that citizens would not be willing to get involved in the construct of preparedness measures, without support or measures from the public authorities. Indeed, a profound dissatisfaction from the local residents could been noticed during the first workshop concerning the perceived lack of initiative in the FRM of the authorities. The Belgian FRAMES team thus decided to start a research-by-design project in parallel with the Community Resilience Workshops. This was the start of the Belgian FRAMES sub-project *"Case resilience areas".*

The first step was to launch a public call for application of which the Tractebel company was selected for the assignment. A first vision plan (see "Annex 1-Tactebel vision plan.pdf") was developed based on the feedback given by local residents during the second Community Resilience Workshop the 11th of June 2018. This vision plan was presented on the 12th of September 2018 meeting to investigate to which degree the plan was applicable for the stakeholders. Several constructive remarks and points of view were shared with the various stakeholders present. This enhanced a positive confidence in a future collaboration with these stakeholders. However, the local authorities made a request to put the project "on-hold", due to the municipal elections in October 2018. No green light from the local authorities could be given as long as the new city council was not set. Ultimately, the council was finally established in January 2019.

In the meantime, the FRAMES team started searching for additional focus areas. The city of Geraardsbergen was selected because of their prior contacts with the province of East-Flanders in the editing of a rainwater management plan. Furthermore, a new city council was set up relatively quickly after the elections. Three meetings were held between November 2018 and February 2019 to define more precisely the focus area and to determine the strategy. The focus area was subsequently located in the sub-municipalities of Moerbeke and Viane. Meanwhile, the situation in Ninove evolved with a new city council and administration. The new aldermen of public works expressed a high interest in the project and his support was thus officially guaranteed.

Last but not least, a second call for application was launched for this next step of the research-by-design project. From now there were two assignments based on the two focus areas: Ninove-South and the sub-municipalities of Moerbeke and Viane. The PlusOffice-Delva and Witteveen+Bos Bureaus were selected for the development of structural FRM measures, and it began its work from the 25th of April 2019 onwards.

5.2. Description of the areas

In order to explore which infrastructural measures could be implemented for FRM in the two focus areas, Plus Office first investigated the hydrological landscape and the origins of floods to in the respective areas.

Ninove is located along the Dender and is situated in the low land area of the river. Historically, the city was first settled between the large winter riverbed and the surrounding higher lands. Through urbanisation, the city expanded to the river installing build up areas in the natural flood plains. As said before this means that floods in Ninove are mainly caused by river overflow. The Dender basin has a quick discharge response due to the increasing imperviousness in the peri urban landscape and relatively dense drainage network, next to the geographical context mentioned before. This makes the

Dender very sensitive for heavy rainfalls. In order to reduce the flood risks, runoff water on higher areas can be retained. At the local level, space need to be reserved for water buffers by re-establishing natural flood plains. For inhabitants already located in those flood prone areas, infrastructural measures, such as dykes or additional measures to enhance flood proof residents, need to be considered (PlusOffice, 2020).

Moerbeke and Viane are villages on the higher banks of Geraardsbergen. They were originally villages settled on the Mark, a tributary river of the Dender. However their urban extensions did not reach the natural flood plains of the Marke yet. Nevertheless, these villages are still subject to floods and endured severe damages during the floods of 2010, 2011, 2014 and especially in 2016. It was induced by the runoff water during heavy rainfall, in combination with the modernization of the agriculture in the surroundings. Where water would flow through the natural drainage system in normal circumstances, water is now drained through a sewer system, along roads or on agricultural land where it can cause erosion. This runoff water accumulates in the next settlements. Floods are generally very local and intensive for a couple of hours. Measures such as retention basins, enhanced infiltration structures or soil and water conservation aren't sufficient in these cases. For that additional measures are needed.

5.3. Progress and results

5.3.1. Ninove

- *Tractebel*

The final report of Tractebel, delivered in September 2018, presents a vision plan with three focus areas and a set of infrastructural climate resilient measures (figure 4): 1. The park district, 2. The Dender quay district and 3. The green area of the *Burchtdam*. The park district consists of 4 housing blocks were social housings are located. These social housings are under the supervision of *Ninove Welzijn*, the local social housing cooperative. The Tractebel vision plan proposes several measures such as rainwater recuperation systems from the roofs that would be redirected to ponds in the gardens. Another measure includes green strips and channels to control the flow of rainwater on surface. Finally, the possibility to install green roofs is also mentioned to improve neighbourhood's resilience against urban heat island effects. The Dender quay district is a residential area as well located along the Dender. The main infrastructural measure in that area proposed by Tractebel's vision plan is to create leisure space along the river that could be flooded in case the Dender level increases. The last infrastructural measure was a by-pass that would reopen the old natural river course. The by-pass leading to the *Burchtdam* area would offer a natural flood plain in case of a river overflow.

As mentioned above, the Tractebel final report and the proposed measures were presented to local and regional stakeholders the 12th of September 2018 meeting to local and regional public stakeholders in order to investigate to which degree the plan was applicable for them. The social housings of the park district were already intended to be renovated and the plan was submitted to the local government. On the other hand, the sewer system manager was also planning a renovation of the local evacuation system, but had not started the juridical procedure yet. Further collaboration was thus possible in case of the green strips and channels on the streets area. This measure was however not well received by the traffic department, because of the presumed lack of parking lots. Moreover,

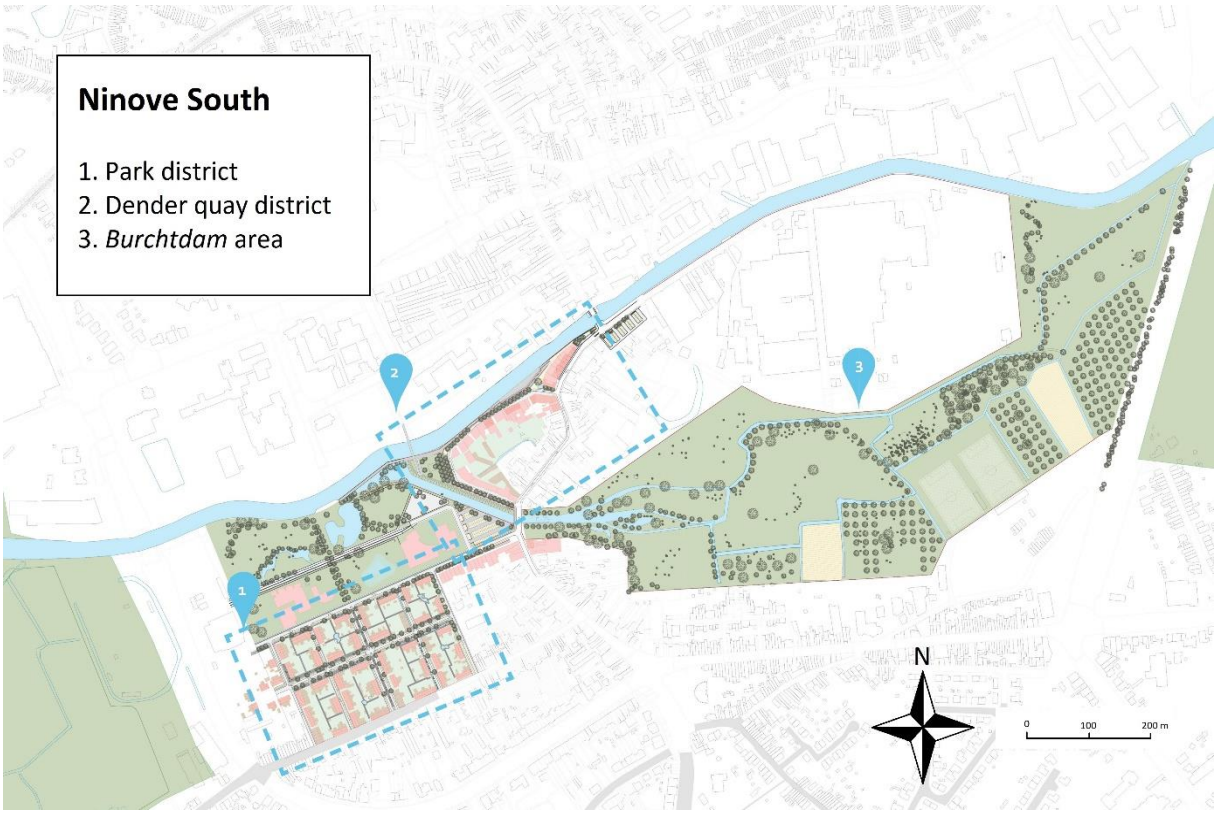

Figure 5: The three focus areas of the vision plan in Tractebel's final report with infrastructural measures for climate change adaptation in Ninove South (based on Tractebel, 2018).

it was also underlined that the area has a limited infiltration capacity. The green strips and channels would consequently be only efficient for reducing the flow rate during heavy rain events. Therefore the measures presented for the Dender quay district were not well received by *De Vlaamse Waterweg*. Finally, the by-pass did not receive much support, except for some water channels, which already exist at the beginning of the *Burchtdam* area behind the residences. Those channels are connected with the sewer system and are smelly. Exploring a solution for that matter was thus welcomed.

