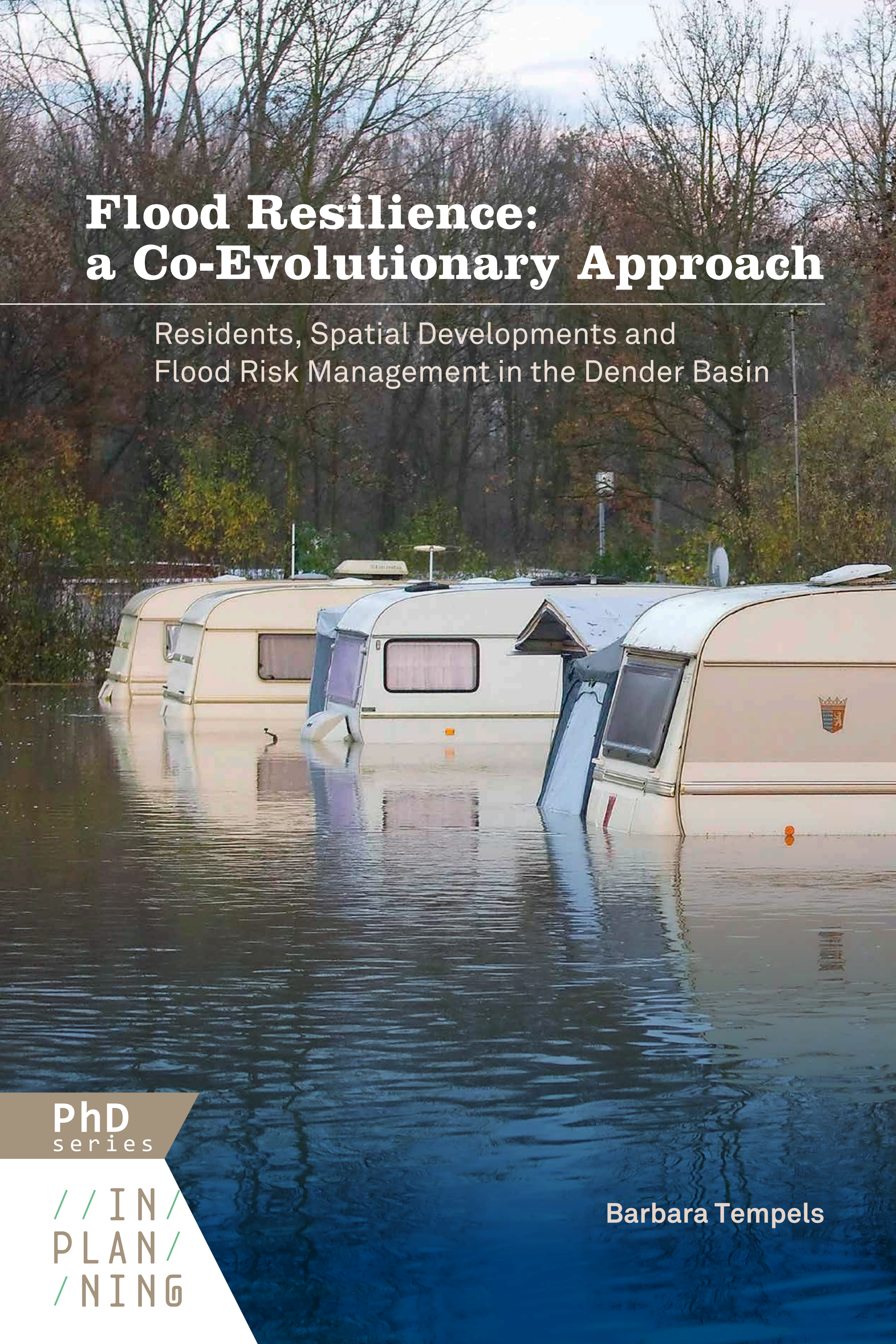

Flood Resilience: a Co-Evolutionary Approach

Residents, Spatial Developments and Flood Risk Management in the Dender Basin

PhD series

IN PLANNING

Barbara Tempels

Veerkracht tegen overstromingen: een co-evolutionaire benadering
Bewoners, ruimtelijke ontwikkelingen en overstromingsbeheer in het Denderbekken

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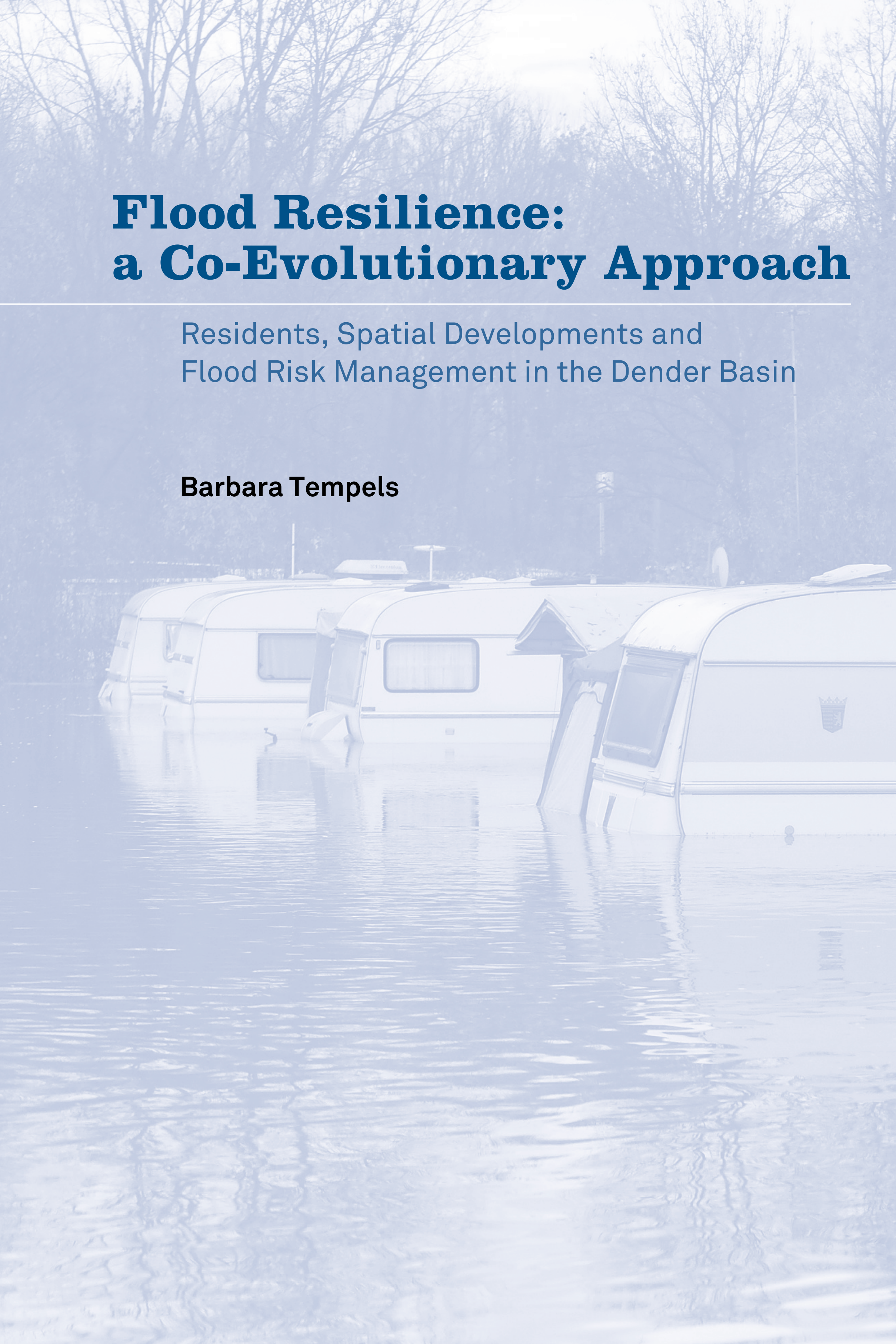
Barbara Tempels

Promotoren: prof. dr. ir. L. Boelens, prof. dr. ir.-architect K. Boussauw
Proefschrift ingediend tot het behalen van de graad van
Doctor in de stedenbouw en de ruimtelijke planning

UNIVERSITEIT
GENT

Vakgroep Civiele Techniek
Voorzitter: prof. dr. ir. P. Troch
Faculteit Ingenieurswetenschappen en Architectuur
Academiejaar 2016 - 2017

ISBN 978-90-8578-950-5
NUR 907, 945
Wettelijk depot: D/2016/10.500/82



Flood Resilience: a Co-Evolutionary Approach

Residents, Spatial Developments and Flood Risk Management in the Dender Basin

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The research reported in this dissertation was conducted at the Centre for Mobility and Spatial Planning, Department of Civil Engineering, Faculty of Engineering and Architecture of Ghent University and funded by the Policy Centre for Spatial Planning 2012-2015 of the Flemish government.

Acknowledgements

Resilience and climate change. That was the topic of my research project for the Policy Centre for Spatial Planning. Needless to say that over the years things got turned around quite a bit. When the research project was presented to me by prof. Georges Allaert, about five years ago, I had just had my first taste of planning research in the context of the Policy Centre for Spatial Planning and Housing. As a recent architecture and urbanism graduate, my fellow students (or maybe just my own critical voice) didn't fully understand why I would be interested in a field that curtails the freedom of architects and a job that would result in more paper. But I was curious, so I said goodbye to AutoCAD and delved into a whole new universe of ArcMap, Endnote, SPSS, nVivo, and alike. Markers were exchanged for recording devices, tracing paper for an endless stream of academic literature and drawings for badly layouted presentations in hideous fonts (I must admit that I have become more of an academic than I set out to, writing in equally hideous fonts and producing equally badly layouted presentations; so many thanks to InPlanning for preserving my integrity as an architect). While they were out getting things built, I tried to make sense of vague concepts in a language that I couldn't quite grasp. This first year was a great experience and pivotal for my interest in research. Under the skillful guidance of prof. Georges Allaert I learnt that planning is so much more than making rules (in an ideal world, it might even be anything *but* making rules; actually, I might be indebted to prof. Luuk Boelens' idealism for this position). Team AMRP anno 2010-2011, and in particular Ann and Thomas, thank you for introducing me to the ins and outs of spatial planning and academic research.

And then the real work started: prof. Georges Allaert presented me the opportunity to do PhD research on resilience and climate change, which I accepted without hesitation. Georges, thank you for providing me with the opportunity to develop myself as a researcher.

A few months into my PhD, prof. Kobe Boussauw became my co-supervisor. His enthusiasm and hands-on approach kick started my PhD project. Kobe's straightforwardness and sincerity was very refreshing in a PhD trajectory that sometimes felt like a blind dropping in unknown territory. I am very appreciative of his determination, which ensured that things were going forward (even if I wasn't too sure about it).

While there was a clear outline for the research project, it went out the door quite quickly once prof. Luuk Boelens entered the stage as my supervisor. His critical attitude and rebellious spirit challenged what I assumed to be obvious, keeping my thoughts straight (eventually) and my work on edge. I could always count on Luuk for an inspirational discussion to offer perspective. Luuk, Kobe, thank you for pushing me forwards when things were happening, and the patience when things weren't happening.

I have also had the privilege to meet and work with some extremely inspiring and talented people. Discussing ideas with fellow academics, policy-makers and inspirers of all sorts at conferences, workshops, seminars, informal meetings, etc.,

has been a driving force. Through conversations small and big, ideas grew. I would like to thank all discussants, track chairs, reviewers and accidental conversationalists I have encountered for the time they have taken to comment on my work and exchange thoughts. I would also like to thank my examination committee for their insight and feedback. I hope our discussions further materialize in the future. A special thanks goes to the people I have co-authored with. Thomas, Hannelore and Ann, writing with you was a true pleasure.

My work is also highly indebted to all the people that participated in this study: the residents of the Dender basin that have responded to my survey, the interviewees that have taken the effort to explain their position and the participants of the focus groups. It is my dearest wish that my work will in some way help you too.

And then there is team AMRP (whether or not Congé). For six years, this group (in various configurations) has been my base. The people at AMRP have assisted and advised me on the most diverse and sometimes trivial of challenges. They fulfilled multiple roles, ranging from walking encyclopedia and logistic support team to self-help group and friends. Their enthusiasm and compassion provided me with an environment that enabled me to flourish. I want to thank them for the moments we shared. In particular thanks to Thomas (partner-in-crime extraordinaire), Els (partner-in-creativity), Karel (partner-in-travel) and Suzanne (partner-in-optimism) – you have gained my utmost respect as fellow academics, and even more as great individuals in general.

And last but not least, I want to express my appreciation to my friends and family for all the love and support I receive on a daily basis: my mom and dad for the confidence and freedom they have given me and their assistance with everyday concerns; my sister Jorinde, my brother Sebastiaan and their families for providing me with both focus and distraction at the appropriate time; my close friends for sitting through exposés about my work over dinner or a beer; my fellow musicians at Andante Favore and the VUB Orchestra for the motivational talks; Lennart, Brecht, who never stopped supporting me; and Igor, who, while being increasingly exposed to my stress as the finalization of this book came closer, has given me nothing but understanding and acceptance – you keep me grounded.

This support and guidance has enabled my evolution from an architect graduate to a spatial planning academic, for which I am sincerely grateful. However, while this book is finished, this evolution is far from over. I am looking forward to whatever the future might bring, and feel comfortable knowing that I can count on the people around me to support me!

Ghent, November 20, 2016
Barbara Tempels

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List of acronyms

CIW	Flemish Coordination Committee on Integrated Water Policy *(Coördinatiecommissie Integraal Waterbeleid)*
DIWP	Decree Integrated Water Policy *(Decreet Integraal Waterbeleid)*
FD	European Floods Directive
FRM	Flood Risk Management
FRMP	Flood Risk Management Plan *(Overstromingsrisicobeheerplan)*
RBMP	River Basin Management Plan *(Stroomgebiedbeheerplan)*
RCMP	River Catchment Management Plan *(Bekkenbeheerplan)*
VMM	Flemish Environmental Agency *(Vlaamse Milieumaatschappij)*
W&Z	Waterways and Sea Canal *(Waterwegen en Zeekanaal)*

Summary

This dissertation starts from the observation that flood protection based on a predict-and-control approach often does not effectively reduce risk and will not suffice in the light of increasing flood risks. These risks are increasing due to changes taking place in the water system, particularly climate change and increases in impervious land, but also the presence of certain infrastructures (e.g. canalization). Spatial developments, such as the presence of buildings and infrastructures in flood-prone areas, also induce increasing risks. However, within these flood protection approaches, spatial planning does not play a substantial role in managing flood risks.

Within the shift towards resilience-oriented approaches, spatial planning is gaining attention as a potential complementary strategy to deal with flood risks. Resilience is often proposed as an alternative to flood protection that is more sensitive to the possibilities of spatial planning for the (spatial) management of flood risks. However, flood risk research traditionally focuses on mostly technical responses. Due to the historical disconnect between water management and spatial planning, insights in the spatial development and management of flood risks are lacking. Therefore, this dissertation looks into the role of spatial planning in managing flood risks. Based on complexity theories in planning, it adopts a co-evolutionary perspective focusing on the interactions between various actors.

First, this study explores what resilience means in relation to spatial developments and flood risk management (chapter 2). The research adopts the socio-ecological resilience concept, which – in contrast to the earlier engineering and ecological conceptualizations – rejects the existence of equilibria and instead assumes an evolutionary perspective based on complex adaptive systems. Resilience is then the emergent capacity of complex systems to change, adapt and eventually transform as a reaction to strains and stresses. Resilience can only be adopted in spatial planning if the theoretical assumptions on the nature of systems that the socio-ecological resilience concept builds on (i.e. complexity theories) are also adopted in the planning paradigm. This means that spatial developments are the outcome of the complex interactions between different actors, and are thus highly non-linear and uncertain – and therefore uncontrollable. In relation to flood risk management, resilience makes a valuable contribution to both the conceptualization of flood risks and the resulting flood risk management strategies. Through an evolutionary

resilience lens, flooding is not a purely physical problem. Multiple societal actors play a role in the spatial development of flood risk, both positively (mitigating flood risks) and negatively (increasing flood risks), and both consciously (using strategy) and unconsciously (as a side-effect of other pursuits). This opens up the possibility of socio-spatial interventions as a solution. Based on literature review, we develop a framework for flood resilience strategies (i.e. content, process and context) and extend this view with an actor-centered co-evolutionary approach, capturing the interactions between various actors that carry out all forms of flood risk management strategies.

Based on this theoretical framework, the outline for the empirical research is further specified. The aim is to gain insight into the role of different actors in the spatial development of flood risks and discover how their actions and interactions contribute to overall resilience. Chapter 3 identifies the main actors involved in the spatial development and management of flood risks. They are part of public, business or civil society and operate in the water or land system, or in the indirect mechanisms influencing flood risk management choices. Within a case study in Flanders that combines the regional (Flanders), basin (Dender) and local scale (Geraardsbergen), the roles of these actors were analyzed through different methodologies depending on the type of actor:

- a policy document analysis on the Flemish level (chapter 4),
- a survey amongst residents of flood-prone areas in the Dender basin (chapter 5),
- interviews with societal stakeholders in Geraardsbergen and on the Flemish level (chapter 6),
- and focus groups on the Dender basin with policy-makers and stakeholders (chapter 6).

Through this qualitative and quantitative research centered on different actors and actor groups, we acquire insights that, on the one hand, explain the current relationship between formal flood risk management and spatial developments but, on the other hand, could be used to support the development of flood resilience.

In the policy analysis of flood risk management in Flanders (chapter 4), some elements of a flood resilience strategy can be observed in the formal strategies to manage flood risks. Multilayered safety is, for example, an explicit policy objective for flood risk management. Within spatial planning, complementary spatial interventions are proposed to deal with flood risks. Also for the process, some elements of adaptability can be noted. Nevertheless, the current planning system with its fixed zoning codes cannot sufficiently respond to new or changing knowledge on flood risks and uncertainties. Furthermore, formal flood risk management does not support other actors to develop resilience, even though the concept of shared responsibilities is an important element of the recent policy discourse. The restrictive top-down approach; lack of participation, deliberation and communication with non-governmental actors; and the high degree of expert knowledge development create a closed formal flood risk management practice. Formal flood management practices in Flanders are thus moving to the development of flood resilience in a narrow sense, building flexibility and adaptability into their own activities, but not fully supporting other actors in developing adaptive capacities.

As for the residents of flood-prone areas in the Dender basin (chapter 5), the survey shows a predominantly passive attitude. A large majority of residents have low risk awareness; are poorly informed; have little or no intention to relocate; and, strikingly, often impose all responsibility for the risk they run on the authorities. Residents do not believe they can actively contribute to managing flood risks and, therefore, assume little responsibility. These findings paint a rather negative image of the role of residents in flood risk management. Nevertheless, the survey also shows some promising elements to engage residents in managing flood risks. Respondents like to live in flood-prone areas and are mostly satisfied with their current homes. Civil parties play an important role in knowledge dissemination. Furthermore, there is some confidence in the power of collective action, although social capital seems to be currently lacking to put this into practice. These elements can be interpreted as opportunities that – if appropriate support is provided – could lead to more resident involvement and active contribution in flood risk management.

For other civil society and business actors (chapter 6), we make similar observations in the interviews. Generally, these actors still consider mitigating flood risks a governmental task. Nevertheless, these actors do take some measures to manage risks individually *within their own capacities*. On the local scale, societal actors are increasingly aware of their own responsibility and there is some willingness to self-organize. The institutions on the regional scale, however, do not support the further development of the capabilities of these different civil society and business actors. The several professional associations for market actors (such as those for insurers and real estate agents) limit their role to fulfilling the strict legal obligations imposed by the government. As most of the market actors do not currently experience any difficulties in fulfilling their legal obligations, they do not see the need to change anything.

Chapter 7 brings these findings together and connects them to the theoretical framework of co-evolution and resilience. Considering the institutional context, it may not be surprising that so few non-governmental actors take up responsibilities. The old flood risk management paradigm shines through these results. For a long time, managing flood risks was the exclusive responsibility of water managers, which have mainly been governmental bodies. The findings represent a clear connection with the flood protection approach of the Sigma plan (that promised safety) and the Belgian institution of regional zoning plans (that enabled spatial developments, also in flood-prone areas). Some policy instruments already try to turn this around but, so far, few effects are visible. There are signs of a certain dormant social capital, but it is not sufficiently addressed under the current policy. Because of the rigid structures on the regional scale – especially the top-down organization in water management – there is no openness, recognition or support for the local seeds of initiative. There are also few incentives or support structures for individuals to minimize flooding. There is almost no individual responsibility to manage flood risks or the resulting financial damages, nor any type of open discussion on these subjects.

Currently, the way formal flood risk management is organized thus seems to be counterproductive for social resilience against flooding. Residents behind high dikes, for example, may feel that their safety is guaranteed in the future. Empirical research identified five co-evolutionary mechanisms that are currently counter-productive to social resilience, meaning that they do not support other actors to positively contribute to flood risk management. They are: (a) the dominance of structural and protective measures, (b) the emphasis on economic damage, (c) the high degree of government responsibility, (d) the low degree of incentives in insurance and compensation systems, and (e) the strong specialization and institutionalization of knowledge on flood risks.

The analysis shows that, within the actor field, the interactions between land and water actors, and those between governmental and societal actors are two key issues for flood resilience policies. On the one hand, the interactions between land and water actors pose questions on integration. Flooding is still seen as a 'water issue' more than a 'land issue.' Therefore, the awareness on flood risks amongst land users is low. While integrated water management has improved this situation, this remains an important focus point. On the other hand, issues of participation arise from the interactions between governmental and societal actors. Participation options are currently rather limited. The strongly technical approach and the closed communication on flood risks might give citizens the impression that the government controls the flood risks – or at least it should do so – and, therefore, nothing is expected from these citizens.

The co-evolutionary perspective not only forms an explanatory framework to understand the state of flood risk management today, but also provides a perspective for the management of flood risks in the future. So how can policy-makers turn this negative spiral around? How can they stimulate citizens to be more involved and to contribute actively and constructively to the management of flood risks? Building on the research outcomes, we suggest two simultaneous and complementary roles for spatial planners to navigate these co-evolutionary processes between water/land actors, and governmental/societal actors to make them more fruitful: adaptive condition planning and co-evolutionary interventions. Adaptive condition planning is about creating conditions that stimulate societal actors to actively contribute to preventing and managing flood risks. The co-evolutionary interventions are more action oriented, as policy-makers act as an equal partner to the existing public, civil and business actors in order to attain more resilience.

Samenvatting

Dit onderzoek vertrekt vanuit de vaststelling dat technische bescherming tegen overstromingen, gericht op het controleren van overstromingen, vaak het risico niet effectief vermindert en tevens niet zal volstaan in het licht van stijgende overstromingsrisico's. Deze risico's stijgen ten gevolge van veranderingen in het watersysteem, met name klimaatverandering en voortgaande verharding, en zelfs de aanwezigheid van sommige technische infrastructuren (zoals kanaliseringen). Maar ook ruimtelijke ontwikkelingen, zoals de aanwezigheid van gebouwen en infrastructuren in overstromingsgevoelig gebied, zorgen voor stijgende risico's. Binnen deze traditionele technische aanpak speelt ruimtelijke planning echter geen substantiële rol voor het beheren van overstromingsrisico's.

Binnen de verschuiving naar veerkrachtbenaderingen wordt ruimtelijke planning meer en meer gezien als een mogelijke complementaire strategie om om te gaan met overstromingsrisico's. Veerkracht wordt vaak voorgesteld als een alternatief voor technische bescherming die meer oog heeft voor de mogelijkheden van ruimtelijke planning voor de (ruimtelijke) ontwikkeling van overstromingsrisico's. Onderzoek rond het beheersen van overstromingsrisico's focust zich echter vaak op hoofdzakelijk technische maatregelen. Door de historische scheiding tussen waterbeheer en ruimtelijke planning ontbreken inzichten in de ruimtelijke ontwikkeling en het ruimtelijk beheer van overstromingsrisico's. Deze thesis gaat daarom in op de rol van ruimtelijke planning in het beheren van overstromingsrisico's. Op basis van complexiteitstheorieën in planning, nemen we een co-evolutionair perspectief aan dat focust op de interacties tussen verschillende actoren.

Eerst verkent deze studie wat veerkracht betekent in relatie tot ruimtelijke ontwikkelingen en overstromingsrisico's (hoofdstuk 2). Het onderzoek neemt het socio-ecologische veerkrachtconcept aan dat – in tegenstelling tot de eerdere *engineering* en ecologische conceptualisaties – het bestaan van een evenwicht verwerpt, en in plaats daarvan uitgaat van een evolutionair perspectief, gebaseerd op complexe adaptieve systemen. Veerkracht is dan de emergente capaciteit van complexe systemen om te veranderen, zich aan te passen en uiteindelijk te transformeren als reactie op schokken en spanningen. Veerkracht kan enkel overgenomen worden in ruimtelijke planning als de theoretische uitgangspunten over de aard van systemen waar het socio-ecologische veerkrachtconcept op bouwt (i.e. complexiteitstheorieën) ook aangenomen worden in het planningsparadigma. Dit betekent

dat ruimtelijke ontwikkelingen het resultaat zijn van de complexe interacties tussen verschillende actoren, en dus in hoge mate non-lineair en onzeker zijn, en daarom ook oncontroleerbaar. Wat betreft overstromingsbeheer levert veerkracht een waardevolle bijdrage aan zowel de conceptualisatie van overstromingsrisico's als de daaruit volgende overstromingsbeheerstrategieën. Door een socio-ecologische veerkrachtlens is de overstromingsproblematiek geen zuiver fysiek probleem. Verschillende maatschappelijke actoren spelen een rol in de ruimtelijke ontwikkeling van overstromingsrisico's, zowel positief (overstromingsrisico's beheren) als negatief (overstromingsrisico's verhogen), en doelbewust (strategie) als onbewust (als een neveneffect van andere activiteiten). Dit schept mogelijkheden voor socio-ruimtelijke oplossingen. Op basis van literatuuronderzoek, ontwikkelen we een kader voor strategieën om de veerkracht tegen overstromingen te verhogen (i.e. inhoud, proces en context) en we breiden dit kader uit met de co-evolutionaire benadering met een focus op actoren, die de interacties tussen verschillende actoren die overstromingsbeheersstrategieën (in al hun vormen) uitvoeren.

Op basis van dit theoretisch kader wordt het opzet voor het empirisch onderzoek verder gespecificeerd. Het doel is om inzicht te krijgen in de rol van verschillende actoren in de ruimtelijke ontwikkeling van overstromingsrisico's, en hoe deze actoren en de interacties tussen hen bijdragen aan de globale veerkracht. Hoofdstuk 3 identificeert daartoe de belangrijkste actoren uit de publieke, bedrijfs- of private sector die actief zijn in het water of land system, of in de indirecte mechanismen die overstromingsrisicobeheerskeuzes beïnvloeden, die betrokken zijn bij de ruimtelijke ontwikkeling van overstromingsrisico's. Binnen een case studie in Vlaanderen, die de regionale (Vlaanderen), bekken- (Dender) en lokale schaal (Geraardsbergen) combineert, werd de rol van deze actoren geanalyseerd aan de hand van verschillende methodologieën, afhankelijk van het type actor: een beleidsdocumentanalyse op Vlaamse niveau (hoofdstuk 4), enquêtes bij bewoners van overstromingsgevoelige gebieden in het Denderbekken (hoofdstuk 5), interviews met maatschappelijke stakeholders in Geraardsbergen en Vlaanderen (hoofdstuk 6) en focusgroepen over het Denderbekken met beleidsmakers en stakeholders (hoofdstuk 6). Via dit kwalitatief en kwantitatief onderzoek naar de verschillende actoren en actorgroepen, worden inzichten verworven die enerzijds de huidige relatie tussen formeel overstromingsbeheer en ruimtelijke ontwikkelingen verklaren, maar anderzijds ook gebruikt kunnen worden om de ontwikkeling van veerkracht tegen overstromingen te ondersteunen.

In de beleidsanalyse van overstromingsbeheer in Vlaanderen (hoofdstuk 4) zien we dat de formele strategieën om overstromingsrisico's te beheersen een aantal elementen van de veerkrachtstrategie gedefinieerd in hoofdstuk 2 bevatten. Meerlaagse waterveiligheid is bijvoorbeeld een expliciete beleidsdoelstelling voor overstromingsbeheer. Binnen ruimtelijke planning worden complementaire ruimtelijke interventies voorgesteld om om te gaan met overstromingsrisico's. Ook binnen de procesdimensie kunnen enkele elementen van aanpasbaarheid opgemerkt worden. Niettemin kan het huidige planningssysteem met zijn vaste, gezoneerde bestemmingen niet voldoende inspelen op nieuwe of veranderende kennis over overstromingsrisico's en onzekere omstandigheden. Formeel overstromingsbeheer ondersteunt echter andere actoren niet echt om veerkracht te ontwikkelen, hoewel gedeelde verantwoordelijkheid een belangrijk element is van het recente beleidsdiscours. De restrictieve, top-down benadering, het gebrek aan participatie, overleg en communicatie met niet-overheidsactoren, en de hoge graad van gespecialiseerde kennisontwikkeling creëren een gesloten formele overstromingsbeheerspraktijk. We kunnen dus besluiten dat formele overstromingsbeheerspraktijken in Vlaanderen evolueren naar de ontwikkeling van veerkracht tegen overstromingen in de enge zin, met name het inbouwen van flexibiliteit en aanpasbaarheid binnen hun eigen activiteiten, maar niet echt wat betreft het ondersteunen van andere actoren bij het ontwikkelen van adaptieve capaciteiten.

Wat betreft de bewoners van overstromingsgevoelige gebieden in het Denderbekken (hoofdstuk 5), toont de enquête een overwegend passieve houding. Een grote meerderheid van de bewoners heeft een laag risicobewustzijn, zijn slecht geïnformeerd, hebben niet de bedoeling om te verhuizen, en leggen vaak alle verantwoordelijkheid voor het risico dat ze lopen bij de overheid. Bewoners geloven niet dat ze actief kunnen bijdragen aan het beheren van overstromingsrisico's, en nemen dan ook weinig verantwoordelijkheden op. Deze bevindingen schetsen een vrij negatief beeld van de rol van bewoners in overstromingsbeheer. De enquête toont echter ook een aantal veelbelovende elementen om bewoners te betrekken in overstromingsbeheer. De respondenten wonen graag in overstromingsgevoelige gebieden en zijn over het algemeen tevreden met hun huidige woning. Burgers spelen bijvoorbeeld een belangrijke rol in kennisverspreiding rond overstromingsrisico's. Verder is er redelijk wat vertrouwen in de kracht van collectieve actie, hoewel momenteel het sociaal kapitaal lijkt te ontbreken om dit in praktijk om te zetten. Deze elementen kunnen gezien worden als mogelijkheden die, indien ze voldoende ondersteund worden, kunnen leiden tot een grotere betrokkenheid en actieve bijdrage van bewoners in overstromingsbeheer.

Voor andere maatschappelijke actoren (burgers en bedrijven) (hoofdstuk 6) zijn er gelijkaardige vaststellingen in de interviews. Over het algemeen beschouwen deze actoren het beheren van overstromingsrisico's als een overheidstaak. Niettemin nemen deze actoren ook enige maatregelen om individueel de risico's te beheersen *binnen hun eigen mogelijkheden*. Op de lokale schaal zijn maatschappelijke actoren steeds meer zich bewust van hun eigen verantwoordelijkheid en is er enige openheid voor zelforganisatie. De instituties op de regionale schaal ondersteunen de verdere ontwikkeling van de mogelijkheden van deze verschillende maatschappelijke actoren echter niet. De verscheidene beroepsassociaties voor marktactoren (bijvoorbeeld verzekeraars en vastgoedmakelaars) beperken hun tol tot het nakomen van hun strikt wettelijke verplichtingen die door de overheid opgelegd zijn. Aangezien de meeste marktactoren momenteel geen moeilijkheden ervaren bij het volbrengen van hun wettelijke verplichtingen, voelen zij de nood niet om iets te veranderen.

Hoofdstuk 7 brengt deze bevindingen samen en koppelt ze terug naar het theoretische kader van co-evolutie en veerkracht. Gezien de institutionele context is het immers misschien niet zo verwonderlijk dat er thans zo weinig maatschappelijke actoren (zelf)verantwoordelijkheid opnemen. Het oude overstromingsbeheersparadigma schijnt door deze resultaten. Overstromingsbeheer was lang de exclusieve verantwoordelijkheid van waterbeheerders, die de afgelopen eeuwen vooral door overheden wordt aangestuurd. Deze resultaten staan dus duidelijk in verband met de technische benadering van het Sigmaplan (dat veiligheid beloofd heeft) en de Belgische gewestplannen (die ruimtelijke ontwikkelingen mogelijk maken, ook in overstromingsgevoelige gebieden). Enkele recente beleidsinstrumenten proberen hier verandering in te brengen, maar tot dusver zijn er nog weinig effecten zichtbaar. Er zijn tekenen van een zeker slapend sociaal kapitaal, maar onder het huidige beleid wordt dit slapend kapitaal niet voldoende aangesproken. Door de rigide structuur op de regionale schaal, en in het bijzonder de top-down organisatie in waterbeheer, is er geen steun of erkenning voor lokale kiemen van initiatief en openheid. Daarnaast zijn er ook weinig incentives of ondersteunende structuren om zelf je risico's te minimaliseren. Er is zo goed als geen individuele verantwoordelijkheid voor het beheersen van overstromingsrisico's of de financiële schade ten gevolge van overstromingen, of een open discussie hierrond.

De wijze waarop het formeel overstromingsbeheer georganiseerd wordt lijkt momenteel dan ook eerder contraproductief voor de sociale veerkracht tegenover overstromingen. Zo kunnen bewoners achter hoge dijken het misleidende gevoel krijgen dat hun veiligheid gegarandeerd is in de toekomst. Op basis van de resultaten van het empirische onderzoek werden vijf co-evolutionaire mechanismen die momenteel contraproductief zijn voor sociale veerkracht, wat betekent dat ze andere actoren niet ondersteunen om positief bij te dragen aan overstromingsbeheer, met name (a) de dominantie van structurele en beschermende maatregelen, (b) de nadruk op economische schade, (c) de hoge graad van overheidsverantwoordelijkheid, (d) de lage graad van incentives in verzekerings- en compensatiesystemen, en (e) de sterke specialisatie en institutionalisatie van kennis over overstromingsrisico's.

Uit de analyse komt naar voren dat binnen het actorveld de interactie tussen land- en wateractoren, en tussen beleids- en maatschappelijke actoren de twee kernspeerpunten voor een veerkrachtig overstromingsbeleid zijn. Enerzijds genereren de interacties tussen het water- en het landsysteem vragen over integratie. De overstromingsproblematiek wordt nog steeds vooral gezien als een 'watervraagstuk', meer dan als een 'landvraagstuk'. Het bewustzijn rond overstromingsrisico's onder maatschappelijke actoren is dan ook laag. Hoewel het integraal waterbeleid hierin verbeteringen heeft aangebracht, blijft dit nog steeds een belangrijk aandachtspunt. Anderzijds komen participatiekwesties voort uit de interacties tussen beleids- en maatschappelijke actoren. Momenteel zijn de participatiemogelijkheden eerder beperkt. De sterke technische benadering en de gesloten communicatie rond overstromingsrisico's zorgt ervoor dat burgers de indruk krijgen dat de overheid de problematiek onder controle heeft – of toch zou moeten hebben – en dat er derhalve niets van hun verwacht wordt.

Het co-evolutionaire perspectief vormt echter niet enkel een verklarend kader om de staat van overstromingsbeheer vandaag te begrijpen, maar biedt ook een perspectief voor het beheren van overstromingsrisico's in de toekomst. Hoe kunnen beleidsmakers deze negatieve spiraal omdraaien? Hoe kunnen ze de capaciteiten bevorderen van maatschappelijke actoren om om te gaan met overstromingen en hun stimuleren om meer betrokken te zijn en actief en constructief te gaan bijdragen aan het beheren van overstromingsrisico's? Verder bouwend op de onderzoeksresultaten worden twee simultane en complementaire sporen voorgesteld waarmee het beleid kan navigeren doorheen de co-evolutionaire processen tussen land en water, en tussen overheid en maatschappij en om deze vruchtbaar te maken: adaptieve conditieplanning en co-evolutionaire interventies. Bij adaptieve conditieplanning gaat het over het creëren van condities die maatschappelijke actoren stimuleren om actief bij te dragen tot het voorkomen en beheren van overstromingsrisico’s. De co-evolutionaire interventies zijn eerder actiegericht, waarbij beleidsmakers optreden als gelijkwaardige partners van de aanwezige overheids- en maatschappelijke actoren, om samen en afhankelijk van de omstandigheden naar tijd en plaats (situationeel) meer veerkracht te bereiken.

1

Introduction

Deltas are historically attractive areas for urban developments (Boelens and Taverne, 2012; Meyer, 2014). The presence of water provides fertile soils with rich, diverse ecosystems, and allows development of economic activities. At the same time, these areas are prone to flooding due to their location in the water system. Throughout history, civilizations have had to deal with these conditions in order to enable further development and thrive.

In the current context of climate change and urbanization, flood risks are expected to increase in both intensity and frequency in the future (IPCC, 2014). This will affect urban areas in particular, because they are often located close to rivers or coastlines, thereby exposing valuable and vulnerable land uses to floods. The European Floods Directive (FD) defines a flood as "*the temporary covering by water of land not normally covered by water*" (Directive 2007/60/EC, Article 2). River floods are amongst the most prominent, urgent and devastating consequences of climate change that one can experience in Europe. Therefore, dealing with flood risks is one of the main environmental issues in spatial planning

1.1

Background

1.1.1 Changing flood risks as a challenge

Flood risk management (FRM) is facing some major challenges leading to increased flood risks. First of all, the frequency and intensity of flooding is expected to increase due to climate change (IPCC, 2014). Although most systems are able to adapt to gradual changes in average conditions, they are particularly vulnerable to changes in the occurrence and intensity of extreme events (De Groof et al., 2006). This climatological trend is exacerbated by morphological changes due to spatial developments, such as the increase in impervious land, preventing the infiltration of rainwater and causing a larger surface runoff and, therefore, an even higher probability of flooding. For example, a review on FRM in England and Wales has proven that urbanization of floodplains and the increasing economic value of buildings and their contents have significantly increased flood risks over the last 50 years (Hall et al., 2003). Ongoing urbanization in floodplains not only leads to higher losses in flood-prone areas, but also the creation of additional, new flood-prone areas.

Floods are often conceptualized as an external threat to human systems, a disturbance that needs to be minimized and, if possible, even eliminated. However, the analysis of the flooding issue indicates that reality is more complex. Human agency also contributes to the flood frequency, and, more importantly, determines the extent of the flood losses and the appropriateness of flood management actions. For example the potential losses due to flooding are increasing due to spatial developments. Urban developments in floodplains contribute to the problem in two ways. Firstly, space for the rivers diminishes and water levels increase downstream. Secondly, most settlements are not adapted to inundations, exposing people and assets to floods (Hartmann, 2011b; Petrow et al., 2006).

All these changes are associated with a great deal of uncertainty (Dessai and van der Sluijs, 2007). Although the overall effects of climate change in Western European regions are relatively well known, the actual extent and distribution of potential impacts, especially on the local scale, are unknown. In addition, climate extremes are quite unpredictable in the long term, and the societal changes described above, such as urbanization, are subject to uncertainty. Furthermore, decision-making is characterized by uncertainty as to the outcome of decision (Tompkins and Adger, 2004). So, while most of these changes are gradual and continued existing trends, the consequences are difficult to predict due to the interactions amongst the different driving forces. This range of uncertainties cannot be mitigated through modeling or further research, as they are inherent to complex systems and, therefore, inherently unpredictable.