- *PlusOffice-Delva and Witteveen+Bos Bureaus*

The results from the meeting with the local stakeholders concerning Tractebel's proposals were thoroughly noted and used as basis for the PlusOffice work. The main strategy of PlusOffice to find win-win situations within a larger ray of challenges. It organized a total of 2 multi-actors workshops and a final meeting with the local authorities. The first workshop, on the 21st of May 2019, gathered the city of Ninove, Aquafin (sewer system manager), the Province of East-Flanders and De Vlaamse Waterweg. Several challenges were defined in the area of Ninove South based on four themes: water, landscape, mobility and development. Using this information, PlusOffice developed priority areas and drew a first round of infrastructural measures for each of these areas. The second workshop took place on the 5th of September. Here the applicability of the different proposed measures were discussed. Three citizens' participation moments were held afterwards: the 5th, 15th and 22nd of September. These moments were not organised as workshops like in the previous process with Tractebel. The participation moments included foremost a phase of informing citizens about the results of the two multi-actors workshops and subsequently a feedback phase where citizens could express their perception, appreciation or discontent with the proposed measures. This feedback would thus be incorporated in the vision plan. A final consultation meeting was held on the 9th of October with the original actors to further refine the vision plan and its applicability.

The overall vision plan proposed by PlusOffice (see "Annex 2-PlusOffice vision plan.pdf") is based on three basic strategies to tackle the water issues. The first is to restructure the features of the streets of the park district to retain rainwater during heavy rainfall. The second is to retain and control the drainage of that rainwater towards specific locations of the *Burchtdam* green area where the water could be cleaned by purifying vegetation. The third is to use the *Burchtdam* natural area as a buffer zone in case of high levels of the Dender combined with recreational purposes during drier periods.

Further, the plan is divided in three focus areas where concrete measures are proposed based on the input of expertise from the different actors and the feedback from citizens' participation moments. The first focus area is the park area district which is currently in renovation under the supervision of *Ninove Welzijn*. Moreover, the sewer system manager is planning to reconstruct the local sewer system. This offers the opportunity to renew the public area through a co-financing procedure with the Flemish Government. Following the feedback from citizens' participation moments, grouped parking lots could be installed without reducing the current amounts of parking lots. This would create space for the instalment of buffer canals that would drain the rainwater towards the *Burchtdam* area. The second focus area is located at the Dender quay. The site is presented as a transient location between the *Burchtdam* area and northern part of the city centre. PlusOffice proposed to rebuild the quay as a lower trampled public space that would serve as recreational area by nonetheless keeping accessibility undisturbed. Creating space for an easy access to the *Burchtdam* area, combined with a network of channels to drain the rainwater, would serve recreational and FRM purposes. The third focus area is the transition zone between the *Brusselsesteenweg* and the *Burchtdam* area. The current *Brusselsesteenweg* is a closed space without access to the natural area. PlusOffice vision plan implies the reconstruction of the transition with apartment buildings and underground parking lots. This would

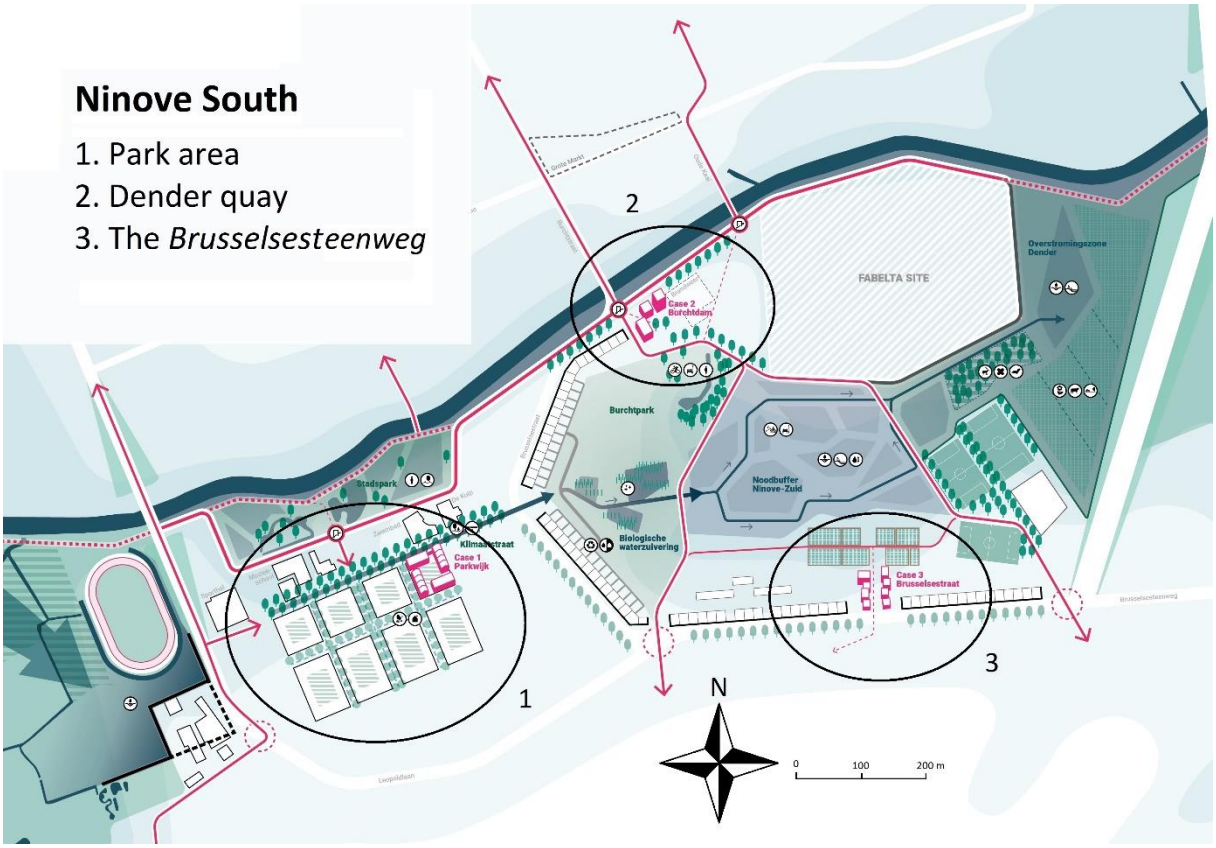

Figure 6: Overview map of the vision developed by PlusOffice with the three focus areas (based on PlusOffice, 2020).

create space to open up the access from the street to the natural area. The space created could thus be used to install collectively managed water buffering gardens. The dense traffic on the *Brusselsesteenweg* limits however the possibility for additional changes in the area.

In conclusion, the authorities of Ninove have issued a formal approval for the proposed measures and a list of prioritization was drafted. Hence, the implementation of the *Burchtdam* buffer zone has become a prerogative, which is planned for realisation in 2023. The next measure on the list are the opening up of the transient area between the *Brusselsesteenweg* and the *Burchtdam* natural area. The design and the formal permit of the third measure, the reconstruction of the residential park district, is planned to be finalised by the end of this legislature (2023). The last two measures on the list are the redevelopment of the park and the Dender quay zone.

5.3.2. Moerbeke-Viane

The focus of Moerbeke and Viane was set after the third meeting with the participation official of the City of Geraardsbergen on the 19th of February 2019. The strategy of PlusOffice was different compared to the approach they used in Ninove due to the rainwater management plan in progress. A first residents' exploration was organised on the 30th of May 2019. During this exploration, the areas of interest and local challenges of the residents have been listed and was used as a basis for the first analysis. Further on, four workshops were organised the 25th of June, 18th of September, the 17th of October and finally the 2nd of December 2019. A similar approach, as the first in Ninove, was used during the first workshop by defining challenges and priorities based on four slightly different themes: pubic space, mobility, soil and erosion. These challenges and priorities were discussed with several local public, civic and private stakeholders: Aquafin, public officials of Geraardsbergen, the VMM (Flemish Environmental Agency), the Farmers' Union, three NGO's (Climaxi and RLVA) and three private companies (a real estate agency, an expert surveyor and local consultancy bureau). These priority cases covered during the workshops that followed, which included design sessions and plenary discussions. Finally, the fourth workshop was organised during which a large group of local residents were invited to gather a last input from citizens. The final proposed vision plan of PlusOffice comprised five priority areas with specific implementation measures (figure 7).

The first one is the main valley of the *Hollebeek*, a small tributary stream flowing towards the flood plains of the *Marke*. The plan proposes to implement a foot and cycle path along the stream that would cross the stream at a regular distant. The crossing would give the opportunity to construct dykes to install several water-retention zones. Hedges could be installed on the croplands of the slopes of the valley to reduce the runoff and the erosion rate. The next three priority zones were located upstream of that tributary stream. The crossing of the stream with the street by means of an underground pipe creates however a bottleneck. Using the grassland as occasional water retention zone would allow to reduce flood damage. The third and fourth priority areas imply the implementation of two extra water retention zones combined with hedges on the slopes to enhance infiltration and reduce the flow rate of the water in case of heavy rainfall. The last priority area is located on the other side of the *Marke* valley along the *Wijzebeek*, a tributary stream.

Congruently with Ninove, the city of Geraardsbergen also issued a formal approval for the proposed measures but without a prioritization list.

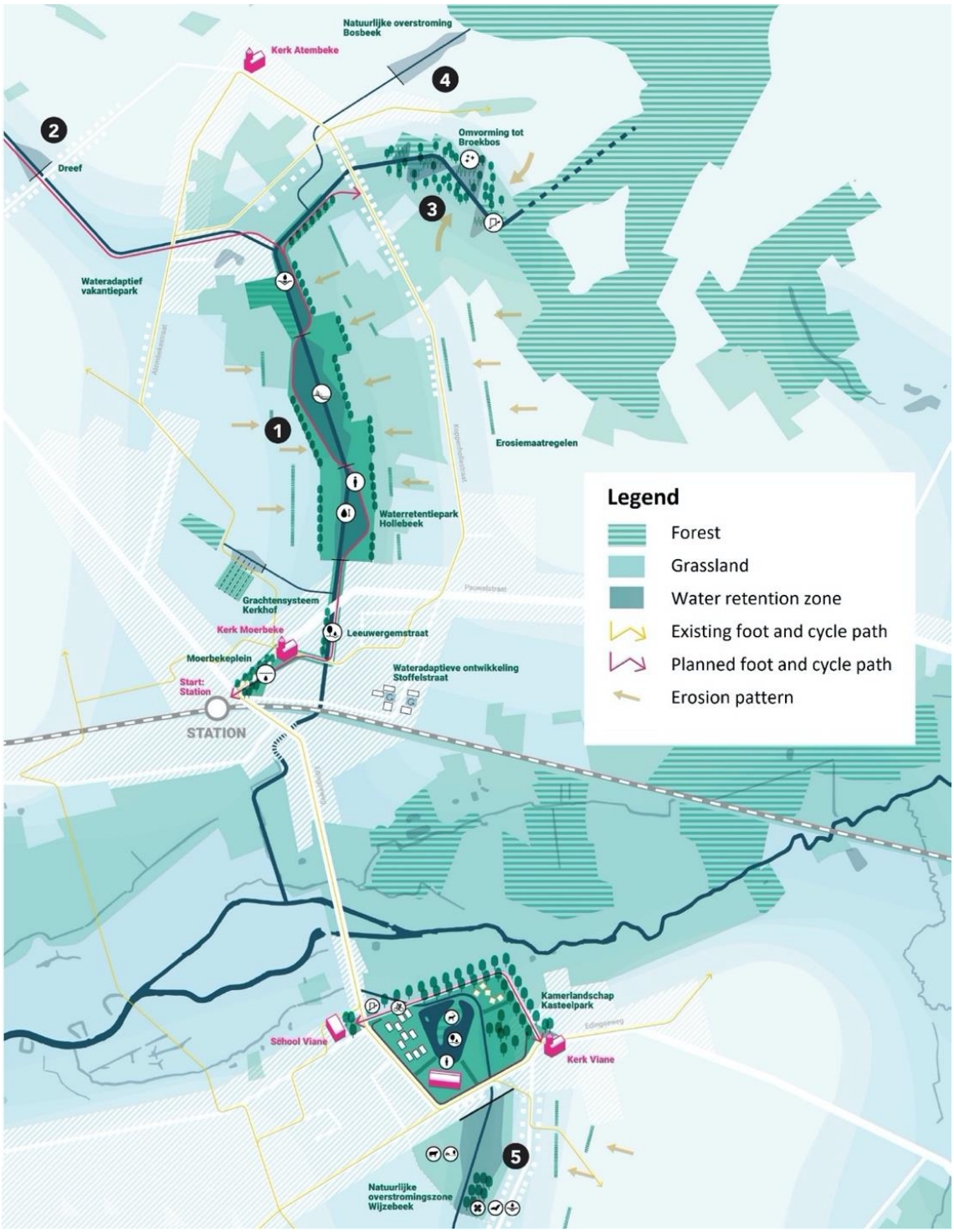

Figure 7: Overview map of the vision plan developed by PlusOffice with the 5 focus areas: 1. The Hollebeek valley, 2. The North-western grassland at the Dreef street, 3. The Karkool forest, 4. The Northern grassland of the Bosbeek, 5. The Wijzebeek valley (based on PlusOffice, 2020).

5.4. Results and discussion

5.4.1. Multi-Layered Water Safety

The two projects originally started from the acknowledgement that adding citizen's participation in the public FRM measures could serve as a motivating factor for the elaboration of preparedness measures during the Community Resilience Workshops. Two bureaus successively explored and designed structural FRM measures through a continuous collaboration with leading stakeholders. Consequently, the projects are mainly focused on the protection and prevention measures and the traditional stakeholders connected to that:

1. By-pass to floodable area, retention basins, erosion measures, retention of water at household level.
2. Proposal of flood robust Dender quay area.

The projects try to come up with win-win proposals and co-financing of already existent budgets, therewith regaining trust and willingness to invest together in a project that could mutually bring forward various goals. In that regard, it fulfils one of the requirements for an efficient MLWS, participation of the different stakeholders. However, the two projects did not tackle preparedness and recovery measures, thus not applying the MLWS approach in a broad sense.

5.4.2. Flood resilience

Therewith the proposals stay strongly with engineering resilience but also addresses ecologic resilience by the erosion measures, retention basins and the floodable natural area. Since there is yet no transition plan to make that happen, it is hardly sure if that flip would be secured also for longer times. On the other hand, socio-ecological resilience is not really addressed, since a behavioural change of the population and local stakeholders, was only presented as a possible consequence of the measures.

5.4.3. Actor's Relational Approach

The main focus of both research-by-design projects, is to chance features in the factors of importance at the moment. It was first and foremost focussed on the improvement of ongoing projects and landscape characteristics. Secondly it could possibly induce new collaborations between the leading actors and stakeholders in and around Geraardsbergen and Ninove. Moreover, this is predominantly done and focused (at least until now) in one direction and not vice versa or reciprocally. In addition, an institutional change of how to deal with floods and climate change is hardly touched. Therewith these proposals have all the features of a classic condition planning, but now only focused on a higher variety of actors.

Nevertheless, both projects aren't translated yet in a final consortium agreement, keeping the link with a local institutionalisation of these plans limited. Changes in budgets and focus could therewith make or break the projects. The proposals have fixed cooperative targets, with regard to present challenges, but are hardly adaptive to future changes in climate.