Managing flood risks can thus be characterized as a 'wicked problem' (Rittel and Webber, 1973). Due to the inherent uncertainties and complexities of flood risks, solutions are never 'true' or 'false' and different actors will have different, possibly conflicting views, on the problem. Solutions are always the result of a particular framing of the problem, and thus imperfect; and every solution poses new problems. As such, these problems can never be solved, but rather are subject to a constant discussion.

Considering this complex nature of managing flood risks, strategies can no longer be based on conventional methods of risk assessment, development and evaluation of alternative measures, and implementation of the optimal measure. The changes in flood risks and the associated uncertainties give rise to an array of questions on how we as a society deal with flood risks, particularly in our spatial developments.

1.1.2 Dealing with flood risks: from flood protection to flood risk management and resilience

In recent decades, new approaches in dealing with floods have been discussed in literature and in practice (Folke, 2003; Hutter, 2006; Klijn et al., 2004; Liao, 2012; Pahl-Wostl et al., 2007a). Throughout time, the way floods and flood risks are framed and the understanding of how floods should be managed has changed. Flood policy is shifting from the rather robust defense mechanisms against floods towards a more flexible and adaptive FRM (Hartmann and Juepner, 2014; Klijn et al., 2015; Vinet, 2008).

In principle, floods can be approached with two different concepts: resisting the risk (robustness), or accepting the risk and adapting to it (flexibility). The first usually requires modeling and prediction, technical flood protection measures such as dikes, and strong water management institutions with technical skills. The latter depends on comprehensive and integrative concepts, encompassing many stakeholders and asking for collaboration at various levels. Adaptability does not mean simply amending the city, thus enabling the existing urban structure to remain the same. Rather, adaptive cities will be transformed by (the threat of) flood events. This transformation not only refers to enabling flexibility in the physical or spatial interventions (e.g. adaptive building techniques), but also a wider field of the broader societal structures that surround and support the spatial development of flood risk, such as the social (e.g. citizen involvement, social networks), economic (e.g. damage compensation and investments in FRM) and governance structures (e.g. responsibility and liability).

a Flood protection

Since the beginning of industrialization, flood protection has been the dominant approach in most European countries. It is based on the predict-and-control paradigm, which assumes a more or less constant trend in flooding frequency. Floods can thus be modeled and predicted, with a calculable return period and degree of safety (Pahl-Wostl, 2007). Subsequently, they may be constrained through engineered solutions (dikes, dams, etc.) (Fleming, 2002; Johnson and Priest, 2008; Patt and Juepner, 2013). In this way, a high degree of protection is provided by governmental interventions in the water system and floodplains can be made available for all kinds of land uses (Hartmann, 2011b; Loucks, 2000). Emphasis is on absorbing shocks, limiting short-time damages and performing a speedy recovery back to the same functions (Liao, 2012). The goal is to preserve existing developments by defending oneself against the water and enforcing a strong boundary between land and water (Hartmann, 2009).

The advantage of flood protection is that it enables constant conditions for settlements behind the dikes, and therefore facilitates using (protected) land efficiently without making compromises because of a flood risk. Resistance is easier to live with in everyday life. It enables easier decision-making for land-use planners and clear division of responsibilities between water management and spatial planning (Hartmann and Driessen, 2014).

Despite major investments in such flood protection measures the annually increasing damageover the past decades (Munich Re, 2010) suggests that this approach might no longer effectively reduce flood risks. Flood protection projects have allowed flood-prone areas to develop, assuming them to be flood free due to the technical interventions. However, this causes more people and capital to be exposed in case of a flood (Burby et al., 2000). So, although the probability of flooding is lowered, a potential flood will cquse increasingly unacceptable damage.

The ability to control extremes by technical means has its limitations, since any technical system can fail. Due to the inherent variability, climate extremes and discharges can always be above the design discharge and its safety level. This can cause flooding anywhere; and the course of events, in this, case is principally unpredictable (Vis et al., 2001). Furthermore, technical systems are associated with high costs borne by the whole community, such as infrastructure works and maintenance.

Also, the tolerance of flood risk is decreasing due to improvements in the control of flood risk, prompting the need for a higher degree of safety (Brilly and Polic, 2005). At the same time, awareness is also decreasing. Residents generally perceive the government to be responsible for flood protection (Wardekker et al., 2010), causing a low autonomous adaptive capacity for extreme shocks.

The increasing probability of flooding thus challenges the assumption of predictable and, therefore, constrainable floods. In the light of these increasing flood frequencies, maintaining safety levels is no longer economically or technically viable due to the inherent limits and side effects of a flood management system that is based on the outdated paradigm of controlling nature and neglects the inherent uncertainty arising from complex systems (Liao, 2012). If no other approach to FRM is chosen, this entrenches a lock-in situation in technical flood protection approaches because existing settlements can hardly be removed (Hartmann, 2011a).

In summary, flood protection, based on a predict-and-control approach, often does not effectively reduce risk and will not suffice in the light of increasing flood risks due to urbanization and climate change.

b Flood risk management

Under the influence of increasing flood risks and uncertainty, as well as increasing recognition of the fact that absolute protection against flooding cannot be achieved, many Western European governments have adopted a risk-based approach to flood management (Kellens et al., 2013; Klijn et al., 2008).

The aim of FRM is to lower the flood risks to an acceptable level in relation to moral values, costs, benefits, and societal expectations. As flood risks are calculated by multiplying the probability of flooding and the expected loss, FRM aims to lower flood damages by reducing the probability of flooding (much like flood protection), as well as reducing the impact or expected losses (Schanze, 2006). The earlier flood protection paradigm considered the socio-spatial context to be given and attempted to find solutions within the confines of the water system itself by avoiding flooding altogether. The risk-based approach puts emphasis on avoiding damage rather than avoiding flooding (Johnson and Priest, 2008).

The vulnerability of exposed elements (both people and objects) thus becomes an important element in dealing with floods. This approach implies taking into account the (potential) consequences of flooding when designing flood protection, and complementing them with measures at the level of the vulnerable objects. The European Union, for example, sets out a FRM approach in its Floods Directive that incorporates five stages: prevention, protection, preparedness, emergency response and recovery. All are aimed at both preventing and reducing flooding and the damages caused by it. Accordingly, spatial planning and land-use policy have become more prominent in integrated FRM (Löschner et al., 2014).

c Flood resilience

Recently, the concept of resilience has gained a lot of attention in regard to dealing with flood risks, not only in academia, but also in practice and policy-making (de Bruijn, 2005; Hutter et al., 2014; Liao, 2012; Restemeyer et al., 2015; Vis et al., 2003; Wardekker et al., 2010; Wiering et al., 2015). It is often discussed as a new flood management approach (Begum et al., 2007; Petrow et al., 2006; Roth & Warner, 2007). Although there are divergent interpretations that emphasize different aspects of resilience, a clear general trend can be observed in flood resilience approaches.

Extending on the FRM[1] approach, resilience does not mean the quest for fail-safe options to prevent flooding. Rather, it assumes that flood risks vary and calamities will happen. Resilience asks for adaptations of vulnerable objects in order to minimize the consequences of floods, but, at the same time, it allows some flooding to occur (Vis et al., 2003). This vulnerability encompasses not only (infra)structural aspects, but also social aspects, such as adaptive capacities, which determine communities' ability to cope with flooding. Examples for physically resilient structures include floating homes (Pierdolla, 2008) and adapted interiors for houses (e.g. not putting electrical installations in the basement), as well as escape routes for evacuations or calamity polders (Roth and Warner, 2007), and even, in some cases, abandoning certain areas (McLeman and Smit, 2006).

In addition to adjustment and physical restructuring, the socio-economic and political setting of managing flood risks also needs to be examined. Adaptive capacities are a result of several social, economic, technological, knowledge-related, institutional and cultural mechanisms (Brouwer et al., 2007). However, these mechanisms and their interactions are very complex, making increasing adaptive capacities less straightforward. It involves financial recovery capacity, insurance schemes (Berke and Campanella, 2006; Clark, 1998), liability issues, availability of information, etc.

These examples show that resilience comes with costs for adaptation and compromises for land uses. In addition, it challenges existing institutions and well-entrenched modes of governance (van den Brink, 2009).

The list of examples also reveals that centralized governmental institutions such as water management agencies can hardly manage flood risks on their own. FRM asks for the compliance and cooperation of not only many different institutions, but of public and private stakeholders as well (Loucks et al., 2008). So, not only does resilience require a fundamental rethinking of the existing paradigms working within water management agencies, but this shift of paradigms also needs to be supported and sustained by various stakeholders with sometimes competing interests: public and private actors, comprehensive and sector planning, central and decentralized structures.

1.1.3 Flood risk management in Flanders

In Flanders (the northern part of Belgium and the main case study in this dissertation), a similar evolution has taken place from flood protection to a risk-based approach, and eventually the first steps towards flood resilience.

Before the start of the formal flood protection approach, water management was self-governed by the societal stakeholders. Later, it gradually transferred to the public realm to become the (exclusive) responsibility of governments in different levels and policy domains (Crabbé, 2008). From the 9th century onwards, farmers

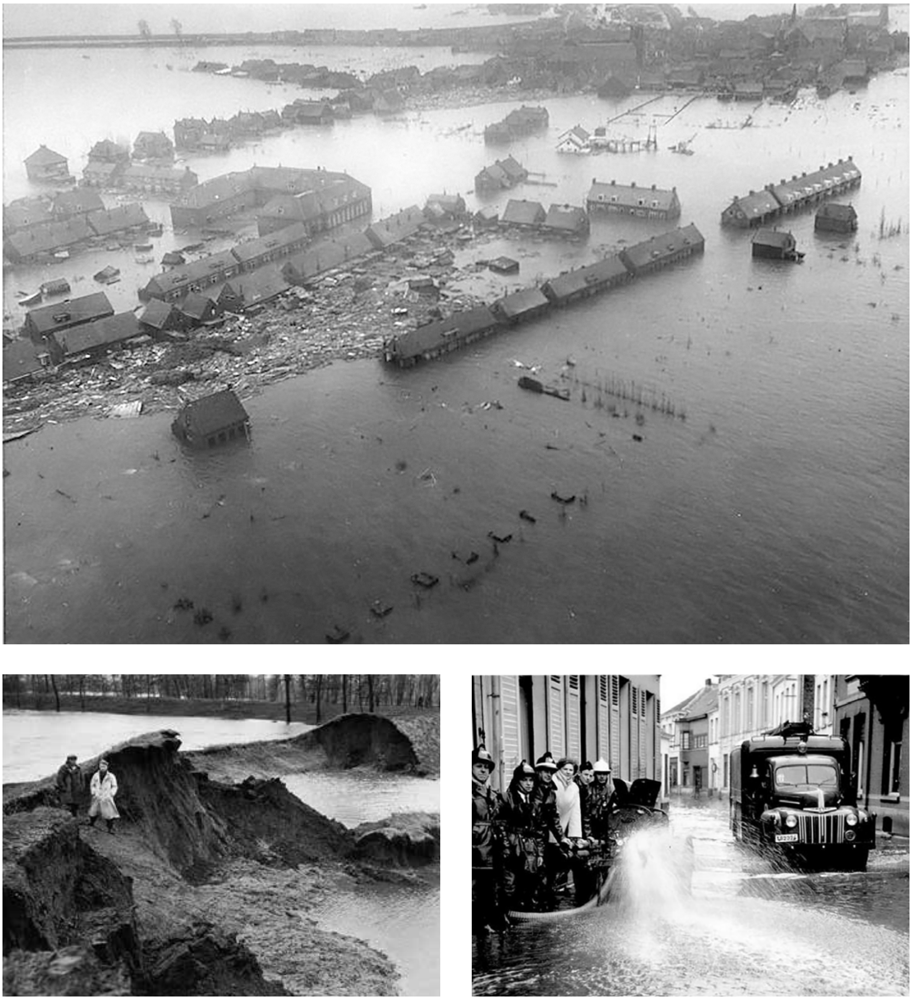
1 FRM is meant here as the risk-based paradigm to managing floods. However, it is often used as a broad term to indicate all efforts to manage flood risk. In the remainder of this dissertation, it will be used in this latter sense.

organized themselves to protect agricultural and residential lands against flooding through small dikes. Later on, the Counts of Flanders also constructed dike rings; and from the 12th century onwards, abbeys took the initiative for dike construction and embankments in order to support their agricultural activities. This was also the time when landowners and renters formed partnerships to manage the water, and economic interests (i.e. trade and transportation) also started to lay their claim on water management. In the 14th century, these partnerships gained public functions and become institutionalized as semi-public bodies.

At the beginning of the 19th century, Napoleon laid out the fundaments of uniform, governmental FRM with different levels of government, as we know it today. Around this time, water quality also became an important societal issue under the influence of industrialization, and, gradually, a divide between water quality management and water quantity management was created. The main outlines drawn by Napoleon were retained after the foundation of Belgium in 1830, but governments kept taking up more responsibilities in water management, and centralization took – a trend that continued after World War II. A gap emerged between the management of navigable waterways, which was mainly inspired by economic and transportation interests, and the management of non-navigable waterways serving agricultural needs. The divides that existed between water quality and quantity management and between navigable and non-navigable waterways originating in this period are still strong in today's institutions.

This shows a shift in the responsibilities of water management, both from self-government by society towards governments, and from local actors towards regional ones (Crabbé, 2008). Unlike the Netherlands, where water management is centralized under one coordinating agency and water boards, water management in Flanders is distributed amongst a wide range of governmental actors (Nolf, 2013). After the 1953 flooding of the Scheldt river (Figure 1), the government announced its intentions to draw up a flood protection plan. But it was not until the major flood in 1976 that the government effectively embarked on a mission to provide protection against flooding. In the 1980s, this resulted in the Sigma plan: a water engineering protection program based on a flood control approach with technical infrastructures, as exemplified by the Dutch Delta Works (Nolf, 2013). This marks the beginning of a comprehensive governmental flood protection program (Kellens et al., 2013; Nolf, 2013). The Sigma plan envisioned the construction a storm-surge barrier downstream of Antwerp, the heightening of the embankments of the Scheldt river and the construction of controlled flood areas.

Since the 1980s, however, the idea that such technical measures alone would not be sufficient or (financially) feasible has evolved. A clear need emerged to reclaim more space for rivers. A young environmental movement criticized the institutional fragmentation of water management, the lack of participation and the degradation of ecological values (Crabbé, 2008). Instead, they proposed an area-based approach at the scale of the ecological basins. This led to the emergence of the discourse on integrated water management in the early 1990s, and eventually to the institutionalization of integrated water management in 2003. The aim was to bring together different governmental administrations and services that were active in water management, as well as representatives of interest groups such as agricultural



Source: commons.wikimedia.org/wiki/File:Watersnoodramp_1953.jpg, accessed on November 5, 2016;

Source: www.drogevoeten.be/Hamme_1953.html, accessed on November 5, 2016

Figure 1 Pictures of the 1953 flooding in the Netherlands (top) and Belgium (bottom). This flood was caused by a levee break due to high tidal waves.

and ecological associations, leading to integrated water management plans. This has led to the installation of the Flemish Coordination Committee on Integrated Water Policy (CIW), which brings together the different policy domains and levels within the Flemish government administration (Van den Berghe and De Sutter, 2014; Wiering and Crabbé, 2006).

Within flood management, this new discourse led to the adoption of a risk-based approach (Kellens et al., 2013; Vanneuville et al., 2003). Since floods are expected to increase significantly in the 21st century due to economic developments and sea level rise, the Flemish government developed and implemented of a risk-based approach in the early 2000s. This risk-based approach is materialized in the actualization of the Sigma plan (2005), in which flood safety is obtained through more environment-friendly interventions such as reduced tidal areas and wetlands, in addition to the pre-existing approach with dike reinforcements and storm walls (Broekx et al., 2011).

Currently, water managers are experiencing the financial and technical limitations of providing flood protection. In response, they want to share responsibilities with citizens and other governmental and non-governmental actors. Therefore, water managers have adopted the concepts of multi-layered watersafety and shared responsibility for water management in their discourses. The first means that combinations of protection, prevention and preparedness measures are considered the most optimal. The latter implies that water managers intend to share responsibilities for managing flood risks with spatial planners, residents, etc. However, due to the historical evolution described above, these societal actors have lost their affinity with water management, making this a difficult and highly contested issue.

1.1.4 The role of spatial planning in flood risk management

Until now the role of spatial planning in water management has remained relatively limited. Within the flood control approach, managing spatial developments was not considered an important instrument to reduce flood consequences. Solutions for the problems within the water system were restricted to engineering this water system. The 2001 in-depth review on FRM by the Environment Agency in England and Wales, for example, states that flood risk has not been a primary consideriation in statutory planning processes over the last 50 years (Hall et al., 2003). In Flanders, spatial planning was only needed in the implementation of the Sigma plan to reserve sufficient space for hydrological defense mechanisms and their related infrastructures (such as dikes, weirs, drainage systems, controlled flooding areas, etc.) through land-use allocations and spatial processes. This was the most basic, technical role of spatial planning, supporting water managers in performing FRM within the water system.

Within the later FRM approach, new challenges came up to integrate flood-control areas within the urban fabric or with other interests, such as nature or recreation. To fulfill those challenges, the role of spatial planning stretched beyond mere institutional endorsement, taking up more responsibility towards integrated development. In the 2005 revision of the Sigmaplan in Flanders, spatial planning was used to provide space for (natural) retention basins, for example.
More recently, the presence of (valuable) spatial developments in flood-prone areas is questioned due to increasing damages (Burby et al., 2000; Munich Re, 2010; Woltjer and Al, 2007). Within debates on integrated water management, spatial planning aims to prevent the development of vulnerable functions in flood-prone areas by restricting building options. However, in the present situation, it proves to be extremely difficult to clear those areas, even in places that have not yet been developed. Existing zoning plans might not take (changing or increasing) flood risks into account. Although building activities are always subject to a permitting process, landowners often assume that existing zoning plans grant them development rights. Relocation of property or building rights requires intensive juridical procedures, and often financial compensation as well. That is one reason why such relocation only happens sporadically, especially when public budgets are under pressure. In the recent cost-benefit analysis for the Flood Risk Management Plans (FRMP, 2016), measures related to spatial developments in flood-prone areas (such as property level protection, expropriation and changes in land-use allocation in the zoning plans) have been included in the set of measures. However, this analysis does not

include any consideration of who should be responsible for bearing the costs and carrying out these measures. The societal debate on the distribution of (financial) responsibilities in FRM and the social feasibility of these spatial measures still needs to take place.

1.1.5 The role of flood risks in spatial planning

Considering the potential of (complementary) spatial measures to manage flood risks, the question arises: what role do flood risks play in spatial planning and how could spatial planning contribute to FRM?

The regulative framework for regional planning in Flanders consists of the regional zoning plans (*Gewestplan*), an area-wide set of land-use allocation plans that have been in practice since the 1970s. They distinguish between zones that, in principle, could be developed and zones that are intended for agriculture, nature and forest (and where construction is, in principle, not allowed). Despite some preparatory studies, water – and thus also flood risk – was not fully taken into account in the conception of these plans in the 1970s (Nolf, 2013; Van den Broeck, 2004). Little effort was done to prevent or control development in flood-prone areas, as controlling flooding through structural solutions was considered to be the main or even sole responsibility of water managers.

Within the shift towards integrated water management and a risk-based approach to managing floods, flood risks are increasingly regarded as a spatial issue (Neuvel and van den Brink, 2009). The Spatial Structure Plan for Flanders (*Ruimtelijk Structuurplan Vlaanderen*) of 1997 explicitly emphasizes the importance of the physical system, including the water system, as a spatially structuring element for different land uses. In the past, however, the lack of integration with spatial planning in the management of flood risks has led to the presence of unadapted spatial developments in flood-prone areas and a high degree of soil sealing due to urbanization, further intensifying flood risks. Furthermore, the 1970s regional zoning plans are, nevertheless, still applicable. While there were some plans drawn up in the context of revising the Sigma plan in order to allocate land for flood-control areas, the overall allocation of residential areas and other vulnerable land uses in flood-prone areas under the regional zoning plans was not (systematically) changed under the Spatial Structure Plan for Flanders. Attempts to integrate flood risks in spatial planning were thus still limited to supporting and enabling water management plans and specific projects; spatial planning was still not used as a tool to proactively manage flood risks through land-use allocation or conditions for urbanization, for example.

Over the last decade, different instruments have been developed to include flood risks in spatial planning: the so-called “water assessment” (watertoets), which has been a mandatory part of the approval procedure for new buildings or spatial plans in flood-prone areas since 2006 (according to the Flemish water assessment maps), and the selection of a number of “signal areas” (signaalgebieden) where rezoning options are examined because of imminent water issues (De Smedt, 2014). The goal is to create this proves to be particularly difficult and time consuming, considering the historical legacy described above and the lack of societal support for land-use restrictions.

Source: jimmykets.wordpress.com/2010/11/, accessed on November 5, 2016, © Jimmy Kets

Source: www.flanderstoday.eu/current-affairs/flanders-recognises-last-summers-flooding-natural-disaster

Figure 2 Pictures from the 2010 flooding in the Dender basin. Intense rainfall caused unprecedented flooding.

Despite the investments in flood protection and FRM, the 2010 flooding[2] again caused significant damage (Figure 2). These major floods intensified the discussions about the presence of buildings and infrastructure in flood-prone areas. More and more, peripheral developments, sprawl and poor urban planning are pointed out by the media (Figure 3), policy-makers (CIW, 2011) and politicians (Flemish Parliament, 2011) as important factors contributing to the extent of the flooding damages. This is quite remarkable, as before the introduction of integrated water management in the 1990s, managing flood risks was not an explicit responsibility of spatial planning. In the public debate, people are looking more and more at spatial planning, both as being partly responsible for the extent of the damages as well as a potential part of the solution.

2 Heavy rainfall on November 12-14, 2010 caused heaviest floods in Belgium, especially in the provinces of East Flanders, Walloon Brabant and Hainaut. All retention basins were completely filled and in certain places, the flood defences failed. These floods are considered the heaviest in 50 years. Four people died and the damage is estimated at 180 milion euros.

HET NIEUWSBLAD VRIJDAG 29 APRIL 2011

Kans op overstromingen stijgt, maar Vlaanderen blijft bouwen

Het risico op overstromingen is nu 20 procent groter dan 15 jaar geleden. En toch blijft Vlaanderen maar woningen bouwen, parkings aanleggen en industrie neerpoten in gebieden die bij hevige regen meteen blank staan. Ze zijn te duur om te onteigenen, luidt de verklaring.

VINCENT DOUCHY

De Watercommissie in het Vlaams Parlement presenteert volgende week een eindrapport over de oorzaken van de watersnood van november 2010. Hevige neerslag zette toen 20.000 hectare Vlaams grondgebied blank.

De conclusies zijn alarmerend. Ondanks investeringen in dijken en wachtbekkens werd het risico op overstromingen sinds 1996 een vijfde groter. 'Vlaanderen is immers in snel tempo aan het *verharden*', zegt commissievoorzitter Bart Martens (SP.A). Tussen 1976 en 2000 verdrievoudigde de bebouwde oppervlakte met huizen, wegen, industrieterreinen en parkings tot 18,3 procent. Zonder ingrijpen wordt dat in 2050 42 procent.

Waar beton en asfalt ligt, kan water niet insijpelen. 'Men plaatst dikke rioolbuizen om water snel weg te krijgen', zegt Martens. 'Maar door die rechtstreekse afvoer zitten de bekkens snel vol. Water krijgt geen ruimte meer om in landbouwgrond of beddingen in te sijpelen.'

13 overstromingsgebieden

Sinds 2003 realiseerde Vlaanderen amper 13 overstromingsgebieden, goed voor slechts 616 hectare. Oorzaak van die magere balans is meestal lokaal burgerprotest. 'De potpolder van Kruibeke-Bazel-Rupelmonde ligt sinds 1977 op tafel. Nu pas wordt hij aangelegd', zegt Martens. 'De talloze administratieve procedures moeten we dringend stroomlijnen.' Dat in Vlaanderen talloze organen bevoegd zijn voor water – Vlaamse overheid, provincies, gemeenten, talloze experteninstanties… – maakt het niet efficiënter. 'Iedereen betrokken, niemand verantwoordelijk', zegt Martens.

Ander pijnpunt is dat de Vlaming blijft bouwen in risicogebied. Vandaag ligt 11.000 hectare grond – 23.700 percelen – op terrein dat ooit bebouwbaar is verklaard maar risicovol blijkt. Een bouwverbod zou door het recht op schadevergoeding miljarden kosten. En dus blijven steden en gemeenten vergunningen toekennen. Al gelden er vandaag wel voorwaarden. Notarissen krijgen de plicht om bij verkoop van onroerend goed in de akte aan te geven dat het terrein overstromingsgevoelig is. En een watertoets gebiedt gemeenten sinds 2006 om het watersnoodrisico na te gaan. Maar die toets echt bindend maken, blijkt voor de overheden een stap te ver. De Watercommissie zal zich daarover nog buigen.

Intussen moet Vlaanderen alternatieven zoeken om het water zo efficiënt mogelijk op te vangen, zegt voorzitter Martens. 'Via aangepast bouwen, met constructies op poten of waarin het gelijkvloers een open parkeerruimte is.' En door bestaande woonwijken in overstromingsgebied te beveiligen. 'Verhoog dáár de dijken, en compenseer elders langs de waterloop met extra overstromingsruimte.'

TUSSEN 1976 EN 2000 VERDRIEVOUDIGDE DE BEBOUWDE OPPERVLAKTE MET HUIZEN, WEGEN, INDUSTRIETERREINEN EN PARKINGS TOT 18,3 PROCENT

Bart Martens (SP.A)

© pdw

BINNENLAND 13

DUIZENDEN PERCELEN IN RISICOGEBIED OVERSTROMING

Bouwverbod is onbetaalbaar

Deze woonwijk in Geraardsbergen werd afgelopen winter overspoeld.

356.699

De overstromingsgevoelige gebieden in Vlaanderen totaliseren een oppervlakte van 356.699 hectare.

71.556

Van die oppervlakte is 71.556 hectare effectief overstromingsgevoelig, de rest is mogelijk overstromingsgevoelig. De effectieve zones beslaan 5,26 procent van Vlaanderen.

23.700

Er staan op die 71.556 hectare tussen de 36.000 en 56.000 gebouwen.

Ter grootte van 11.000 hectare liggen er nog 23.700 onbebouwde percelen met 'harde' bestemming (woningbouw, bedrijven, openbaar nut).

Schadevergoeding, grondenruil of paalwoningen bouwen. Aan Vlaanderen de keuze om het overstromingsgevaar te lijf te gaan.

De toets werkt nog niet naar behoren. Het advies wordt niet altijd gevolgd, de kwaliteit ervan laat te wensen over, de betrokken partijen schuiven de verantwoor-

le betrokken overheidsdiensten en de waterloopbeheerders zitten) bestaat geen consensus om de watertoets dwingend te maken. Het ligt wel in de bedoeling

Figure 3 Societal debate following the 2010 flooding. "Probability of flooding increases, but Flanders keeps on building" (left, Het Nieuwsblad, 29 april 2011, p. 9) and "Ban on construction is too expensive" (right, De Standaard, 29 april 2011, p. 13).

The question thus arises: how can spatial planning and FRM become reconnected, taking into account the historical disconnect and the subsequent efforts to integrate these fields? To what extent is spatial planning responsible for the presence of (vulnerable) developments in flood-prone areas and the corresponding flood damages? And if responsqble, what should spatial planners have done? Can spatial planning contribute to the management of flood risks? And how? What would be an appropriate spatial planning approach to managing flood risks, considering the inherently uncertain nature of flood risks and the historical evolutions? How can flood issues be integrated in spatial developments, while at the same time creating shared responsibilities between different actors involved in the spatial development of flood risks?

Flood risks are thus gaining interest in the spatial debate in Flanders (Grietens, 2005). Within the debate on flood risks (and other climate change effects), resilience has recently been adopted as a concept. For example, spatial resilience is an important concept within the 2012 Green Paper on the Spatial Policy Plan for Flanders. It is within this context that the Flemish government commissioned research on resilience to climate (change) in spatial planning within the Policy Centre of Spatial Planning 2012-2015. This dissertation has been financed within that project.

1.2

Research outline and synopsis

1.2.1 Research scope and focus

Socio-spatial dimensions of natural hazards are becoming more and more important (Raschky, 2008). Within the shift towards resilience-oriented approaches, spatial planning is gaining attention as a potential complementary strategy to deal with flood risks, and there is growing awareness that spatial planning should play an important role in FRM (De Smedt, 2014; Jong and van den Brink, 2013; Pattison and Lane, 2012; White, 2013). Flood management is no longer reactive to changes in spatial developments, but becomes an integral part of spatial planning and the conception of spatial developments (Woltjer and Al, 2007).

Furthermore, the role of (societal) actors other than water managers is also receiving more attention in the debates around flood resilience. A great number of actors are (directly or indirectly) involved in the spatial development and management of flood risks. Taking into account the limited resources of governments, climate change and the inherent limitations of flood protection, involving residents in FRM can become an important part of the solution (Kreibich et al., 2011). More and more, residents, but also spatial planners, architects, etc. are expected to contribute to the management of flood risks in one way or another (Fleischhauer et al., 2012; Löschner et al., 2014; Penning-Rowsell and Pardoe, 2012).

However, due to the historical disconnect between water management and spatial planning, flood management research traditionally focuses mainly on the exclusive study of (mostly technical) systems (Pahl-Wostl, 2002; Pahl-Wostl et al., 2007b). As a result, flooding frequencies and technical solutions have been well studied and discussed (de Moel et al., 2009), yet there is a lack of insights in the development and management of flood risk; people who, until now, have not received much attention in (research on) the spatial management of flood risks. In the Western European context, the role of residents and societal actors in dealing with flood risks is new to the debate. It is gaining interest due to the inherent limitations of the traditionally high degree of government responsibility in the light of climate change. There is still a lack of an integrated understanding on how flood risks and societies interact and how this affects spatial planning and FRM.

Therefore, this research looks into the socio-spatial dimension of the flooding issue, or how society interacts with flood risks and how it can contribute to the spatial development and management of flood risks. It explicitely takes the perspective of land users and other societal actors who are indirectly involved in the spatial development of flood risks, against the instutional background of formal FRM*. Until now, these actors have not received much attention in (research on) the spatial management of flood risks. The institutional context is presented as the background against which these non-governmental actors act. Instead of analyzing governmental actors or policy-making processes in themselves, it looks at the societal processes and interactions they generate, trying to gain insight into their FRM processes in relation to the formal FRM context.

Following this focus, this research more specifically aims to gain insight into the role of different actors in the spatial development and management of flood risks, and how (the interactions between) these actors contribute to overall resilience. Through both qualitative and quantitative research centered on different actors and actor groups, insights are acquired that, on the one hand, explain the current relationship between spatial developments and formal FRM but, on the other hand, could also be used to support the future development of flood resilience.

* As such, it is complementary to the PhD research performed by Hannelore Mees, which focusses on governmental actors (see Mees et al., 2016a; Mees et al., 2016b; Mees et al., 2016c).

1.2.2 Objectives and research questions

The overall research question is:

How can spatial planning contribute to flood resilience?

This question is answered through six research questions, which are triggered by three research objectives:

Objective A
To review the state of the art in research and policy on flood resilience.

Objective B
To analyze flood resilience, specifically the role of different actors in FRM and how they contribute to overall resilience.

Objective C
To suggest elements and strategies for spatial planning to improve resilience to flooding.

The first two objectives have an analytical orientation. Based on the theoretical and analytical insights developed under the first two objectives, the third objective is more action-oriented and normative.

The following six research questions provide input to reach these objectives stepwise:

RQ 1 What does resilience in relation to spatial developments and FRM mean?

RQ 2 Which actors contribute to the spatial development and management of flood risks?

RQ 3 To what extent does formal FRM in Flanders enable or support the development of flood resilience?

RQ 4 What is the current and potential role of residents in the spatial development of flood risks?

RQ 5 What is the current and potential role of land users and market actors in the spatial development of flood risks?

RQ 6 How do the interactions between governmental actors, residents, land users and market actors influence to overall resilience and how can these interactions become more fruitful?

This research, on the one hand, advances both the theoretical and practical development of the resilience principle in spatial planning. It adds the co-evolutionary perspective, which is then applied to FRM. On the other hand, it contributes to the discussion on the inclusion of non-governmental actors in FRM. It does not assume the management of flood risks to be an exclusive governmental activity or responsi-

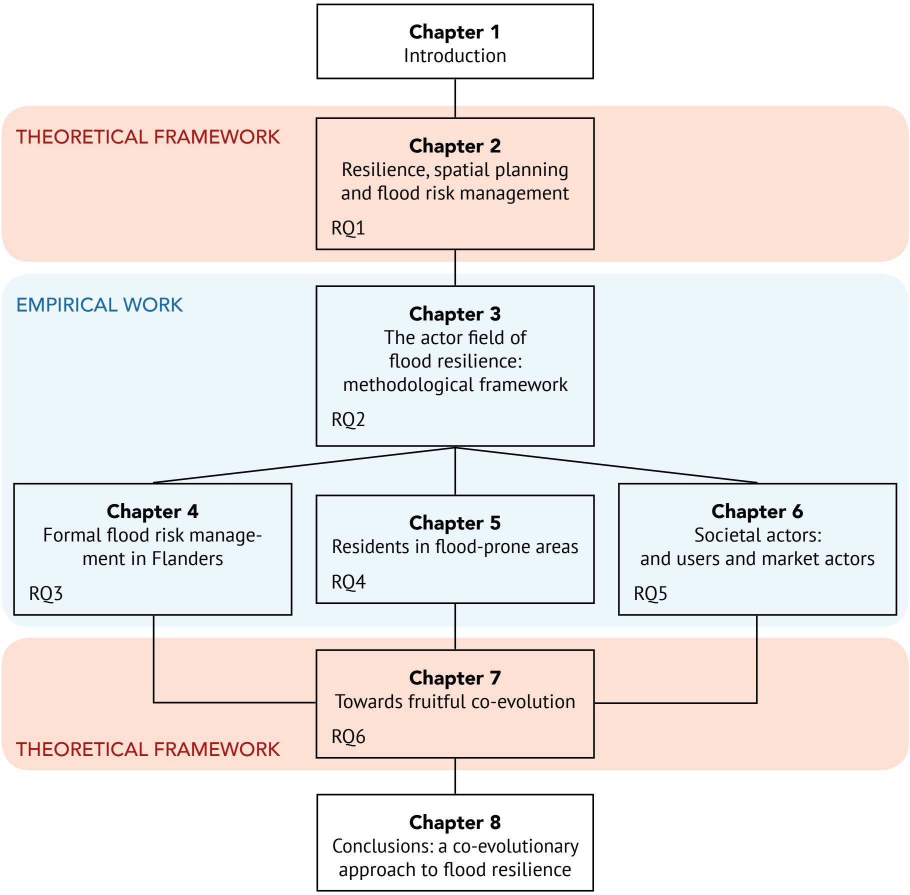


Figure 4 Structure of this dissertation

bility, and abandons the idea that governments control the management of flood risks. As such, it focuses on the interactions between formalized policy actors, and the informal actions of residents and other societal actors.

1.2.3 Outline of the dissertation

Chapter 2 explores what resilience means in relation to spatial developments and FRM (RQ 1). It presents the theoretical framework of resilience, translating it to spatial systems and FRM. Based on literature review, it develops a framework for a flood resilience strategy based on the dimensions of content, process and context. The framework is extended to include actors to take into account the recent developments in the FRM towards shared responsibility between water managers, spatial planners, citizens and other societal actors, thus stressing the importance of a multi-actor approach. This leads to the co-evolutionary perspective.

Chapter 3 detects the main actors involved in the spatial development of flood risks (RQ 2). Based on literature review and exploratory interviews with governmental actors, the main stakeholders are identified and a methodological framework is drawn up. This chapter also presents the case studies and overall methodology for the empirical research. This chapter draws the outline for chapters 4, 5 and 6, which go deeper into how different actors manage flood risks and how this contributes to overall resilience.

Chapter 4 presents a policy analysis of FRM in Flanders (RQ 3). More specifically, it looks at the extent to which policies incorporate flood resilience in the governmental strategies to deal with flood risks, as well as the extent to which these policies support other actors in developing resilience against flooding. This question is answered by mapping and analyzing the different dimensions of the flood management strategy in Flanders according to the framework developed in chapter 2 (content, process and context) through (policy) document analysis, supplemented with some interviews.

Chapter 5 explores the role and point of view of residents of flood-prone areas in the Dender basin, based on a survey (RQ 4). It addresses the topics of awareness and knowledge on flood risks, risk perception, location choice, sense of responsibility and protective behavior.

Chapter 6 discusses the role and points of view of different civil society and business actors (RQ 5). Based on interviews, it explores how they see their own and others' responsibilities, and how this will develop in the future. Subsequently, the points of view of the different actor groups, i.e. policy-makers, residents and civil and business societies, are brought together in a focus group discussing the resulting policy options.

Chapter 7 relates the empirical findings to the framework developed in chapters two and three (RQ 6). Based on the empirical findings from chapters 4 to 6, it theorizes the relationships between both governmental and non-governmental actors involved in FRM and how this affects policy-making. The co-evolutionary perspective forms an explanatory framework to understand the state of FRM today, but also a framework for the management of flood risks in the future. This chapter discusses the challenges and building blocks for policy-making that result from this co-evolutionary perspective. Finally, it addresses how we can achieve more flood resilience through FRM, taking into account these co-evolutionary interactions. It addresses the question: how can co-evolutionary processes become more fruitful, and, in particular, how can policy-makers navigate these co-evolutions in attaining (more) flood resilience?

The eighth and final chapter presents the overall conclusions from this research on a co-evolutionary approach to FRM, while reflecting on the three above-mentioned objectives of this dissertation.

2

Resilience, spatial planning and flood risk management

Parts of this chapter have been previously published as

- Tempels, B., 2013. Veerkracht en ruimtelijke planning : een conceptuele verkenning, met toepassing op overstromingsbeheer, in: Filius, F., Vanempten, E., Uittenbroek, C., Bouma, G. (Eds.), *Planning is niet waarde-n-loos: gebundelde papers en bijdragen aan de PlanDag 2013, Proceedings* (F. Filius, E. Vanempten, C. Uittenbroek, G. Bouma, eds.), Stichting Planologische Discussiedagen, Antwerpen, Belgium, pp. 229-240.
- Tempels, B., 2013. Veerkracht en ruimtelijke planning. Een conceptuele verkenning, met toepassing op overstromingsbeheer. Agora **29**(4):40-44

Within the debate on new forms of FRM, resilience has recently gained a lot of interest. A vast array of literature that theorizes the resilience concept and translates it into practice has been developed. Also in practice, it has become a guiding principle for managing floods and other hazards in different policies (e.g. Defra, UK), programs (e.g. Making Cities Resilient (UNISDR), Climate Resilient Cities (ICLEI), City Resilience Profiling Programme (UN-Habitat)), research programs (e.g. SMARTeST, StarFlood – EC 7th framework program), educational programs (e.g. Institute for Water Education – UNESCO-IHE), etc.

However, there are divergent interpretations as to what flood resilience – and other related terms – actually encompasses. There is a vast body of academic literature discussing and reviewing the definitions of resilience, its sub-concepts and its relation to other concepts. In practice, we observe different interpretations by different agencies. For example, in the UK, flood resilience on the building scale is often used as a synonym for wet-proofing (allowing water into buildings but minimizing damage through adapted design) and an antonym for resistance or dry-proofing (stopping water from entering a building). In Flanders, however, architects use the term 'water robust or resilient building' to indicate all types of adapted building techniques to minimize flood damages on the building scale, including both wet- and dry-proofing.