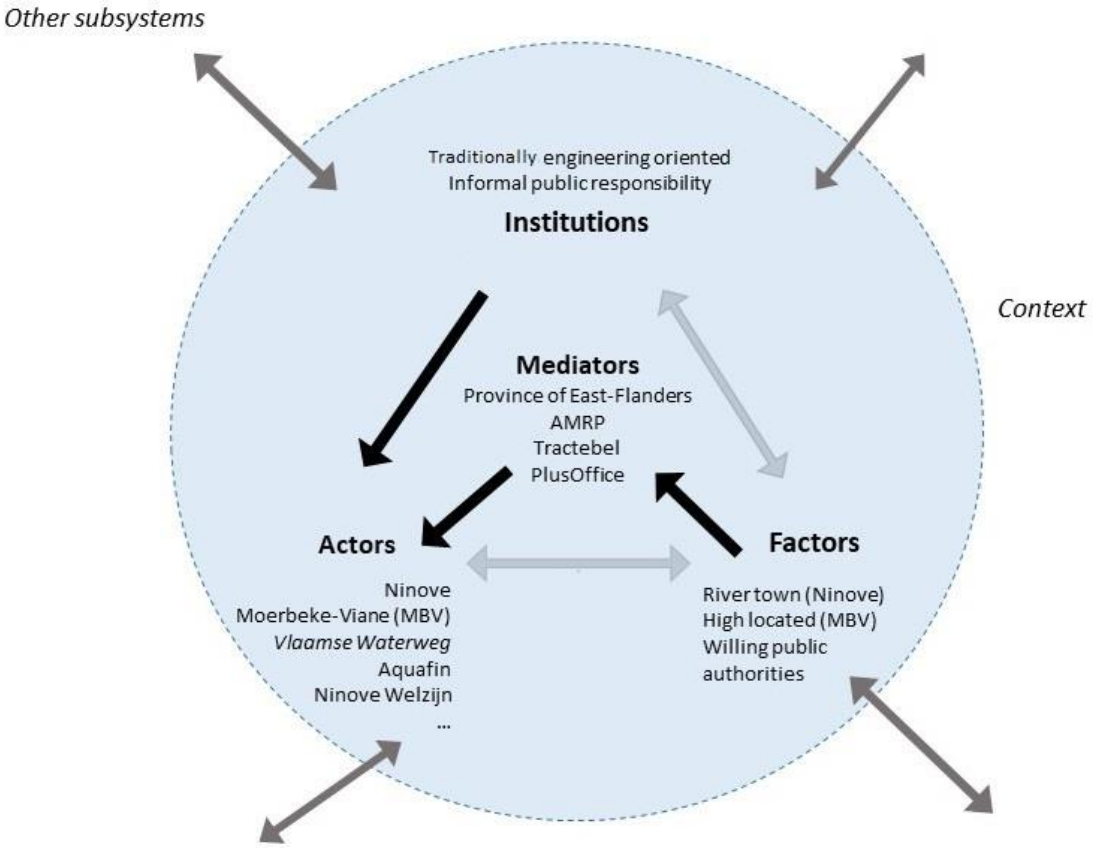

Figure 8: Evaluation of Resilient Areas according to ARA.

6. Case resilient businesses

6.1. Introduction of Denderleeuw

The case resilient businesses has been also part of an assignment to AMRP, with regard to intermunicipal collaboration by the Flemish government. Next to that it was subject of a Masterstudio Urban and Spatial Planning at Ghent University. The focus was collaboration on working areas. But with that focus the intentions were not only set on the typology of the work-locations itself, but also on other aspects (such as sustainability, accessibility, innovative strength, etc.), in order to achieve other intermunicipal social and spatial goals. In this case, special attention was given to the flooding problems of the Dender, which had been deployed simultaneously and parallel to this section by *De Vlaamse Waterweg* and in the INTERREG FRAMES project. After all, a large part of the industrial sites within the region are located along the Dender. Originally, these were mainly companies producing matches due to the specific trees of the Dender catchment area. In addition, lace and tobacco were transported via the river. With the introduction of the railways from the mid-19th century, the industrial industry was also attracted to the region. However, the introduction of the E40 (Brussels-Ghent) motorway after the Second World War in particular gave a boost to industrial site development along these highways. Large truck-oriented areas were created in the industrial zones South of Aalst, near Erpe-Mere, Denderleeuw and Liedekerke (on the E40). Beyond that, however, the provincial-roads also contributed to business development, whereby each municipality also developed their own industrial areas.

6.2. Problem statement

Within this context the Studio was in principal focused on the collaboration of industry parks. Due to Belgian and Flemish municipalities being relatively small (some 22.000 inhabitants on average), and due to Flemish economic-geographic policies focused on an exhaustive supply for light industries in order to enhance economic welfare, industry parks have been scattered over the Flemish countryside. This is especially the case for the fringe of Brussels, as a result of spill-overs from this dense metropolitan region. Based on a first exploration of possibilities, the involved master students came up with a case in the west fringe of Brussels, covering five municipalities (Aalst, Affligem, Denderleeuw, Liedekerke and Haaltert) next to the E40 highway.

Despite these spill overs from Brussels, the working and residential rate is out of balance. In a number of municipalities within the region, fewer than 1 in 10 salaried employees work close at home, within the municipal boundaries. Therewith most municipalities have a negative commuters balance. There is a need to turn this figure around, or at least to shift commuting form car to public transport. For that purpose the Regional Express Train Brussels is and has been developed; however also shifting the best accessible nodes from Aalst to Denderleeuw and Liedekerke. Therewith four challenges were traced for this intermunicipal area, however also including new opportunities for cross-overs:

- *Industrial*: due to internal competition, the area accommodates no less than six industry parks, each housing retail, offices, congress and other facilities who actually weren't meant to be there in the first place;
- *Accessibility*: due to the Brussels express light rail network, the most accessible nodes move southwards from the core city Aalst to the smaller villages Denderleeuw and Liedekerke;

- *Flooding*: due to climate change, the basin of the Dender is regularly flooded, especially in this area where side-streams come together, and the industries and infrastructure cause bottlenecks;
- *Energy transition*: the region of Aalst has been explored as a major opportunity for sustainable energy production (wind and solar), provided an energy hub will be put up in the area.

6.3. Proposals for ecologic/energetic transitions

Tracing the actants behind each of these challenges, and mapping their needs and future options, the students came up with the proposal to organize six municipal industry parks, including the two new key nodes of the Brussels express light rail network (Denderleeuw and Liedekerke) under one cross-municipal managerial umbrella. This would allow relocation of offices, retail, and congress facilities to the key nodes of the express rail network, to gain new room for industries and transport & distribution facilities on the industry parks itself, and to reconfigure these parks for a better flowing of the Dender as well. This would greatly reduce the chance of flooding, especially at the earmarked dark green locations. Pivotal to these proposals is relocating and enhancing nature reserves, and therefore restoring the original historic dimensions and environmental characteristics of the Dender by making room for the river. At the same time, these transitions would allow implementation of the necessary (ground)works for the energy hub, making the common business park the central focus point for the intended energy transition in East Flanders.

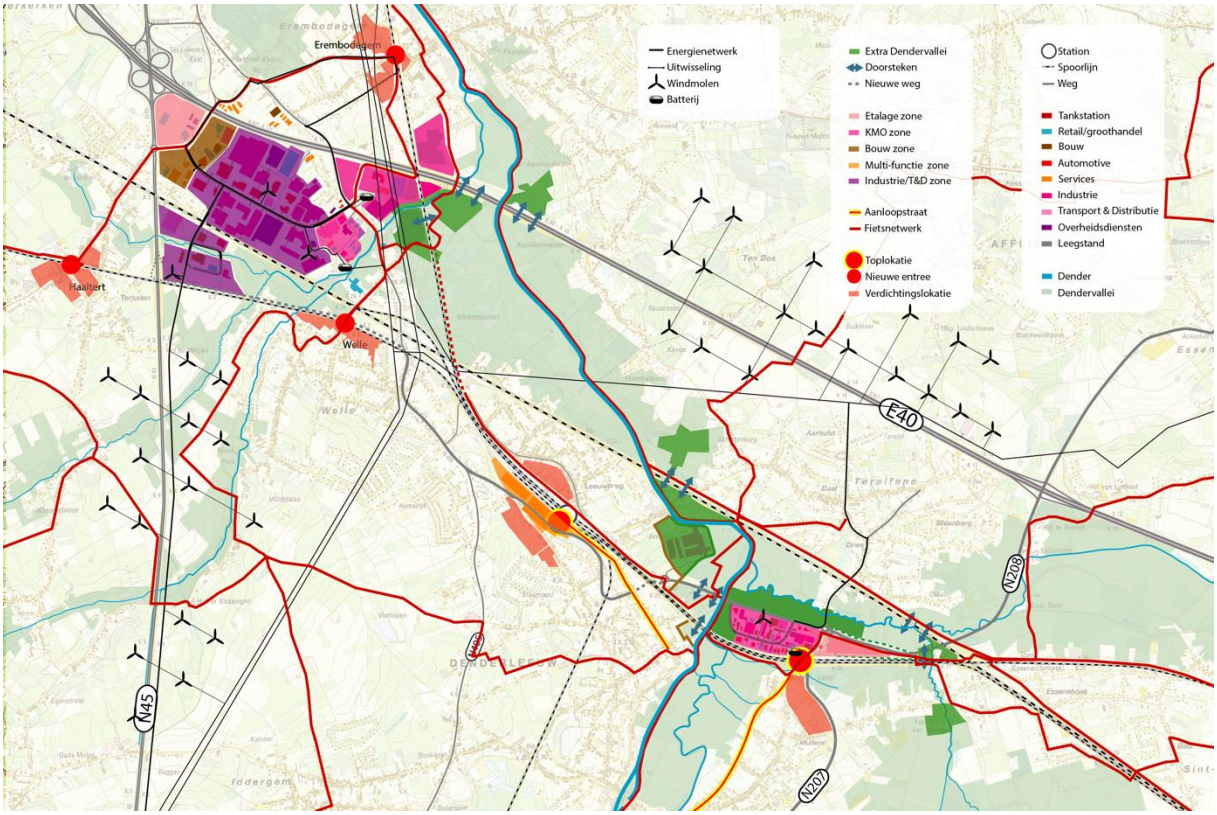

Figure 9: The end proposal for Denderpoort

6.4. Implementation

An initial calculation showed that the costs of such a transition - i.e. relocation, purchase of new land, construction of the infrastructure and nature that is still missing, the crossings, etc. - can be largely offset by the profitable parts of the project. Ideally, this business case mainly consists of purchasing land, studying the repurposing and selling a business right - leasehold, building, full ownership - to real estate developers. The positive balance that arises can then be used to realize other objectives: construction of infrastructure, landscape and ecological design, purchase of green areas, including a major improvement of the Dender flood prone area. Given the size of such an investment, such an operation should only be capitalized upfront by approximately € 5 million.

Nevertheless, discussing these windows of opportunity with all involved stakeholders during some five roundtables in various stages of the plan, also showed that in order to implement the proposals there would be a need for a sophisticated phasing and a smart collaborative development beyond the traditional individual municipalities' progress. The first challenge requires a sophisticated development model, with a joint go- or no-go moment after each step to adapt the plans to changed circumstances if necessary. It is also important to give the weak interests (like nature, green, landscaping etc.) sufficient development opportunities at an early stage, in order to prevent cherry picking. For that purpose and as such, four important transition steps were communally marked.

The second challenge requires a development model that can further unfold the business case in a responsible and focused manner and build an organization that can effectively deploy the necessary instruments across borders and individual responsibilities. For that purpose, we proposed an urban re-allotment model, where each of the stakeholders and municipalities would put in their shares upfront in an intercommunal project development agency, which would redistribute ownership and give dividends proportionally after reconstruction. Listed as important advantages of this model are:

a. the immediate availability of the necessary land for redevelopment,
b. the payback effect of the public investment needed to ensure the success of the project,
c. value capture of the more profitable parts to finance the less profitable parts of the project, and last but not least
d. the decisiveness and transparency for all parties involved.

A crucial condition is that a more or less independent, objective party, on behalf of all the actors, temporarily manages the land positions, concludes contracts and takes out financing, as well as making available or hiring its own know-how to create the intended conversions and deploy the positive balance, in order to achieve other objectives as well: construction of infrastructure, landscape and ecological design, purchase of green areas, etc. Given their position and know-how, we proposed the Provincial Development Companies of East Flanders and Flemish Brabant; but for this case not accountable to the relevant provincial governments only, but to a steering committee that includes representatives of both provinces, the four municipalities, involved landowners and/or other stakholders, such as De Vlaamse Waterweg, energy companies or business associations.

6.5. Discussion

6.5.1. Multi-Layered Water Safety

With regard to the MLWS rose, this project did not so much focused on the preparedness of the inhabitants, but on the improvement of the preparedness of the businesses. After all this was a case of ***resilient businesses***. Nevertheless, in respect to that it covered the protection, prevention, preparedness and recovery measures as well. Moreover, by focusing on the interaction and collaboration between businesses and the respective public authorities, the final proposals became also highly feasible. In that respect the project stretched MLWS to other, more financial supportive domains. However, in the end, *De Vlaamse Waterweg* decided to turn on its steps and just go for their core-business; e.g. protection measures. It became not apparent what were their exact reasons, but probably they weren't ready yet to delve into the 'unexplored waters' of shared and collaborative responsibilities. Here it seems that when push comes to shove, all Flemish authorities aren't ready yet to embrace MLWS full hearty. Therewith MLWS remains for the moment in Flanders predominantly and merely window dressing

6.5.2. Flood resilience

With regard to the resilience concept, the final proposal included engineering, ecological and co-evolutionary resilience as well. Along some parts of the Dender it proposed new dykes and technical measures for a better flowing of the river in order to reduce the risk of floods at the key points near Denderleeuw-Liedekerke-Affligem, at other parts it proposed room for the river, as well as new ecological features and possibilities. Overall it tried to enhance (economic and ecologic) resilience in the adjoining industry parks and industries as well. As such it tried to comply with the resilience model overall, in order to enhance resiliency not only with regard to water management, but also ecologically, economically, politically and spatially.

6.5.3. Actor's Relational Approach

As such and with regard to the actor relational model it dealt with the industry park managers, representatives of the business communities, involved INGO's (like Natuurpunt), the landowners (like the Belgian Railway Company, involved agrarians and *Agentschap Verkeer en Wegen*), public agencies (like *De Vlaamse Waterweg* and VMM) and the involved five municipalities. The project involved research-by-design with and for these leading stakeholders in order to improve their factors of importance reciprocally and in five rounds of collaborative workshops. Along the way it also included upcoming proposals with regard to energy transition. Moreover, in order to improve the feasibility of the final proposals, it stretched also towards the institutional design by proposing a new kind of urban re-allotment implementation model and involving a new partner (the East Flanders and Flemish Brabant Development Agency) to that effect. Nevertheless, in the final stage, at the moment when contracts needed to be signed, the municipal authority of Aalst decided to move out, apparently afraid of the ongoing shift of the core areas in the region, which became further stipulated by this project. As mentioned above *De Vlaamse Waterweg* NV had already decided to turn on his steps, path dependently. As a result, also the East Flanders development agency (the agency needed to manage the re-allotment) decided to leave, under the motto 'all in or nothing'. At the moment each of the municipalities have thus turned towards their own box, therewith fragmenting the integrated proposals into various projects of their own, without much prospects for a new flood and ecologic resilience anymore. At the moment, the challenges of climate change seem to be still not so pressing to stretch the age-old path decency with regard to inter-municipal competition towards collaboration.