Therefore, this chapter addresses the research question: *what does resilience in relation to spatial developments and FRM mean?*

2.1

The resilience concept: evolution and interpretations

The resilience concept originates in studies from the 1960s and 1970s and discusses how ecological systems deal with stresses and shocks caused by external factors. Since its introduction by Holling (1973) in his influential paper on stability of ecosystems, the concept has been introduced in different research fields such as psychology, anthropology, environmental psychology, cultural studies and social geography (Folke, 2006). It gained increasing popularity in scientific research and a number of policy domains as a framework to understand dynamics in socio-ecological systems (Folke, 2006; Turner, 2010).

Under the influence of new insights and beliefs, it has also undergone a number of substantive conceptual reorientations that are founded in different worldviews and scientific traditions (Davoudi et al., 2012). An evolution can be noted from engineering to ecological and finally to socio-ecological resilience (Folke, 2006; Holling, 1996). This conceptual evolution thus reflects a paradigm shift in how scientists think about complex adaptive systems. These systems are conceived as "complex, non-linear and self-organizing, permeated by uncertainty and discontinuity" (Berkes and Folke, 1998: 12). The fundamental differences between these interpretations are of major importance as they lead to different problem definitions, focus points and approaches.

Although the relevance and potential of the concept is widely recognized, resilience is often used inconsistently and poorly explained (Fünfgeld and McEvoy, 2012), causing the concept to become vague, an umbrella for a seemingly infinite number of new ideas and desirable system attributes (Klein et al., 2003). Therefore, we will first discuss the conceptual evolution and application within academia and especially spatial planning.

2.1.1 Introduction of resilience by Holling (1973)

The paper from 1973 on the behavior of ecological systems exposed to external changes by Holling is widely accepted as the origin for the development of the resilience concept. In this paper, he discerns two kinds of behavior or system properties: stability, which is "the ability of a system to return to an equilibrium state after a temporary disturbance," and resilience, "a measure of the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables" (Holling, 1973: 17). Based on these definitions of stability and resilience, a system can have very low stability (i.e. fluctuate greatly) but be very resilient, or be very stable but have a low degree of resilience (i.e. vulnerable to, for example, climatic extremes).

He makes this distinction to refine and restrict the notion of stability, which, in his view, is inadequate to describe the behavior of certain systems because it assumes conditions very near equilibrium points. This analytical conceptualization, however, does not comply with the non-linear behavior observed in some ecological systems. It is, according to Holling, only a convenience considering the difficulties in analyzing the behavior of non-linear systems at some distance from equilibrium. To date, this challenge of the dominant stable equilibrium view is an important contribution of the resilience concept to different strands of academia (Folke, 2006). The stability view emphasizes equilibrium, little fluctuation and a predictable world. Resilience, on the other hand, emphasizes domains of attraction and persistence (as the opposite of extinction.) Extinction is, in this view, not purely a random event; it results from the interaction of random events with those forces that define the shape, size and characteristics of the domain of attraction.

2.1.2 Three conceptualizations: engineering, ecological and socio-ecological resilience

What resilience exactly is depends on the theoretical assumptions about systems and stability adopted, which are highly tributary to the view on systems assumed. Since the introduction of resilience, the concept has been elaborated further, leading to the three main conceptualizations of engineering, ecological and socio-ecological resilience. In his later work, Holling (1996) makes a distinction between engineering resilience and ecological resilience as two different aspects of stability. The shift in focus from merely ecological systems towards coupled social-ecological systems has led to the third socio-ecological conceptualization of resilience (Berkes et al., 2003; Folke, 2003). Figure 5 provides an overview of the differences between engineering, ecological and socio-ecological resilience in terms of the theoretical foundations; system state; definition of resilience; how resilience can be measured; and an example from FRM.

a Engineering resilience

Engineering resilience (Figure 5a) as defined by Holling (1996) corresponds with what he calls stability in his earlier work (Holling, 1973). In this definition, resilience is determined by the time it takes for a system to return to equilibrium after a perturbation. A resilient system is one that returns quickly to its stationary position.

Engineering resilience is based on the single-equilibrium paradigm. It assumes a pre-determined stable state, to which all systems eventually return after a disturbance (recovery). Therefore, it only applies to the behavior of linear systems, or non-linear systems in the immediate vicinity of a stable equilibrium where a linear approximation is valid (Folke, 2006). This conceptualization is particularly useful when describing simple systems that behave predictably and can be approximated with a single stable-equilibrium state, since it is embedded in a worldview based on reductionism, determinism and predictability. However, this linear approach is insufficient to describe time and spatial scales in which a system is intrinsically dynamic. Indeed, in certain cases, bouncing back might cost more than it saves, or resistance to change might have negative consequences, such as failure or (further) losses.

b Ecological resilience

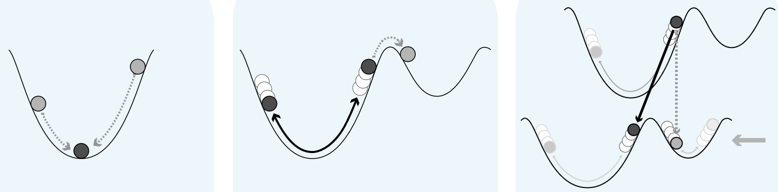
The ecological interpretation (Figure 5b) rejects the existence of one single stable-equilibrium state. Instead, it acknowledges the inherent dynamism of systems and the existence of multiple equilibrium states – and, therefore, the possibility that a system flips into an alternative stability domain after a disturbance (Holling, 1973, 1996). This alternative stability domain is characterized by other structures and processes, making a return to a previous equilibrium extremely difficult, if not impossible (Holling, 1973). Tipping points or thresholds mark the transition between stability domains. If a system passes such a tipping point, it will reorganize. In Figure 5b, a resilient system moves within the thresholds of its basin. A transition to a new basin would cause the system to change its structure and function, which is considered a loss of resilience.

Resilience can then be measured as “the magnitude of the disturbance that can be absorbed before the system changes its structure” (Holling, 1996: 33). Focus here is on staying within critical thresholds and staying within the same regime defined by the same processes, structures and feedback – and, therefore, the same identity (Walker et al., 2004).

c Socio-ecological resilience

The socio-ecological conceptualization of resilience grew from the growing interest in interlinked social and ecological (or natural) subsystems and the study of their behavior. It is based on the underlying idea that these subsystems are complex and the co-evolution between them causes additional complexity (Berkes and Folke, 1998; Gual and Norgaard, 2010).

This interpretation is represented by Figure 5c. Since the basin shape (conditions) is changing, resilience is defined not only by the state of the system (position of the ball) in relation to the thresholds, but also by the relationship between the system (ball) and its conditions (basin). Under changing conditions, the system needs to



	ENGINEERING RESILIENCE	ECOLOGICAL RESILIENCE	SOCIOECOLOGICAL RESILIENCE
system	linear	non-linear	complex
state	static equilibrium	dynamic equilibrium	(co-)evolution
definition - ability of a system after a disturbance to...	return to the original state	persistence of relationships in order to remain within critical tresholds	adapt and eventually transform
measure	time	amount of disturbance that can be absorbed	adaptive capacity
example flood risk management	dikes: artificially maintain stable configuration (control natural dynamics)	retention basins: allow dynamics within tresholds to maintain the existing configuration	multilayer watersafety: diversification of measures and involved actors

Figure 5 Schematic representation of (a) engineering, (b) ecological en (c) socio-ecological resilience. Resilience is illustrated by the position (i.e. state) of a ball (i.e. system) in a basin (i.e. conditions). Disturbances cause the ball to move.

co-evolve with these conditions in order to be resilient (black arrow). Conservation of a certain state, in fact, could lead to a loss of resilience, as the shifting basin can potentially cause the system to pass to a different basin unnoticed if assumed stability is maintained artificially (dotted gray arrow).

Although engineering and ecological resilience are fundamentally different, both assume that equilibria in systems exist, whether as a pre-existing equilibrium to which a resilient system can bounce back (engineering) or a new one to which it can bounce forward (ecological). Theories on complex adaptive systems reject the existence of a single stable equilibrium and instead assume that that systems can change through time (Scheffer, 2009 in Davoudi et al., 2012). Changes and regime shifts in complex adaptive systems are not necessarily the consequence of external disturbances, but can occur due to internal dynamics with no clear or linear cause-effect relationship (Davoudi et al., 2012). Complex adaptive systems thus develop in a non-linear and chaotic way, with characteristics such as emergence, self-organization, co-evolution, surprise and uncertainty. Resilience is then an emergent property of such a complex adaptive system. From this perspective, resilience is not a return to a 'normal' condition, but rather the capacity of complex socio-ecological systems to change, adapt and eventually transform as a reaction to strains and stresses (Carpenter et al., 2001). While earlier conceptualizations of resilience are mainly concerned with preventing irreversible change, socio-ecological resilience also encompasses the possibility of reorganization. In this interpretation, the ideas of adaptation, learning and self-organization become much more the center of focus (Carpenter et al., 2001; Folke, 2006).

Resilience encompasses being persistent or robust to disturbance while at the same time having the ability to renew, regenerate and reorganize following a disturbance. However, in practice, focus has been more on short-term damage reduction (absorbing shocks) and maintaining function (bouncing back), and less on the capacity for reorganization and development (Davoudi et al., 2012; Folke, 2006). Davoudi et al. (2012) contest this equilibristic view proposed by the engineering and ecological interpretations. To overcome this, they propose an evolutionary approach where long-term change is necessary in the face of changing conditions. They question the strong emphasis on bouncing back and short-term damage reduction, and advocate long-term adaptive capacity building instead. Resilience is then *"not conceived of as a return to normality, but rather as the ability of complex socio-ecological systems to change, adapt, and, crucially, transform in response to stresses and strains"* (Davoudi et al., 2012: 302). Resilience from this perspective is closely related to adaptation, which is *"not about returning to some prior state, because all social and natural systems evolve"* (Tompkins and Adger, 2004: 5).

Within this dissertation, we focus on this concept of socio-ecological resilience with a particular attention on evolutionary aspects. This interpretation is in line with recent theoretical developments on complexity and non-linear behavior within spatial planning, which view urban systems as complex adaptive systems (see section 2.2.2).

d Relation between the three types of resilience

The subsequent conceptualizations of resilience do not replace older ones, but can be seen as gradual extensions of the concept. In each new concept, the scope is broadened based on new knowledge of system behavior in relation to change. For example, the idea of a single equilibrium (engineering resilience) is sufficient to explain the state of a dynamic system (which is the assumption of ecological resilience) in the immediate vicinity of a stable equilibrium. Complex adaptive systems change under the influence of disturbances (evolution) and thus do not return to their 'original state' (socio-ecological resilience.) But if disturbances are small and therefore this change is not fundamentally reorganizational, the concept of returning to stable equilibrium (which is a characteristic of ecological resilience) might be an acceptable approximation. This means that engineering and ecological resilience are, in a way, part of socio-ecological resilience as an abstraction that is useful only under certain circumstances.

This is also evident in the fact that the three key characteristics of socio-ecological resilience — persistence or robustness, adaptability and transformability (Restemeyer et al., 2015) — correspond to the emphases of engineering, ecological and socio-ecological resilience, respectively. According to Folke et al. (2010), adaptability is *"the capacity to adjust responses to changing external drivers and internal processes and thereby allow for development along the current trajectory (stability domain)"* (Folke et al., 2010: 1). On the other hand, transformational change at smaller scales enables resilience at larger scales.

2.2

Resilience and the spatial system

Through related fields such as ecosystem services; natural hazards and risk mitigation; climate change adaptation; etc. resilience has been introduced in spatial planning. While resilience is mainly used in relation to environmental hazards and increasing risks, it also has found a broader application in discussions on urban planning in the context of a a complex society facing environmental, demographic, economic and social change (Eraydin and Tasan-Kok, 2013b).

On a very basic level, resilience describes the ability of a system to absorb disturbances (shocks); so it means that cities are, in one way or another, able to absorb the negative consequences of flooding. In this view, it advocates a more flexible approach as a response to the changing conditions in flood risks (e.g. climate change and socio-economic developments), while retaining some robustness.

In what follows, we go into what the implications and challenges are for the adoption of resilience in spatial planning. A number of elements of the translation of resilience and its foundations to spatial systems and planning are discussed. What does the resilience principle imply for spatial planning? This part aims to embed resilience within spatial planning theory. It will provide some insights in what the adoption of the resilience concept within spatial planning implies for planning practice, leading to a theoretical framework on resilience within spatial planning and development.

2.2.1 Challenges in translating resilience to spatial systems

While in some research fields, the adoption of the resilience principle has led to a new creative view on existing practices, it has led to confusion, ambiguity and criticism in other fields (see for example Swanstrom, 2008). Especially in social sciences, the adoption of the resilience concept has received much criticism. Since the resilience concept originates from natural sciences, it runs the risk of being translated too literally into other fields. The question can be asked to what extent a concept that originates from natural sciences can be translated to other fields, without denying the specificities of other systems, problems and domains. If resilience is translated too litteraly, it runs the risk of losing its meaning.

The difficulties in translating resilience to other fields is related to the similarities and the differences between the considered system and ecological systems, which form the original base for the theoretical framework of resilience. Social systems and their relation with space differ fundamentally from ecological systems. These differences are situated both on the level of the system itself (natural species versus society) as on the level of the shock (environmental external shocks versus external and internal change).

A fundamental difference between ecological and social systems is human agency. Since resilience originates from ecological sciences, it often disregards issues of power. While species undergo change and respond to it reactively, people often undertake conscious, proactive and purposeful action based on knowledge, predictions and assessment of potential effects. These action strategies are charged with values and norms, and are influenced by emotional and political aspects (see for example Prater and Lindell, 2000). While ecological adaptation is aimed at the persistence of genetic properties within a species, social systems aim for much more than merely survival. A broader array of issues is at stake, such as social justice; emotional aspects; individual and often conflicting interests; the desire to minimize economic damage; etc. Furthermore, strategies are strongly influenced by the prevailing political and institutional framework, as well as the actors and factors involved. In addition, one could ask how a stability domain or regime can be defined and delineated in the social context. However, not all human actions are purposeful and values are not supported by all groups of society, leading to an emergent complexity that is similar to that of ecological systems.

With regard to the disturbance, a major difference is that ecological systems only deal with environmental disturbances. In engineering resilience, these disturbances were conceptualized as being external, although later conceptualizations recognize the possibility that shocks are internal to the system. However, in spatial systems, changes are not always fully external to that system. Often, society itself is partly responsible for these changes. For example, disturbances such as floods are not fully external to the system. Changes in the system itself – such as urbanization, an increase in impervious soil and even, to a certain extent, climate change – are also responsible for these shocks. Furthermore, spatial systems do not only deal with environmental disturbance. They also deal with political, social and economic disturbances, which are very much internal to a social system.
The above shows that a simple adoption of resilience in other fields is not possible. In order to apply the resilience concept in any field, the theoretical foundations of socio-ecological resilience – being complexity theories – also need to be embraced in that field. If this is not the case, it might jeopardize the validity of the application of the resilience concept in other fields. Applications of resilience in other words should always be embedded in a wider view on compex adaptive system behavior. To further deepen the understanding of resilience in relation to spatial planning, we look at how complexity theories have found their way into the field of spatial planning.

2.2.2 Complexity theories in spatial planning

The understanding of spatial systems in planning theory has shifted over the last decades. Since the 1960s and 1970s, it is acknowledged that a worldview based on technical rationality is not sufficient for the societal challenges that planners are facing. Under conditions of uncertainty, spatial developments have proven to be not as controllable and unambiguous as expected. Traditional planning approaches providing a robust framework for spatial developments are considered to no longer be sufficient to accommodate complex interactions spatial developments that are the results of these.

Therefore, complexity theories have become very influential to the field of spatial planning. Over the last decade, several planning scholars have adopted a complexity perspective to understand diffuse planning processes that often involve a great variety of governmental and non-government actors and behave in unexpected and unpredictable ways (de Roo, 2012; Portugali et al., 2012). Structuralist theories have made place for post-structuralist and complexity theories, with aspects such as non-linearity, uncertainty, adaptation and co-evolution (see for example de Roo, 2000; de Roo, 2012; De Roo and Silva, 2010; Gerrits, 2008; Healey, 2007; Teisman et al., 2009).

Complexity refers to how systems exhibit patterns that emerge from interactions between individual components in unexpected and nonlinear ways. Cities and spatial developments are seen as complex adaptive systems, characterized by the complex relations and interactions between its parts. These interactions, flows and movements are emergent and produce unexpected, non-linear change through time. In order to deal with those complex settings, the need for additional management strategies that include civic initiatives and facilitate self-organized and adaptive approaches arises. As Bertolini (2005: 5) puts it: "*Evolutionary and complexity approaches seem especially appropriate because they both recognize the high level of interdependency between the different components of the system and the limits to dealing with such interdependency by means of prediction, because of irreducible uncertainty*." He argues that since urban systems behave in an evolutionary fashion, planners need to focus on enhancing the resilience and adaptability of the system. The planning focus is thus moving away from managing and controlling developments by direct intervention and tight central control, and instead moving towards boosting the adaptability of a region, market-led development and self-sufficiency (Boelens, 2010; Boschma, 2015).

Within this complex and relational view on spatial development, different planning approaches focus on actor networks and their adaptive capacities (Boelens, 2010; de Roo, 2012; Hillier, 2008). de Roo (2000) argues that a more open form of planning is needed for complex issues – one that does not start from logically deducted knowledge but rather from local knowledge and participation, and which is not oriented towards predefined goals but is rather geared towards process optimization. Planning thus has to focus on conditions that open up, on navigation, and on creating consistency between a redundancy of spatial initiatives, rather than controlling spatial developments (Boelens, 2010; Boelens and de Roo, 2016; Boonstra, 2015). The role of planners is then no longer to create (within a technical real) or to mediate (as in communicative planning), but to manage transitions (de Roo, 2012). Governmental actors thus become process facilitators for the development of the self-organizational capacity of regions. In this approach, the role of citizens and civic actors is becoming more important.

Since resilience focuses on the persistence of relations in an inherent dynamic and uncertain system and environment (Holling, 1973), the concept fits well within this complexity view on spatial planning. The growing interest in complexity theories enables a swift but thorough adoption of resilience in urban planning, since these complexity theories are in line with the theoretical assumptions of the resilience concept.

2.2.3 Implications for spatial planning

In this section, we look at how resilience can be applied in spatial planning. Although resilience has proven to be a strong analytical framework for empirically observed change, the question is how the concept translates to planning practice, which deals more with questions of foresight and intervention (Shaw, 2012).

Resilience is an analytical framework and therefore holds no normative connotation or judgment on the desirability of the state of the system under study; it merely describes the persistence of system. When actively pursuing resilience in systems, as is the case when it is applied in spatial planning and FRM, it assumes a normative position and the question arises, what state of a system is desirable and what state we therefore want to make more resilient. However, this question is often not explicitly addressed. This leads to a conservative attitude, because purposefully increasing resilience implies that the current condition is assumed to be the most optimal one (Davoudi et al., 2012). This is especially the case for engineering and ecological resilience. The evolutionary perspective transcends this normative question, as now the emphasis is less on one ideal state but rather on long-term adaptability and flexibility, allowing for uncertainty and surprise.

Furthermore, much of the confusion about the resilience concept arises from the lack of an explicit definition for which type of resilience is being referred to. In practice, analyses have shown that the interpretation of resilience is, at best, ecological and, at worst, engineering (Davoudi et al., 2013; Davoudi et al., 2012). This has led to a frustration amongst resilience scholars, arguing that conceptual clarity is needed and resulting in a vast production of theoretical works on the definition of resilience and its operationalization.

However, the implementation issues might run deeper than a lack of definition. Another difficulty in the adoption of the resilience principle in planning practice is that it is not consistent with the prevailing planning discourse and paradigms. As argued above, in order to implement a resilience approach in spatial planning, the theoretical foundations of the resilience principle (such as complexity and non-linearity) should also be part of the spatial planning paradigm, which is not yet the case. Linear thinking is still deeply rooted in existing practices, while complexity theories are often not a part of dominant planning practices. Non-linearity, uncertainty and complexity are actually just the opposite of what spatial planning originally pursued. This means that a thorough application of the resilience concept within spatial planning implies a paradigm shift, based on the acknowledgement of uncertainty and complexity in spatial developments (Shaw, 2012). Figure 6 clarifies these differences between resilience planning and rational and communicative planning.

This paradigm shift is based on some recent insights in spatial systems. Governments are not the only actors that shape space; civil society, citizens, businesses and other societal actors shape space, sometimes in relation to governments (Boelens, 2006; Kreukels, 1985). Furthermore, spatial developments are not always purposeful or rational, but sometimes a side effect of other societal processes (Boelens, 1990; Boelens, 2006). Spatial developments are a result of

	Rational comprehensive planning	Communicative/ collaborative planning	Resilience planning
Rationality	Instrumental rationality	Communicative rationality	Integrative rationality A framework that combines instrumental and communicative rationality
Actors	Individuals/ technicians	Individuals in interactive groups	Interdisciplinary groups with technical expertise Social groups as learning agents of change
Relations between actors/issue of power	Defining goals for all	Consensus generation	Commitment
Time perspective	Medium to long term	Short term	Long-term perspective, systems approach and immediate action
Concern	Problem solving	Collective agreement/ decision	Issues raised under the instrumental rationality act as constraints
Aim	Defining the most effective actions/to achieve goals	Consensus, mutual understanding	Defining priorities for a no-regret situation Preparedness for both slow and major disturbances
Output	Decisions: based on technical knowledge	Collective decision based on socially constructed values	Flexible solutions depending upon spatial heterogeneity, function and temporal change
Context/substance	Comprehensive decisions	Context as an outcome of process	Red tape and priorities
Value systems	Individual values	Socially constructed values	Universal values for common benefits
Bases of evaluation of outputs	Efficiency	Consensus-based values	Resilience attributes

Figure 6 The resilience planning paradigm and its major characteristics in comparison to rational and communicative planning paradigms (Eraydin and Tasan-Kok, 2013b: 30)

the interactions between many actors and actions at different scales (Boelens, 2009; Boelens, 2010; Boonstra and Boelens, 2011). Choices from the past influence future development options, since evolutions and transitions are affected by path dependencies (Martin and Simmie, 2008). These path dependencies include both physical (e.g. structures) and socio-cultural (e.g. identity, institutions) region-specific characteristics. Furthermore, developments elsewhere and global trends also affect spatial developments. When trying to control spatial evolutions and transitions, these elements can influence the outcome in an unexpected way. Therefore, spatial developments can no longer be seen as controllable processes.

The planning focus thus shifts from managing and controlling spatial developments through direct intervention and strong central coordination to a more adaptive planning approach that fosters the capacity of a region to react to change (Hartman et al., 2011). This implies a mentality change from functional distribution of spatial developments towards a differentiated, location specific, qualitative approach. As such, the central government is then rather a process mediator, supporting the development of the self-organizational capacity of regions. Spatial planners can thus take up multiple roles ranging from inspiring and informing to initiating and facilitating. It is important to seize opportunities from autonomous developments so that planning becomes the outcome of self-organizing processes (Boonstra and Boelens, 2011).

Although these ideas recently received a lot of attention, the transfer of complex adaptive systems thinking within spatial planning practice is still in an early stage because linear thinking is deeply rooted in planning practice (Wilkinson, 2012a; Wilkinson, 2012b). While resilience is in line with recent developments in planning theory, (e.g. complexity and complex adaptive systems, self-organization, adaptive planning) it seems that the lack of integration of this worldview into the prevailing paradigm is leading to an implementation gap. For example, many authors have tried to distill the attributes of urban resilience in order to measure resilience (Albers and Deppisch, 2012; Godschalk, 2003). However, no agreement on such indicators has been reached. While there is some consensus on the resilience attributes, it may be impossible to model for the emergent uncertainty and complexity in complex adaptive systems, as modeling assumes some degree of predictability and, therefore, is more in line with linear thinking.

The main paradigm shift towards resilience thus lies in the consideration of urban areas and spatial developments as complex adaptive systems (Eraydin and Tasan-Kok, 2013b). The systematic approach by considering the interaction between the components of spatial systems as proposed by resilience thinking is not new. However, the novelty lies in the understanding that change can result in different outcomes depending on these interactions. It is important to understand the interactive relations, interfaces and arrangements amongst the components of the urban system and their impacts. As Eraydin and Tasan-Kok (2013a: 238) put it: "*understanding the co-evolutionary dynamics of urban systems and defining the substance of planning accordingly are vital for resilience planning.*"

2.3

Applying resilience to flood risk management: a co-evolutionary approach

Resilience is often is often cited as an important attribute in relation to flooding (Begum et al., 2007; de Bruijn, 2005; Petrow et al., 2006; Roth and Warner, 2007). The concept is used more an more as a basis for new FRM approach that is able to deal with the uncertainty and surprise inherent in flood risks and spatial developments. Nevertheless, its applicability hinges on how it is embedded in the broader system view. Therefore, we discuss in this paragraph what a resilience approach to flooding encompasses and how it differs from other flood management approaches. This part aims to elaborate and operationalize a resilience approach by translating the theoretical aspects of the resilience approach to the context of flood management.

In this paragraph, we look at how the resilience concept can contribute to FRM. We first discuss how resilience translates to the conceptualization of flood risks. Then we explore what could be a flood resilience strategy by examining what the analytical framework of resilience implies for the different dimensions of FRM strategies as defined by Hutter (2006) (Figure 7). Based on literature, we review resilience aspects of process, content and context. This application of the resilience concept on flooding and FRM shows the potential of the concept with regard to both framing the issues as well as inspiring innovative approaches for responses.

2.3.1 Flood resilience

Referring back to the three different concepts of resilience as discussed in section 2.1.2, we now discuss how existing FRM practices relate to the different types of flood resilience in relation to urban development.

Traditional flood protection approaches that use engineering mainly strengthen engineering resilience. They focus on artificially maintaining a stable equilibrium, i.e. dry conditions in the floodplains, to enable urbanization. Controlling and resisting the natural dynamics of the water system promotes a quick return to this original stable equilibrium after a disturbance. As such, dikes, rectifying rivers, storm-surge barriers and dams can be seen as instruments to attain engineering resilience.

An ecological resilience approach to FRM would be to provide space for redundant water during floods, for example through specifically dedicated and controlled retention basins, either engineered or natural. This allows for a certain degree of fluctuation within certain thresholds. If these thresholds are surpassed, the system is no longer resilient. So, while the inherent dynamism of the water system is accommodated to a certain extent, this approach is still quite conservative: it aims to maintain the existing configuration while protecting urban development. The Space for the River program is an example of such an ecological resilience approach to FRM.

The socio-ecological conceptualization of resilience encompasses three main characteristics (robustness, adaptability and transformability) that are simultaneously present in systems. Restemeyer et al. (2015) discuss these characteristics in relation to flooding. Robustness is about withstanding a flood event, for example by building dikes, sluices and storm-surge barriers. Adaptability means adjusting the floodplains to the potential occurrence of a flood so that flood events produce less substantial damage. This might include physical adjustments such as elevating houses or property level protection. Transformability means reconsidering previous choices, for example by removing urbanization. The discourse on multilayered safety is more in line with the socio-ecological resilience approach, as it combines elements of different safety layers (prevention, spatial planning and emergency management.) However, examples of transformative elements are still hard to find in practice. For further elaboration on a socio-ecological resilience perspective on FRM strategies, see section 2.3.3.

2.3.2 Implications for the conceptualization of flood risks

Some lessons on the conceptualization of flood risks can be drawn from the socio-ecological resilience perspective. Traditionally, floods are framed as purely natural-physical disturbances in the water system. As such, they are external threats to human systems. By framing floods like this, solutions are usually confined within the boundaries of the water system and water management, and intended to minimize or even eliminate floods. However, as indicated above, socio-spatial aspects (e.g. vulnerable urban developments in flood-prone areas or settlements in potential retention areas upstream) also substantially contribute to the probability of flooding and potential flood losses. From a socio-ecological resilience stance, floods are no longer a merely biophysical problem, but emerge from the interaction between land and water. Taking this into account charges flood risks with additional complexity, but also implies that potential solutions can be found in socio-spatial interventions, e.g. by lowering vulnerabilities. So the issue of flooding rests at the intersection of the water system (water flows, engineering infrastructures, etc.) and the socio-spatial system (settlements and spatial development). Consequently, integrating socio-spatial systems in FRM can lead to a more comprehensive view on the issue.

This framing of flood risks charges FRM with a multi-actor perspective. Traditional FRM often starts from the perspective of water managers as the sole actors managing flood risks. However, this view is a one-sided perceptual convenience, as water managers are not the only actors involved in or even responsible for the (spatial) development of flood risks. FRM is often described as a purposeful activity to mitigate flood risks. All actors that are involved in the spatial development of flood risk indirectly contribute to the overall management of flood risks, may it be positive or negative. In this view, FRM is not only performed by water managers or spatial planners, but by a whole lot of government, business and civil actors that contribute to flood risks to varying degrees. These actors include emergency managers, spatial planners, land users in and outside of flood-prone areas, insurers, real estate agents, architects, contractors, etc. The different involved actors have different rationalities about flood risks (Hartmann, 2010) and, therefore, each has different strategies to deal with them. In fact, questions of 'who' are central in recent debates on FRM (Wiering et al., 2015). However, not all actions that contribute to flood risks are purposeful. In fact, contributions to flood risks might be formal or informal, direct or indirect, positive or negative, and purposeful or unconscious.

Furthermore, emphasis in practice is mostly on absorbing shocks, minimizing short-term damages and a speedy recovery to the pre-existing condition and functions, corresponding with engineering resilience, or ecological resilience at best. This leaves little space for reorganization and development. The socio-ecological resilience concept questions this attitude. Controlling nature and other conservative mechanisms limits the dynamic that is needed to allow a system to adapt to a changing context in order to be more suited. In a long-term perspective, focus is more on dynamics and renewal than (technically) embedding stability.

2.3.3 Flood resilience strategies: three dimensions

Which management strategies would lead to flood resilience?

> *"A management approach based on resilience, on the other hand, would emphasize the need to keep* ***options open****, the need to view events in a regional rather than a local context, and the need to emphasize* ***heterogeneity****. Flowing from this would be not the presumption of sufficient knowledge, but the* ***recognition of our ignorance****; not the assumption that future events are expected, but that they will be* ***unexpected****. The resilience framework can accommodate this shift of perspective, for it does not require a precise capacity to predict the future, but only a qualitative capacity to devise systems that can* ***absorb and accommodate future events in whatever unexpected form they may take****."*
> (Holling, 1973: 21, emphasis added)

FRM is focused on minimizing disturbance while reducing risks and the negative effects of potential disturbances. However, a resilience approach would include disturbance as an integral part of the planning process. *"The idea is to accept the fact that changes are going to take place, and while taking steps to reduce the risks, urban systems should be prepared to absorb these changes, reorganize themselves and develop new adaptive strategies to manage and cope with the change while improving their capacities"* (Eraydin and Tasan-Kok, 2013b: 231). Priorities then shift from controlling change to increasing the capacity of the spatial system to cope with, adapt to and shape change (Eraydin and Tasan-Kok, 2013b).

Now the question is what kind of strategies the socio-ecological resilience principle leads to for FRM. Resilience as a concept embraces three characteristics: the robustness or strength of a system when subjected to stress, achieved through diversification (heterogeneity); the adaptability or flexibility of a system in response to changing conditions and objectives (keeping options open); and the transformability to eventually reorganize. The resilience concept can be applied both to governance systems and to the many elements and features of the built environment (Holling, 1973). From this perspective, floods should be managed through diversification (e.g. technical measures *and* behavioral change, government *and* private initiative) and flexibility (e.g. taking into account potential changes in flood risks).

Based on literature review, the implications for FRM strategies are discussed based on the three dimensions of strategies:
- *content*: the objectives, measures and (policy) instruments of flood management
- *process*: the way in which content is gradually developed
- *context:* the internal and external context within which floods are managed

The content and the process thus constitute an actor's flood management strategy, in relation to the context in which it takes place. This framework has been further developed in relation to FRM by Hutter (2006) (Figure 7).

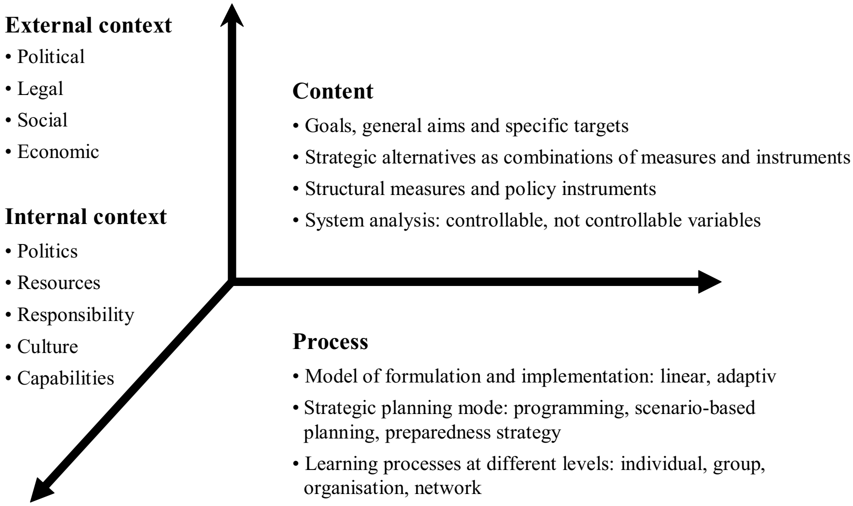


Figure 7 Dimensions of strategies for FRM (Hutter, 2006)

Within this framework, the resilience principle can be applied to each of these three dimensions, leading to the following questions: (a) what measures and instruments contribute to flood resilience, (b) which processes lead to flood resilience, and (c) what context allows flood resilience? In what follows, we discuss how the concept of resilience translates to each of these three aspects of FRM strategies.

a Content: from protection to multilayered approaches

A resilience approach encompasses a diversification of measures to deal with flood risk, providing a degree of redundancy in the face of surprise. Although current practice is often quite one-sided and strongly focused on technical protection measures, there is a large diversity of options on how to reduce the impacts of extreme weather-related events such as floods. In fact, it is not the quantity but the function and structure of elements that is important for resilience. Measures that are little considered and applied in current practice might contribute to a more diversified approach to flood risk.

However, this diversity of measures also comes at a cost. It might imply that the occurrence of floods does not diminish or might even increase, as investments in flood resilience would not only focus on preventing floods. However, complementing measures would lower overall damages – maybe not in the most efficient way (building a higher dike might be easier or cheaper) but in a more effective way (failure of one of the measures would not imply total collapse of the system).

In addition to diversity in measures and aims, these measures should also be flexible, allowing for further adjustment to unforeseeable circumstances in order to contribute to resilience. This means that physical structures should not be planned for one future, but for a large range of potential futures. This has not only technical, but also economical and organizational implications. For example a diversification in initiative and responsibility could also contribute to more flexibility in the face of change by allowing for a quicker detection of and response to change.

Strategy	Option	Examples from FRM
Choose change	Change location Change use	Delocalization, not build in flood-prone areas Flood-proof construction, floodable functions
Reduce losses	Prevent effects Modify event	Warning systems, emergency relief Dikes
Accept losses	Share loss Bear loss	Compensation, insurance

Table 1 Generic options for hazard risk reduction and measures for FRM (based on Klein et al., 2003)

Within FRM, a common classification of measures is structural measures, non-structural measures and instruments. Structural measures are permanent engineering works intended to reduce the frequency of flooding, such as flood storage reservoirs, flood walls, embankments, tidal barriers, etc. Non-structural measures are physical interventions that are not permanent or do not necessarily involve traditional engineering works, such as catchment management to enhance water retention, erosion control by reforestation, river rehabilitation, temporary defenses, flood-resistant construction techniques and flood-proofing. Lastly, instruments are non-structural interventions aimed at changing the social, financial and institutional context of flood risk systems, such as regulation, financial instruments and communication. From the hazard risk reduction field, three generic strategies to reduce risks are defined: choose change, reduce losses or accept losses (Table 1). Within integrated water management, the principle of multilayered water safety also advocates a diversification of measures. The FD embraces this principle, by setting out a FRM approach that incorporates 5 stages: prevention, protection, preparedness, emergency response and recovery. In practice, however, there seems to be a bias towards risk reduction and sharing losses (Bouwer et al., 2007); choosing change, on the other hand, has not extensively been applied as a measure.

However, a wider range of diversified measures is possible, as shown by the framework on adaptive responses by Smithers and Smit (1997). They distinguish seven dimensions of adaptive responses to climate extremes: intent, role of government, scale, timing, duration, form and effect (Table 2). A resilience approach would encompass compelementary measures in all these different dimensions. Currently focus is mainly on technical buffering measures; but as stated before, this is no longer viable. Strategic and autonomous responses, on both the individual and the community scale, are lacking. Also behavioral responses, i.e. the modification of practices of individuals, groups or institutions, have not been properly considered. For example, relocation is believed to increase the physical, social, environmental and economic resilience of flood-threatened communities while allowing them to maintain their essential economic function, social ties and community identity with only modest federal investment (Cummings et al., 2012; Godschalk et al., 2009). Nevertheless, this measure is rarely considered and only seen as a last resort. As a last element, current flood management mainly enhances stability by buffering – both physically as financially – and often does not facilitate societal change.

Intent	– Incidental – Result of purposeful decisions
Role of government	– Autonomous /private (voluntary) – Government/public agency (regulatory) • Direct (implement actions) • Indirect (supporting functions)
Scale	– Spatial (local, regional or national) – Social (actor) (individual or societal/community scale)
Timing (relative to time of climatic disturbance)	– Planning (proactive or reactive) – Operation (before, during or after)
Duration	– Tactic (short term) – Strategic (long term)
Form	– Technological, engineered – Behavioral
Effect	– Buffer from perturbation (enhance stability) – Facilitate change to meet altered conditions (enhancing resilience or flexibility)

Table 2 Dimensions of adaptive responses to climatic variability (based on Smithers and Smit, 1997)

This framework shows gaps in our current FRM practice from a diversity and flexibility point of view. However, the fact that some dimensions of adaptive responses to flood risk are being overlooked might be not so much related to a lack of knowledge, since a call for such alternative measures exists in scientific literature (Cummings et al., 2012; Grothmann and Patt, 2005; Montz and Gruntfest, 1986), but rather with a prolonged discrepancy between recommendations and practice, and the difficulties of applying such measures within the existing processes and context (Hutter, 2006). The resilience approach as such does not suggest entirely new content elements for FRM strategies. Nevertheless, by emphasizing the importance of complementary measures that reinforce robustness, adaptability and transformation all at the same time, it does promote transformational change more that for example integrated water management.

b Process: from linear to adaptive management

The adaptive character of flood management strategies not only depends on the diversity and flexibility of measures and aims, but also on the ways in which they are conceived and embedded in communities' practices (Hutter, 2006), i.e. the processes (internal dynamic) in relation to their specific context (external challenges). Measures with essentially the same aim (e.g. flood prevention) can imply different degrees of adaptation to flooding, depending on the process, e.g. community support, contribution to a learning process, embedding in a cycle of constant reassessment and evaluation, etc. Resilience is not merely considered to be an outcome, but also a process (Djalante and Thomalla, 2010). As both the external challenges and the internal dynamics are constantly changing, the measures and the management process must be diverse, flexible and adaptive (Pahl-Wostl et al., 2007a; Tompkins and Adger, 2004). Resilience implies responsive governance systems – decision-making processes that can quickly identify and respond to new priorities or new threats. The process of constantly incorporating change leads to resilience (Holling, 1986 in Liao, 2012), while the loss of resilience is a consequence of imposing stability through generic evaluations and solutions on a part of a system that is dynamic in nature (Holling, 1996).

	Prediction and control regime	**Integrated, adaptive regime**
Management paradigm	Prediction and control based on a mechanistic system's approach	Learning and self-organization based on a complex systems approach
Governance	Centralized, hierarchical, narrow stakeholder participation	Polycentric, horizontal, broad stakeholder participation
Sectoral integration	Sectors separately analyzed resulting in policy conflicts and emergent chronic problems	Cross-sectoral analysis identifies emergent problems and integrates policy implementation
Scale of analysis and operation	Transboundary problems emerge when river sub-basins are the exclusive scale of analysis and management	Transboundary issues addressed by multiple scales of analysis and management
Information management	Understanding fragmented by gaps and lack of integration of information sources that are proprietary	Comprehensive understanding achieved by open, shared information sources that fill gaps and facilitate integration
Infrastructure	Massive, centralized infrastructure, single sources of design, power delivery	Appropriate scale, decentralized, diverse sources of design, power delivery
Finances and risk	Financial resources concentrated in structural protection (sunk costs)	Financial resources diversified using a broad set of private and public financial instruments
Environmental factors	Quantifiable variables such as BOD or nitrate concentrations that can be measured easily	Qualitative and quantitative indicators of whole ecosystem states and ecosystem services

Table 3 Comparison between the 'predict and control'-regime and the integrated adaptive regime in water management (Pahl-Wostl, 2007)

Adaptive management is defined as a learning-by-doing process in which specific objectives are open and are adjusted after each flood (Pahl-Wostl et al., 2007a; Tompkins and Adger, 2004) (Table 3). It is an iterative process based on feedback and knowledge building, where management strategies are continually being evaluated and improved by learning from experiences (Lessard, 1998) and aimed at increasing the adaptive capacity of the system. Therefore, focus is more on the process (development, evolution, etc.), than on the product. It tries to deal with unpredictable interactions between people and ecosystems while they co-evolve (Berkes and Folke, 1998).

It is based on social and institutional learning – the idea that organizations and institutions, just like individuals, can learn from policy choices through feedback from the environment. Knowledge is not built only in a select group of water managers, but rather within a broader community; and different types of knowledge is combined so the community can adapt to changes in the physical water system through autonomous development (Pahl-Wostl et al., 2007b). The process is co-evolutionary in the sense that feedback takes place in two directions between the management policy and the broader community on the one hand and the condition of the resource on the other (Berkes et al., 2001).

c Context: community resilience

Within flood management, the context is often seen as being external and unalterable, as it "*enables and restricts human agency*" (Hutter, 2006: 241). Therefore, this aspect has not really been the subject of research. Nevertheless, the context has a large influence on FRM, because it sets the conditions for the FRM regime (content and process).

A useful perspective for applying the resilience principle to the context of flood management is community resilience. Norris et al. (2008: 130) define community resilience as "*a process linking a set of adaptive capacities to a positive trajectory of functioning and adaptation after a disturbance.*" This set of networked adaptive capacities comprises both the resources themselves, as their dynamic properties (robustness, redundancy and rapidity).

Resilience calls for building adaptive capacities (i.e. learning capacities of institutions and networks, responsible power structures, etc.). Increasing the political, economic and social adaptive capacities enables a society to adapt to changing conditions and thus increase resilience to flooding on the long term. Economic resources (such as economic growth, stability and equitable distribution of income and wealth, as well as access to housing, health care, schools and employment) are seen as the essential base for a resilient community (Adger, 2000; Godschalk, 2003). In line with what is mentioned under "process," the ability of not only formal institutions, but the entire community to gather knowledge by learning from experiences is an important factor. In addition, responsive power structures are needed that consider the interests of all stakeholders (Berkes and Ross, 2013). Collective action and decision-making are central themes. Governments can offer an integrated framework for institutions at different levels to encourage multi-stakeholder participation and commitment, and even to support self-organization (Djalante and Thomalla, 2010). A last aspect is social capital. Individuals invest in, access or use resources that are embedded in social networks. Therefore, social capital can be defined as the total effective or potential resources that are linked to possessing a durable network of relations.

2.3.4 Extending flood risk management: the co-evolutionary approach

The framework above on strategies to achieve flood resilience provides a comprehensive overview on the elements of a flood resilience strategy. These elements are not entirely new, as they are in line with recent developments in FRM and integrated water management discourses.

However, one important aspect – which was also discussed in section 2.3.2 on the implications of resilience for the conceptualization of flood risks – has remained underexposed until now: the role of actors. Who are involved in the spatial development of flood risks? Who are performing these flood resilience strategies? And how do the different strategies of different actors relate to each other?

a A multi-actor perspective

From an individual perspective, it is true that the context (as discussed in section 2.3.3) is unalterable, and unilaterally determines the boundaries and constraints for one's FRM options. However, if we look at a more systemic view and consider all the FRM strategies simultaneously taking place by all different actors (water managers, land owners, spatial planners, etc.), these contexts are highly dynamic and interact with each other. Confining FRM (strategies) as an activity of only water managers, or even policy-makers, is too deterministic and ignores interactions between flood risk managers and other actors that contribute to the spatial development of flood risks.

The flood resilience framework developed above is thus extended with a fourth dimension: actors (Figure 8). Each of these actors has an individual strategy (content and process in relation to its context) to deal with flood risks. The result of these individual strategies forms part of the context for other actors. The context

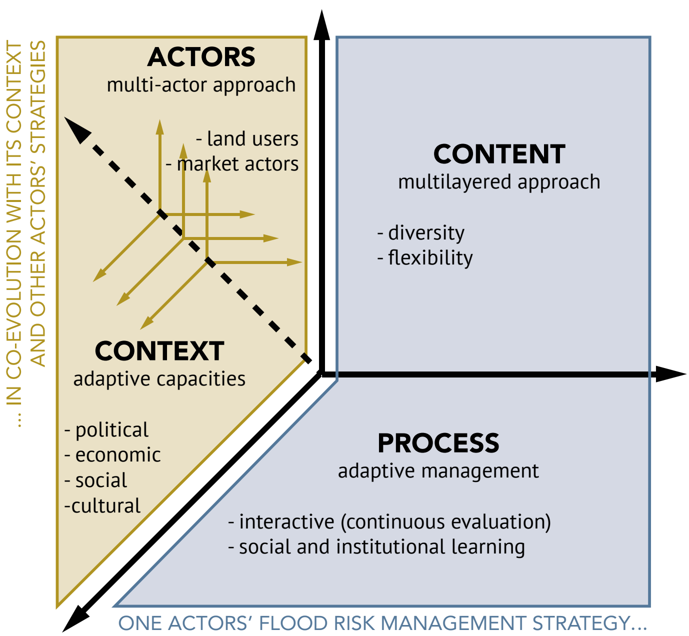


Figure 8 Operational framework for flood resilience

thus includes the actions of other actors and factors, adding an actor-centered perspective to FRM strategies. This means that actions by one actor can change the environment for other actors, destabilizing and putting adaptive pressure on their FRM strategy. From one actor's perspective, the environment thus constantly changes under influence of what other actors do.

However, most actors other than water managers (e.g. residents, land users, market actors, etc.) are not formally concerned with FRM. Their strategies are unintentional, implicit or a side effect of other objectives and their actions can even counteract formal FRM objectives. Therefore, the immediate challenge for flood resilience is not restricted to innovative measures or processes that lead to resilience. It extends to achieving more fruitful interactions between water managers and other actors so that multiple actors constructively manage flood risks. In such a multi-actor approach, responsibilities are shared between governmental and non-governmental actors. The question, however, is how spatial planners and land users can responsibilized so that they positively contribute to managing flood risks, even if they do not feel the need to do so for themselves.

Considering that flood risks and management are produced by a myriad of actors, which are interrelated with each other through policies, business and social ties, the question is how these different strategies relate to each other and contribute to overall resilience. Building on the socio-ecological view on resilience and complexity theory, and in relation to the implications for the conceptualization of flood risks discussed above, we here introduce the co-evolutionary perspective as a conceptual framework to analyze interactions in FRM and how they contribute to resilience. We argue that a co-evolutionary perspective can help to conceptualize relations between these different actors in the development of resilience, and thus enrich views on the spatial development of flood risks. To gain more insights into the reciprocity of the different actors' FRM approaches and how they might influence each other, we further explore the concept of co-evolution, which was already briefly mentioned as one of the characteristics related to complexity theories.

b The concept of co-evolution

The concept of co-evolution originates in ecology – like resilience. It is rooted in Darwinism and closely related to evolutionary theory with its components of inheritance, variation in space and time, natural selection and survival of the fittest. However, the concept of co-evolution adds the idea that evolution does not take place in a vacuum, but rather in reciprocal selective interaction with its biotic circumstances, including other organisms or systems. Murmann (2003, in Kallis, 2007: 4) states that "*a co-evolutionary explanation [...] entails two or more evolving systems whose interaction affects their evolution*."

Co-evolution is more than the mutual influence between both systems (Gerrits, 2011). Not every type of interaction is co-evolutionary; co-evolution is a particular type of interdepency. Co-evolution only occurs when two evolutionary processes are interlinked. As (Holling, 1996: 31) puts it, "*both the biota and the physical environment interact such that not only does the environment shape the biota but the biota transforms the environment".* Co-evolution expresses the idea that evolutionary adaptation in system A changes the conditions for all other systems to which system A is (part of) the environment (Stalder, 1997). In a co-evolutionary process, different subsystems are shaping each other, but not determining each other (Kemp et al., 2007). Co-evolution has multiple mechanisms that can be named and used to understand how connected systems evolve, and this explains the occurrence of unforeseen and unintended effects from decisions.

		System A		
		–	**0**	**+**
System B	**–**	Competition	Amensalism	Predation / parasitism
	0	Amensalism	Neutralism	Commensalism
	+	Predation / parasitism	Commensalism	Mutualism

Table 4 Six different types of co-evolutionary relations in biological interactions (adapted after Haskell, 1947 in Pianka, 2011)

A co-evolutionary relationship between two systems can be beneficial (+, i.e. it benefits from the relationship), neutral (0, i.e. it is neither harmed nor benefited) or harmful (–, i.e. it is negatively affected) for one or both of the systems (Table 4). The co-evolutionary process can produce both opportunities and barriers, depending on the nature of the interactions between the different subsystems. Through path dependencies resulting from past developments, these resulting opportunities and barriers will influence development options in the future. This means that co-evolutionary processes between subsystems can be both positive, mutually enforcing the different subsystems and thus leading to resilience, and negative, where a kind of negative spiral can lead towards a lock-in. In the empirical work of this dissertation, we further explore the nature of these co-evolutions between actors active in the spatial development and management of flood risks.

While the concept of co-evolution originally applies to living organisms and ecological systems, evolutionary theory and co-evolution specifically has been translated to different fields. It was first introduced in social sciences by Norgaard (1981). According to Norgaard, humans change environments both materially and cognitively and, in turn, the new environments change human practices and ideas. As with resilience, the translation of the biological concept of co-evolution to the social realm poses questions on validity. While biological evolutionary processes are based on gene type, social processes are much more purposeful.

Therefore, Kemp et al. (2007) use the definition of co-evolution as relative autonomy in relation to governance. This definition assumes that co-evolutionary systems are shaped but not determined by each other. On the one hand, they are influenced by other systems and interlinked through cause-effect-cause loops across different scales and subsystems (feedback mechanisms). This means that effects become causes for other developments. On the other hand, developments in different subsystems are partly independent, as this influence is not determinative. According to Kemp et al. (2007), a co-evolutionary view is useful for thinking about governance because it acknowledges this seemingly contradictory principles an relative autonomy.

Since the concept was introduced in social sciences, it has been applied in studies of economics, political science, technological studies, psychology, etc. (Durrant and Ward, 2011; Kallis, 2007). As Kemp et al. (2007: 80) point out, different types of co-evolution have been noted in the literature on societal change: supply and demand; technology and users; technology, industry structure and institutions; actor and structure; techonology and society; and ecology, economy and society) (see Kemp et al., 2007: 80 for references on the individual studies). Through the increasing interest in systems theory and complex adaptive systems thinking, the concept is also applied to the entity of systems and subsystems (e.g. Luhmann, 1995). Within post-structuralist geography, relational conceptualizations of space have also explored the co-evolutionary nature of space (Murdoch, 2006). Building on this conceptualization of space and in relation to the adoption of complexity theories in spatial planning (see section 2.2.2), the concept of co-evolution has also been adopted in spatial planning and governance (Boelens, 2015; Gerrits and Teisman, 2012; van Buuren, 2005; Verbeek and Boelens, 2016).

c Co-evolution in flood risk management: what co-evolves?
The question is now what the concept of co-evolution means for the spatial development and management of flood risks, in relation to the theoretical framework discussed above, and how it can be applied in FRM. In this section, we discuss how the actor-centered approach developed above leads to a co-evolutionary perspective focused on actors.

In literature, two conceptualizations of co-evolution occur in academic literature on FRM. The first is the co-evolution between social and ecological systems (Gual and Norgaard, 2010). Social and ecological systems are inherently linked through what Norgaard (1994 in Gunderson, 2010) calls an synergistic and co-evolutionary relationship. According to Eraydin and Tasan-Kok (2013b: 6) "*resilience thinking facilitates the understanding of the co-evolution of socio-economic and ecological systems.*" In relation to flood risk, this would translate to the co-evolution between the ecological water system and societies. Co-evolution thus provides an analytical framework to understand this interdependent evolution of social and environmental subsystems. However, the distinction between ecological and social systems is hard to maintain in the context of FRM, where technical interventions in the ecological system blur the lines between the two.

The second is the socio-technical system view, which places more emphasis on techniques and engineering solutions. Socio-technical systems link physical (and non-structural) systems with actors (e.g. flood management organizations) and rules (e.g. acceptable standards) performing a particular function (e.g. FRM) (Geels, 2004). By focusing on the socio-technical systems, the co-evolution of technical systems and socio-economic systems, of structure and function, thus becomes the focus of attention. From this viewpoint, the interactions within the flooding system should be considered a dynamic process of mutual adaptations and feedback between the physical flooding system and the actors impacted by flooding or responding to flood risk (Ashley et al., 2012).

However, assuming the multi-actor perspective developed earlier, we draw here on the interpretation introduced in evolutionary planning (Bertolini, 2010), which itself is inspired by evolutionary economics (Lambooy and Boschma, 2001). Evolutionary planning places actors and their organizational routines – FRM strategies in this case – central in an evolutionary process (cfr. species in biological evolution). These organizational routines are subject to path-dependecies: based on past experience, actors tend to follow proven ways of conducting because change is often expensive and time-consuming. As such, earlier experiences largely determine the response to new stimuli. However, the actual performance of these routines will be an important incentive to maintain, adjust or substitute a routine. The evaluation of current routines can as such induce organizational routines to change. This performance depends on the degree of fit between the operational routine itself and the environment (cfr. selection environment in biological evolution). In the case of FRM, this environment consists of the biophysical environment (flooding), which is influenced by other water and land actors, such as water managers, spatial planners and land users, but also by indirect societal mechanisms of damage compensation, emergency relief, building techniques, real estate markets, etc. In other words, the actions (i.e. FRM strategies) of other actors form part of the selection environment for one's FRM strategy. However, this environment is not static, but also changes itself through the accumulation of these individual organizational routines. The interrelations between these actors thus cause their FRM strategies to co-evolve.

By placing actors and the way they deal with flood risks central, we avoid restricting our view to the classic dualisms of nature/society or society/technology. These dualisms assume two supposedly opposing or distinct systems, while in complexity theory the networked nature of systems requires a more open perspective. In the methodological framework presented in chapter 3, we elaborate further on the actor field in relation to the systems and societies involved in the spatial development of flood risks.

d Reframing flood risks: from convolution to co-evolution

FRM (e.g. technical infrastructure, governmental rules, engineering rules, technology, etc.) and communities (behavior and habits of citizens) have co-evolved over long periods of time (Pahl-Wostl, 2002). This reciprocal interaction extends beyond merely public support for management choices. Formal FRM itself also shapes the perceptions, expectations, behavior, practices and habits of the broader society (Pahl-Wostl, 2002, 2007). The way governments deal with, and have dealt with, floods and flood losses in the past has an impact on the adaptability of their societies (Bouwer et al., 2007). Actions on land thus affect the water system, while flood risks emanating from the water system affect spatial development options.

However, this mutual interaction is not reflected in the conceptualization of flood risks. Flood risks are generally defined as the probability of flooding weighed against the potential damage. These two variables are often treated as independent variables; flood management strategies lower either the probability of flooding or the damage in case of flooding. In reality, however, these two variables are dependent, as flood risks are the results of the mutual interactions between the water and land systems. Measures to lower the probability of flooding (e.g. building dikes) influence the development of potential damage (e.g. construction of new buildings). Vice versa, the presence of vulnerable groups or structures heightens the need for protection from flooding. This co-evolutionary conceptualization thus sheds a different perspective on the range of possible management options, stressing the need to take into account potential feedback and leaving room for uncertainty, change and surprise.

By considering the uncertainties related to the complex interactions between different actors and the co-evolutionary nature of formal FRM choices and society, a co-evolutionary approach can deepen the understanding of the spatial development of flood risks. As such, it can help advancing FRM or integrated water management approaches, which often struggle with the integration between land and water and the participation between actors.

e The lack of spatial planning in flood risk management: a co-evolutionary explanation

In the traditional robustness-based approach to managing floods, this co-evolution and the emergent interactions between the water and the social system are not sufficiently acknowledged. Natural hazards risk reduction research has focused too long on the isolated study of (mostly technical) systems and responses (Pahl-Wostl, 2002, 2007), disregarding complexity and the human dimension. In these traditional views, systems are conceptually closed, which might well be less a meaningful reality than a perceptual convenience (Holling, 1973).

When framing the flooding issue as a purely physical problem (as discussed above), solutions are restricted to the water system (technical assessments and solutions). The societal context (including spatial developments) is then seen as being external and unalterable, enabling and restricting flood management options (Hutter, 2006). The interaction between land and water is, therefore, one-directional: what happens on the land has consequences for the management of the water system, but land uses rarely respond to changes in the water system. However, this traditional static conceptualization of the societal context does not reflect the dynamic and reciprocal co-evolution of both systems (Boisot and Child, 1999). The restricted conceptualization of flood risks and one-sided focus on the water system is reflected by the steadily decreasing attention for flood risks in the spatial planning of technically protected areas (Vis et al., 2001). This has contributed to a generic, mechanistic and often technocratic interpretation of the adaptation principle towards a preventive approach through technical measures.

2.4

Conclusion

The increasing recognition of the interdepence of biophysical and socioeconomic systems has led to efforts to adopt resilience in spatial planning and FRM. Therefore, this chapter explored the resilience concept as a theoretical framework for managing flood risks in the face of future challenges.

First, we discussed the different conceptual interpretations and definitions of resilience, which arise from different views on dynamics in systems. While engineering resilience is mainly focused on a quick return to a predetermined stable equilibrium, ecological resilience assumes multiple equilibria. The amount of disturbance a system can absorb before it alters its state is then determinative for resilience. The socio-ecological focuses more on the capacity of complex systems to change, adapt and eventually transform as a reaction to strains and stresses.

Then, the translation of the resilience concept to spatial systems and its application in spatial planning and FRM was discussed. Some issues were identified, such as the lack of clear definition of the conceptualization; the differences between social and ecological systems; the use of resilience as a (policy) goal; and the discrepancies between the theoretical foundations of the resilience concept and the prevailing planning paradigm. Therefore, a resilience approach is only useful if it is embedded in a planning paradigm that is in line with the theoretical assumptions of the resilience concept, i.e. an evolutionary approach that takes into account complexity, uncertainty and non-linearity.

The application to FRM shows that resilience makes a valuable contribution to both the conceptualization of flood risks and the resulting FRM strategies. Through a socio-ecological resilience lens, flooding is not a purely physical problem. Flood risks emerge from the interaction between societal and natural processes. This means that societal actors play an important role in the spatial development of flood risks, both positively (managing flood risks) and negatively (enhancing flood risks), thus also opening up the possibility of socio-spatial interventions as a solution. Furthermore, resilience advocates a long-term perspective, focusing more on dynamics and renewal than (technically) embedded stability. As to FRM strategies, resilience gives rise to three tendencies: (1) from protection to multilayered approaches (content), (2) from linear to adaptive management (process) and (3) from preservation towards community resilience and adaptive capacities (context). This leads us to include a fourth element in our framework: the multi-actor approach.

To further operationalize this theoretical framework, the concept of co-evolution was introduced. It brings together two important aspects of resilience thinking for the role of spatial planning within FRM, i.e. the evolutionary perspective and the multi-actor approach. The idea that mutual interactions between different actors involved in the spatial development and management of flood risks determine overall flood risks will be the operational framework for the empirical research. Notwithstanding the academic efforts to further define and operationalize resilience theoretically, it is charged with a certain vagueness. Nonetheless, the discussion surrounding the concept of resilience provides an important contribution to the debate on dealing with disturbances within spatial planning. For example, the resilience concept questions a strong conservation-oriented attitude and the emphasis on stability, efficiency and technical solutions, as this is often associated with a loss of resilience. Resilience, on the other hand, leads to a more dynamic attitude, where the system itself adapts to be more suitable to a changing context. Within this theoretical and operational framework, we have tried to deal with this vagueness by highlighting the most interesting aspects for the topic of this dissertation.

3

The actor field of flood resilience: methodological framework

This chapter aims to identify the main actors that are directly and indirectly involved in the spatial development and management of flood risks. Based on literature review and consultation with actors, different societal groups that are involved in formal FRM and deal with flood risks in any other way are identified. As such, this chapter develops an outline for the empirical research, i.e. the policy analysis (chapter 4), the survey amongst residents (chapter 5) and the in-depth interviews with non-governmental actors (chapter 6).

3.1

The actor field of the spatial development of flood risks

3.1.1 Understanding the role of different actors

Different actors shape the physical and organizational environment for the management of flood risk. Not only water managers or policy-makers, but also actors from business and civil society are involved in the spatial development and management of flood risk. To understand how these different actors deal with flood risks, we look at the underlying perceptions. Indeed, as Birkholz et al. (2014: 18-19) state "*there is a need for a re-invigoration of flood risk perception research, in order to deliver a more comprehensive understanding of how risk perceptions influence the vulnerability, capacity and resilience of individuals and communities in the face of flooding*", saying that this *"might broaden and enrich this field of research by drawing attention to a wider range of flood risk perceptions (such as those of policy-makers, or those of tax-payers who live outside flood affected areas) and their links with larger-scale protective measures (such as state-supported flood insurance schemes)".* The aim is not, however, to provide insights into the individual factors that influence flood risk perceptions and behaviors, but rather to explore the interrelations between different mechanisms and how they shape overall resilience. In short, the research focuses on the role of different actors within (formal and informal) FRM from the public, civil and business society, and how the interactions between their strategies to deal with flood risks influence flood resilience.

In what follows, we provide an overview of the different actor groups (Figure 9). In exploring the role of different actors in FRM, we identified different broad actor groupings.

On the one hand, actors can be categorized according to the three societies they belong to: government or public society, business or private society and civil or individual society. This classification is commonly used in literature on transition management (Coenen et al., 2012; Rotmans et al., 2001) and actor-centered relational approaches (Boelens, 2010). These three groups are involved in the governance of flood risks and, although these three domains are heterogeneous in nature, actors from the same domain often share the basic logic of action, resources and general objectives.

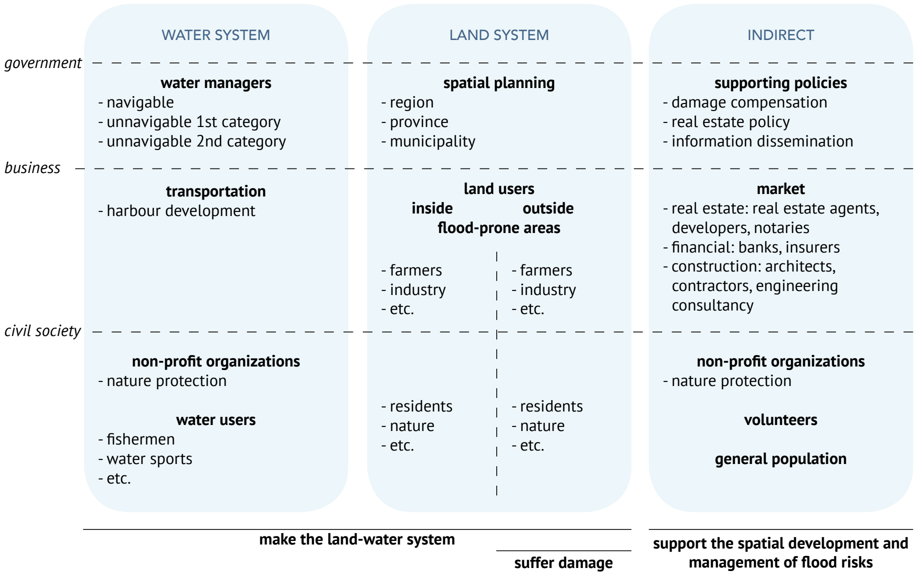


Figure 9 Actor field for the spatial development of flood risks

– *State (government):* State actors create a favorable political, legal and economic environment for society through regulations. These might include both hard regulations (laws, taxes, fees etc.) and soft regulations (subsidies, studies, labels, programs etc.). Apart from their regulating powers, they also make investments that serve the public interest. They have a representational vote-winning focus, as they are bound by politics.

– *Market (business):* Market actors are primarily focused on making profit and, as such, create opportunities for people. However, the values, cultures and management practices that support this purpose may vary widely (Steurer, 2013). Some take up societal responsibilities, while others remain defensive.

– *Civil society:* This group mainly consists of citizens and households. They might act individually or organize themselves in relation to specific partnership interests. They mobilize people's participation and can put (informal) pressure on business and governments to change their policies (Steurer, 2013).

On the other hand, three systems that are involved in the spatial development of flood risks can be defined. Flood risks emerge from the interaction between the water system and the land system. Furthermore, indirect systems related to damage compensation and spatial developments support developments on land.

– *Water system:* This includes both the natural water system (e.g. climate impacts, water quantity, water quality and ecosystem), as well as the technical aspects related to technologies and infrastructures that intervene with this natural system (e.g. dams, dikes).

– *Land system:* The distribution of activities in space influences vulnerability to flooding. Urbanization of floodplains has led to an increase in flood damages (Montz and Gruntfest, 1986). For years, land-use restrictions in highly flood-prone areas have been advocated for as a complement to existing flood protection approaches (Bialas and Loucks, 1978; Scott et al., 2013).

Furthermore, land management affects runoff, and thus flood risks. Urbanization prevents water infiltration and increases water run-off, thus increasing downstream flood risks. However, it remains very difficult to translate this to the larger catchment scale, as cause-effect relations on this scale are very elusive (Pattison and Lane, 2012).

- *Indirect:* Other domains, such as economy, also influence the mechanisms underlying the (spatial) management of flood risks. Supporting policies include damage compensation, real estate and information dissemination. These influence amongst other the behavior of land users, and thus indirectly the spatial system at large.

The intersection of these three systems with the three actor societies leads to the classification of actors for the spatial development of flood risks depicted in Figure 9. These different groups can be directly involved, as in the case of land users in flood-affected areas. Or they can contribute indirectly to flood risks through their spatial developments, for example land users outside of immediately affected areas, or through market mechanisms, for example insurance or building activity.

3.1.2 Focus on actor groups

Based on an exploratory policy analysis and exploratory interviews with stakeholders, we focus this dissertation on four important actor groups for the spatial development of flood risks in Flanders: water managers, spatial planners, land users and market actors (in relation to the supporting policies that regulate their actions). In what follows, these four groups and their roles in and contributions to FRM are briefly discussed.

- *Water managers:* Water managers are primarily responsible for formal FRM. They maintain the waterways and make plans and policies to manage flood risks. Contrary to spatial planners, they not only have regulating powers, but also territorial competence (Hägerstrand, 1995), meaning that they decide on the design of the waterways and implement it themselves.

- *Spatial planners:* Spatial planning is the main governmental actor in the land system, focusing on spatial developments both within and outside of flood-prone areas. They draw up plans for the different parts of the catchment and provide (or do not provide) building permissions to build in floodplains. As such, they have spatial competence, i.e. indirect regulating powers over spatial developments (Hägerstrand, 1995). Through integrated water management policies, spatial planning is also a major actor in formal FRM.

- *Land users:* Land users have territorial competence (Hägerstrand, 1995), meaning that they have competence to decide on land use within the legal frames and, as such, are capable to make real, material and tangible changes. Land users located in flood-prone areas are directly confronted with the consequences of floods and experience the effects of formal FRM measures and policies. These include residents, businesses, nature conservationists and farmers. Apart from material damage, companies also experience financial damage because activities are interrupted. On the other hand, companies have more resources and are more organized in (risk) planning. Agricultural businesses also play a role in water management through cultivation methods and water use. They contribute to the development of flood risks in terms of potential damage through the exposure of vulnerable spatial developments in flood-prone areas, or manage their flood risks through adaptive building techniques and social networks (Grothmann and Reusswig, 2006; Siegrist and Gutscher, 2008). Also, land users outside flood-prone areas influence the probability of flooding through the construction of paved surfaces (increased surface run-off) and the organization of their water drainage.

– *Market actors:* This group indirectly contributes to the spatial development of flood risks, as they are involved in the market mechanisms that influence spatial developments in flood-prone areas and the way land users manage their flood risks. These actors have no territorial or spatial competence, but support land users in varying degrees to consider flood risks in their decisions, take up responsibilities in managing (individual) flood risks and develop adaptive capacities to deal with flooding. This group includes insurers, banks, architects, notaries, contractors, real estate agents, engineering consultancies, etc. They are bound by supporting policies on damage compensation, real estate and information dissemination.

    - *Housing market:* The housing market influences location choices of households. Several studies have shown that the negative impacts of a flood event are capitalized into the selling price of houses, and that these effects fade through time as the market gradually recovers (Chen et al., 2011; Montz and Tobin, 1986; Shultz and Fridgen, 2001). However, not only actual flood events, but also the formalization of flood risks in flood risk maps or other forms of information dissemination can influence both housing prices and housing decisions by potential buyers or renters.

    - *Insurance market:* The way damages are compensated is mainly important in the aftermath of particular flood events. However, they also have an indirect effect on urbanization in flood-prone areas. Depending on the degree of capitalization of the actual risk in the insurance premium and the degree of damage coverage, different effects are possible. On the one hand, the financial safety net provided by insurance coverage reduces the potential damage of land users on the personal level, which encourages development in the floodplains. On the other hand, the capitalization of actual personal risk in insurance premiums can also incentivize protective behavior for people living in flood-prone areas, or can even discourage moving to a flood-prone area (Botzen et al., 2009). Hartmann (2011a) states that these effects are currently side effects of insurance policies, and that they can be used more purposefully in relation to land policy.

- *Building industry:* Architects and contractors are responsible for the conception and construction of built developments both inside and outside of flood-prone areas. In flood-prone areas, construction techniques can play a decisive role in the extent of potential damage from a flood – for example, through flood-proofing. Outside of flood-prone areas, limiting and reducing soil sealing improves infiltration and buffering of water, and thus lowers flood risks. As such, they respectively play an important role in the development and implementation of flood-proof and water-conscious building techniques.

3.2

Research design

This research looks at the interactions between the main actor groups in the spatial development and management of flood risk from the public, civil and business society involved in FRM, focusing on Flanders, the northern part of Belgium. Policy-makers in Flanders are exploring possibilities to share responsibilities with non-governmental actors. 'Shared responsibility' is an important and explicit policy goal in the discourse of policy-makers, especially water managers. For example, in a brochure on adaptive building techniques published by the Flemish Association of Architects, the minister of Environment, Nature and Culture states that "*Water safety is a shared responsibility of water managers, insurers, planners, designers, citizens, emergency services and local policy-makers*" (NAV, 2014: 3, own translation from Dutch).

However, while governmental aspects (Crabbé, 2008; Mees et al., 2016a), technical aspects (Kellens, 2011) and urban design (Nolf, 2013; Putseys, 2013) of FRM are relatively well studied in Flanders, little research has been dedicated to how non-governmental actors operate within the institutional context and how this contributes or counteracts formal governmental FRM strategies.

3.2.1 Three spatial scales

Because of the different scales at which these actors operate, the research takes a multi-scalar case study approach. The three hierarchical scales are: regional (Flanders), catchment (Dender) and local (Geraardsbergen). The Dender basin and Geraardsbergen are selected as focus areas within Flanders. On the one hand, recently the most devastating floods have occured there; on the other, this is on of the most active regions in terms of citizen involvement in FRM in Flanders. As such, it can be considered to be a worst case scenario. The aim of this case study is not necessarily to be representative or to generalize the findings (Flyvbjerg, 2006), but rather, it can be seen as a scenario that could occur more frequently under increasing flood risks in other places in Flanders.

- *Flanders:* Flanders, the low-lying northern part of Belgium, is densely built (more than 460 inhabitants / km^2) and has a dense river network, causing it to be sensitive to flooding. According to the most recent water assessment maps, 71,556 ha or 5.3% of Flanders have recently been flooded or have a flood return period of 100 years with a flood depth of 30 cm.

According to the Flemish Environmental Agency[3] 36,000 to 56,000 buildings and 23,000 building parcels, or 9% of the available building parcels, are located within flood-prone areas. The damage compensations due to flooding amount to 40 to 75 (even 100) million € per year, or approximately 0.05% of the gross national product. This is a relatively high monetary risk in comparison with neighboring countries. By 2050 (under an average climate scenario) an increase in flood risk of 50% is expected.

– *Dender catchment:* The Dender region is one of most frequently flooded areas in Flanders. The Dender catchment is part of the Scheldt basin. The Dender has its source in Wallonia and enters the river Scheldt in Flanders (Dendermonde). The upstream part of the catchment (675 km^2) is thus located in the Walloon Region, and the downstream part (709 km^2) is located in Flanders. As water management in Belgium falls under the responsibility of the regional authorities, this means that the Dender is managed by the Walloon government for the upstream half of the catchment and by the Flemish government for the downstream part. As this research is about the interactions between governmental FRM and societal actors, we assume the position of the land users and the institutional actors they interact with. As such, we make abstraction from the transboundary issues between Flanders and Wallonia and focus merely on the Flemish part of the Dender basin.

  Recent flooding occurred in 2002, 2003, 2010, 2011 and 2014 (Coninx and El Kahloun, s.d.). The most severe flood took place in 2010, causing damage to 1,466 households (data Assuralia). The flooding issue in the Dender catchment continues to receive widespread attention in the area. It is often debated in the media, and there is a social and political debate about what needs to be done to reduce floods and flood-related damage. Known problems are the (relatively) high density of buildings and impervious land in the floodplains (as already reported by Van Nuffel,1969), the outdated flood protection infrastructure and the lack of coordination with the Walloon Region, both during floods and in general (CIW, 2011). Its recent flood history and the ensuing debates make it a valuable case study for the implementation of MLWS. Furthermore, the general attention to the issue of flooding facilitated the cooperation of residents and officials in collecting data.

– *Geraardsbergen:* The city of Geraardsbergen is located in the Dender catchment (part of the Scheldt catchment) in Flanders and borders on the Walloon Region. The municipality of Geraardsbergen consists of one urban center and 15 rural submunicipalities. Geraardsbergen developed along and due to the river Dender. The landscape is hilly and the Dender crosses it from south to north. The city has known different areas of growth and decay. Different industrial revolutions still have their impact on the urban fabric and the waterway. The Dender has been straightened several times to promote shipping. Due to this, most old meanders

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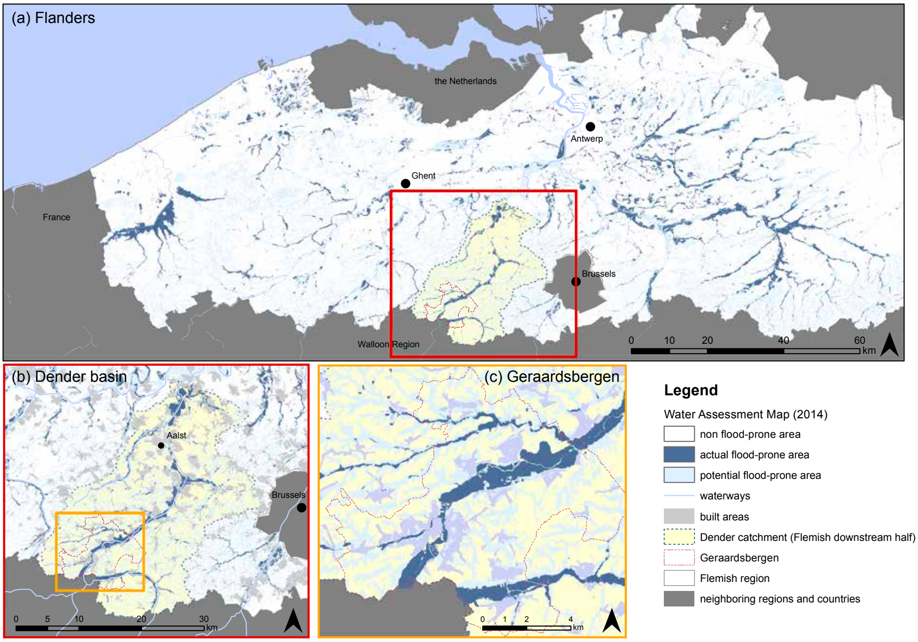

Figure 10 Map of the three scales of the case study research: (a) Flanders, (b) the Dender basin and (c) Geraardsbergen

are now lost. However, from the second part of the 20th century, the industry has been declining and most inhabitants of this area commute.

The area has been confronted with flooding frequently, with reports of flooding in the late 19th and early 20th century affecting mainly the surrounding marshes and the transport connections. However, since the second part of the 20th century, houses and factories have also been affected. Geraardsbergen experienced the most devastating consequences within Flanders during the November 2010 flooding. Not only were frequently flooded areas affected, but a lot of buildings were inundated for the first time.

3.2.2 Four actor groups

Based on exploratory interviews with policy-makers and document analysis, four main groups within this actor field are selected for the case study research (Figure 11): water management, spatial planning, land users and market actors. The first two are governmental actors, responsible for the policies surrounding water management and spatial developments. The latter two are non-governmental groups of actors that are directly and indirectly involved in spatial developments in flood-prone areas.

In what follows, a brief institutional context of these groups and their relevance in FRM in Flanders is discussed.

– *Water management:* In Flanders, the competences for water management are distributed amongst different governmental actors in a hierarchical way. Every water manager is responsible for the planning and implementation of FRM along his waterways. Water managers are traditionally the main responsible party in water management, and they often chair the integrative platforms for water management.

– *Spatial planning:* The three levels of spatial planning in Flanders are the region, the province and the municipality. The powers are distributed amongst them according to the subsidiarity principle, i.e. that decisions are made on the most appropriate level. This means that municipalities can make decisions on building permits in flood-prone areas.

  Through the adoption of integrated water management in the 1990s, spatial planning has become an important partner for water managers. They are represented in all the integrative platforms for water management.

– *Land users:* The role of land users in flood-prone areas is, in the first place, on the individual level. In Flanders, there are also some associations representing these land users that are involved in FRM.

  • *Residents:* Residents are bound by regulations on insurance and building code restrictions. Very little is known about the vulnerability and behavior of residents in flood-prone areas in Flanders. To the knowledge of the author, there are no formal citizen associations related to managing flood risks, except in Geraardsbergen (the local case study in this dissertation), where a neighborhood committee has been set up to pressure policy-makers to manage the flood risks better.

  • *Nature:* Environmental organizations are involved in formal FRM through the platforms of integrated water management. They also actively manage flood risks by developing natural flood retention areas, often financed with a combination of their own revenues and subsidies.

  • *Farmers:* Farmers are also represented in the platforms of integrated water management.

– *Market actors:*

  • *Housing market actors (real estate agents):* Since October 2013, real estate agents are legally required to inform potential buyers on flood sensitivity. Therefore, they play a role in the consideration of flood risks of (potential) homeowners at the moment of their location choice.