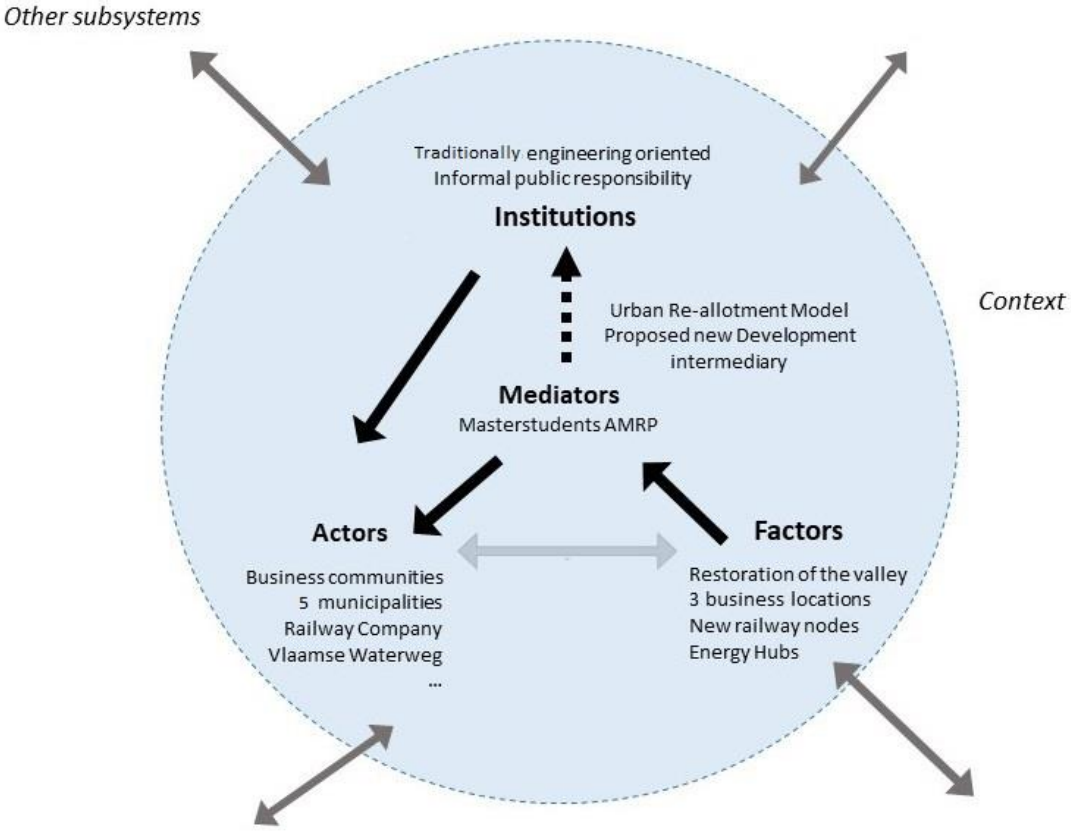

Figure 10: Evaluation of Resilient Businesses according to ARA.

7. Case resilient education

7.1. Introduction: the education system of Flanders

Education in Belgium is managed at community level. In Flanders, it falls within the authority of the Flemish Community. All primary schools in Flanders follow the same curriculum; the secondary school system highly stratified. Two streams are available in the first two years: the general education track, in which the vast majority of students enrol, and the vocational education track. The last four years are divided into four streams with their own curricula; from the highest considered level to lowest general secondary level, e.g. the technical secondary, the secondary arts and the vocational secondary education systems (Rouwers *et al.*, 2016).

Furthemore, the education system in Flanders is highly decentralized (Rouwers *et al.,* 2016). It follows the constitutional principle of freedom of education, which allows any person to set up a school with its own educational principles as long as it fulfils the regulations from the Government. This leads to a situation where government-subsidized and privately-managed school are widespread. Schools managed by public authorities are bound by philosophical, ideological and religious neutrality. On the other hand, this is not the case for privately-managed schools. The largest share of this category is run by Catholic foundations, but also includes schools with particular pedagogic methods. The Flemish education system works with attainment targets since the 1990's, defined by the Flemish Ministry of Education. But each umbrella organization has the right to translate and embed them in their own learning plans.

In that context, this FRAMES Belgian pilot has tended to explore the possibility to which degree climate change and floods are part of these attainment targets and how they are translated in different schools. Moreover, the pilot evaluated whether schools in Flanders focused on raising the pupils/students' awareness with regard to resilient water management and the ability to reflect on it.

7.2. Problem statement

The MLWS concept strongly focuses on the involvement of citizens, and their awareness to floods through a shared responsibility. Such involvement, when not mandatory, is dependent on the willingness of these actors to collaborate, feel involved and reflect on their own framing of a problem. This is influenced by their background, culture and education (Pahl-Wostl *et al.*, 2011). As mentioned in *"2.3.4. Resilient education",* the education system could be a powerful tool to enhance this awareness, both concerning MLWS and the capacity of the stakeholders to reflect on their own frame in the future. Working with the education system for the younger non-adult generation becomes particularly relevant in reference to the increasing flood issues in the future due to climate change.

Thus, the Belgian FRAMES partners designed a school program with the objective of increasing the awareness of the younger generations to the specificities of floods in the face of climate change. That school program tended to find answers to the following questions:

- What is the level of awareness of the younger generations concerning climate change and the increasing risk of floods in Flanders?
- To which level does the Flemish education system raises the awareness of the increasing flood risk in relation to climate change?
- Can a school program with didactic games increase the awareness, preparedness and the recognition of a shared responsibility?

7.3. School program

The school program developed by AMRP comprises three games that are independent from each other (Table 1). Nevertheless, there could ideally be a follow up over several years to make it a multiyear program. The workshops, apart from being independent, increase in complexity in terms of learning objectives, rules and content, congruent with the age of the pupils. Furthermore, each game is structured with 3 sessions:

- The first session takes 30 to 60 minutes during which key concepts were presented to the students in order to trigger their curiosity, and to prepare them for the main session. It was set to bring first insights about floods, their causes and the future challenges. During that first session, the rules of the game of session 2 could be presented if needed. Ex-ante evaluations were also executed during these introductory sessions to assess the initial knowledge and compare these with the final learnings after session 3.
- The second session was organized as a didactic game itself (see above) and took about 1 to 2 hour time depending on the workshop and the school conditions.
- It ends with a conclusive third session of 30 to 60 minutes, during which a common synthesis was drafted of the findings and learning of the students. Feedback was given and an ex-post evaluation was consequently executed during this session.

Each session allowed a flexibility in duration, in order to be adapted to the school organization, the length of the courses and the group size. After these three operational sessions, a post-interview session was organized with the teachers about the pros and cons of the workshops, the knowledge and learning moments of the students, the comparability with the existing teachers' curriculum and the willingness of the teachers to address these subjects in the future.

	Session 1: Introduction (30 min to 1h)	**Session 2: The game (1h to 2h)**	**Session 3: Conclusion (30min to 1h)**
Play with water 4-5-6 primary school	Oral evaluation of the students' perception, experience, knowledge and solutions about floods. Presentation of climate change and the processes causing floods adapted to the students' age.	Game using a landscape model and clay.	Listing the findings and measures made on the landscape.
Play with measures 1-2-3 secondary school		Computer game from the Netherlands	Questionnaire per group of students.
Play with roles 4-5-6 secondary school		Role play with a specific budget but different interests for flood management	Individual questionnaires.

Table 1: Schematic overview of the 3 workshops and the three sessions.

7.4. Operationalisation of the program

7.4.1. Selecting the schools

Selecting schools interested in the program has taken more than three months. A first meeting was held the 18th of April 2018 with representatives of the Flemish Milieuzorg Op School (MOS) program.

This meeting provided a list of possible schools located in Ninove and Denderleeuw. A first contact was made with the school group IKORN of Ninove but after several e-mail contacts and reminders, the school group seemed to be not interested in the program. More focus was then put on Denderleeuw; the involved school directors were contacted just after. Two schools proved to be interested.

The first one who agreed to join the school program was the primary school *'t Landuiterke.* A meeting was held the 4th of July 2018 and dates for the workshops were promptly scheduled. It was agreed that 2 workshops would be carried out the 16th and 18th of October 2018 in the afternoon for two classes of the 6th grade pupils. A list of the pupils' addresses was handed over by the school prior to the workshop, in order to be able to locate pupils' home in relation to known flood zones and get an indication if the pupils could have been already confronted with floods.

The Koninklijk Atheneum van Denderleeuw (KADenderleeuw) also wanted to join. A first meeting was held the 26th of June 2018. Due to a change in the teacher's program, the dates for a first class was set half a year later on the 23rd and 30st of April 2019 and for a second class on the 9th and 16th of May 2019.

The four teachers (two per school) agreed to have an interview at the end of the workshops. In the end, "play with water" and "play with roles" were the two workshops held in the primary and the secondary school respectively. "Play with measures" could not be applied because no age groups were available to execute the workshop.

7.4.2. Results from the primary school

- *The pupils*

Overall, no clear awareness was recorded during the introductory session of both workshops in the primary school. Out of the 42 pupils, a total of 5 had experienced flooding in their home. Relevant answers came generally from those 'experienced' pupils. However only one pupil mentioned a possible link between urbanisation and floods. However, no pupil seemed aware of the future increase in flood risks due to climate change. Pupils came up with diversified measures by their own, going from moving the house to a non-floodable area to structural measures such as dikes, ponds or channels on the slope, increasing the runoff length, or a big retention pond upslope.