  • *Insurance market actors (insurance agents):* Flood risks are, by law, a mandatory part of the fire insurance for private homes. Although fire insurance itself is not compulsory, it is very common; about 95% of Flemish households have fire insurance. Even households outside of flood-prone areas pay a certain portion of the premium to cover water damage. Flood

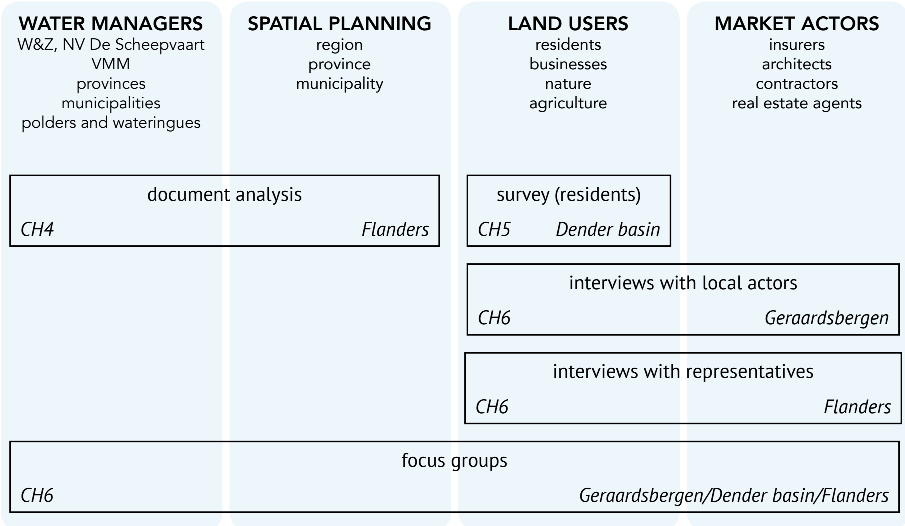

Figure 11 Overview of the case study methodology

risk damages are thus cross-subsidized across almost the entire Flemish population. Insurers are allowed to ask households in flood-prone areas for a higher premium, although there is a statutory ceiling for these premiums. This means that insurers cannot ask more than a certain amount; insurance against this maximum tariff are provided by a tarification office. However, these principles of solidarity do not apply for recently built houses; for houses built after 23 September 2008, there is no maximum for the premium and insurers can refuse to offer insurance.

- *Building industry actors (architects, project developers and contractors):* The Flemish government (financially) supports the project 'water consultant', which is conducted by a Flemish architects' association, in order to create awareness on flood risks in the building sector and eventually make buildings in flood-prone areas less vulnerable to flooding. The water consultant supports architects in the design and construction of property-level protection and the management of water in building projects by providing information. The water consultant also provides feedback to water managers and spatial planners on their policies.

3.2.3 Data collection and analysis

The different contributions of the different actors within (formal and informal) FRM to the spatial development and management of flood risks are analyzed through case study research. Depending on the actor group, a different research methodology is used. The actions of these different groups are confronted with the resilience framework, based on the basic principles of adaptability and diversification. Due to the focus on actors in this research, it uses a case study based, mixed-methods approach. Four actor groups were questioned in three case study scales through four different data-collection methodologies (Figure 11).

In accordance with the type and the size of the different actor groups, different methods for data collection were used. These methods were both quantitative and qualitative. These different data collection methods allowed us to produce rich and complementary data.

- *Document analysis:* In order to understand how and to what extent current formal FRM supports the development of flood resilience, a policy document analysis was performed (chapter 3). The institutional framework was analyzed based on documents discussing the main plans, laws, instruments and other policies aimed at managing flood risks in the fields of water management, spatial planning and complementary policies. The analysis discusses the content, process and context of formal FRM, as discussed in framework on flood resilience strategies in chapter 2. This allowed us to have an extensive overview of the different policy fields active in formal FRM and to reconstruct the recent developments in these policies.

- *Survey:* To better understand the different opinions amongst the large population of residents, a survey was chosen (chapter 5). The survey discussed a wide array of topics. A limitation of this methodology is that the questions are fixed and often restrictive. To overcome this, explorative interviews with residents and input from scholars and policy-makers was taken into account in the development of the questionnaire, and in-depth interviews further contextualize the insights from the survey.

  The data was satistically analyzed using both univariate analysis, to gain insights into the distribution of characteristics and opinions, and bivariate analysis, to reveal the relation between these characteristics and opinions. For more detailled information, see section 5.2.

- *Bilateral interviews:* Bilateral personal interviews were used in a number of ways.

  - Interviews with policy-makers were used to complement the policy document analysis (chapter 4) in order to gain more in-depth insight to aspects of policy that might not be included in official policy documents (yet). The interviews were unstructured and focused on factual knowledge and experience, rather than personal viewpoints. The results of these interviews were added to the document analysis.

  - Exploratory interviews with societal actors were used to explore the actor network and identify the main topics (chapter 3). The questionnaire was semi-structured. The interviews were analyzed based on a grounded theory approach; they were transcribed and coded through open coding in order to gain insights into the most relevant topics. The outcomes support the development of the questionnaire for the survey (chapter 5) and the questions for the in-depth interviews (chapter 6). For more detailed information, see section 6.1.1.

- In-depth interviews were used as a main data-collection method for land users and market actors, both on the regional and the local scale (chapter 6), because this group is smaller and more difficult to reach in a general sense (for example, through surveys). Furthermore, these bilateral interviews allowed us to explore their experiences with flood risks and FRM in depth. The questionnaire was semi-structured, but more focused than the exploratory interviews. Here also, a grounded theory approach was used in the analysis: the interviews were transcribed and coded through open coding. The codes were used to identify themes, conceptualize and eventually interpret the data. For more detailed information, see section 6.1.2.

– *Focus groups:* Because of the divergent discourses found in the various actor groups, three focus groups were organized (chapter 6). This methodology allowed us to bring these actors together and to not only confront their views and discuss different perspectives and aspects of the issue, but also start a dialogue. The discussions in the focus groups were transcribed and analyzed based on a grounded theory approach (open coding).

4

Formal flood risk management in Flanders

This chapter addresses formal FRM and policy in Flanders, as performed by governmental actors such as water managers and spatial planning. The central question here is: *to what extent does formal FRM in Flanders enable or support the development of flood resilience?* This question can be divided into two sub questions: to what extent does formal FRM itself (i.e. the actions of water managers and spatial planners) contribute to resilience (content and process) and to what extent does it support other actors to develop resilience (context). As such, it provides an analysis of how resilient formal FRM in Flanders currently is, but also gives an overview of the institutional and regulatory context for the analysis of the role of non-governmental actors in the following chapters.

These questions are answered by mapping and analyzing the content and process dimensions of formal FRM strategies in Flanders, in relation to its context and other actors. This is done through a policy document analysis, supplemented with some interviews with policy-makers (see Appendix 3 for an overview). We look at how existing formal FRM strategies within water management, on the one hand, and spatial planning, on the other, relate to the flood resilience strategy discussed in chapter 2. In addition, we discuss the policies aimed at influencing the behavior and strategies of non-governmental actors, mainly residents and land users. Focus is here particularly on instruments and processes related to the spatial aspect of flood risks.

Considering the existing research on FRM in Flanders, this chapter does not aim to provide an exhaustive overview of FRM in Flanders. Nolf (2013), for example, gives a historical overview of flood management; Crabbé (2008) provides a detailed analysis in the formation of integrated water management; Kellens (2011) discusses the past developments and future challenges of FRM; and Mees et al. (2016b) gives an extensive overview of the governance arrangements active in FRM. Instead, it discusses the main elements in relation to the flood resilience strategy discussed in the theoretical framework (chapter 2), i.e. content, process and context.

4.1

Water management

4.1.1 Actors

a Water managers

Water management in Flanders is organized according to the hierarchy of the water system (see Table 5). These governmental actors are charged with implementation, i.e. the management of the watercourses.

Throughout time, these responsibilities have shifted repeatedly, with a strong tendency towards centralization and government responsibility (Crabbé, 2008). The most recent step in this process happened in 2014, when municipalities were given the option to transfer the management of their watercourses to the provinces, which most municipalities have accepted.

Watercourses	competent actor
Navigable	Department of Mobility and Public Works (MOW)
Non-navigable 1st category	Flemish Environmental Agency (VMM)
Non-navigable 2nd (and 3rd) category	Provinces
Non-navigable 3rd category	Municipalities
Non-navigable 2nd and 3rd category under their charge	Polders and Wateringues

Table 5 Governmental water management actors (based on Mees et al., 2016b)

b Integrative platforms

Following the 2003 Decree on Integrated Water Policy (DIWP), two platforms that ensure coordination and integration within this highly fragmented field of actors have been installed: the Flemish Coordination Committee on Integrated Water Policy (CIW) on the regional scale and the sub-basin authorities at the sub-basin scale.

The CIW is a consultation platform that brings together all relevant policy domains and levels involved in water policy within the Flemish government administration (Van den Berghe & De Sutter, 2014; Wiering & Crabbé, 2006). It includes the regional departments of mobility and public works; spatial planning; agriculture; economy and environment; representatives of the sub-basin boards; and umbrella organizations for the water companies, provinces, cities and municipalities, and polders and wateringues. It is the principal actor for water-related policy-making in Flanders. This institution is responsible for policy-making and the development of plans and strategies. The different water managers individually provide input by contributing expertise, relevant information and analytical results such as modeling of flood risks.

At the sub-basin level, coordination between the different authorities is organized in the sub-basin boards. The daily operation at the sub-basin level is provided by the sub-basin secretariat, consisting of representatives of the Flemish and provincial water managers and the department of spatial planning. The sub-basin council includes representatives of societal stakeholders and sectors involved in water policy: agriculture, nature and environment, mining and energy, fishing, tourism and recreation, housing and mobility. It gives advice to the sub-basin board.

4.1.2 Content and process

a Sigma plan (1977 and 2005)

The Sigma plan is the first comprehensive plan to manage flood risks in Flanders. The Sigma plan was originally drawn up after the heavy 1976 floods. This plan for the tidal Scheldt river set out a flood control approach (Kellens et al., 2013), as exemplified by the Dutch Delta Works (Nolf, 2013). Based on a cost-benefit analysis, a T1000 protection level for rural areas and T4000 for cities was considered most effective. This was to be achieved through dike elevations, a storm-surge barrier and flood-control areas. The storm-surge barrier was never executed because it was not considered cost efficient enough. Within this approach, spatial planning was needed

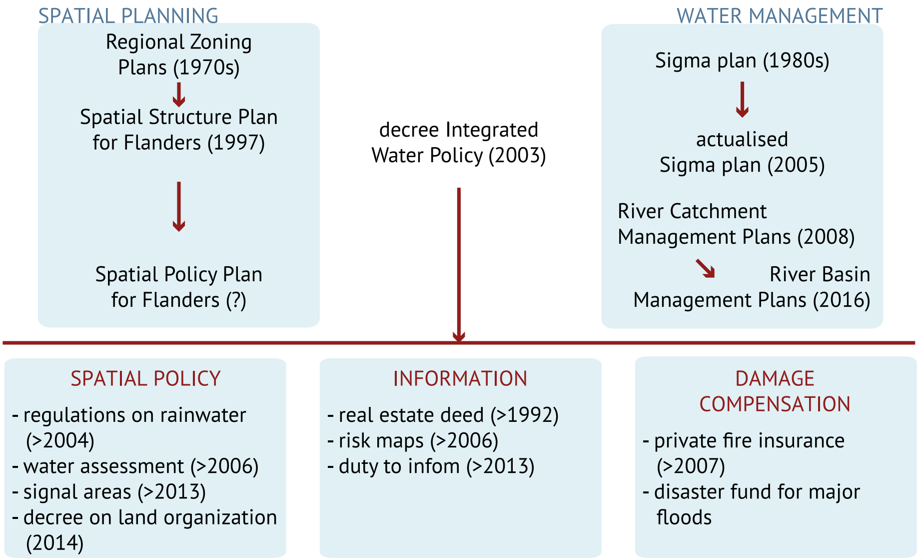

Figure 12 Overview of the main formal FRM plans and instruments

to reserve sufficient space for hydrological defense mechanisms and their related technical amenities (such as dikes, weirs, drainage systems, controlled flood areas etc.). The role of spatial planning was thus limited to supporting water managers in performing FRM within the water system. This is the most basic, technical role of spatial planning.

Since the 1980s, the idea evolved that such technical measures alone would not be sufficient or (financially) feasible. More space for rivers was reclaimed in so-called adjoining flood-control areas to enable ecological resilience. Under influence of this discourse on integrated water management that emerged in Flanders in the late 1990s to early 2000s, the Sigma plan was actualized. This actualization shifted the aim of the Sigma plan from merely flood protection towards improving flood safety, accessibility, recreation and natural values. New challenges came up to integrate flood-control areas within the urban fabric or with other interests, such as nature or recreation. To fulfill those challenges, the role of spatial planning stretched beyond mere institutional endorsement, taking up more responsibility towards integrated development and providing space for (natural) retention basins. Here spatial planning mainly plays a role in providing space for retention basins and flood-control areas. Based on the experience from the implementation of the original plan, it also set out a decision-making structure with discussion opportunities at general plan and at project level. This included a soundboard group and thematic working groups, including representatives of different stakeholders, such as nature preservationists, farmers, hunters, fishers, etc.

The Sigma plan is still being implemented today, and has proven to be a valuable experience and an example of collaboration between W&Z and other stakeholders such as environmental NGOs, farmers, the government's nature administration, the governmental research institute on nature conservation, etc. on the delivery of

FRM. The design and structure of this plan has evolved under influence of internal experiences and external social developments.

b Decree on Integrated Water Policy (2003 and 2013)

The DIWP (2003 and 2013) is the main legal framework for the management of flood risks in Flanders. It forms the start and legal anchoring for integrated water management, which brings the spatial planning domain into FRM. The original decree from 2003 establishes the aims, instruments (e.g. the water assessment, RCMPs, expropriation, right of pre-emption, duty to buy) and organizational structure (e.g. the establishment of the CIW) of integrated water management in Flanders. It also consolidates several existing legal water management instruments in one comprehensive framework. Different consecutive implementation orders have brought these instruments into practice.

In 2013, the decree was substantially reformed. The main reason was the (procedural) simplification of the levels of planning in water management through the integration of the different water management plans into one RBMP. Also, the Duty to Inform was included. The sections of these individual plans or instruments go deeper into the content of these reforms.

c River Basin Management Plans 2016-2021

The River Basin Management Plans 2016-2021 (RBMP) for the Scheldt and Meuse basin are the main integrated plans for FRM. They are the first generation of Flood Risk Management Plans (FRMP) and, as such, form the implementation of the European FD. They were published in March 2016 and contain sub-basin specific parts, listing per sub-basin all the actions to implement the plan. These actions are based on a comprehensive cost-efficiency calculation.

The RBMPs are the second generation of water management plans. They succeed the first generation of RBMPs, River Catchment Management Plans (RCMP) and Sub-River Catchment Plans (SRCMP) of 2008-2015. The first generation of RBMPs on the level of the river basin was drawn up by the CIW, while the catchment and sub-catchment level plans were drawn up by the eleven different sub-basin authorities. They have been approved and adopted through a process of public consultation. Over a period of six months in 2006-2007, stakeholders could comment on the draft plans. This was the first time that participation in governmental water management was possible. The RBMPs were subject to a yearly evaluation, which monitored the progress of the implementation of the action plan.

In the second and current generation of RBMPs, it was chosen to integrate the different levels in order to simplify the planning process. All levels are now integrated on the level of the river basin, with different sub-basin specific parts, in the comprehensive RBMPs. This is an important scaling up of the level of plans. According to the FD, the FRMPs should be drawn up based first on a preliminary flood risk assessment followed by the development of flood risk and flood hazard maps. Since data on flood risk assessment were already available, the first phase was skipped. In 2013, the flood risk and flood hazard maps were developed, based on which a comprehensive analysis weighing costs and benefits of different potential actions by water managers (such as levees), residents (such as property level protection) and planners (such as expropriation) was performed. The resulting FRMPs were integrated in the RMBPs, which then went into public consultation in 2014, just like the first generation of RMBPs, and were published in 2016.

d Evaluations of flood events

After the flooding of November 2010, a global evaluation on the flooding issue was made. On the one hand, the CIW drafted a report (CIW, 2011) that included an inventory of the flood event and important points of attention, as well as an action plan on the regional level. On the other hand, a series of parliamentary discussions was organized in January to March 2011. A wide array of stakeholders and representatives of various organizations presented their findings, considerations and recommendations for FRM. This led to the resolution on flooding (July 2011). The CIW reported annually on the progress of the action plans, with the last report concluding the implementation of the resolution in July 2014.

4.2 Spatial planning

4.2.1 Actors

Spatial planning is performed by regional, provincial and municipal administrations. Their powers are distributed according to the subsidiarity principle, meaning that decisions are made on the most appropriate level. Each level of government draws up its own spatial plans, with a degree of detail befitting their level. Issues that are relevant for the regional scale are included in plans drafted by the regional spatial planning authority (Department Space Flanders). Lower level authorities, i.e. the provinces and municipalities, can draft their own plans within the constraints of these regional plans. This subsidiarity principle also applies for issuing building permits. Large-scale projects (for example, airports) are licensed by the regional planning authorities, while permits for projects of local relevance (for example, individual housing) are issued by the municipality.

4.2.2 Content and process

a Regulative framework for regional planning

The regulative framework for regional planning in Flanders consists of the regional zoning plans (*het Gewestplan)*, an area-wide set of land-use plans that date back to the 1970s. The plans distinguish between zones that, in principle, could be developed and zones that are intended for agriculture, nature and forest (and where construction is, in principle, not allowed). Despite several land-use plan changes, these zoning plans still constitute the blue print for spatial developments in areas were no new planning processes were started. The plans from the 1970s have enabled suburbanization and led to an enormous increase in the share of built-up land (Poelmans and Van Rompaey, 2009), and still provide a more than sufficient stock of residential areas and zones for residential expansion to meet demographic demands for housing.

However, residential parcels developed under the zoning plans are often poorly located in remote areas, including flood-prone areas. Despite some preparatory studies, flood risks were not systematically taken into account in the conception of these plans in the 1970s (Nolf, 2013; Van den Broeck, 2004). Little effort was done to prevent or control development in flood-prone areas, as controlling flooding through structural solutions was considered to be the main or even sole responsibility of water managers. The belief in flood prevention and protection, as materialized in the Sigma plan, maintained a strong divide between water managers and spatial planners. Other reasons include the limited knowledge on flood risks at that time, a lack of political prioritization of flood-related issues in planning, and even fraudulent manipulation (Boussauw and Boelens, 2015). In addition, the impact of the enormous increase in the share of built-up land and the subsequent increase in flood frequency was not anticipated in the 1970s (Poelmans and Van Rompaey, 2009).

Since the emergence of the integrated water management discourse in the 1990s, efforts were made to counter this strong division between water and land management, and the issue of flooding is receiving more attention in planning practice. The Spatial Structure Plan for Flanders (*Ruimtelijk Structuurplan Vlaanderen*) of 1997 explicitly emphasizes the importance of the physical system, including the water system, as a spatially structuring element for different land uses.

More recently, spatial developments in flood-prone areas are questioned due to increasing damages (Burby, Deyle, Godschalk, & Olshansky, 2000; Munich Re, 2010; Woltjer & Al, 2007). Under the 2003 DIWP, different policies and instruments to include flood risks in spatial developments have been developed, of which the main instruments are the so-called 'water assessment' (*Watertoets*). Since 2006, such assessments have been a mandatory part of the approval procedure for buildings or spatial plans in flood-prone areas, as well as the selection of a number of 'signal areas' (*Signaalgebieden*) where rezoning options are examined because of imminent water issues (De Smedt, 2014). The goal is to create stronger planning control through regulation, especially for new constructions. However, decision-making remains the responsibility of the individual planning institutions.

Nevertheless, the integration of flood risk in spatial planning remains difficult. In the present situation, it proves e extremely difficult to prevent the development of vulnerable functions in flood-prone areas by restricting building options, even in places that have not yet been developed. Since water management (especially in relation to the larger rivers) happens on a regional scale while, according to the principle of subsidiarity, spatial planning is largely practiced on a local level (Van den Broeck, 2004), integration, responsiveness and decisiveness are hard. Furthermore, the regional zoning plans still form the blueprint for spatial developments. As the zoning plans are only modified when new planning processes are started, a large part of these plans dates back to the 1970s. The impact of the massive increase in the percentage of occupied (built-up) land and the subsequent increase in flood frequency was also not anticipated in the 1970s (Poelmans and Van Rompaey, 2009). When comparing the recent flood risk maps with the regional zoning plans, it becomes clear that, on the one hand, the regional zoning plans were inadequately informed with regard to flood risks from the beginning and, on the other hand, today these plans should be considered obsolete in view of flood risk, as the water system has significantly changed since the 1970s. It is also difficult to change ‘hard’ zoning codes, such as residential area, into ‘soft’ ones that might produce less damage in case of flooding, such as nature and recreation, due to the rigid planning system and the emphasis on property rights. Existing zoning plans often imply the existence of acquired development rights for landowners. Relocation of property or building rights requires intensive juridical procedures and financial compensation – a reason why such relocation only happens sporadically, especially when public budgets are under pressure.

Land-use and spatial planning are still often mentioned as a shortcoming in the flooding issue (Flemish Parliament, 2011). Over time, knowledge on flood risks has increased through new experiences and modeling techniques. But, as stipulated above, zoning plans have only been able to incorporate this new knowledge to a very limited extent. There is a call for a better integration between different governmental levels and institutions active in water management (Flemish Parliament, 2011). So the question arises: how can spatial planning contribute to FRM, given the context outlined?

b Water assessment

Firstly, there are a number of instruments to better integrate water issues in spatial policy. Since 2006, licensing authorities need to perform a water assessment in the context of building permit requests or spatial plans approvals. This is similar to the Dutch water assessment introduced in 2003. The water assessment examines whether a plan, a building permit or a program has a harmful effect on the water system. According to the extent of the harmful effects, the government can impose conditions to limit or prevent damage, or impose measures to restore or compensate for the harmful effect, or even deny the permit. The decision of the licensing authorities is supported by advice from the water managers.

The water assessment maps support the assessment process by providing information on flood risks in a user-friendly way. The most important map indicates actual and potential flood-prone areas. Actual flood-prone areas have recently flooded or have a flood return period of 100 years with a flood depth of 30 cm. In potential flood-prone areas, flooding is possible under extreme weather conditions or failure of flood defenses.

Although the instrument was included in the DIWP of 2003, its implementation only started with the implementation decree of November 1, 2006, following some discussion (Grietens, 2005). Since then, it has been optimized and changed several times. In 2010, the CIW performed an evaluation of the process based on a survey of advising and licensing authorities (CIW, 2010). In May 2011, an evaluation of the water assessment was part of the general evaluation of the November 2010 flooding (CIW, 2011). In July 2011, the two main advisory boards, i.e. the environmental council and the socio-economic council, issued advice on their own initiative. Following these evaluations, the decree was amendmended, in order to simplify both the content and the formal procedure of the water assessment, on October 14, 2011; these amendements came into force on on March 1, 2012. The main changes were: the advice of the water manager became obligatory; the list of plans and building permits to which the water assessment applied was elaborated; and the motivation requirements of the water paragraph and advice in the building permit became stricter. A new web application and updated maps supported licensing and advising authorities to execute the water assessment. Also, citizens can use the web application to gain information on their project and the water assessment.

The renewed water assessment was again evaluated in 2013 by the CIW, again based on a survey of advising and licensing authorities (CIW, 2013). Based on this evaluation, some technical adjustments were made in the decree of December 12, 2014, and implemented on January 22, 2015. Also, the maps underwent a second modeling update in September 2014.

In practice, however, it remains difficult to stop or limit development of flood-prone areas. Permits are rarely denied (CIW, 2010, 2013). This is a result of the passive or reactive nature of the water assessment; only when plans are drawn up is a decision made on the development of the area. At that point, refusal is difficult. This situation creates legal uncertainty and provides insufficient protection for the space needed for water storage. Other reasons, according to De Smedt (2014: 108), are "*the fear of compensation claims, the lack of knowledge about the vulnerabilities of the water system among the authorities and civil servants and the lack of political courage to take stringent but necessary measures.*" Also, the lack of clear water retention policy leads to varying (sometimes free) interpretations, and the advice of the water manager in the water assessment is not binding. Moreover, there is no enforcement on compliance with the conditions or building regulations of the water assessment.

c Signal areas

A policy framework was established to proactively preserve water storage capacity in so-called signal areas. Signal areas are plots in flood-prone areas that have been assigned a hard land-use allocation (e.g. residential and industry) within the regional zoning plans, but have not yet been developed. These areas comprise 11,000 ha or about 0.83% of the Flemish territory. The 'signal areas' instrument is aimed at controlling the development of these areas to avoid a substantial increase of potential risks.

To achieve this, the decree on land use of August 25, 2014 made a comprehensive array of instruments available. Examples of these instruments are public utility servitude; statutorily required reparcelling, if necessary combined with infrastructure or construction works or a zoning swap; and the application of a sharpened water assessment (De Smedt, 2014). To the knowledge of the authors, this toolbox has not yet been applied in the context of the signal areas at the time of writing.

Another important accompanying measure concerns the financing of potential planning blights due to zoning changes in the signal areas. The Flemish government foresees a 60% subsidy of the planning blight fees in the context of a spatial implementation plan (*ruimtelijk uitvoeringsplan*) that implements approved initial agreements; the remainder is paid by the provinces and municipalities. The subsidy of the Flemish government is paid by the Rubicon fund. This fund was established in

2003, after the 2002 floods, to support investments in flood control by the Flemish region and local governments. It currently receives incomes from the plan income taxes of zoning changes towards business activities, its own revenues and potential grants from the general expenditure budget of the Flemish Community.

The process of the signal areas consists of three steps. The first step was the definition of the signal areas. As established in the DIWP of 2003, the signal areas were spatially delineated in the first generation of RCMPs of 2009. Three types were defined:

1 natural water conservation areas: areas where precipitation is naturally retained for a long time
2 current water storage areas: areas suitable for water retention (without causing flooding to existing buildings) that are currently used by the water system for water retention
3 potential water storage areas: areas that are physically suitable to store water but do not flood anymore due to human interventions

The RMCPs determine that the spatial development perspective for these areas should be reconsidered, based on an analysis of the risk. However, the process was quite slow until in 2012, the Green Paper for the new Spatial Policy Plan for Flanders (*Beleidsplan Ruimte Vlaanderen*) stimpulated a short-term action to take measures in areas with a hard land-use zoning allocation and high flood risks or an essential infiltration function. This was an important impetus to further develop the signal areas instrument. In order to avoid that development would take place before the signal area process is finalized, additional development restrictions apply since March 2013 (Concept Note) for all signal areas. This includes signal areas that are not selected for systematical review, or waiting for the results of the follow-up trajectory (see further).

The next step was to systematically review the most relevant and prioritary signal areas. These were selected on three criteria: (1) location in current water storage area, (2) size of the (cluster of) signal area(s) and (3) location in an area with significant known problems and/or opportunities. In these reviews, the sub-basin authorities gathered all juridical, biophysical and policy information available on the area and made suggestions on a spatial development perspective that is not contradictory with the interests of the water system.

After the systematical review, a follow-up trajectory is started. Based on an area-specific analysis of the impact of potential development of the area, the potential development perspectives are deliberated with the involved governmental bodies (municipal, provincial and regional). This process results in an initial agreement. It contains an area-specific spatial development perspective, the initiating administration (appointed by the provincial governor if no consensus was reached) and the instruments to be used for implementation. There are three options for the spatial development perspective:

1 no action: The existing zoning is compatible with the need for water retention. The water assessment is sufficient

2 additional measures through the water assessment while maintaining the zoning: The existing zoning is negative for the water system, but there is no high flood risk
3 zoning change: The existing zoning is not compatible with the need for water retention and has a high flood risk

Series	Number	Review	Initial agreement
1	66	before February 2013	March and May 2014
2	17	between February and December 2013	May 2015
3	151	2014	currently in process

Table 6 Process timing of the three series of signal areas

Three series of signal areas were processed within a different timeline (see Table 6). The third series does not only include problems within the water system, but for this series it is also possible to expand the areas based on the spatial vision of the municipality. If, for example, 90% of a natural area is flood-prone, it is possible to include the remaining 10% that is not flood-prone in order to include a coherent area in the reallocation. This integration, however, causes some issues. Can the preservative policy also be applied to the non-flood-prone part? If urban development is refused in this part, policy-makers expect that the council of state will grant a permit nevertheless, since there are no compelling reasons to refuse permits in this part.

d Spatial planning regulations on rainwater (2004, 2013)

The regulations play an important role in the discharge of rainwater in a heavy storm. These regulations apply to wells for rainwater, infiltration installations, buffer installations and separated discharge of wastewater and rainwater. The general starting point is that as much rainwater as possible is re-used locally. In second instance, the remainder must be infiltrated or buffered so that only in the last instance is a limited amount of water discharged in delay. According to the paved area of the building project, certain volumes of water need to be infiltrated or buffered. This regulation applies to the whole Flemish region, but provincial and municipal governments are free to implement additional stricter regulations. The 2013 reform of the regulations significantly tightens the rules.

4.3

Complementing real estate policies towards land users in flood-prone areas

Apart from water management and spatial planning policies, there are also some relevant complementing policies from related fields that influence the way societal actors deal with flood risks. They might stimulate (e.g. provide information on flood risks) or discourage (e.g. allow for relatively low insurance premiums) homeowners to take initiative.

4.3.1 Insurance and damage compensation

Regulations on insurance and damage compensation are relevant for spatial developments in flood-prone areas since they influence the attitudes and actions of residents. Federal legislation from 2007 stipulates that flood damages are a compulsory part of the private fire insurance. Through this legislation, citizens become responsible for flood damages through private insurance, although the system is highly regulated. Even though fire insurance itself is not obligatory, about 95% of Flemish households buy such insurance, as it is often a condition for obtaining a mortgage.

The federal flood risk maps (2007) indicate the risk zones where insurers are allowed to charge a higher premium and, for houses built after September 23, 2008, they can even refuse coverage. Insurers use their own risk assessment to calculate this premium. The tarification office covers households that cannot find an insurer willing to cover them or that only find coverage against a very high premium. In this case, there is a legal maximum tariff of a 90% surplus premium related to natural disasters. On average, this is about 4% of the whole fire insurance premium extra (Vanneuville et al., 2006). This tarification office is a common pool in which all insurers partake. In case of damages, all insurers bear the costs together, proportional to their relative share of insurance policies. However, the tarification office does not cover houses built after September 23, 2008. For these houses, the legal maximum tariffs no longer apply. This approach thus accommodates a certain, but limited solidarity principle between all citizens, at risk or not at risk.

Before 2007, flood damages were compensated by the National Disaster Relief Fund if the flood was recognized as a natural disaster. The Act of May 21, 2003, introduced a mandatory insurance coverage against flood through an extension of the fire insurance policy. However, this act was never implemented because the insurance coverage under the 2003 act was limited to buildings located in flood-prone areas. The fact that flood damages would be covered by the premiums of a small group of households with a real risk of flooding would lead to an uninsurable concentration of risks. This was contrary to the basic principle of solidarity of insurance systems.

4.3.2 Duty to Inform

The law on the land insurance contract of June 25, 1992, stipulates that notaries, architects, etc. can consult the location of real estate in a flood risk zone (following the federal flood risk maps) through the municipal administration.

In October 2013, this was extended to the Duty to Inform, an instrument that was included in the amendments to the DIWP of 2013 and was implemented on October 10, 2013. The Duty to Inform applies to all stages of real estate transactions (both rent and sale), i.e. from promotion and publicity, for all real estate (both buildings and land) in flood-prone areas. People that sell or rent real estate in effective or potential flood-prone areas on the water assessment maps need to disclose this fact in all publicity in the form of a logo or an explicit verbal indication, depending on the type of publicity. Notaries also need to include a water paragraph in the real estate deed.

4.3.3 Availability of information

Information on flood risks and the possible measures that residents of flood-prone areas can take is freely available online but not actively disseminated. Different websites inform on flood risks. For example, www.waterinfo.be is a joint project of the regional water managers. It provides information on current and predicted water levels, but also historical maps and hydrological reports on flood events. The website of the CIW also includes a geoportal with the maps supporting the RBMPs, the water assessment and the signal areas.

Different maps on flood risks are available. The regional water assessment maps clusters a number of maps. The effective flood-prone areas consist of recently flooded areas and modeled flood-prone areas. Potential flood-prone areas include naturally flood-prone areas (both alluvial and colluvial), potential flood-prone areas delineated within the Sigma plan and mine subsidence areas. The federal maps with risk areas for flooding are based on slightly stricter criteria than the regional water assessment maps and applies for regulations on damage compensation.

4.4

Analysis: resilience in formal flood risk management in Flanders

This part discusses to what extent the policies discussed above contribute to a flood resilience strategy, as conceptualized in the theoretical framework in chapter 2. It addresses the adaptability and flexibility of the content, process and context of spatial developments in flood-prone areas.

a Content: from protection to multilayered safety?

Throughout the policy document analysis, we see a trend in water management towards more diversification of measures, shifting from sheer engineering solutions towards more ecofriendly integrated approaches and adaptive building techniques. Multilayered safety is one of the most important principles in water management policies. However, within this diversification of measures, there still seems to be a certain bias or preference for technical, protective solutions. These interventions and policies are based on the extended technical knowledge on flood risks that water managers have developed through modeling and risk maps. However, this knowledge is mainly centered on hydrological modeling and economic damage (see for example the FRMPs, as discussed under section 4.1.2). While there is some information available on the number of houses in flood-prone areas, there is no knowledge on the socio-economic profiles of their residents and their vulnerability to flooding. This bias is reflected in the analysis supporting the new FRMPs. Although the model – in line with the EU FD – takes into account direct economic damage as well as also cultural heritage, ecosystem damage and social damage (in terms of loss of life), these are all converted and expressed in economic damage.

Within this line of reasoning, the possibility of a more socially embedded approach, with for example flood groups, information dissemination, education, etc. is not thoroughly considered, as it does not result in a calculable reduction of flood risks. Nevertheless, it is expected to contribute to the response capacities of the general population.

Spatial planning, on the other hand, has to deal with a rigid legacy of the regional zoning plans from the 1970s, both in terms of built development resulting from these plans and the rigid regulatory framework it still constitutes. Due to the relatively late conception of the regional zoning plans in the 1970s, some flood-prone areas had already been urbanized. Furthermore, on the one hand, regional zoning plans were inadequately informed with regard to flood risks from the beginning, and generously allocated residential areas that were also in flood-prone areas. On the other hand, the water system has significantly changed since the 1970s. Within water management (e.g. the Sigma plan of the 1970s), measures related to spatial developments in flood-prone areas were not included. This resulted in not only further development in flood-prone areas, but also in a rigid regulatory framework that allowed developments to take place in flood-prone areas without taking into account the water system. These zoning plans have proven to be extremely influential and are still important parts of spatial planning policy in Flanders.

From the 2000s onwards, a number of policy initiatives has emerged to overturn this situation and to support spatial solutions to manage flood risk, and thus a greater diversity in measures. Firstly, within water management (e.g. in the renewed Sigma plan of 2005), the scope widened towards multifunctional land use, natural retention basins etc. Within spatial planning itself, the water assessment and signal areas are the two most important instruments that promote spatial solutions. While the water assessment aims to neutralize potential impacts on the water system in the first place, it also imposes adaptive building techniques if required. By assessing each plan individually, tailor-made recommendations are possible. The signal areas allow the reevaluation of existing land-use allocations, thus enabling the introduction of building restrictions in the most critical areas. In order to decide on the most desirable development perspective in relation to the current and expected future flood risk, area specific considerations and deliberation between different actors involved are taken into account. However, the optimizations in the signal areas process stay within the logic of the zoning plans by merely altering them. This further strengthens the entrenchment in a strong regulatory framework, limiting adaptability in the face of changing flood risks even more.

Despite these efforts, spatial planning has little to no control over existing buildings. Only substantial renovations require a permit, and are thus subject to the water assessment. For these existing spatial developments, measures depend on the initiative and willingness of homeowners, which is incentivized through accompanying policies (see section 4.3). However, these are still relatively young, so it is hard to assess the effect they have in the diversification of measures.

b Process: from linear to adaptive management?

Due to the high diversity of actors and governance levels involved in the flooding issue, a lot of time and effort is put into coordination and integration between the different governmental actors, with varying degrees of success. A particular challenge is the difference in organizational scales between water managers and spatial planners. Throughout the last decades, the increasing degree of specialization within water management has led to a gradual scaling-up of responsibilities and competencies in the management of watercourses, often at the request and with the approval of the lower level water managers (Crabbé, 2008). For example, since the creation of the option to transfer the management of municipal watercourses to the provinces in 2014, most of the municipalities have voluntarily done so. On the other hand, the subsidiarity principle applies in spatial planning, placing more responsibilities on lower levels of public authority. This means that, for example, decisions on building permits for housing are taken on the local level. The different organizational structures of water management and spatial planning thus complicate integration between the two disciplines.

Furthermore, the organizational structures of the decision-making process sometimes result in suboptimal solutions. For example, municipalities often feel pressured to approve building permits in flood-prone areas, especially if these areas are allocated as residential zones. However, when problems arise, they often shift the responsibility of lowering the flood risks – which they supported to develop – to regional water managers. Or they take water management measures within their (limited) jurisdiction and power, which might not always be the most cost-efficient measures on the scale of the catchment.

Within formal FRM, there is a strong emphasis on content, i.e. the selection of the most optimal measures, at the expense of a full consideration of the process and social context. For example, calculation for the prioritization of FRM actions within the RBMPs was based on a cost-efficiency model. This analysis weighs the overall cost-efficiency of different potential measures without taking into account any social dimensions. It makes abstraction of a number of social issues – such as the distribution of responsibilities, power, and costs and benefits – amongst both public and private actors. Who is responsible for paying and implementing these measures, and who benefits from them? Who has the power to decide, who is involved in the decision-making process and whose voice is heard? What measures have social support? Only after the cost-efficiency modeling and the approval of the RBMPs will deliberation with other actors take place (currently ongoing). However, the outline of the plan is at that point already established, merely based on cost-efficiency considerations. In combination with the relatively closed communication of water managers, this challenges the legitimacy of these plans and creates conflicts and discussions amongst actors.

As for spatial planning, both the process of the water assessment and the signal areas are charged with some rigidity. Granting a building permit is a linear, one-off process. In that sense, permits are not adaptable at all; it is not possible to change or withdraw a building permit, and in reality, virtually no follow-up or monitoring of compliance takes place. Notwithstanding this rigidity, linking the water assessment to the building permit allows policy-makers and water managers to base their recommendations on current knowledge and insights. This reactivity allows for a certain degree of adaptability, which is not possible within the rigid land-use allocations of the regional zoning plans. The content of the water assessment has also shifted from merely compensating lost buffer capacity of the water systems towards also including regulations to reduce potential flood damages, such as adaptive building techniques.

The signal areas, on the other hand, are more proactively aimed at preventing harmful spatial developments in flood-prone areas. However, changes to the land-use plans of the 1970s are subject to slow and lengthy procedures, which limits the ability to quickly identify and respond to new priorities or new threats. This approach is relatively slow and requires long processes with different stages of approval. Although the signal areas, for example, take into account projections for climate change, this attests to a limited capacity for dealing with changes.

The weak spot of both the water assessment and the signal areas is the legal status and enforceability of measures (De Smedt, 2014). The advice of the water manager in the water assessment is not binding. Also, the decision by the Flemish government on the development perspective of the signal areas is not binding on the government that approves or establishes the spatial development plan (De Smedt, 2014). So there is little guarantee that the conditions in the development perspective for the signal areas will be implemented.

Evaluation of plans and instruments, both in water management and spatial planning, is performed frequently and systematically, resulting in adjustments to these plans and instruments. This enables adaptability and allows for the development of learning capacities. However, these evaluations are oriented at short-term optimizations of existing plans and instruments, while the more strategic questions on long-term effects are less prominent. For example, evaluations in the water assessment are mainly focused on managerial optimization: making the information more accessible for the different actors involved, simplifying the performance of the water assessment, making the process more transparent and uniform. Also, evaluation is foreseen for the Signal areas instruments, but it has not yet been performed, as the process is ongoing. As such, most of these processes are cyclical rather than adaptive.

c Context: adaptive capacities

The way governments deal with flood risks is quite top-down. Both the water assessment and signal areas take a restrictive approach towards limiting damages in flood-prone areas to avoid land-uses that are expected to aggravate flood risks. However, under uncertainty and a lack of information, restrictions on, for example, private property rights might not be justified (Fleischhauer et al., 2012). Moreover, there is no supervision on the compliance with the conditions or building regulations of the water assessment, so it is uncertain that the conditions in the water assessment will be implemented.

While the aim is to include multiple actors and share responsibilities in FRM, participation and deliberation options for non-governmental actors are limited. It seems that relationships are mainly built between different governmental actors.

The CIW aims to bring together different actors, but this integration is limited to public administrations. Within the sub-basin council, organized societal actors are represented and can draft recommendations for the RBMPs and the Water Implementation Program, or on their own initiative. For the RMBPs, participation of the broad public and societal stakeholders is organized through a formal public consultation procedure. However, this excludes participation in the earliest conception of the plans. Nevertheless, the models include measures that fall under the jurisdiction or reasonable responsibilities of other actors, such as adaptive building techniques for private housing. So the government is looking to make citizens responsible while at the same time not including them in policy-making and only vaguely communicating on flood risks (Mees et al., 2016c). This leads to discussion and mistrust amongst other actors towards water management, thus putting their legitimacy at risk.

While water managers have a good technical knowledge on flood risks, other actors – especially non-governmental actors – often cannot use this knowledge, as it is not actively communicated with them. Some maps are available online, but for a layman, it might be difficult to accurately interpret the information the maps provide. The knowledge is institutionalized in the form of maps. While this is a very good communication tool, there are also some constraints linked to this representation, such as the different terms and classifications to indicate different levels of risk and the strong delineation of flood risk areas. Another point is inconsistency due to the different flood risk maps (federal and regional). This might cause confusion and ambiguity on flood risks. Considering the closed nature of knowledge development and the lack of communication of this knowledge, it is likely that the resulting learning processes are confined to a small expert group, and do not extend towards societal actors.

Furthermore, residents and other societal actors operate on a local level, while water management is organized in a much more top-down manner. The question is how their local knowledge, involvement and participation can be brought together with the expert knowledge and higher scale operating levels of water management.

4.5

Conclusion

This chapter provided an overview of formal FRM in Flanders, i.e. the policies to manage floods present in water management and spatial planning, and other policies related to real estate and damage compensation in flood-prone areas. The central question was: to what extent does formal FRM support the development of flood resilience? To answer this question, we have discussed the different aspects of the formal FRM strategy according to the theoretical framework on flood resilience strategies developed in chapter 2. Without going into detail on the specific regulations and measures, we here sum up the main conclusions in relation to the content and process of formal FRM and its (potential) effects on its context and other actors.

The first question was: to what extent does the content, the process and the context of formal FRM contribute to resilience? First, there is a certain tendency towards the diversification of measures evident in Flanders. Multilayered safety is, for example, a clear and explicit policy objective for FRM in Flanders. The scope of FRM is broadening to include a more integrated approach and adaptive building techniques. Also, within spatial planning, complementary spatial interventions are proposed as a solution to deal with flood risks through the water assessment and signal areas. Nevertheless, both FRM and spatial planning have to deal with strong path dependencies, complicating the implementation of this transition. In water management, a certain bias towards economical damage and technical protective measures can be noted. Spatial planning, on the other hand, has to deal with the inertia and rigidity of existing spatial developments and regulations. At this point, spatial planning has not yet succeeded to break with the strongly regulatory approach of the zoning plans, which might not be flexible enough to account for changing flood risks; and water managers have not yet managed to include more socially embedded approaches, which might be necessary as a complimentary strategy in light of increasing flood risks and limited budgets.

As for the process, some elements of adaptability can be noted, although there are still major challenges. While responsibilities within water management have been gradually scaled-up, spatial planning is organized according to the subsidiarity principle, leading to challenges in the coordination between the different government actors, and thus suboptimal solutions. Within water management, there is a strong emphasis on content at the expense of the full consideration of social dimensions of FRM. In spatial planning, the rigidity of the regulatory framework leaves little room for adaptability. Land-use allocation changes (as in the signal areas) require long and intensive processes. The water assessment, on the other hand, allows the most recent knowledge and insights to be taken into account, although there is no follow up in terms of implementation and the building permit itself is a linear process. The RBMPs and instruments are subject to frequent and systematical progress reports and evaluation, thus enabling adaptability and the development of learning capacities. However, the more strategic choices are often not included in these evaluations.

So there is a certain evolution towards flood resilience, as defined in chapter 2, taking place within formal FRM. Some elements of flood resilience can be noted in both the content and the process of formal FRM. However the transition is slow and there are still some gaps.

The second question was: does formal FRM support other actors to develop resilience (co-evolutionary aspect)? Although 'shared responsibilities' is an important element of the recent policy discourse of mainly water managers, few elements of formal FRM support the development of adaptive capacities. The restrictive top-down approach; lack of participation, deliberation and communication with non-governmental actors; and the high degree of expert knowledge development create a closed formal FRM practice. This might limit the adaptive capacities of non-governmental actors. Therefore, it can be expected that, under these conditions, actors do not actively take responsibilities in managing flood risks. However, it is clear that both the integration of flood risk concerns within spatial planning and the development of instruments aimed at the involvement of land users in FRM are still relatively young. These policies are still in development and implementation has sometimes not yet taken place.

5

Residents in flood-prone areas

Parts of this chapter have been previously published as:

- Tempels, B., 2015. *Residents and flood risk management in Flanders: two worlds apart?* AESOP Annual Congress 2015: Definite space, fuzzy responsibility. Book of proceedings, pp. 2912-2927.

In order to contribute to the recent discussions about responsibilities of residents in relation to spatial development in flood-prone areas, this chapter provides insights into the attitude and behavior of these residents towards spatial development and flood risk. This chapter addresses the question: *what is the current and potential role of residents in the spatial development of flood risks?* Flood risk perceptions and motivations for protective behavior are significant features of community resilience in the face of flood events. The behavior and attitude of residents in relation to flood risks and floods has been subject to research for some time in the United States (Montz and Gruntfest, 1986; Waterstone, 1978; White, 1945), and gained interest in Western Europe recently (Bubeck et al., 2013a; Filatova et al., 2011; Grothmann and Reusswig, 2006; Kreibich et al., 2011; Parker et al., 2009; Siegrist and Gutscher, 2008; Terpstra and Gutteling, 2008). However, in Flanders, such research is largely lacking.

This chapter analyzes a wide array of the interactions of residents with flood risks in the Dender basin (Flanders, Belgium), based on a survey amongst residents in flood-prone areas. These interactions include (1) the availability and use of knowledge, (2) the way risks are experienced, (3) how residents chose their location and the extent to which they are willing to move, (4) who they deem responsible for different aspects of the issue and (5) what they do to protect themselves. This chapter discusses how these interactions contribute to FRM and how they could become more fruitful for FRM in the future.

As such, this part contributes to the existing knowledge in two ways. On the one hand, the focus is specifically on residents and spatial planning, since the debate on FRM is often conducted from the perspective of water managers. On the other hand, it discusses a large array of topics — from psychosocial aspects, such as awareness and knowledge, to behavioral aspects — and, eventually, the translation to policy.

5.1

Interactions between residents and flood risks

In what follows, we will discuss some of the main aspects that influence residents' experiences of flood risks and how they deal with them accordingly, based on literature review. Most of the topics addressed in this chapter have been described individually within different fields and geographical or political contexts (see further). However, the survey provides an integrated view on these issues.

Several studies have shown that there is a complex interplay of socio-psychological mechanisms that affects protective behavior (Bubeck et al., 2012; Bubeck et al., 2013a; Filatova et al., 2011; Grothmann and Reusswig, 2006; Kreibich et al., 2011; Parker et al., 2009; Siegrist and Gutscher, 2008; Waterstone, 1978). These mechanisms include elements of risk appraisal elements (e.g., risk perception, awareness, potential damage, previous exposure) and coping appraisal (e.g., self-efficacy, resources and outcome expectation, cost-benefit ratio), within respective institutional contexts (e.g., political focus and reliance on public protection).

On the other hand, the impetus for individual adaptation can be reduced or even removed by technological or financial assurances (Smithers and Smit, 1997). The confidence in flood prevention and centrally led, engineered solutions implicitly triggers a low risk awareness and disbelief in the efficacy and praticality of private damage prevention, which may contribute to an inactive attitude towards autonomous adaptation measures (Grothmann and Reusswig, 2006).

Lalwani and Duval (2000) have shown that personal responsibility is not assumed when there is no clear information indicating that individuals are personally responsible for threat management, even under conditions of high risks and sufficient resources to deal with the risk. When governments are assumed to provide protection, there may be a reluctance to accept responsibility. The limits on the capacity of the state to manage flood risk are widely recognized and, therefore, there is an overall plea for more individual responsibility in FRM (Johnson and Priest, 2008). However, the division of responsibility between state, public organizations and citizens in the management of flood risk is often not clearly established. At the moment, the government is perceived to be responsible for protecting private persons against flood losses in many European countries (Vari et al., 2003). Strong reliance on and confidence in public flood protection may hamper a private sense of responsibility (Grothmann and Reusswig, 2006). Even if personal responsibility is clear, it is mostly accepted only if individual resources or instruments to act upon risks are available (Filatova et al., 2011).

Filatova et al. (2011) state that low individual flood risk awareness leads to inefficient spatial developments and increased flood risks. They argue that, by increasing individual risk awareness, it is likely that flood risks are integrated into the individual economic decisions at the level of the the housing market, since housing prices are often lower in flood-prone areas (Eves, 2004; Montz and Tobin, 1988).
Individual decisions on private risk mitigation measures and location choices are also influenced by the extent to which insurance premiums internalize actual variations in risk and damage is cross-subsidized by the whole population (Bouwer et al., 2007). Possible incentives for individual risk reduction might include lower premiums, higher coverage and lower levels of tax deduction (Botzen et al., 2010). However, in practice, premiums generally do not fall as risk is reduced (Penning-Rowsell and Pardoe, 2012).

As a last element, knowledge on flood risks is a precondition for being in the position to act (McEwen et al., 2012). However, (White et al., 2001) state that increased knowledge does not necessarily lead to declining damage levels. Possible reasons for this are found in lacking or flawed knowledge, the fact that knowledge is not used, that knowledge is used in an ineffective or contradictory manner, or that the proper application of knowledge is overtaken by other, vulnerability increasing, processes.

Therefore, risk communication is an important element of any strategy to activate residents. However, since knowledge of risks does not always translate into personal worry, merely providing information about risk is not enough (Parker et al., 2009; Willis et al., 2011). Risk perception generally depends on personal characteristics, situational factors and risk characteristics (Lindell and Hwang, 2008). Explicitly dealing with risk perceptions in risk communication can make FRM more effective (Baan and Klijn, 2004; Buchecker et al., 2013; Grothmann and Reusswig, 2006; Kellens et al., 2011). Flood forecasting and warning play a central role in this (Brilly and Polic, 2005).

The above shows that the interaction between residents and FRM is influenced by complex economic, psychological and social mechanisms. Therefore, the transition towards more resident involvement and a more active role for spatial planning in flood management, as advocated in literature and policy plans alike, is difficult to realize. Existing flood management paradigms are, in a way, self-preserving, as they reproduce themselves through feedback mechanisms (Jong and van den Brink, 2013). The path dependencies following the high expenditures for flood protection induce low responsibility awareness amongst the involved citizens.

5.2

Methodology

Based on the literature review in section 5.1, five themes were selected to analyze the relationship between residents and flood risks and the associated actions and attitudes, with the following associated research questions:

1. Awareness and knowledge: are residents aware of the flood risks and how much do they know about flood risks?
2. Risk perception and experience: how do residents experience the flood risks?
3. Location choice and willingness to move: how do residents take into account flood risks in their location choice?
4. Sense of responsibilitiy: who do residents deem responsible for different aspects of the issue?
5. Protective behavior: what do residents do to protect themselves?

We conducted a survey amongst residents of flood-prone areas in the Dender basin in order to measure their attitudes and behavior in relation to riverine flood risks – for the first time in Flanders. The questionnaire consisted of 66 questions and resulted in a database with 317 unique variables (see Appendix 1 for the full questionnaire). It discussed the respondents' experience with flooding; their knowledge on the risk and possible private measures; their housing location choice and flood protection behavior; and their views on FRM. It was the explicit choice of the authors, in line with the research design, to conceive a broad and comprehensive questionnaire, that addressed a wide range of flood-related themes relevant to the role of spatial planning in FRM, as illustrated by the state of the art given above.

The questionnaire was developed based on the outcomes of the exploratory interviews and the existing literature. Preliminary versions were reviewed by experts in survey design and policy-makers in FRM in Flanders. It was tested by five households in flood-prone areas outside of the study area for comprehensibility and clarity, and adjusted in accordance with their feedback. A pilot study

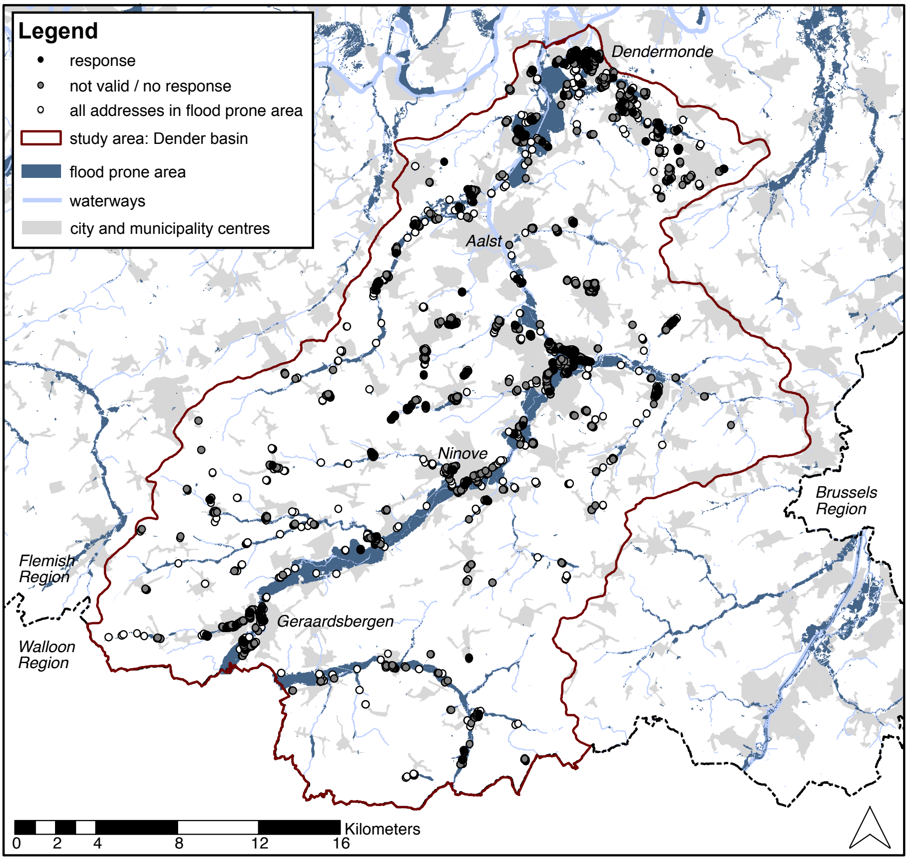

Figure 13 Map of the case study area: the Flemish part of the Dender basin, with indication of flood-prone areas according to the water assessment maps and the sample of the survey

with 41 respondents in the study area, which were not included in the final sample, provided preliminary insights that allowed further adjustment of the questionnaire to maximize usability of the results.

In September 2014, the survey was distributed amongst residents of actual flood-prone areas following the Flemish water assessment maps (version 1 September 2014, see Figure 13). These areas have recently flooded or have a flood return period of 100 years with a flood depth of 30 cm. From the 4,732 addresses in this area, 1,100 were ramdomly sampled, as there was no demographical data available on the level of flood-prone areas. Businesses and public institutions, vacant homes and incorrect addresses were omitted, based on onsite assessment. This led to a sample of 916 active private households, and an estimated population of 3,940 active private households. A relatively small sample was chosen in order to use the available resources in obtaining an as high as possible response rate to limit non-response bias. In order to maximize the response rate, the questionnaire was personally delivered and could be returned on paper or online.

We received 184 completed questionnaires. One response was excluded because it was a double entry, resulting in 183 valid responses (response rate 20.0%).

Considering the length of the questionnaire and the relatively small population, this was considered sufficient. This amounts to a margin of error of 6% at a 90% confidence interval Representativeness of the sample could not be tested because socio-economic data of the population (residents of actual flood-prone areas) are not available for privacy reasons. Descriptive statistics on the sample can be found in Table 7.

		total
N		183
age, mean (standard deviation)		57.0 (15.5)
gender	male	61.2%
	female	38.3%
occupation	retired	39.3%
	non-active	7.1%
	active	53.0%
flood experience	none	41.2%
	without damage	25.3%
	with damage	33.5%

Table 7 Descriptive statistics of the survey sample

After exploring the data through graphical representation such as bar charts, we analyzed the pairwise relation between variables from the survey by means of Spearman's bivariate rank tests for non-parametric variables (such as Likert scale questions) and Mann-Whitney tests for dichotomous variables (such as yes/no question). For Spearman's test the correlation coefficient (r_s) and significance level ($* = 0.01 < p < 0.05$; $** = p < 0.01$) are reported. For the Mann-Whitney test, the significance level is reported. Some socio-economic variables that yielded only few significant correlations, such as income, level of education, gender and size of the house, were left out. A full overview of the statistical analysis results can be found in Appendix 2 (Table 10 for the Mann-Whitney tests, and Table 11 and Table 12 for the Spearman's rank tests).

5.3

Results

Following the research design, the results are discussed in five themes: (1) awareness and knowledge, (2) risk perception, (3) location choice and willingness to move, (4) sense of responsibility and (5) protective behavior and seeds of self-initiative.

5.3.1 Awareness and knowledge

About two thirds of the respondents are aware that they live in a flood-prone area, while a quarter of the respondents think their residence is not situated in a flood-prone area. This awareness is associated with flood experience ($p<0.01$, Mann-Whitney). This is confirmed by the fact that only one third of all respondents indicate they were aware of the flood risk when they moved there. This is not correlated to the length of residency; respondents that have recently moved were not necessarily more aware of the flood risk at that time. However, younger respondents are better aware of flood risks when moving ($0.01<p<0.05$, Mann-Whitney).

However, the knowledge on the flooding issue is rather limited. A bit more than half of respondents (57.5%) say they know little or very little about the flood risk. Here again, the number of floods experienced is of significant relevance (r_s=0.16*), but also length of residency (r_s=0.16*) and ownership (r_s=0.25**). Respondents that were aware of the flood risk at the time of moving also feel that they know more about the flood risk ($p<0.01$, Mann-Whitney). Respondents that are aware that they are living in a flood-prone area, however, do not necessarily feel that they know more about the flood risk ($p>0.1$, Mann-Whitney).

About 80% of the respondents say they know little about measures they can take themselves. As with the knowledge on flood risks, the respondents who have experienced more floods (r_s=0.26**) and have lived longer in the same house (r_s=0.16*) indicate that they know more about possible measures. Respondents that know more about flood risks (r_s=0.51**) and were aware of the flood risk at the time of housing choice ($p<0.01$, Mann-Whitney) know more about measures. However risk awareness does not yield a significant correlation ($p>0.1$, Mann-Whitney).

The above suggests that knowledge on flood risks and measures is, in large part, experience based. This is confirmed by looking into the origins of this knowledge (Figure 14). Besides flood experience, the most important actors that provide information on flood risks are civil parties, followed by governmental bodies (especially local governments) and business actors. The relative importance of these actors in information dissemination is generally the same for flood risks and possible measures, with the exception of the differences between civil parties and the rest being smaller for information on measures.

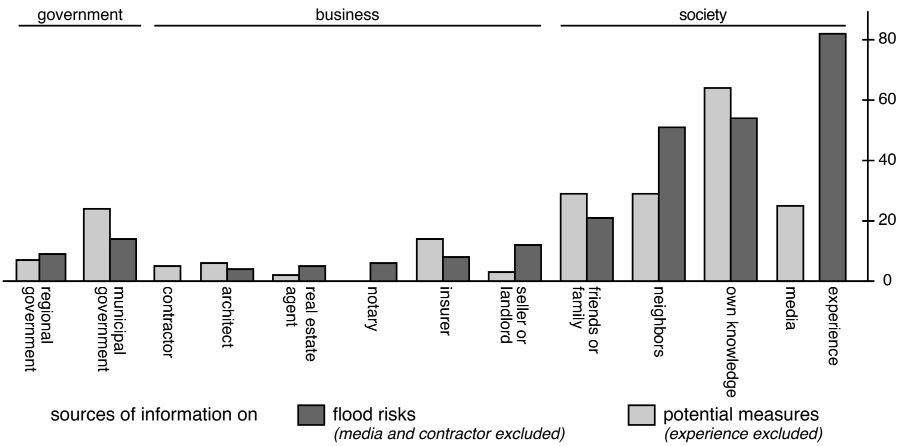

Figure 14 Sources of information on flood risks (a) and measures (b), measured in number of respondents that have accessed these sources

Although over half of the respondents (59.2%) know the official water assessment maps, only on third of these respondents (36.9%) know the correct classification. Only 18.7% of the respondents have consulted the water assessment maps; which is, nevertheless, the highest rate of all the information sources (e.g. websites, informal conversation, brochure or newsletter). Also, the governmental website with information on flood risks reaches 13.7% of the respondents, which is similar to the rate of informal conversation as a source of information.

5.3.2 Risk perception and experience

Around half of respondents (55.6%) indicate not knowing when the next flood will take place. A fifth (21.3%) think it will be in less than 5 years, and another fifth (19.1%) between 5 and 25 years. As all respondents live in areas that have a modeled return period of 100 years (or less) with a flood depth of at least 30 cm, these answers might indicate that there is no real underestimation of flood frequencies, but rather that there is a great uncertainty or lack of knowledge on the flood risk. There is no significant difference between the estimation of the current expected flood frequency and the expected flood frequency in 2050 ($p>0.05$, Wilcoxon Signed Ranks test). This indicates that respondents do not expect a substantial increase in flood frequency.

The emotional impact from the flood risk is analyzed for three different aspects: suffering, fear and worrying. About 40% indicate that they suffer from these emotional impacts. The most important emotional impact is fearing floods ($m=3.02$ on a 5-point Likert scale, $s.d.=1.47$) and worrying about the flood risk ($m=3.00$, $s.d.=1.41$), while suffering from the flood risk is perceived as the least important emotional impact ($m=2.64$, $s.d.=1.45$). All three emotional impacts (suffering, fear and worrying) show similar patterns of association with other variables. Significant correlations were found with the age of the dwelling (resp. $r_s=0.28^{**}$, $r_s=0.22^{**}$ and $r_s= 0.20^{**}$), flood experience (resp. $r_s=0.61^{**}$, $r_s=0.45^{**}$ and $r_s=0.43^{**}$) and risk awareness ($p<0.00$ for all three variables). However, only for suffering were correlations found with knowledge on the flood risk ($r_s=0.25^{**}$). For suffering and fear, associations were also found with length of residency (resp. $r_s=0.22^{**}$ and $r_s=0.20^{**}$) and state of dwelling (resp. $r_s=-0.26^{**}$ and $r_s=-0.19^{**}$).

Subsequently, the impact of flooding in terms of how the different types of damage are experienced by respondents (with flood experience) was examined (Figure 15). Emotional impacts – such as the cleanup effort and the uncertainty, fear, shock and helplessness – appear to be the most disruptive and frequent impacts. More temporal effects – such as the difficult accessibility and disruption of everyday life – are frequent, but less disruptive. However, more long-term effects – such as administration and negotiation with insurance companies and contractors, and financial and material loss – are considered less frequent, but very disruptive. These findings largely correspond to what Siegrist and Gutscher (2008) have observed. However, it is remarkable that, in this case, financial loss is perceived as quite hindering, which is not in line with Siegrist and Gutscher's observation that emotional impacts are greater than material and financial ones.

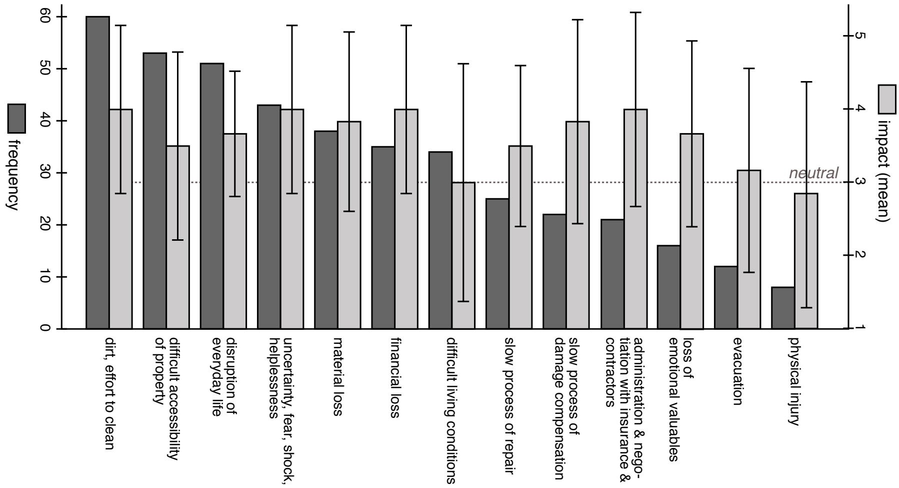

Figure 15 Frequency of different damage aspects (a) and perceived impact of different damage aspects (b)

5.3.3 Location choice and willingness to move

The respondents like living where they reside. More than three-quarter of respondents are happy with their home and 60.7% are planning to spend the rest of their lives there, while only 11.4% want to move away within five years. Respondents who know more about flood risks are more likely to like living where they live (r_s=0.18*) and plan on staying there longer (r_s=0.24**). Besides that, mainly non-flood related variables play a significant role. The pleasure of living is associated with the state of the dwelling (r_s=0.22**) and income (r_s=0.20*). On the other hand, desired future length of residency is correlated with ownership (r_s=0.32**), how long respondents have lived there (r_s=0.33**) and age (r_s=0.33**). It is remarkable that respondents with experience of flooding do not necessarily dislike the idea of staying, as no significant correlation for these variables was found.

The overall satisfaction with their home is confirmed by the fact that only 14% of respondents regret their choice of location. There is a strong correlation with flood experience (r_s=0.49**), as all respondents that regret their location choice have experienced floods. However, it is remarkable that having regrets correlates with the pleasure of living (r_s=-0.38**) and the state of the dwelling (r_s=0.22**), but not with the intended length of residency; respondents that regret their location choice are not planning to move away faster. Respondents that were not aware of the flood risk at the moment of their location choice also are more likely to regret having decided to live ($0.01<p<0.05$).

The question comes up: why do respondents live in flood-prone areas? The main motivations for housing choice are non-water related factors, such as accessibility, proximity to facilities, characteristics of the dwelling and social ties with the area (Figure 16a). These are far more important than amenities related to the location in the flood-prone area, such as proximity of water or, possibly, lower real estate

Figure 16 Reasons for housing choice in general (a) and for respondents aware of flood risks at the moment of housing choice (b), measured in mean score on a 5 point Likert scale, error bars indicate 95% CI

prices. So there is no clear link between location choice and flood risks. On the other hand, a green and quiet environment is an important attractor as well; but it is unclear whether this is specifically related to the flood-prone area or rather to the broader (rural or suburban) environment.

For respondents that were aware of the flood risk at the moment of location choice, the main considerations for their location choice are that the risk is low, on the one hand, and that the location and characteristics of the residence are favorable, on the other (Figure 16b). Motives that are less desirable from a flood management perspective – such as misjudgment of flood risk, reliance on insurance and financial deprivation – are of less importance. This might indicate that the location choice for respondents who are aware of the flood risk is well informed. However, it is possible that risks turn out to be higher than expected, and issues could emerge in the near future.

In line with the finding that respondents like to live where they live, the desire to move away is very low; 5.4% want to move, while 85.5% do not want to move. The desire to move is correlated with flood experience (r_s=0.27**) and risk awareness at the moment of location choice (0.01<p<0.05), next to the state of the residence (r_s=-0.17*). Also the willingness to move (as a flood protection measure) is low; only 10.8% are willing to move, while 89.2% are not willing to move. This, however, does not correlate with risk-related variables, such as knowledge or flood experience, but rather with non-flood related variables, such as age (r_s=-0.21*) and length of residency (r_s=-0.19*); the younger the respondents and the less time they have lived there, the more willing they are to move. Nevertheless, the desire and willingness to move away is associated with high emotional impacts; r_s=0.22** for suffering (only desiring to move), r_s=0.37** and r_s=0.29** for fear, r_s=0.37** and r_s=0.29** for worrying, and r_s=0.59** and r_s=0.38** for regretting their location choice, respectively.

When asked after how many floods respondents might be willing to endure before wanting to move, 40.5% indicate that they would never move due to flooding. Surprisingly, this persistence correlates positively with flood experience (r_s=0.25**). This means that respondents with flood experience are more persistent in wanting to stay there than respondents without flood experience. These are also the respondents with the highest knowledge on risks (r_s=0.22**) and measures (r_s=0.31**), and the respondents that have lived there longest (r_s=0.28**).

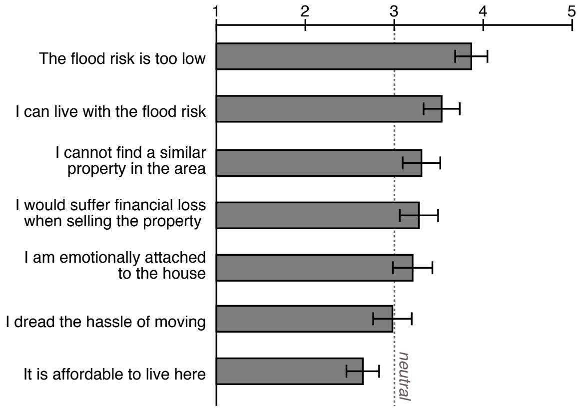

Figure 17 Reasons not (willing) to move, measured in mean score on a 5 point Likert scale, error bars indicate 95% CI

Parallel to the considerations of respondents aware of flood risks at the moment of housing choice, the main reason why respondents do not want to move is that the risk is low (Figure 17). Remarkably, the second most important reason is that the respondents can live with the flood risk, which might indicate a certain acceptance of the flood risk; although, again, it is possible that risks are underestimated. Notwithstanding the low desire to move, 20.1% of respondents indicate that, if they did move, it would be at least partly because of the flood risks; and a third of the respondents (29.7%) state that they would move to a similar residence outside of the flood-prone area if it would not cost any money.

Thus, the attachment of respondents to their homes is associated with non-flood related variables, such as socio-economic and real estate characteristics, while flood risks and experience do not necessarily reduce this attachment. Also, the willingness to move seems to be related to socio-economic variables, rather than flood risks.

5.3.4 Sense of responsibility

The respondents consider the government (both local and regional) to be the main party responsible for the existing flooding issue, while they perceive the residents to be least responsible (Figure 18a). It is remarkable that there is a large consensus on this. The vast majority of respondents (about 80%) agree with the statement that the government is responsible for the existing problems, while only 10% agree with the statement that residents are responsible for the existing problems.

The extent to which different actors are expected to be able to help in resolving the issue (Figure 18b) shows a similar pattern. Eighty-nine percent of respondents also deem the government responsible for resolving the issues, while only 19% believe that residents can help resolve the issues. Nevertheless, 42.1% of respondents wish to be involved in finding solutions to the flooding issue.

In relation to location choice and flood risks, 70.6% of respondents agree with the statement, “as the authorities have allowed me to come and live here, they are responsible for protecting me against flooding,” while only 19.5% of respondents agree with the statement, “I have moved here, so I am responsible to protect myself against flooding.” This is quite remarkable, considering the fact that regional zoning plans originally did not sufficiently take flood risks into account.

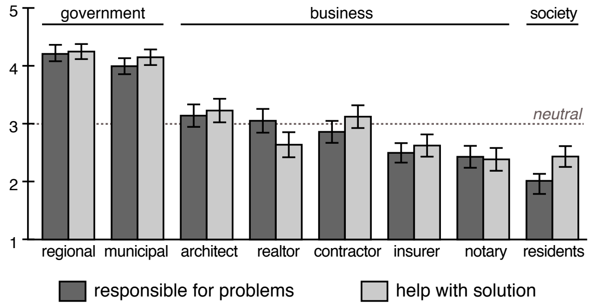

Figure 18 The extent to which different actors are responsible for the existing problems (a) and can help solving problems (b), measured in mean score on a 5 point Likert scale, error bars indicate 95% CI

So the government is perceived as the leading actor in both causing and solving the flood issue, while respondents see only a limited role for themselves. However, the extent to which residents consider themselves to be responsible for the existing problems and can help in resolving them is associated with knowledge on flood risks (resp. r_s=0.23** and r_s=0.18*) and knowledge on measures (resp. r_s=0.19* and r_s=0.30**). High levels of knowledge are thus associated with a higher sense of responsibility. Also, risk awareness at the moment of location choice is of relevance; respondents that were aware of the flood risk at the moment of location choice put less responsibility for the existing problems on the government (0.01<p<0.05) and more on residents (p<0.01), while they also are more likely to believe that residents can help in resolving the issue (p<0.01). This indicates the importance of knowledge on risks and measures, and risk awareness at the moment of location choice in assuming responsibility.

When asked to what extent governments and residents take sufficient action, about 44% of respondents indicate that they themselves take sufficient action, while only 30% think the government does so. This is associated with flood experience: respondents with flood experience feel more often that the government is not taking sufficient action (r_s=-0.19*) while they themselves are doing so (r_s=0.26**).

5.3.5 Protective behavior

About one third of respondents indicate they have taken initiative to learn about the flood risk and the measures they can take. These respondents indicate that they know more about the flood risk (p<0.01) and the possible measures they can take

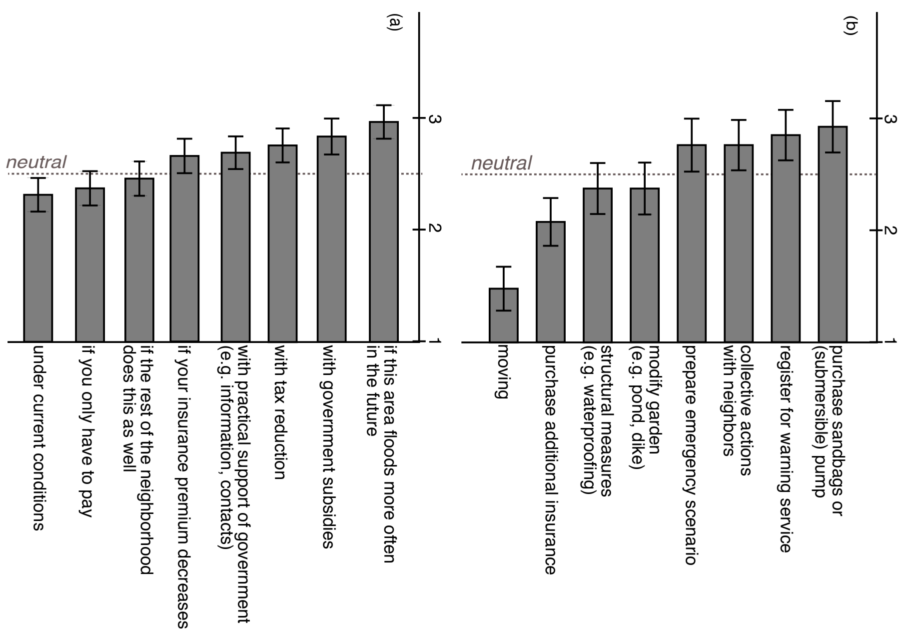

Figure 19 Willingness to take measures to reduce flood damage under different conditions (a) and by type of measures (b), measured in mean score on a 4 point Likert scale, error bars indicate 95% CI

($p<0.01$). Information-seeking behavior on flood risks seems to be inspired by risk awareness at the moment of location choice ($0.01<p<0.05$), while information-seeking behavior on measures is related to flood experience ($p<0.01$).

A bit less than half of the respondents (43.4%) are willing to take measures against flooding. Respondents that are willing to take such measures have more often sought information on risks ($0.01<p<0.05$) and possible measures ($p<0.01$). The willingness to take measures is also associated with flood experience (r_s=0.33**) and knowledge on measures (r_s=0.27**). Taking into consideration the conditions under which respondents would be willing to act, we see that an increased flood frequency and government incentives such as subsidies, tax reduction and practical support are most preferred (Figure 19a). The low score for the option 'if the rest of the neighborhood does this as well' indicates a lack of sense for collective action.

The type of measures the respondents are willing to take are mainly low-cost and low-key measures (Figure 19b). However, collective action scores high, which is remarkable since the previous results showed little belief in the respondents' own capacities in dealing with flood risks.

Nevertheless, half of all respondents have already taken action to reduce the consequences of flooding. Taking action is mainly associated with flood experience (r_s=0.63**); 16.4% of respondents without flood experience, 47.6% of respondents with non-damaging flood experience and 89.5% of respondents with damaging flood experience have taken measures. This indicates that taking action is mainly reactive to flooding. Other significant flood-related variables are knowledge on risks (r_s=0.22**) and measures (r_s=0.31**), information-seeking behavior on risks ($0.01<p<0.05$) and measures ($p<0.01$), but also non-flood related variables such as condition of the property (r_s=-0.21**), age of the dwelling (r_s=0.27**), and length of residency (r_s=0.34**) play a significant role.

However, the investment in these measures is rather limited; 60% of the respondents that have taken action invested less than € 500 in these measures. The invested amount is associated with flood experience (r_s=0.31**), knowledge on measures (r_s=0.29**) and the extent to which respondents like to live there (r_s=0.30**). The most frequent measure is purchasing sand bags or a pump(ing installation) (73%), followed by storing valuables on an elevated spot in the house, and structural measures (around 30%). Meanwhile, only a small fraction (around 5%) joined a neighborhood committee, waterproofed their interior, registered for a warning service or purchased additional insurance. Here again, easy and low-cost measures are preferred over structural measures. Furthermore, we observe very little collective action, although the findings above have indicated a relatively high willingness to take collective action. About half of the respondents that have taken action are satisfied with the measures they have taken. Nevertheless, only about a third of respondents think these measures protect them sufficiently against flooding or feel more at ease since taking these measures.

The motives to take action (Figure 20a) are mainly flood-event related. We notice a tendency towards more ad-hoc decisions in the context of a specific flood event, rather than pro-active or reactive reasoning. In addition, new information does not appear to be a significant motivator for taking action. So, even though our survey has showed strong correlations between knowledge levels and sense of responsibility on the one hand, and willingness to take action on the other, it seems that knowledge in itself is not enough incentive to take action. The main reasons respondents give for not taking action are, first, the strong belief in collective action and government responsibility, followed by the belief that risks are low and a distrust in individual capabilities (Figure 20b). Personal circumstances were mentioned least. Here, proclaimed trust in collective action again conflicts with observed protective behavior.