In the end of the game, the awareness increased significantly in one of the two classes. The number of pupils expecting their house could be exposed to floods went up from 2 to 10. Overall and in both classes, the students made the correct assumption that the school was not located in a downstream area. No clear answer was given if the school could help to diminish flood risks in the neighbourhood itself.

- *The teachers*

The teachers of the primary school who attended the workshop "play with water" were overall enthusiastic concerning the workshop itself and made suggestions to increase its quality. However, they expressed their confidence and preference for the traditional class setting to fulfil its objective. According to the teachers, the pupils' knowledge and awareness about floods and climate change would remain close to their own experience, or regular broadcasts on the news.

Therewith, floods were clearly not regarded a main subject in the teachers' curriculum. Only major regional flood events would make it part of the education program. The relation of floods with landscape features, urbanisation or climate change has also never been mentioned in their curriculum.

Yet, the importance of climate change as a primary school subject is increasingly mentioned since the year 2000. Nowadays, the causes, consequences and solutions to climate change are pronounced to become mandatory education subjects. However, following the teachers' interview, their focus seems to be put on climate change mitigation, hence a reduction of CO_2 production, and not so much on climate adaptation. Therewith there is only low to none attention to the influence of climate change on the occurrence of floods or droughts in Flanders.

7.4.3. Results from the secondary school

- *The students*

Both classes in the secondary school tended to know the problematic of climate change through the relation of CO_2-emmission and the mobility and energy consumption portfolios. They also mentioned droughts and floods as consequences but only as hazards that would occur in other continents. The knowledge was nonetheless limited, mixing different concepts such as plastic pollution, "acting ecologically responsible" or high population density without being able to explain correctly their relation to climate change.

The game intended to change this by giving the students various roles with each specific interests, from where they needed to solve the local flood problematic through communal discussion. The first main objective was to solve the flood issue, while each player had his own secondary objective to win. It is up to them to convince the mayor to implement preferred measures. After the game, the students' needed to perceive each and others actors' influence. It turned to be diverse. This diversity indicates that the students are aware at the end of the game that different actors can play a role on flood risk management. However, when asked whether it reflected reality, the majority of students responded that the game was not realistic. Some argued it was not an important issue in their habitual surroundings.

- *The teachers*

The teachers of the secondary school were overall satisfied of the workshop setting and didactic material, underlining the added value of such workshops. A teacher emphasized the importance to implement didactic methods to enhance the students' skills in listening to others' argumentation and constructing their own. The teachers also pointed out that climate change was a very contemporary subject due to the recent youth climate movements. Climate change is part of their curriculum but only focuses on the reduction of CO_2 and in relation to other forms of pollution. However, consequences of climate change, such as droughts and floods, are not addressed in their curricula. These problems are generally regarded as issues for with a strong "not in my my turf" feeling.

Finally, the teachers expressed their interest in implementing climate change adaptation in their curriculum. Being not part of the curricula of the Flemish education systems, it is only up to the schools to address issues as droughts or floods. Some opportunities were mentioned in regard to the future education reform of 2020, which will put more emphasis on combined and transdisciplinary teaching through project programs, extra-muros activities as well as co-teaching.

7.5. Discussion

Coming back to the research questions, the project has shown that the pupils from the primary school as well as the students from the secondary school gained a certain level of awareness of climate change as a general subject. The subject is broadly discussed but mainly through information that is available through mainstream media. In both schools, the knowledge is essentially related to CO_2-production

and the main focus is thus put on its reduction. While some awareness was noticeable, the pupils and students' knowledge seemed limited and subject to confusion. For instance, a wrong link was made between climate change and plastic pollution. No pupil/student has shown any awareness about the increasing risk for floods or droughts due to climate change in Flanders.

Concordantly, the curriculum of primary and secondary teachers includes the subject of climate change through the problematic of CO_2-production and focuses primarily on climate change mitigation (CO_2-reduction). The increasing flood risks in Flanders due climate change are not mentioned in the teachers' curriculum, both in the primary and secondary schools. The increasing risk of hazards are mentioned in the teachers' curriculum of the secondary school but not as problems *per se*. The interest of the teachers to implement these subjects in their curriculum was diverse however. The primary teachers did not consider it an important subject as long as the problem did not increase in the region itself. The secondary teachers were more enthusiast deeming it an important subject to be added to their curriculum.

7.5.1. Multi-Layered Water Safety

From the perspective of the MLWS approach, only measures of the three first layers were addressed (without recovery) in the secondary school. The MLWS approach was not mentioned in the primary school to limit the complexity of the program's subject.

The ex-post evaluation demonstrated that the pupils and the teachers of the secondary school assimilated unevenly the plurality of measures and of stakeholders that can play a role in FRM. The project concludes thus that a school program can increase the awareness, preparedness and the recognition of a shared responsibility but only to a certain degree. The results were positive but limited and the teachers presented some didactic suggestions that could enhance the effectiveness of the program.

7.5.2. Actor's Relational Approach

Therewith the school program mainly served as an intermediary, without developing new knowledge. It served to make the students aware of the upcoming need to flood risk adaptation. Nevertheless, the responses remained meagre from the pupils and the teachers as well. The intermediary mainly made use of a circumstantial opportunity, e.g. the school yearly program, to add a new knowledge to four classes. This first experiment therewith worked in only one direction. There is a need for more reciprocal interaction and a diverse implementation of climate adaptation through the several years of primary and secondary Flemish education system, in order to increase individual engagement also in later years.

In the current situation of the Flemish education system, a first step would be to take advantage of the education reform to be put into practice from 2020 onwards, which shall include more emphasize on transdisciplinary teaching, extra-muros activities and co-teaching. This would concur with the conclusion and the recommendations previous studies (Rouwers et al., 2016; Vanderlinde & Braak, 2010). A second -but nonetheless important- step would be to add to climate change mitigation also climate change adaptation as a subject in the attainment targets of the Flemish education system. Finally, the regular involvement of schools in diverse projects that focus on the development of new knowledge and the implementation of measures would increase the use of collaborative multi-actors' approach in the future institutional education system.

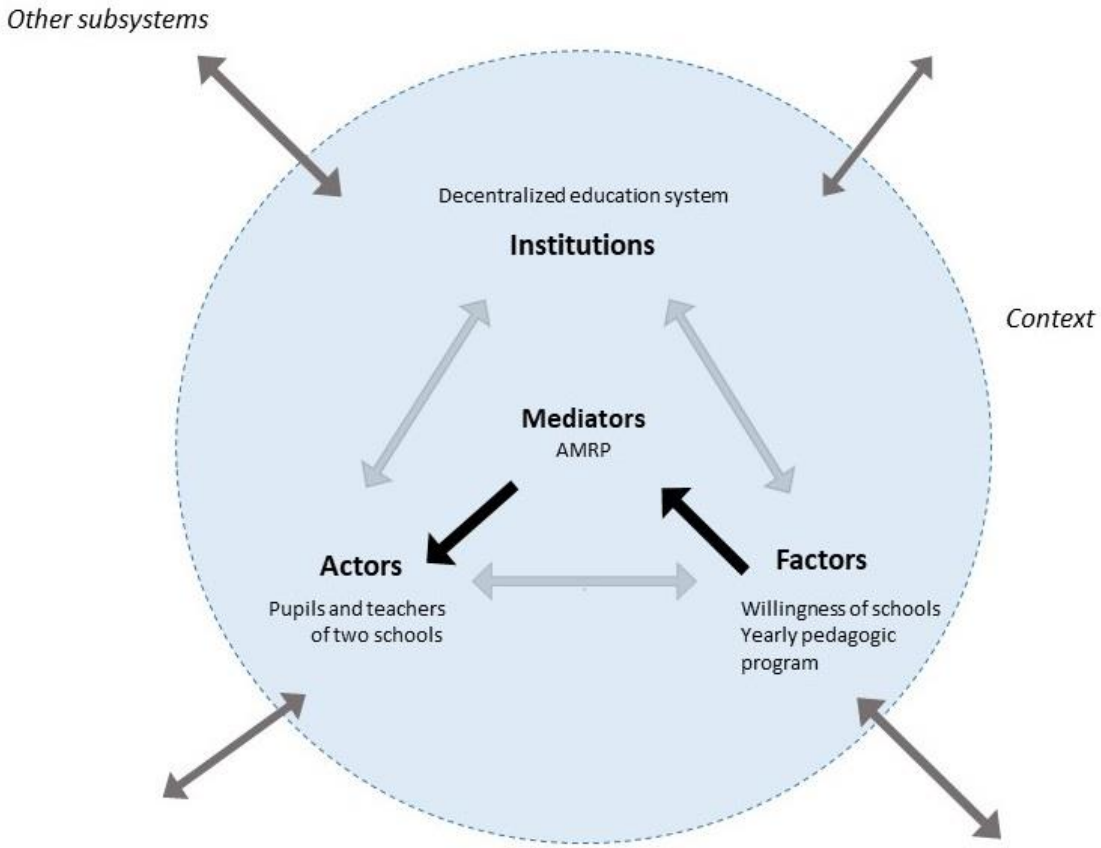

Figure 11: Evaluation of Resilient Education according to ARA.