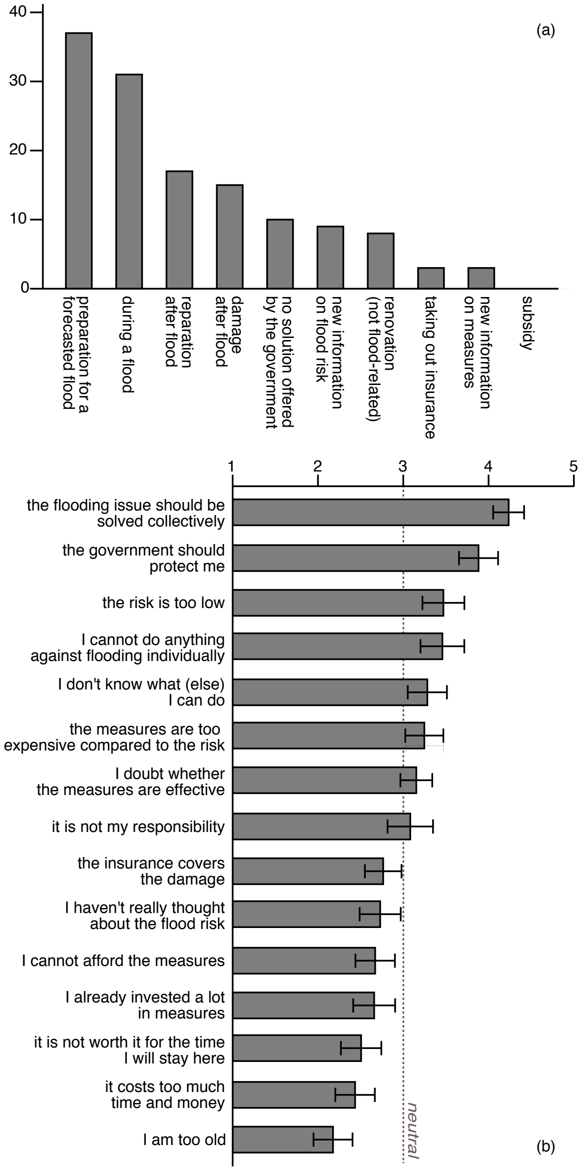

Figure 20 Motives to take action (a), measured in number of respondents, and motives not to take action (b), measured in mean score on a 5 point Likert scale, error bars indicate 95% CI

5.4

Conclusion and discussion

Research in water management and planning often presents the flooding issue as a rather technical matter, while the interrelationship with broader social dynamics and institutional issues is not always discussed thoroughly. We have, therefore, conducted a survey that assesses how residents of flood-prone areas in the Dender basin (in Flanders, Belgium) deal with the risk to which they are exposed. Our survey has probed for the residents' knowledge of the flood problem, their perception of the associated risks, the measures they take, the satisfaction with their home and their sense of responsibility. We started from a sample of households whose residence is designated as a flood-prone area in official maps. This research base is interesting since Belgium is known for a rather weak position in steering development (Boussauw and Boelens, 2015; Verbeek et al., 2014), unlike many neighboring countries such as the Netherlands. This context would suggest that residents play an active role in FRM. However, very little efforts have been made to include or activate residents in FRM; as compared to, for example, the United Kingdom. This would suggest that residents included in our research would show a relatively low degree of risk awareness and responsibility, and would not be inclined toward self-initiative.

The survey shows that residents included in our research show a relatively low degree of risk awareness and responsibility, and are not be inclined toward self-initiative. A large majority of residents have low risk awareness; are poorly informed; have little or no intention to relocate; and, strikingly, often impose all responsibility for the risk they run on the authorities. Residents do not truly see themselves as responsible and do not believe they can actively contribute to managing flood risks. They deem a very limited role for themselves, and expect solutions from the government. Nevertheless, they do take some action, but these actions are low-key, individual and ad hoc. So far, recent government initiatives – such as publishing and regularly updating flood risk maps, adjusting insurance policies and introducing a mandatory notification on flooding issues when a house is sold – seem to bring little change.

We believe that the key to understanding the dismissive attitude towards responsibility in the population must be partly sought in the very rigid and inert Belgian institution of regional zoning plans (see chapter 4), which in the 1970s have set land-use allocations for the whole of Belgium and provided ample space for possible contrustrion. Although these plans have their merit in managing to keep some open space areas free of any construction, they also implied a de facto right to build on land that was actually never thoroughly determined to be appropriate for construction. As such, the plans primarily provide legal certainty instead of implementing a vision on future spatial development. Once a plot is marked as construction land, a right to build is supposedly established, after which the government is considered responsible to facilitate realization of this right. Today a number of flood-prone areas are still considered to be construction land, certainly by owners, developers and residents, yet the responsibility to keep the plot (and in many cases, the house on it, as well) dry is placed solely on the government. Even in flood-prone areas, residents assume that the permission to build implies that the plot is flood-free.

Our survey shows that residents have little to no awareness of the inadequate nature of the regional zoning plans in relation to flood risk, in the sense that the government is actually incapable of reducing flood risk to zero in many areas that are allowed to be developed according to the regional zoning plans. Local governments have few effective instruments or incentives to reject building permits based on flood-risks, because building in areas that have been allocated as residential zones in the regional zoning plans is usually thought of as an established right. Therefore, recent developments in policy-making are looking into the possibility of somehow loosening the link between a particular land use designation in the zoning plan and the actual right to build; and, in some cases, to cancel such existing – although inappropriately awarded – development rights. However, it is still unclear how these policies will be implemented.

In this respect we adhere to a co-evolutionary approach of planning. Here we argue that individual actions are influenced directly and indirectly by (amongst others) regulatory frameworks. In this case, a strong emphasis on governmental technical protection has proven to be counterproductive in influencing a passive community that is refusing responsibility. Therefore, we should also look at the unintentional effects of common protective policies. Existing flood management paradigms are in a way self-preserving as they reproduce themselves through feedback mechanisms (Jong & van den Brink, 2013). The path dependencies following high expenditures for flood protection induce low levels of responsibility awareness among the involved citizens. In a context of budget cuts and uncertain climate change, there is a growing need to rethink this position.

From a co-evolutionary perspective, one cannot expect that residents are spontaneously self-reliant if the way they deal with flood risks has co-evolved with a FRM paradigm that attaches much importance to a technical, top-down approach. For a long time, flood protection was a governmental activity and flood risks were not formally taken into account in spatial plans and developments. As such, the survey results bear testimony of the old FRM paradigm. So how could the complex adaptive co-evolution between residents and FRM be stimulated towards increasing social resilience and shared responsibilities? Although it is not easy to answer this question, we can at least state that the shift towards more resident involvement needs to be openly addressed and supported in all aspects of the interactions with residents who are facing flood risks, especially considering that the intended transition towards citizen responsibilization does not comply with the public opinion on responsibilities in FRM. On the one hand, policy-making should be informed by what residents think and do. On the other hand, FRM choices generate feedback mechanisms towards civil society and influence the way citizens deal with flood risks through experience and expectation. Targeted dissemination of information is an only very recent phenomenon and there is very little experience with taking private flood protection measures.

Although the results of the survey paint a rather negative picture on the self-organizational capacities of residents, they also show a number of promising elements. Respondents are mostly satisfied with their current homes, and civil parties play an important role in knowledge dissemination. Furthermore, there is quite a bit of confidence in the power of collective action; although currently, social capital seems to be lacking to put it into practice. These elements are opportunities that could lead to more resident involvement and more active contribution in FRM, as long as there is appropriate support.

6

Societal actors: land users and market actors

This chapter aims to gain insights into the role of social actors in the development of flood risks and their management. How do societal attitudes and actions affect flood management options, and what are these attitudes and actions based on? Various points of view are analyzed based on interviews with different types of societal actors (residents, real estate agents, etc.) on the local (Geraardsbergen) and regional (Flanders) scales. Through three focus groups, the different opinions are brought together in order to draw policy-oriented conclusions. Some insights are formulated, which can help overcome the difficult transition to new forms of flood management and governance, as well as put more effective flood management strategies into practice.

6.1

Methodology

Because FRM strategies for non-governmental actors are often less formal, explicit or purposeful than those of governmental actors, it was chosen to explore their FRM strategies through qualitative research methodologies. The point of view of the societal actors (both land users and market actors) is examined through interviews and focus groups in three successive stages on three levels: exploratory interviews in Geraardsbergen, in-depth interviews on the Flemish levels and three focus groups on the Dender basin. These different stages build upon the findings of the preceding phase. All these interviews have been transcribed and coded through open coding. This approach also allows us to take a more open and thematic approach on more complex social issues.

6.1.1 Data collection

a Exploratory interviews: Geraardsbergen

In the first stage, local non-governmental actors (both land users and market actors) in Geraardsbergen were interviewed. The aim of these interviews was, on the one hand, to map the role and views of societal actors involved in FRM in Geraardsbergen, but, on the other hand, to also provide an outline and focus for the more in-depth interviews with societal actors on the Flemish scale. The interviews focused on the role they currently play in managing flood risks, i.e. measures they have taken and their views on governmental FRM.

In April 2014, following the classification of societal actors discussed above, 17 societal (non-governmental) actors were interviewed on their experience, their role, their own responsibilities and those of others, and the future management options of the flooding issueThe selection of the relevant actors was made in consultation with the sustainability official from the municipality. The questionnaire was semi-structured. The respondents were:

– six residents
  a four residents in the flood-prone area with flood experience and involvement in citizen groups
  b two residents close to the flood-prone area without flood experience

- three businesses in the flood-prone area (industrial company, retailer and tavern)
- two farmers in the flood-prone area (hobby farmer with flood experience and dairy and arable farmer without flood experience)
- one insurance broker (located in Geraardsbergen)
- three real estate agents (two offering real estate in Geraardsbergen and one with particular experience handling real estate in flood-prone areas)
- two environmental organizations active in Geraardsbergen

For a list of the respondents, see Appendix 3.

b In-depth interviews: Flanders

In a second stage, professional associations and organizations at the regional level (Flanders) that are indirectly involved with flood risks but familiar with policy-making were interviewed. The interviews focused on the role they currently play in FRM, their involvement in policy-making on flood risks, their views on governmental FRM, and if and how they could contribute (more) to FRM.

From May to July 2015, six representatives of non-governmental stakeholders at the Flemish level were given in-depth interviews lasting one to two hours. They were asked about the societal role of their profession in FRM, any issues they encounter in performing this role and how they see future developments. The questions explored how these different actors could contribute more to FRM, in line with the policy discourse of shared responsibility. See Appendix 3 and 4 for an overview of the dates of the interviews and the questionnaire, respectively. The questioned associations were:

- an agricultural professional association
- a professional association for insurers
- an independent voluntary association for nature protection
- a professional association for architects
- a professional association for the construction sector
- a professional association for the real estate sector

c Focus groups

The points of view of the interviewed non-governmental actors were confronted with those of policy-makers in three focus groups. Policy implementation and options for more stakeholder involvement were discussed in these focus groups.

A focus group on FRM in the Dender basin and Flanders took place in November 2015. This focus group started from the question: how can we create greater involvement among residents? The participants comprised 19 actors: 12 policy-makers and 7 stakeholders. The policymakers included people from the regional, provincial and municipal spatial planning departments, regional water managers and a mayor. First, the results of the survey were presented and discussed. Then, three themes related to the role of societal actors in FRM were discussed:

1 the way responsibilities are distributed
2 the way the financial burdens of measures and damages are distributed
3 how non-governmental actors participate in FRM

The participants discussed three statements on one of these topics and then jointly discussed the outcomes. See Appendix 5 for the list of participants and discussion statements. The report of these focus groups is available on request.

6.1.2 Analysis

The interviews and the discussions in the focus groups were recorded. These recordings were then transcribed word for word and coded in Nvivo. Labels were added to the text extracts, indicating the main concept or idea expressed by the respondent. Open coding was used, meaning that no conceptual framework was imposed at the beginning of the analysis. Instead coding was based on the conceptualizations presented by the respondents (Mortelmans, 2007). This methodology allowed us to focus on the topics that the respondents brought up, and to detect differences and similarities on certain subjects amongst different actors. These codes provided structure for discussion on the results of the interviews. The data from this analysis can be requested from the author, on condition of approval from the interviewee.

6.2

The local scale: land users and market actors in Geraardsbergen

6.2.1 Land users

Land users are generally aware of flood risks; although the frequency and intensity of flooding, and especially the gradual expansion of the flood-prone area, surprises them. Most actors mention that the government has made mistakes in the past by assigning residential land uses in flood-prone areas.

There lives a certain misunderstanding about the fact that land users are not allowed to implement certain measures to protect themselves from flooding. For example, raising the ground level or building small dams requires authorization through a building permit. However, these building permits are often not granted because such projects frequently have a negative impact on the water system by decreasing the capacity for water storage. In other words, such measures would cause more problems in the immediate surroundings (e.g. neighbors, etc.). So residents are frustrated that, even if they are willing to take action, they are not allowed to protect themselves.

a Residents
All residents agree that they have limited responsibility in the flooding issue. They feel the government has created the existing situation by allowing developments in the floodplain.

Some residents in flood-prone areas knew about the flood risks when they moved there, but were not fully aware of the extent and consequences. Others have seen the risks increase over the years. Residents often feel helpless and left out in the cold. They feel that they cannot take sufficient or effective measures themselves. Nevertheless, some residents have invested heavily in individual engineering solutions. They feel that the government should take responsibility and provide safety to residents, but that it does not understand the structural solutions it promises. They also believe that there is not enough communication with residents.

Some kind of collective action by citizens is taking place in both Zandbergen and Overboelare. After the 2010 floods, some citizens in Zandbergen assembled to explain to the city council the effects of the flood and their views on possible solutions and responsibilities. This resulted in the municipality setting up a cell phone alert service to alert citizens automatically about imminent flooding. Furthermore, renewal of the road construction and dike is planned. This civil initiative did not continue any activities after this one-time intervention. However, at the time of the interview in 2014, the Zandbergen village council was being established to improve communication between the municipality and citizens. The flooding issue does not play a central role in the village council, but it is one of the working points. The intent is for the village council to communicate with citizens about what the government is planning and executing. However, its practical functioning was still unclear, as the sructure of this council was still under development at the time of the interview.

In Overboelare, respondents in the worst affected areas have set up a committee. The main objective is to put pressure on policy-makers and to keep the debate alive in order to obtain structural measures. They also disseminate information and advice amongst residents on how to deal with flooding.

Nevertheless, there is a sense that all individual measures are limited and temporary:

> *"The city has organized a kind of mini market where a number of solutions to keep the water out were presented. But all these measures are only temporary. A wall can only handle a certain capacity. So solutions are for example to put barriers in front of the windows to stop the water. But if there's water up against your wall for two days, it will come in anyway."*
>
> *– inhabitant of flood-prone area*

b Residents outside of flood-prone areas

The respondents living outside but close to flood-prone areas are generally worried about increasing frequencies of flooding, as they witness more frequent and intense floods close to their homes. However, they do not expect floods to affect their houses, even though they are aware that this might happen. Although the residents outside of flood-prone areas have some fear of flooding, they do not actively inform themselves. They agree with the government investing heavily in protecting residents and damages, and with the cross-subsidization of damage through insurances; but they generally feel that the government does not take enough action.

c Businesses

In contrast to residents, managers are not emotionally attached to their property and experience little emotional impact. Decisions to take precautionary measures are mainly based on economic motives. There are large differences between businesses in terms of damage and taking action. The retailer has few expensive fixed elements in his store, causing the damage to be rather limited. As all damage was reimbursed by the insurance, the retailer and the tavern feel no need to take precautionary measures other than moving their merchandise when a flood is expected. The industrial company, on the other hand, has experienced extensive damage (both material as operational), which was mostly not reimbursed by its insurance. Therefore, the company is more willing to take precautionary measures. Since the municipality does not authorize building a dike, as it would reduce the water storage capacity, the manager does not see any other effective precautionary measure that he can take. Relocation is not an option for any of the businesses; the retailer and tavern are bound to their location in the shopping district and municipality center, and it would be too expensive for the industrial company.

d Environmental organizations

One organization is very committed to the flooding issue and strives for a full restoration of the natural floodplain of the Dender. They state that it is not financially viable to protect all buildings in light of increasing flood risks. They feel that no new buildings should be built in known flood-prone areas, existing buildings in the floodplains should be (in the long term) demolished and nature should be able to take its course. To achieve this, they contest building permits, advocate a stricter enforcement of existing water policies (especially locally) and inform local media on malpractices. Although they are very active in the societal debate, they are not formally involved in policy-making. In general, the other organization agrees with the first one, but it does not take any action to that end.

e Farmers

The farmers feel that agricultural lands are less protected against flooding than residential areas, for instance, and that their damages receive less compensation[4]. They think the government does not protect them to the fullest extent possible. They feel that farmers should have the same rights as other residents, although they understand the need for more protection in residential areas, as damages are higher there.

They do not feel like their activities contribute to the problem[5]. They believe that urbanization and the increase in impervious land are mainly responsible for increasing flood risks. They also feel that farmers cannot take any measures against flooding, at least not on an individual level. At most, they can purchase pumps.

4 In case of damage they can obtain tax reductions, while inhabitants have private insurances and disaster relief funding by the government.

5 Although other sources point out certain cultivation methods as part of the problem.

6.2.2 Market actors

a Real estate agents

The real estate agents indicate that they provide accurate information on flood risks to potential buyers (although they claim that this is not the case for all real estate agents). They state that it is government responsibility to provide them with objective information on flood sensitivity. This was not the case in the past, but this is no longer a problem. However, knowledge on flood risks remains in a bottleneck. They do not see an active role for themselves in FRM (for example, by investing in flood measures to increase the value of flood-prone land). They do not see any problems in selling properties in flood-prone areas, as long as the client is correctly informed. They have a strong belief in technical measures on the building scale (e.g. flood-proofing) to prevent damage. One agent sees an additional role for himself in providing expertise and advice on precautionary measures and building techniques. Although prices are lower (about equal to the additional cost of flood-proofing the building), they state that selling properties in flood-prone areas is difficult, as flood risks put off a lot of potential buyers. According to one agent, the lower price does not compensate for the disadvantages of living in flood-prone areas. Another agent emphasizes the advantages of an attractive location in a natural environment close to the city.

b Insurance broker

Residents in known flood-prone areas pay a higher premium. Premiums are calculated based on flooding history and location within known flood-prone areas. Additional precautionary measures by residents do not lead to a lower premium. The broker feels that he can provide advice on precautionary measures, but cannot impose them. He indicated that he probably would not insure a house built after September 23, 2008, as the principle of solidarity has its limits. He is not prepared to use the insurance premiums to invest in flood measures, as he considers that to be a governmental responsibility.

6.3

The Flemish scale: contributions of societal actors to flood risk management

6.3.1 The current role of different societal actors

Nature and agriculture are two of the most important land users in flood-prone areas.

– *Nature:* For members of the environmental organization, the flooding issue is an opportunity to realize win-wins for their biodiversity objectives. They have become an important landowner in valley areas through systematic voluntary procurement on the market, and also manage natural (valley) areas owned by others. To do so, they are partly subsidized by the government, but also use their own resources. They are an important project partner for governments for natural restoration in valleys and flood-prone areas. They believe that they could contribute more to FRM by purchasing additional land, but this would require more resources.

- *Agriculture:* The agricultural association stresses that farmers are very well aware of their land and the water system, and that they often have adjusted their activities accordingly. The environmental organization, however, states that there is much to gain in terms of management in agricultural areas, both within and outside of flood-prone areas. This includes erosion measures, water conservation and adapted land-use in flood-prone areas (i.e. grassland). They argue that a major mind switch would be required, as the thinking about water in agriculture has been focused on draining for a very long time.

  The different market actors all stress the boundaries of their professional activities. They feel that any contributions to FRM should stay within the social role of their profession.

- *Real estate agents:* Through the Duty to Inform, the role of real estate agents in the communication of flood risks towards potential buyers is legally established. According to the association, this law is merely a codification of their general duties as real estate agents. They believe that advice on potential individual flood protection measures is not strictly within their scope. Although it might be possible that some real estate agents specialize and profile themselves by providing technical advice on flood-proof building techniques, they believe that this is only a niche market.

- *Insurers:* Brokers indicate that it is possible for insurers to give a discount on the premium if residents take measures. However, under the current conditions, this is unlikely because the market for it is too small. They do not feel that it is their duty to proactively inform residents on flood risks or measures since they are only consulted after a house has been built or acquired.

  They have questions about the effects of the modeling updates to the flood risk maps, as a changing classification has implications towards insurability. Nonetheless, in most cases, this classification change goes unnoticed, as the insurance policy is drawn up once and not updated afterwards.

- *Architects and contractors:* The architects' association indicates that architects play an important role in prevention. It is the task of the architect to advise the building owner on potential measures to prevent damage, though the initiative for flood-proof building primarily has to come from the building owner. Both the contractors' and the architects' associations state that techniques for flood-proof construction will develop if the demand grows; at the moment, however, it is still a niche market.

They all face relatively few problems carrying out the duties included in the legal framework for their respective professions. Issues are mainly concentrated on optimizing the practical implementation and the need for good information on flood risks from the government.

However, their role in FRM generally seems to be restricted to the mandatory legal framework. Outside of the legal requirements, the role of these market actors is limited, and little initiative is taken. Thus, there is still some room to take up more FRM-related tasks within their professional activities.

6.3.2 Relation with formal FRM

a Involvement of societal actors in FRM policy-making

The open space land users, i.e. environmental and agricultural organizations, are most familiar with developments in formal FRM, as they were involved in the Sigma plan and the turn towards integrated water management in the 1990s and 2000s. They are familiar with the organizational structures and responsibilities of the different governmental actors involved in FRM. They are also locally represented in the sub-basin council that issues recommendations on the sub-basin board. They are, however, less familiar with the more recent developments towards shared responsibility.

Nevertheless, both environmental and agricultural organizations criticize the relationships between policymakers and local stakeholders. The agricultural organization feels that it is not involved in the conceptual phases, but only in the later stages of the process when decisions have already been made. They argue that a public inquiry is not the most efficient way to communicate with local stakeholders. Farmers often have knowledge on not only the local water system, but also on the suitability of certain measures within the operation of their businesses. Taking this into account is keystone for the public support of this group, as this allows tailor-made, location-specific solutions. In fact, they argue that it should be easy for governments to create public support for FRM from farmers, as they are also concerned with the water system; but, due to the lack of deliberation, this is often not the case. The environmental organization, on the other hand, is under the impression that so much effort goes into internal deliberation between the different governmental departments that by the time stakeholders are consulted, the process has progressed so far that the options for deliberation are limited.

The market actors, on the other hand, were not involved in the earlier stages; but they are becoming more involved in the more recent developments towards shared responsibility. The different professional associations were involved in the development of the relevant policies. For example, the architects' association was involved in the development of the spatial planning regulations on rainwater, and the insurance industry was involved in the development of the legal framework for the fire insurance of 2005.

While water managers have since invited the insurance industry to FRM seminars to think about the role of damage compensation in the discourse of shared responsibility and in the light of climate change. The insurance industry was not very avid to play an active role in this discussion, however, as they encounter little to no problems in the implementation of the existing legal framework. The professional association for architects, on the other hand, is subsidized by the Department of Environment, Nature and Energy of the Flemish government to appoint a water consultant. This consultant informs architects on water related building regulations and the technical aspects of structural measures that can be taken to prevent flooding on the building level. He plays an intermediary function between the construction industry and policy-makers in water management. On the one hand, input for policy issues based on practical experience is provided to policy makers, while on the other hand, the government indicates on which topics communication with the construction industry is needed.

b Interaction between formal FRM and societal actors

All actors indicate that they consider the government to be the leading actor for FRM. As they encounter no major flood risk related problems in their daily activities, they take a reactive attitude towards government initiatives instead of proactively raising issues about their role in FRM.

The architects' association indicated that they consider the government to be the most important partner in regard to building in flood-prone areas, as it determines where building permits can be issued and under which conditions (through the water assessment). The construction sector association has a similar point of view, stating that technical expertise is not the main issue that is lacking. They believe that building techniques will develop if there is a sufficient demand for them, but that the government is responsible for creating this demand. Regarding water infiltration, for example, they argue that the government should set the example in the design public space.

However, as shown by the following quote, this reactive attitude does not necessarily imply a passive one:

> *"It was communicated by the government that a total ban on building could not be imposed and that building in flood-prone areas would be permitted. So from within the construction sector, the question rose "how should we then build?" And from this question, an IWT project proposal (ed. research proposal on flood-resistant building techniques) grew."*
>
> *– representative of architects' association*

This proposal was refused, but the government subsequently funded the water consultant project of the architects' association.

6.3.3 Views on formal FRM

a Levels of governing

The environmental organization thinks that the scaling up of responsibilities in FRM — for example, from municipalities towards provinces – is a good evolution because it leads to more professional and integrated water management, which was needed in many places. The farmers' association, on the other hand, stresses the importance of the local level in communication and deliberation with the individual farmers. They indicate that projects by local authorities have more public support because municipal authorities are better positioned to discuss potential solutions with farmers.

The architects' association indicates that the different regulations from the regional, provincial and municipal levels should be integrated and easily consultable. Otherwise, it is hard for architects to keep an overview of the regulations they should consider, since, for example, the spatial planning regulations on rainwater can be specified on every level.

b Spatial planning

The environmental organization feels that FRM is still more performed by water managers than by spatial planners:

> *"Integrated water management is actually not about water, it is about land. All the problems that need to be solved in integrated water management are caused on land, and not in the streams. So water managers often cannot solve this. Because they don't have the instruments and the power to do so. And within the instruments and powers they have, they often do what they can."*
>
> *– representative of environmental organization*

They argue that water managers sometimes chose suboptimal solutions because spatial planners and land users do not take up their responsibilities. They propose two main roles for spatial planning. First, to mitigate the negative effects of further building developments. Second, to create an active recovery policy to make up for mistakes made in the past.

c Water management

The environmental and agricultural organizations consider the Sigma plan to be very successful. An important reason for this success was the presence of sufficient supporting policies and resources. Within the Sigma plan, there is a frequent project-based collaboration between W&Z and both Natuurpunt (environmental organization) and Boerenbond (farmers' association).

Such collaborations are lacking in the implementation of the EU FD through the RBMPs by both the main regional water managers (VMM and W&Z). The process is perceived to be very closed; and, at the moment, supporting policies are still conceptual and available resources seem to be much more limited. While it is true that this approach is still relatively young, the plans have, nevertheless, already been established. They are now being further developed in local pilots, where more participation is intended.

The environmental organization stressed the need for social project management skills. Most water managers were schooled as hydrological engineers, while the newly developing discourse on shared responsibilities requires a more social approach. This requires a cultural switch for water managers, which is a slow process.

6.3.4 Towards more involvement of societal actors

How can societal actors be stimulated to contribute to managing flood risks? The following is a discussion on the essential elements for an improved contribution to FRM, according to the participants.

a Knowledge on flood risk
For the market actors, knowledge is an essential element for their contribution to FRM. They expect the government to deliver this knowledge. Therefore, three important elements are the availability, accessibility and comprehensibility of this information. Comprehensibility is especially important, as these market actors are not experts in FRM. A lack of comprehensibility leads to oversimplification, and, therefore, misjudgment of the flood risk. The current conceptualization of flood risks seems to be insufficient to communicate the inherent uncertainties, which leads to a very black-and-white view on flood risks and a limited capacity to deal with changes in these risks.

b Societal awareness
The interviewees indicate that their current limited role is related to the lack of demand for societal solutions, such as private structural protection measures, additional insurance and technical advice from real estate agents. Potential real estate buyers do not especially worry about flooding, and, therefore, also do not ask for information on possible solutions. Therefore, specialization in flooding creates little added value to businesses. Residents will only take up these additional roles if doing so would give them some kind of competitive advantage, but this is currently rare. Still, they are convinced that, if this demand emerges in the future, the market will respond and these arrangements will develop spontaneously.

c Specialization
An important condition for more involvement from market actors in FRM is the development of specialized knowledge on their (potential) contributions to FRM. However, the architects, real estate agents and insurers all currently show no real specialization towards FRM within their fields. The architects' association stresses the importance of involving more actors in the building industry, such as engineers, building contractors and research labs for technical certification. Currently, technical knowledge is still limited. The role of the water consultant is limited to disseminating and exchanging information, as well as raising awareness, while the development of technical knowledge is still lacking. Infiltration and flood-proof building are still abstract concepts for many architects, and the application of these techniques raises a lot of questions and uncertainties. However, the development of a technical framework requires better collaborations and resources for research. All market actors argue that this will develop once there is sufficient demand for it.

6.4

Policy-making for shared responsibilities in managing flood risks

6.4.1 Responsibility

All participants agreed that the government is responsible for creating a global vision that also sets conditions for residents of flood-prone areas. This means what can be solved collectively and what should be solved individually should be deliberated with citizens. It must be stated clearly that the government cannot protect all buildings against flooding and that building permits are not a guarantee of protection. Through the new FRMPs and the accompanying cost-efficiency models, it is relatively easy to list the buildings that, in the future, cannot be protected from this cost-efficiency perspective. If residents need to protect themselves, the governments need to inform them properly on the measures that have been taken in the past, what measures residents can take now and the timeframe in which it should happen. The participants think that, if full responsibility is placed on residents, actions will only be taken after a new flood occurs. Although floods have a catalyzing force, they consider this to be too late. Furthermore, the government could also support residents through group purchases.

However, in addition to this supportive and deliberative role, the participants felt that public authorities also need to react more strictly in order to put more responsibility on residents. For example, if residents do not comply with the conditions in the building permit, which were imposed based on the water assessment, they feel that all responsibility for damages should be placed on those residents. Opinions differ on the proposal to make the flood damage compensation conditional on taking private measures on the building scale. On the one hand, such a system could set good examples. On the other hand, in the current system, insurers are not consulted until it is too late in the process (often when building is completely finished) to impose such measures. A diversification of risk profiles in classes could provide a framework for communicating on flood risks and might incentivize residents to improve their houses. It could also be used to better capitalize risks in insurance premiums; however, insurers are not in favor of this, and policy makers are also cautious. It is important that the insurance system stays affordable in order to prevent a social deprivation due to the concentration of socially vulnerable groups that cannot afford insurance in the possibly cheaper housing stock of flood-prone areas.

6.4.2 Financing

There was agreement that the lack of differentiation from the fire insurance premiums in accordance with flood risks creates a very inert system. When the law requiring inclusion of natural hazards in the fire insurance policy was created, there was not as much information available on flood risks as there is today. Now, a differentiation of premiums is practically feasible due to better knowledge. The participants are in favor of a more differentiated premium system, and thus higher premiums in flood-prone zones, as they believe it could be an incentive for private mitigation behavior. The government actors indicate that the mentality has shifted from 'the government can solve this' towards 'everyone needs to contribute.' Therefore, the rules on damage compensation should be altered. Societal actors, to a certain extent, agree. However, all agree that flood risks should absolutely not be fully capitalized in the insurance premium, as to maintain a certain degree of solidarity. Also, too much differentiation might induce social problems for vulnerable groups. Therefore, a certain upper limit is necessary to maintain affordability and, therefore, avoid social deprivation. Especially for new developments, higher insurance premiums are considered to be justified. The participants argue that it is impossible to prevent new constructions in flood-prone areas. Therefore, higher premiums could discourage building in flood-prone areas and make residents bear their own risks.

As to the zoning issues, the participants question the fairness of changing land use allocations and development rights without compensation. They argue that if the government changes the rules, it should compensate the affected citizens. On the other hand, they also feel that the government cannot be held responsible for information on flood risks that was not available when the zoning plans were established. This should be taken into account when determining planning blight and compensation.

Traditionally, compensation can be settled through a planning blight, but doing so requires large funds. Therefore, participants argue that this compensation can take the form of zoning swap, tradable development rights, etc. But, strictly speaking, land use allocations do not equal building rights. If land is technically unsuited for construction, building permits can be refused. Nevertheless, if adaptive building techniques develop further, it becomes harder to refuse building licenses because the argument that residential plots in flood-prone areas are not technically suitable for construction is no longer valid. This might also increase the right to compensation if zoning is changed. As to the development of flood-prone areas pending a zoning decision, there is some disagreement. Some argue that the government should ban building activities in the meantime, as doing so forms a stronger basis for negotiating. Others argue that building should be possible under certain negotiable conditions.

The participants agree that the government (i.e. the whole population, through taxes, etc.) should pay for FRM measures, such as reparcelling with a zoning swap. If residents are expected to financially contribute to FRM measures directly, they believe that it is only possible on the individual residence scale. However, some participants believe that financial contributions towards the FRM could also play an important role in raising awareness.

The participants agree that the government is not responsible for the consequences of legal uncertainty from flood risk map updates. These consequences include, for example, insurers becoming entitled to charge higher premiums or potential buyers suddenly needing to be informed of flood risks - with potential implications on the real estate value - if a residence suddenly falls under the effective flood-prone area. They believe that the government is not responsible for changes in flood risks and the incremental knowledge on them, and can never provide legal certainty for it. They also express the limits of flood risk maps and modeling, and the need to be cautious with the knowledge that they generate. It should be possible to adjust to the maps based on local knowledge, as the models are not always accurate. However, the question then remains: who bears the burden of making these changes, and should there be some kind of redistribution of that burden?

6.4.3 Participation

The participants acknowledge citizens' local, area-specific knowledge and indicate that it is important to take this knowledge into account when making plans. Land users know the terrain and, therefore, might suggest better solutions. Citizens groups also keep policy-makers awake. However, participants questioned whether citizens should have decision-making powers. FRM is a complicated matter, due to the interplay between the individual risks and the wider water system. Therefore, FRM also requires technical knowledge that citizens might be lacking. The participants argue that it is important for the government to maintain its role as a regulator to safeguard the overall perspective. Letting citizens decide is also not viewed as desirable, as it would imply that policy-makers shun their responsibilities.

Nevertheless, policy-makers and societal stakeholders both stress the need for participation and the current lack of it. They believe that decision-making processes with intensive, early participation will result in higher public support. The current public consultation procedures, in contrast, only take place after decisions are more or less made.

Policy-makers are not eager to give real powers to citizens, and societal stakeholders are not always interested in possessing such powers. The water managers are perceived as very inaccessible, even for the organized societal stakeholders, such as the farmers' association. The policy-makers involved in FRM, however, indicate that these groups hardly make use of the existing structures to participate in FRM decision making. Also, citizens are reluctant to make budgetary decisions because they are aware of the different interests at play. Other problems include the challenge of thinking from the individual versus the collective interest, as well as the difficulties of including less vocal or interested groups.

The policy-makers indicate that the results from the FRMPs (which modeled the costs and benefits of different combinations of protective, preparedness and prevention measures) will be used for participatory deliberation. Policy-makers argue that funds should be used as optimally as possible. A uniform, basic degree of protection is considered undesirable because it might not be cost effective. However, differentiated levels of protection might be a difficult message to communicate to land users, though policy-makers are in favor of it.

Information plays an important role in this. Therefore, univocal communication towards citizens is important, especially considering the fragmented nature of governmental responsibilities in water policy.

6.5

Conclusion and discussion

6.5.1 Local scale

It is apparent from the exploratory interviews that there is quite some variation in interpretations and framings of the problems and the conflicting needs amongst the different groups.

First, there is some controversy on what ‘good measures’ are. For example, dredging the Dender is the most frequently mentioned solution, but is not believed to be effective by water engineers. Also, people feel abandoned because they cannot see any tangible solutions and, therefore, feel like nothing is happening, though policy processes are in motion (although slow) to develop effective solutions (e.g. preparatory studies). There seems to be a need for communication and information dissemination, not only on the risks and potential measures by land users, but also on government plans and projects, and on solutions that are effective and feasible.

There is a discrepancy between the type of measures and the time span for action that the land users expect. On the one hand, they want long-term and fail-safe solutions but expect actions to be quick and reactive in the aftermath of the flood. However, long-term solutions are achieved through long-term processes (from study to implementation). Because of the difficult reconcilability of these two aspects, residents feel like they are not heard and that their needs are not met.

There is a large reliance on government, especially by residents, but also by farmers. Out of the three types of land users, businesses seem to be the most proactive in dealing with potential flood damages. Farmers and businesses also worry the least about damages. The land users often do not mention source-oriented solutions (e.g. removing impervious land, expropriation) as these consume more space and are difficult to implement. They want the water problem to be resolved outside of their property, even though this might not be the most efficient method. Also, the actors who are not land users feel like managing flood risks is a governmental responsibility, and, therefore, have limited willingness to actively contribute to it. Local environmental organizations do, however, contribute to managing flood risks, although by counteracting governmental actions rather than by active collaboration. Everyone interviewed explicitly or implicitly agrees that, if the government grants building permissions, it must also be responsible for protecting these buildings from water. There also seems to be a general consensus that errors were made in the past when assigning land uses to floodplains in the 1970s. Although this is probably true to some extent, some problems may also arise from increasing and shifting flood risks. In this context, it is not possible to guarantee that all authorized buildings will be flood free in the long term, and protection is neither technically feasible nor economically sound. The societal actors (except for environmental organizations) do not take the increasing risk into account when formulating the problem and potential solutions, although they often experience increasing risks themselves. Also, providing information on flood risks is seen as a governmental task. This is contrasted by quite a passive attitude. Information-seeking behavior could only be observed in the worst affected areas – and only after floods (reactive), but not when buying a property (proactive).

As can be expected, in the worst affected areas of Geraardsbergen, people are relatively well informed on the risks and most people have taken precautionary measures. Nevertheless, they state that they feel the government is responsible for protecting them. Their action is inspired by frustration and disappointment in the government, rather than a belief in the effectiveness of the measures themselves. Also, they do not perceive themselves as being well informed, although they have the most knowledge on flood risks, possibly for the same reason.

6.5.2 Regional scale

The market actors consider the government to be the leading actor in FRM, both directly and indirectly. On the one hand, they decide where and under what conditions permits can be issued, how damages should be compensated and what information should be provided to potential buyers. Therefore, they believe that the government is thus also responsible for protecting land users.

On the other hand, FRM-related markets (e.g. individual flood protection) are not developing due to a lack of demand. The respondents believe that governments are the key actors in generating this demand. Currently, technical knowledge and frameworks for individual flood protection are lacking, impeding its implementation. However, the architects' association thinks that the government plays a more crucial role in this than engineers because the governments set the conditions for this market.

6.5.3 Policy implications

Changes in policies that affect citizens living in flood-prone areas are subject to heavy discussion and disagreement. Societal actors often argue that, if the government changes its rules, it should also bear the consequences. For example, an often-heard argument is that, since residents have built in these areas in a legitimate way, they should not have to pay for any changes in policies. Policy-makers, on the other hand, stress that changing these rules is necessary under the current conditions. They are thus in favor of more adaptable policy-making, while this might not be accepted by the societal actors. This static view conflicts with the inherently uncertain nature of flood risks.

In this respect, there is often a stark contrast in discourse on the existing developments and new developments. Generally, actors agree that new developments are easier to control through regulations such as the water assessment, signal areas, etc. It is also more justified to place more responsibility on citizens in terms of, for example, private protection, insurance premiums, etc., because they are assumed to be properly informed and, therefore, will make well-informed and conscientious choices in relation to the flood risk. Therefore, they expect that future flood risks will be easier to manage through better zoning and building restrictions as well as shared responsibilities. Existing developments, on the other hand, are harder or even impossible to manage. It is generally believed that they earn more protection, compensation, etc., because they were not informed about the risk and have complied with all regulations.

However, the presumed knowledge that is at the base of this discursive distinction between new and existing developments is always circumstantial and temporary. Flood risks themselves, as well as the technical restrictions and cultural conditions that influence the conceptualization of risks, evolve over time. Knowledge is thus always relative, uncertain and incomplete (Scott et al., 2013; White et al., 2001). Therefore, what seems to be stark contrast in the reasoning above may not be so stark in reality. Our current knowledge might also prove to be faulty in the long term, and current policies and decisions run the risk of being considered 'mistakes from the past', much like the majority of stakeholders in FRM consider the zoning plans from the 1970s to be antiquated and insufficient.

Furthermore, there is a remarkable tension between the acknowledgement of incremental knowledge on the one side, for which the government cannot be held accountable, and changing the rules – often according to this incremental knowledge – for which societal actors expect compensation from the government.