8. Overall conclusion

The four FRAMES projects touch a great variety of flood resistance projects and they offer different insights based on the challenges encountered in their process. In this conclusion, the different findings of each individual project are compiled according to the three theoretical concepts used to analyse and evaluate them. Based on these insights, several policy recommendations are drafted and presented in the final section.

8.1. Multi-layered Water Safety

As a whole, the four Belgian FRAMES projects have touched in various degrees upon each layer of the MLWS approach. However, this solely addresses to the actors responsible for their design and coordination, the Province of East-Flanders and the AMRP. This was not the case within each project individually and the respective actors involved in these different projects.

The project resilient citizens focused on a wide range of measures from the four layers that citizens could eventually apply but were in the end too reluctant to implement them, with the paradigm of the government's responsibility prevailing. The shift from the resilient citizen to the resilient area project meant also a shift in the methodological approach. In that sense, the type of structural measures discussed with the actors during the project and, in the end, drafted by the mediators were strongly influenced and guided by the traditional *modus operandi* and approach of the actors invited around the table. This led the project to orient mainly towards preventive and protective measures, part of which are planned to be implemented. The case resilient business has a more generalized approach towards FRM measures, as it tended to focus on measures of the different layers that each actor could undertake. However, while the approach in this project was more holistic from the MLWS perspective, it is currently confirmed that they won't be implemented in the end. The last project, resilient education, addresses a very different issue. It focused mainly on raising awareness and the preparation of the future generation to the upcoming challenges. The comprehension that each actor in society can act at different stages of a flood is a concept that seemed easy to grasp for the pupils. The concept of a shared responsibility is however more difficult to apprehend.

This leads to the conclusion that most actors are inherently attached to their anteriorly defined and traditional functionalities. The MLWS approach currently presented at the scale of the Flemish regional institutions is merely a figurative display that widens the perception of the possible measures but is not used to design an overall multi-actor FRM strategy, let alone the implementation of measures. The MLWS approach is not yet set in the organisation of actors and flood risks are not captured as a main or predominant issue to tackle from an individual perspective.

8.2. Flood resilience

Similar observations and conclusions have been drawn from the viewpoint of the flood resilience concept. While there are attempts by the mediators to focus on socio-ecological resilience in the first place, the reaction of other actors is still reluctant. The idea of an overall behavioural change of every actor to increase resilience seemed understandable as a concept but not apprehensible pragmatically speaking by most citizens but also by some public and private actors. Ecological resilience is starting to get its marks depending on the actors around the table, as shown by the cases of resilient areas and business. As seen by the formally approved measures in Ninove and Geraardsbergen by the public

authorities, the implementation of these ecological measures are yet still regarded as a top-down governmental issue.

8.3. Actors' Relational Approach

Overall and from the ARA, the results of the four projects remain modest. The relation between actors, factors and institution were often only drafted in one direction. The dominant setting in all projects were the influence of the current factors, being the existing circumstances – as in the traditional condition planning – only challenging the mediators to approach different actors. Subsequently, the mediators tended to develop a multi-actor MLWS strategy and plan the implementation of the ensuing measures. However, it did not result in the adoption of a MLWS strategy from the perspective of the involved actors.

The initial formal and informal rules and *modus operandi* of the involved actors had a significant influence on the process and the outcome of the different projects. In the first case, the informal paradigm of a government's responsibility prevailed and while the concept of a shared responsibility seemed comprehensible to citizens, it was not acceptable. The case of resilient areas will more likely result in the implementation of measures. However, the processing of the measures was strongly influenced by the institutionalised conceptions and *modus operandi* of the actors around the table. This lead rather from the beginning of the project to the development of protective and preventive measures. While some of these measure are traditional (e.g. enhanced drainage systems), others have only received increasing attention in recent years (erosion control measures, retention basins) but both do not require a substantial change in the existing institutional frames. The case resilient business, on the other hand, presented a new methodology to numerous actors involved in the project. The new FRM strategy that was proposed, implied a wider range of MLWS measures and their implementation required approval and the input of each actor around the table. However, the project was not finalised towards the implementation because each actor gradually and individually returned to their previous approaches.

The case resilient education was on the other hand set in a very different context with other institutional formal and informal rules. As the Flemish education system is highly decentralized, it is up to the umbrella organisations to set their standards and procedures, leaving more or less freedom to each school to individually develop their projects. It was acknowledged that subjects such as climate change adaptation and resilient FRM were not in the curriculum of the Flemish education and as such were barely addressed in schools. While the project resilient education could take the opportunity of the schools' availabilities and well-willingness to join the project, it basically transferred new knowledge to a quite limited amount of classes. So, a change in the curriculum of the Flemish education system could ensure a scaling up and a more enduring impact.

8.4. Policy recommendations

As indicated by the ARA, the inherent formal and informal rules of the actors involved in the projects had a strong influence on the process and finalisation of each project. These formal and informal rules were in the cases of resilient citizens and resilient business too influential to finally get to the actual implementation of MLWS measures. In the case of resilient areas, it limited the possible MLWS measures to mainly traditional preventive or protective measures. Finally, the project of resilient education concluded that a institutional change in the curricula of the Flemish education system could provide a more enduring impact on the future generation's FRM. These observation indicate that a

change in the frame of formal and informal rules as well as in the role of actors who lead the implementation of FRM measures could be beneficial

We conclude therefore that a first step is to **intensify communication efforts to open up awareness and the shared responsibility paradigm** amongst the different private, civic and public actors. This raising of awareness can be enhanced through a change in the curricula of the Flemish education system to ensure future generations to be better prepared, but also through efforts oriented towards the current actors. Coinciding with the prevailing informal view of the government's responsibility, public authorities could focus on examples of concrete daily practices and decisions that actors make and the overall consequences of such decisions in the short term but also the long term. In that sense, public authorities would take up a new role as facilitators, who demonstrate the general earn-back effects of good practices, and as coordinators for the implementation of MLWS measures.

A second and more decisive step is to **define the specific responsibilities of the public, civic and private actors depending on their location in the water system**. Any actor located near or in a flood zone does not have the same responsibilities than others located in a higher topographic area. Public authorities would then have the responsibility to inform, support and instigate the actors to implement the necessary measures by using the MLWS approach. As the MLWS approach implies an integrated FRM and a multi-actor collaboration, this approach should then be integrated in the *modus operandi* of all public actors. This should ensure coherence and consistency in the overall FRM strategy of the public authorities. This coherence and the clear definition of responsibilities of each actor would instigate trust and transparency in the possible future collaborations. For instance, the building of new settlements in flood areas should be avoided or simply forbidden. In case settling seems unavoidable, it must be clear it is the responsibility of the settler to implement the needed measures. Further, public authorities should consequently have the responsibility of informing and supporting the settling actor with the possible measures that he could implement.

The definition of the actors' specific responsibilities in function of their location in the water system is not necessarily in contradiction with local aspirations or ambitions. The water element should be integrated at every level of spatial management, not as an external issue but as an integral element of the territory in question. **Taking into account the aspirations of the local actors** from the beginning of the project allows to develop measures that would conclusively be formally approved.

Last but not least, **new alliances and the involvement of new actors should be explored** in the FRM using the MLWS approach at each new opportunity. As the MLWS advocates the involvement of non-traditional actors and development of new measures, it would be irrelevant to continuously use the established collaborations and approaches.

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