In the tendency towards participation, there seems to be friction between the operating levels of formal and informal FRM. Decision making in formal FRM is aimed at making comprehensive, integrated decisions based on the global perspective of the water system. Over the last decades, powers in water management have been scaled up, which is expected to be more effective due to the need for expert knowledge, on the one hand, and a global perspective, on the other. Citizens' and stakeholders' involvement, on the other hand, takes place at the local level. This is evidenced by the fact that it turns out to be difficult to keep societal actors interested and involved in current participation options within the sub-basin councils and on the regional level. Within the hierarchical policy-making in FRM, there seems to be little room for early, local participation.

7

Towards fruitful co-evolution

Parts of this chapter have been previously published as

– Tempels, B., Hartmann, T., 2014, A co-evolving frontier between land and water: dilemmas of flexibility versus robustness in flood risk management, *Water International* **39**(6): 872-883.
– Mees, H., Tempels, B., Crabbé, A., Boelens, L., 2016, Shifting public-private responsibilities in Flemish flood risk management. Towards a co-evolutinoary approach. *Land Use Policy* **57**:23-33.

This chapter connects the evidence from the empirical research in chapters 4 to 6 back to the theoretical framework on co-evolutionary resilience developed in chapter 2. It reflects on the interactions and relations between governmental actors (i.e. water managers and spatial planners, chapter 4), residents (chapter 5) and other non-governmental actors (i.e. other land users and market actors; chapter 6) in Flanders. It identifies different co-evolutionary mechanisms between these actor groups, which can be observed throughout the findings. It then conceptualizes the challenges arising from these interactions from the co-evolutionary perspective and explores how these co-evolutionary mechanisms could be navigated in policy-making. These theoretical considerations might be relevant for other contexts and contribute to the international discussions on the future of FRM

7.1

Towards a better understanding of co-evolution in flood risk management

7.1.1 Five co-evolutionary mechanisms

In chapter 2 we developed the theoretical framework on resilience. The assumption underlying this theoretical framework was that the FRM strategies of all different actors are in co-evolution with each other through multiple feedback loops. The outcomes from this co-evolutionary process determines overall resilience to flooding. Based on the evidence in Flanders that was presented in chapters four to six, we identify a number of the co-evolutionary mechanisms at play between formal and societal FRM attitudes and strategies. They are supported by academic literature that discusses similar mechanisms in other contexts.

It is not the intention to prove any conclusive cause-effect relations. Rather, the findings bear witness to the feedback from the prevailing flood management regime and show how these co-evolutionary processes play an important role in the FRM strategies of each individual actor. The intention is to give an indication of the complex mechanisms that are at play when considering the multiple FRM strategies of all actors involved in the spatial development and management of flood risks.

a Dominance of structural and protective measures

The strong focus on structural and protective measures in the recent past entrenches FRM in a technical approach. While on the one hand, it creates an expectation amongst citizens that floods can be fully controlled and prevented, it also creates a financial path dependency where the high investments in infrastructural measures prevent a radically different approach to managing flood risks.

Engineering strategies and structural control measures have dominated in developed countries worldwide since the mid-20th century (Montz and Gruntfest, 1986), bringing about a bias towards loss reduction (Klein et al., 2003). However, the wide implementation of flood prevention projects has encouraged and sustained further development and encroachment of floodplains and (potential) flood-prone areas, leading to a vast increase in exposed capital in the case of flooding (Burby et al., 2000). The confidence in flood prevention and centrally led engineered solutions also implicitly triggers a low risk awareness and autonomous adaptive capacity amongst land users (Grothmann and Reusswig, 2006).

b Emphasis on economic damage

Both policy-makers and residents, especially those without flood experience, tend to reason in terms of economic and/or physical damage. This is in line with the economic rationality of a technical approach, balancing costs and benefits of protection measures. However, (Siegrist and Gutscher, 2008) have proven that people having experienced a flood indicate that emotional aspects are more important than financial damage. Their research has demonstrated that people with no flood experience generally underestimate the affective impacts (e.g. fear, feeling of insecurity) of rare events. This might be related to the fact that media coverage, as well as assessment tools (such as cost-benefit analysis) focus on the economic impact of flooding, which influences the capacity to evaluate of the consequences of flooding. Although there is growing attention on the social and emotional aspects, this topic remains difficult.

c Responsibility and political decision-making

Although not formalized in any type of law or decree, both policy-makers and non-governmental actors assume the government to be responsible for managing flood risks. Governments use funds from general taxation to pay for flood mitigation projects, as infrastructural works are the government's responsibility. However, in the case of flood protection, public funding is used to protect private goods, giving rise to the question of who is responsible for the costs. In the context of climate change, it is even harder to determine who is responsible and, therefore, who has to pay for adaptive measures (Biesbroek et al., 2009).

Moreover, as governmental flood management interventions are the outcome of a political decision-making process, the decision to provide protection in certain areas is not always based on objective criteria. Instead, it can be politicized with regard to victim pressure, power structures, elections, etc. (Penning-Rowsell and Pardoe, 2012; Prater and Lindell, 2000).

Furthermore, the empirical data show that governments are not the only ones managing flood risks. Private actors also influence flood risks and have their own strategies to deal with flood risks. Therefore, the strong emphasis on governmental interventions might be unwarranted.

d Insurance and compensation systems

Insurance or compensation packages buffer the economic consequences of flooding by spreading the financial costs of flood related losses. As high-risk households are cross-subsidized by low-risk households, this might reduce or even remove the impetus for other types of adaptation (Hallett, 2013; Smithers and Smit, 1997). However, in view of climate change, it might not be possible to sustain this situation.

Insurance systems could also broadly stimulate adaptation of societies to climate change by giving incentives for risk reducing behavior of individual citizens (e.g. house construction). Insurance companies could transfer price signals by setting premiums based on actual risk, so that they reflect the variation in risk more accurately (Bouwer et al., 2007). Also, lower risk due to adaptation of societies or individuals could be rewarded with lower premiums, higher coverage and lower deductibles (Botzen et al., 2010). At the moment, this is not the case; premiums generally do not appear to fall as risk is reduced (Penning-Rowsell and Pardoe, 2012). This indicates that insurance companies currently do not support adaptation, despite the fact that they benefit from the reduction of damage (Mills, 2007 in Botzen et al., 2010).

e Knowledge on floods risk and its institutionalization

Knowledge and acknowledgement of flood risk is the most fundamental prerequisite for adaptation by individuals or communities. Risks can, for example, be disregarded through time as the memory of flood experiences fades. That is why flood risk is often institutionalized in maps. However, the formal identification and classification of risks can give rise to the perception that, if an area is not indicated on a map, there is no risk. Therefore, it is important to combine expert knowledge with locally produced knowledge.

BOX 1

The institutionalization of knowledge on flood risks in flood risk maps

This box describes the case of a complaint of the Flemish ombudsman published in October 2015 on the confusion surrounding the term ‘potential flood-prone area’ used in the water assessment maps.

The report was a result of a complaint of a homeowner who, after informing himself on the context of selling his residence, discovered it is situated in a potential flood-prone area. On the one hand, he disputes that his residence is located in a flood-prone area; the residence has never been flooded in the 27 years he lived there and it is located about 4 meters higher than the normal level of the waterway. His main concern is that the label of ‘potential flood-prone area’ will scare off potential buyers and have negative effects on the property price.

On the other hand, he deplores that the government did not spontaneously and actively notify him of the fact that his property was in potential flood-prone area. Furthermore, he believes that the government should provide him with an official document stating that there have been no recent floods on his property.

The water manager replied by explaining that the flood risk is due to colluvial flooding instead of alluvial flooding, a result of the steep slopes in the area. Furthermore, the water manager indicated that the terminology will be subject to a scheduled evaluation by the Duty to Inform tool in 2016. As for the communication of the maps, the manager argues that the introduction of the Duty to Inform tool was the subject of a campaign and, therefore, widely communicated through real estate agent associations, architectural forums, etc. The water assessment maps were introduced in 2007 as part of the water assessment instrument, and updated in 2010 and 2014. The Duty to Inform was introduced in October 2013. While the location of the residence is indicated as in a potential flood-prone area since 2007, this location only received legal consequences in form of the Duty to Inform at the moment of its introduction in 2013. However, the campaign in 2013 only focused on the legal consequences of real estate located in flood-prone areas. It did not disseminate information on the location of flood-prone areas according to the official maps. Consequently, one can assume that this campaign in 2013 only reached citizens who were concerned with flood risks and/or selling their property.

The ombudsman, however, deemed this answer to be insufficient and wrote a report on this case, which was published in October 2015. This report triggered some discussion and consternation in the media. Some of the newspaper headlines included "Your house is located in the flood plain (and you don't know it)," "Sorry, your house can flood," and "Mandatory logo potential flood-prone area can plummet the value of your house".

Apart from demonstrating the passive communication by the government and the associated problems, this situation also indicates the difficulties related to the updates of the flood risk maps in general. As the location in flood-prone areas according to the maps is linked with regulations on the Duty to Inform and for the federal maps with regulations on fire insurance premium), changes to the flood risk maps due to updates of these maps also entail a certain degree of legal uncertainty. The representatives of the real estate agents and the insurance agents share this concern. They are in favor of clear scenarios in case a property's flood risk status changes due to the updates of the maps, which are currently not present. In practice, the maps are only consulted at the time of selling a property or taking out insurance.

Apart from the general issues on the legal uncertainty due to the update of flood risk maps, this case also demonstrates popular thinking about flood risks. The presence of advanced flood risk maps might create the impression that the government has full knowledge on flood risks, thus placing the responsibility for FRM even more on the government. Furthermore, the stark (legal) contrast between being located in flood-prone areas and outside of them might cause a false sense of security and sense of entitlement to protection amongst people located outside of flood-prone areas on the maps.

These maps also have their limitations, as they are based on imperfect knowledge (e.g. on terrain elevation, but also on local flood protection measures). For this reason, citizens can request to alter the maps based on a founded argument that a certain plot is not supposed to be exposed to flood risks. Investigating the true flood risk (through recommendations of local authorities, for example) and changing the flood risk maps is, however, a very labor-intensive process. Furthermore, only the most empowered citizens – those who are aware of the maps and the options to have them altered – might benefit from this approach.

Precise insights into the mechanisms behind the interactions between elements of formal FRM and how the wider society deals with flood risks are currently still rather limited. The social and the technical aspects of flood risks are, in themselves, relatively well studied separately; on the one hand, social research describes issues of vulnerability (Grothmann & Reusswig, 2006; Siegrist & Gutscher, 2008), while hydrological models estimate the effects of infrastructural interventions on the probability of flooding. However, the effects of choices in formal FRM on how the wider society deals with flood risks in spatial developments remain largely unknown. The way technical measures affect, for example, the wider society's perceptions of flood risks and responsibilities in managing flood risks is largely ignored, both in knowledge production as well as in the formal FRM decision processes. Due to a lack of understanding and recognition of these co-evolutionary mechanisms, formal decision-making processes often largely ignore these interactions.

However, these societal effects of formal FRM are important, as the wider society's perceptions translate into how societal actors deal with flood risks (e.g. location choice, individual protection), and this, in turn, affects overall flood risks in a diffuse but fundamental way (i.e. run-off, infiltration and retention, potential damage, etc.). As such, the indirect effects of (technical) FRM actions may influence overall flood risks in an unexpected and potentially unwanted way, undermining the efficiency of flood risk management.

7.1.2 From lock-in to resilience: co-evolutionary side-effects

The lack of acknowledgement of the reciprocal relation between flood management and its societal context has led to some unwanted (side) effects. Examples are the ongoing urbanization in floodplains and the lack of consideration of flood risks in household location choices. The strong focus on protecting against and preventing flooding results in risks being less and less tolerated, inducing the need for an even higher degree of safety. At the same time, the awareness is also decreasing. An example of this is the 'levee effect' or the 'paradox of safety' (Baan and Klijn, 2004; Bubeck et al., 2013b), whereby investments in defense infrastructures enabled citizens to build in floodplains, which resulted in a need for continuous investment in flood defense. On the one hand, this excludes a more natural approach, such as making room for the river; and on the other, it increases potential losses in case of flooding. Hartmann (2008: 8) discusses this lock-in as follows: "*embankments pretend security, which justifies value accumulation behind them. (...) The social arrangement in the floodplain sustains this effect. Finally, a threshold-based flood-protection based on embankments is a technological lock-in. Due to time, this lock-in tightens, because more embankments will have been build, more values will have to be protected*."

Relatively high safety standards sustain the impression that areas protected by dikes are safe to live in. Therefore, there is no incentive to minimize vulnerability to flooding through appropriate land-use planning (Vis et al., 2001). Buffering a system from environmental perturbations (e.g. through dikes) and their adverse effects (e.g. through insurance and compensation systems) reduces or even removes the impetus for other types of adaptation (Botzen et al., 2010; Smithers and Smit, 1997). Furthermore, the strong reliance on public flood management hampers individual responsibility (Grothmann and Reusswig, 2006). The strong emphasis on government intervention causes a low sense of responsibility amongst residents and, therefore, low autonomous adaptive and self-organizational capacities. Also, the lack of citizen involvement in any flood risk policy phase is limited, resulting in low levels of flood awareness and responsibility. Consequently, residents not only adopt a passive attitude, but their individual choices of interventions sometimes even increase risks. In the U.S. context, Loucks et al. (2008) argue that governmental policies are not preventing floodplain development; in fact, they may be facilitating it. The current flood management regime itself thus appears to be quite self-preserving, as some mechanisms maintain it from within (Liao, 2012).

It is often argued that spatial planning can reduce vulnerability by discouraging development in flood-prone areas (Burby et al., 2000). In practice, however, spatial planning has not succeeded in this (Hutter, 2006), as proven by the ongoing urbanization of floodplains (Montz and Gruntfest, 1986). Spatial planners are faced with a lack of societal support to enforce land-use restrictions in flood-prone areas. Essentially, this failure is not so much related to a lack of knowledge or a problem of uncertainty, but rather to the strong focus on the water system in FRM. Through the co-evolutionary process, this causes a negligence of flood risk in the land system and a lack of support to manage flood risks through spatial planning. The interactions between the land and water system are thus not fruitful. The broader land mechanisms (such as real estate markets) induce maladaptations, serving short-term human goals. But these often come with attendant costs on individuals, communities and society, which are accepted to be ‘the cost of business,’ but which may become unbearable in light of a heightened exposure to extreme climatic events (Smithers and Smit, 1997). As the need for managing flood risks in spatial planning is growing due to increasing damages, spatial planners are confronted with their limited effectiveness, result of the co-evolutions taking place between spatial planning, water management and society.

It can thus be concluded that the co-evolutionary process currently taking place in FRM is not productive. These co-evolutionary mechanisms further entrench a generic, technocratic, protective FRM approach, putting formal FRM at risk of becoming trapped in a negative co-evolutionary spiral where more and more protection is needed and making a shift towards flexibility and shared responsibility in order to attain flood resilience even harder. If co-evolutionary processes are not sufficiently recognized and actions do not adequately anticipate and respond to co-evolutionary feedback, this process might even lead to a lock-in.

7.1.3 A co-evolutionary approach to developing resilience: key policy challenges

Co-evolution is not only useful as a framework to understand how the observed situation came about today; it can also help in guiding transitions towards flood resilience. According to Kemp et al. (2007), a co-evolutionary view is useful for thinking about governance as it presents the idea of relative autonomy. Different actors are bound to each other through cause-effect-cause loops across different scales and subsystems. Their needs and actions are partly endogenous to their

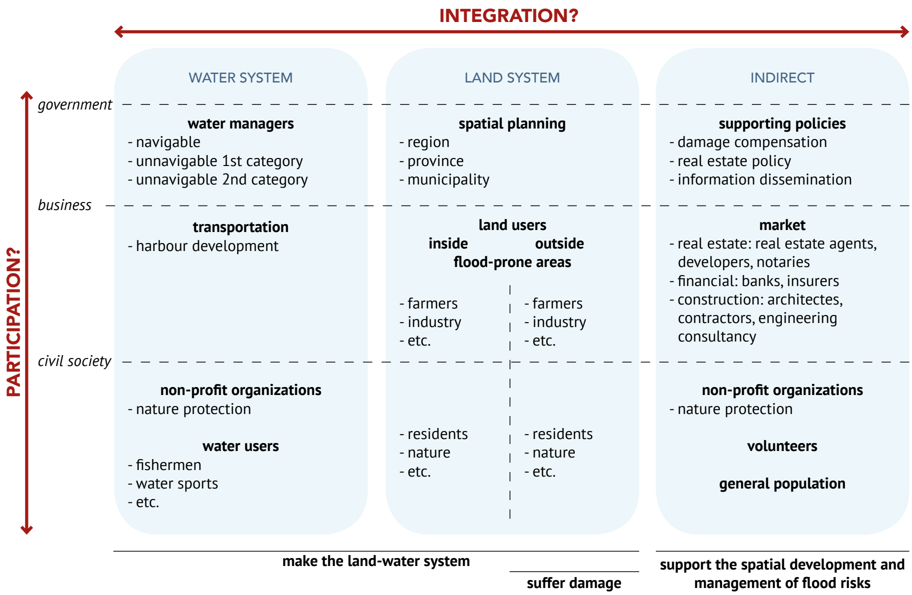

Figure 21 Interactions between different actors in the different subsystems of FRM and the related policy questions

context (built up amongst others by others' FRM actions), as they are shaped by a selective environment. Nevertheless, the developments in different subsystems are partially independent, as they each have their own decision-making processes in which to allocate their resources and achieve their goals.

A more profound co-evolutionary approach of spatial planning, taking into account the relation and interactions between flood management choices and society described above, could help to overturn these lock-ins. To achieve this, insights in these co-evolutionary interactions and how they can become more fruitful is keystone. In this context, Pahl-Wostl (2007: 50) argues that *"one needs to better understand the interdependence and co-evolutionary development of management objectives and paradigms, environmental characteristics, technologies and social routines."* More specifically, the societal effects of formal FRM choices and how they, in turn, might affect flood risks and FRM options need to be further analyzed and monitored. For example, how do flood risks influence housing prices, and what is the overall effect on vulnerability of this? How does a (false) sense of safety impede individual actions to manage flood risks and how can this be overcome?

In what follows, we discuss how the co-evolutionary perspective sheds a different light on two policy challenges related to the interactions within the actor field of the spatial development and management of flood risks: the integration between the systems (i.e. water, land and indirect; horizontal axis in Figure 21) and the participation between the different actors (i.e. government, business and civil society; vertical axis in Figure 21).

On the one hand, the interaction between land and water raise questions on the integration between systems (land, water and indirect). The flood issue is still seen as a water problem rather than as a land problem. The awareness on flood risks amongst societal actors, therefore, is low. The question can also be asked: what is the function of spatial planning precisely? This is especially true if we consider that, currently, a lot of effort is going into solving problems that have been created in the past and will inevitably be created again in the future, given the changing and uncertain conditions. Although integrated water management has brought important improvements, this remains an important concern. The issue of balancing water and land-use demands, and the dilemma of flexibility vs. robustness that arises from these interactions, is further discussed in section 7.2.

The relation between actors, i.e. state and society, on the other hand, raises questions on participation and self-organization. Currently, participation options are limited. The strong technical approach and the closed communication on flood risks create the impression amongst residents that the government has the flooding under control, or at least that it should have, or that citizens are not expected to contribute. This issue of the public-private divide in FRM is further discussed in section 7.3.

These two policy challenges are not new to FRM or spatial planning. The integration of the water and the land system is at the heart of discourse on integrated flood risk management (Wiering and Immink, 2006; Woltjer and Al, 2007), and questions on participation have been a subject of organizational sciences for many years. However, the co-evolutionary perspective developed in this dissertation provides a framework that offers a different perspective to tackle these challenges. In what follows, these challenges are further analyzed.

7.2

Interactions between land and water: balancing robustness and flexibility

The interaction between land and water is characterized by a tension between robustness and flexibility. The turn from flood protection to FRM and eventually resilience is triggered by a need for flexibility to adapt to changing circumstances in the water system. On the other hand, spatial developments ask for sufficient robustness, as spatial structures are quite rigid and investments in spatial developments extend over long periods of time. In what follows, these simultaneous but contrasting needs are discussed in relation to their context. It elaborates on the need for a new mode of governance that balances these issues of flexibility and robustness.

7.2.1 The need for flexibility

The water system is influenced by complex natural–physical components (Patt and Juepner, 2013). For example, the exact occurrence and intensity of climate extremes is unpredictable in the long-term, as the climate is inherently variable. Moreover, the climate seems to be changing towards an increasing intensity and frequency of flooding (IPCC, 2014).

Additionally, human interventions induce (intentional or unintentional) alterations to the water system. Technical infrastructures such as dikes and dams, upstream activities and land uses in the catchment have considerable impacts on the water system. Particularly in urban areas of developed countries, the multiple and intense land-use activities in catchments make the prediction and management of the water system more challenging and complex. For example, the urbanization of floodplains takes up space for the rivers and also increases discharge of rainwater due to impervious surfaces. Urbanization also creates local heat islands with their own microclimate, making the flood forecast more difficult.

In addition, social aspects of flood management are subject to long-term change. Considering multiple actors (water managers, politicians, residents, etc.) leads to relational uncertainty (Brugnach et al., 2008). This type of uncertainty emerges from the parallel and equivalent existence of multiple knowledge frames. Different actors understand the issue differently and hold different values and beliefs; therefore, they have different judgments about the potential actions or interventions. As such, decision-making is characterized by uncertainty (Tompkins and Adger, 2004).

All these elements are associated with a range of uncertainties (Dessai and van der Sluijs, 2007) and complexities that cannot be mitigated through modeling or further research, as they are inherently unpredictable. Therefore, flood management strategies can no longer be based on the conventional linear methods of risk assessment, which evaluate alternative measures to implement the optimal solution. The inherent uncertainty and associated complexity with respect to changes in the physical and social components of flood risk require more flexible schemes to be incorporated into decision processes and management choices.

However, there are some clear disadvantages and discomforts to more adaptable approaches, such as the physical constraints of removing structures or high costs (monetary compensations) and social difficulties (issues of justice, legal certainty and liability) when changing land-use allocations. Nevertheless, there is no adequate alternative. In the face of increasing floods and continuing urban developments in flood-prone areas, traditional approaches to floods fail, and flexibility is becoming an essential component of future FRM.

7.2.2 The demand for robustness

An important argument for traditional flood protection is that it provides a robust setting for all kinds of activities behind dikes. This goes back to the pioneers of water engineering (Nisipeanu, 2008). Building a dike along a river essentially increases the value of property rights behind the dike because the land becomes attractive for building activities. Spatial planning decisions in those areas are based on the assumption that a certain piece of land remains physically consistent over a long period of time. Changing such a designation is rather difficult (as discussed above). Hartmann and Needham (2012) conclude that property rights are inevitable but also desirable. They are inevitable because whenever a spatial plan or a planning measure specifies how a particular plot of land may or may not be used, they are socially constructing and assigning property rights through the law. They are desirable because property rights make planning decisions robust. So, robust planning decisions are essential for the functioning of society – the whole system of property rights, and thus economic investment, builds on reliable and robust spatial planning decisions.

However, contemporary planning theory often criticizes such property-oriented spatial planning as being too inflexible to cope with uncertainties (Bertolini, 2010; Hartmann and Needham, 2012). A spatial allocation and distribution of goods that might have been desirable at one time can become inconvenient, or even dangerous, as seen in the case of riparian urban development and increasing floods. Moreover, planning theory asserts that "*in the everyday world of spatial planning practice, planners are more likely to rely on intuition or practical wisdom*" (Hillier, 2010: 11). To some extent, planners guess (Paterson, 2007) and experiment (Bertolini, 2010; Hillier, 2010) with space. However, abandoning robust spatial planning decisions and shifting towards a system based entirely on flexibility is also not an option. The robustness of spatial planning decisions is and will continue to be an essential element for the functioning of our society.

7.2.3 Balancing flexibility and robustness: a co-evolutionary perspective

So, on the one hand, there is a need for robustness within planning while, on the other hand, there is also a need for flexibility emanating from changing flood risks. Both claims are legitimate (Hartmann and Needham, 2012), and both approaches have advantages and disadvantages (Table 8). Therefore, it is not a question of choosing one above the other; rather, the question is how to accommodate both needs. Therefore, a new balance between flexibility and robustness needs to be found in order to govern land and water effectively in urban areas through a combination of social, financial, political, physical and economic adaptations. This section addresses this balance by discussing the co-evolutionary interactions between land and water.

Considering floods as a result of the interaction of social and physical systems sheds a new light on flood management (Gerrits, 2008). Floods are inextricably results of co-evolving land (socio-spatial) and water (natural-physical) systems (Folke et al., 2002; Tompkins and Adger, 2004). This means that flood risks influence land-use options, and spatial developments on land, in turn, have an impact on flood risks (e.g. increased run-off) (Gerrits, 2011; Hartmann, 2010; Mitleton-Kelly, 2003). The mechanisms behind spatial developments respond to (changes in) flood risks (Hartmann, 2011a; Pahl-Wostl, 2007). These include spatial demands, real estate markets (Eves, 2004; Pryce et al., 2011; Shultz and Fridgen, 2001), insurance systems (Botzen et al., 2009; Burby, 2001; Penning-Rowsell and Priest, 2015), knowledge of flood risks (Bubeck et al., 2012), perceptions and attitudes towards floods and FRM (Baan and Klijn, 2004; Becker et al., 2014; Birkholz et al., 2014), and the behavior and practices of the broader society (Grothmann and Reusswig, 2006). The presence of valuable spatial developments in flood-prone areas, on the other hand, causes a need for protection through technical infrastructure, governmental rules, engineering rules and technology. Co-evolution thus provides an analytical framework to understand the interdependent evolution of social and environmental subsystems.

	Robustness	Flexibility
Perception of flooding	Floods are predictable, with a more-or-less constant trend in flooding frequency	Flood risks vary and are unpredictable
Perception of damage	Quest for fail-safe options	Calamities will happen
Goal	Preservation oriented	Allow for reorganization and development, enable the system to adapt to changing conditions
Means	Defending against the water and enforcing a strong boundary between land and water	Adaptation of vulnerable objects to minimize the consequences of floods, while allowing some flooding
Advantages	Constant conditions: – Facilitates using (protected) land efficiently without compromises – Easier decision-making for land-use planners – Clear division of responsibilities between water management and spatial planning	Deals better with uncertainty and associated complexity with respect to changes in the physical and social components of flood risk
Disadvantages	– Too inflexible to cope with uncertainties and change – May create lock-in	– Costs for adaptation and compensation – Compromises for land uses – Issues of justice, legal certainty and liability – Challenges existing institutions and well-entrenched modes of governance – Compliance and cooperation of many different institutions as well as public and private stakeholders

Table 8 Characteristics of robustness- and flexibility-based approaches to FRM

The examples in box 2 illustrate how a co-evolutionary perspective to the two systems of land and water can help in finding a new balance between robustness and flexibility in FRM. In order for co-evolution to be fruitful, it is important that both systems are dynamic. A co-evolving system tries to adapt to the environment when necessary, and it tries to influence its environment when possible (Edelenbos and van Buuren, 2006). The discussion of flexibility versus robustness thus comes down to accommodating both changing flood risks (when necessary) and stable social development by influencing the water system (when possible) in a co-evolutionary process. In the case of flood management, this means that spatial planning and water management need to be adapted to each other. Currently, in practice, there is a tendency towards this approach due to the increasing importance of spatial planning within the flooding issue (e.g. Coninx and Cuppen, BOX 2

Co-evolution in the boundaries between land and water – three examples

An example for such co-evolution of boundaries between land and water can be found in Nijmegen in the Netherlands. The Waalsprong is a huge urban expansion project north of the center of Nijmegen, across the River Waal. The project is part of the Room for the River program initiated by the Dutch government, which combines water safety targets with spatial planning goals (Coninx and Cuppen, 2010). At the point where the development is occurring, the Waal bends sharply and becomes narrower. In 1993 and 1995, this location was subject to flooding. The extension plans already existed before the Room for the River program; however, the program required that the urban development and flood protection support each other.

The chosen solution is to move the existing Waal dike in Lent a few hundred meters inland to restore the river's floodplain and to construct an ancillary channel there. This enables the hinterland to develop while, at the same time, preparing a sufficient buffer for flood risks. The results provides both robustness (the dike) and flexibility (the creation of a floodplain and an ancillary channel), enabling the frontier between land and water to co-evolve.

Similar considerations were taken into account in the urban regeneration project of HafenCity, located in the center of Hamburg, Germany. This site is located outside of Hamburg's main dike line, making it prone to flooding. All roads and bridges were elevated to the minimum height corresponding to the flood walls protecting the inner city, while the bases of the buildings were constructed so that they are flood secure. Instead of altering the water system, adjustments in the spatial system were implemented to allow flooding. Although this approach is still quite technical and engineered, it reflects a shift towards accommodating more flexibility.

A third example is the river contract in the Maarkebeek in Flanders. Originally, water managers from different levels (regional, provincial and municipal) were planning to align the different measures they each were taking to manage flood risks through a river contract. The initiative thus originally only envisioned an integration effort within the field of water management. However, the provincial spatial planning department decided to use this water management initiative as an opportunity to embed the flooding issue in a broader vision for the area and develop a regional spatial vision on the Maarkebeek area. Residents were actively involved in the development of this regional vision at an early stage. They received information on the flood protection plans of the water managers, and could give input for the spatial vision.

These examples show differing approaches in the integration between land and water. While HafenCity is an urban project that takes a quite technical approach, the river contract of the Maarkebeek presents a more landscape-based and socially embedded approach. Also, the involvement of different actors varies widely (see also section 7.3), yet they all explore the options for spatial solutions to the flooding problem.

2010) and the growing interest in co-evolutionary planning (Boelens and de Roo, 2016).

The concept of co-evolution does not provide a solution to the dilemma of flexibility versus robustness, per se, but it does offer another perspective that bridges the socio-spatial demand for robustness with the natural-physical constraint and need for flexibility in the interplay of land and water at its fluid frontier. By understanding the mutual influence (the co-evolutionary character) of the two systems, the perspective on FRM measures changes. When drafting measures in one system, the effects on the other system should be considered in order to obtain a more realistic estimate of the resulting flood risks. When areas are protected from flood risks, what does that imply in terms of spatial development perspectives? What are the effects of urban development on flood risks, both locally and downstream? And what does this mean in the long term? By considering the interactions and co-evolutionary nature of water and land systems, more comprehensive and effective results can be expected.

Although this seems obvious, it is not yet standard practice. Often, the focus in FRM is more on the water system and less on the effects of the land system and how they influence water issues. FRM measures are generally restricted within the boundaries of the water system, while, a remedial approach to managing flood risks is used within spatial planning.

The perspective of co-evolution helps to understand the interdependencies of the social and environmental subsystems of land and water, thus helping to understand the fluid frontier between the two. The co-evolutionary perspective raises a couple of essential research questions. One of the issues has to do with the costs of flexibility (adaptation measures, but also compensation claims for disturbing the robust system 'land'). Also, questions of justice and equity need to be dealt with. If FRM requires a more flexible approach to floods, who will get what kind of protection? This requires new discourses on the risk absorption capacities of land uses; but it also raises a couple of legal issues related to liabilities or responsibilities.

7.3

Interactions between state and society: sharing responsibilities

The second issue, the interaction between state and society, leads to the issues of the public-private divide. While FRM was, until recently, mainly a government responsibility, policy-makers are now looking to share responsibilities while integrating and activating other actors in FRM. In this section, it is discussed how the co-evolutions between state and society can play a role in this.

7.3.1 The public-private divide in flood risk management: theories and concepts

For a long time, flood management has been considered a prime example of a pure collective good (Meijerink and Dicke, 2008). In several Western European countries and in the United States, however, there is an increasing trend towards individual responsibilities in FRM, turning it partially into a club or private good (e.g. Bubeck et al., 2013b; Geaves and Penning-Rowsell, 2016; Meijerink and Dicke, 2008).

Mees et al. (2012) underline that a particular set of public-private responsibilities is driven by a certain rationale amongst its stakeholders. This rationale can take a juridical, economic and/or political perspective, which leads to considerations of fairness, effectiveness, efficiency and legitimacy, respectively. Firstly, the distribution of responsibilities should be well defined and lead to a reasonable share of risks, costs and benefits between and amongst generations (fairness). Secondly, the distribution should lead to an effective and efficient adaptation policy. Lastly, the policy needs to be approved by those directly involved or affected (legitimacy). Often, the different criteria are conflicting, depending on the specific context. Individual flood risk protection in rural areas is, in some cases, most efficient; but it poses questions of fairness in comparison to others living in collectively protected areas if these measures are to be financed and implemented by households themselves (Johnson and Priest, 2008; Leichenko and O'Brien, 2006; Walker and Burningham, 2011). This problem could be solved through governmental subsidies, which might, in turn, lead to the question: why should taxes be spent on citizens who choose to live on floodplains? In these cases, issues of water management and land use become entangled. Consequently, distributing public and private responsibilities in FRM is not a technical matter of calculating efficiency and effectiveness, but requires a political debate and broad social support.

7.3.2 Co-production and its limitations

In the growing debate on flood risk responsibilities, citizens are expected to co-produce FRM. Co-production is defined as "*the involvement of citizens, clients, consumers, volunteers and/or community organizations in producing public services as well as consuming or otherwise benefiting from them*" (Alford, 1998). The concept has been employed within divergent disciplines. In planning theory, it is used to describe the participation of citizens in the strategic planning process (Albrechts, 2013); scholars of public administration and services management link it to the involvement of citizens and civil-society actors in the delivery of public services (Osborne and Strokosch, 2013). Analogue to Osborne and Strokosch (2013) and Bovaird and Loeffler (2013), we employ co-production as an umbrella term, which contains several subconcepts to describe citizen involvement in decision-making and delivery (Figure 22):

– *Co-planning*, which entails forms of public participation in the decision-making phase, i.e. in the formulation of opinions, adoption of decisions and, in rare cases, in the agenda-setting

– *Co-delivery*, i.e. the involvement of citizens in the implementation of policy measures

– *Comprehensive co-production*, where citizens are involved in the entire policy cycle (i.e. policy agenda-setting, decision-making and implementation)

Although its definition does not explicitly prescribe it, most scholars consider co-production to be initiated by governmental actors (Watson, 2014). This implies that citizens are either uninvolved or little involved in defining the issue at stake (i.e. the agenda setting phase), which is criticized by others as being counter-productive (Boelens, 2010; de Roo, 2012; Purcell, 2008). Indeed, in practice it has proven difficult to successfully engage non-governmental actors in a later stage of governance due to the lack of mutually understood governmental and societal goals (Reed, 2008; Rees et al., 2005). Co-produced planning processes are criticized for being too time consuming, reproducing existing power relations (Currie-Alder, 2007; Huitema et al., 2009), too focused on process and not enough on content (van der Cammen and Bakker, 2006; Wigmans, 1982), not genuinely improving the quality of output (Innes and Booher, 2000) and just resulting in a 'public support machine' (Hendriks and Tops, 2001; Woltjer, 2002). Boonstra and Boelens (2011) claim that these kinds of traditional participatory processes cause new restrictive inclusionary processes – thematically, procedurally and even geographically.

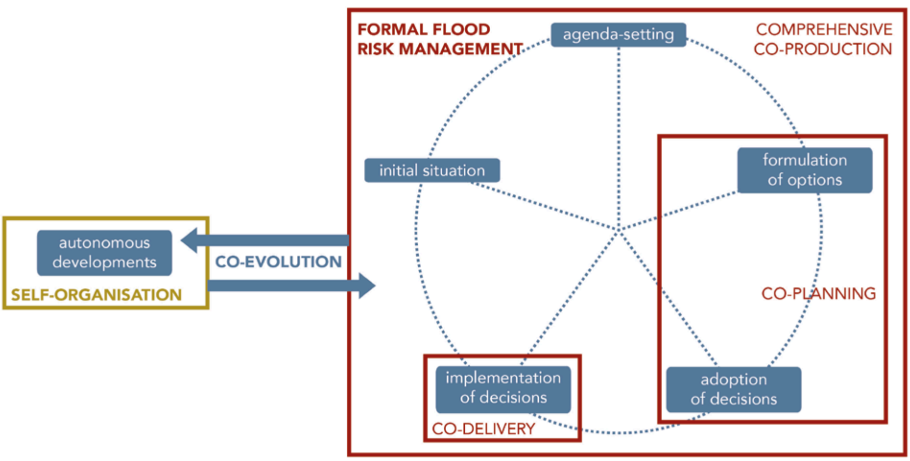

Figure 22 Overview of the different forms of co-production, based on the stages of the policy cycle (Crabbé and Leroy, 2008; Werner and Wegrich, 2007). The red boxes indicate which phases of policy-making are included in participatory processes.

Several authors have also critically addressed co-delivery. Nye et al. (2011), for example, attribute the trend of co-delivery observed in English flood risk governance to "*the environmental rhetoric of individuals becoming the repository of environmental responsibility*" (Eden, 1996 in Nye et al., 2011). This way, it fits into a neo-liberal conceptualization of resilience, stressing the need for individual self-reliance (Davoudi et al., 2012).

7.3.3 A co-evolutionary perspective

To meet the challenges of co-production, a co-evolutionary approach to FRM is adopted. While many forms of co-production focus on the mutual implementation of fixed targets (set by governments), co-evolutionary approaches are based on mutual interactions between different subsystems. Therefore, this approach is more open and adaptive, making it more suitable for dealing with complex and changing conditions.

If we apply this to decision-making in FRM, two relevant subsystems are the state and society. The first comprises of water managers and spatial planners on different levels; the latter, of residents, insurers, architects, contractors, etc. Within these subsystems, different (groups of) actors are directly or indirectly, actively or passively, and deliberately or unintentionally involved in the development of flood risks and ways to deal with them (Tempels and Hartmann, 2014). They interact with each other through real estate markets; building activity; spatial developments; insurance systems; the behavior and practices of individuals; and public protection measures. This means that decisions and actions taken by the state influence what societal actors think and do, and vice versa. All actors involved in the development and management of flood risks thus have their own cycles of agenda setting, decision-making and implementation, which are being influenced by those of others.

This co-evolutionary process between state and society has shaped the state of FRM today (Pahl-Wostl et al., 2007b). Co-evolution is thus an inherent part of FRM; it is inherently different from co-production, which is part of formal FRM strategies and is thus based on a conscious and active relationship between policy-makers and societal actors. While co-production is rooted in policy development and is thus a goal-oriented process, co-evolution is undefined in its result. The resulting co-evolution can be fruitful for preventing and mitigating flood damage, or it can lead to a suboptimal lock-in of state-society relationships. In order to stimulate a fruitful co-evolution, policy-makers can purposefully engage in the existing co-evolutionary processes. By doing so, authorities take into account the existing co-evolutions to attain common goals of security and preparedness. Boelens and de Roo (2016) call this ‘planning of undefined becoming.’ It means that the living micro-scale is taken as a starting point to explore a variety of options within the specific institutional setting, without pre-defining management goals. Through mutual understanding of the subsystems, anticipating feedback and adapting their own strategies, constructive co-evolutions between state and society can be built (Boonstra, 2015).

7.3.4 Tensions and bridging points in the discourses of state and society

The results in chapters four to six show a clear gap between the discourses prevalent amongst public officials and residents of the flood-prone areas in the Dender basin. Most governmental actors believe precautionary actions at the household level can, in some cases, form a useful flood risk strategy. Therefore, they are in favor of sharing flood risk responsibilities between authorities and citizens, and they believe these actions should be encouraged. By contrast, the majority of citizens appears very skeptical about household-level flood prevention measures and primarily considers the government to be exclusively responsible for their protection. While the discourse within governmental administrations is primarily inspired from an economic perspective, considerations of fairness and legitimacy dominate the discourse amongst residents.

Between these discourses, however, a number of bridging points are present, which offer the opportunity to link them. Indeed, the Flemish government itself has not yet developed a clear viewpoint on the implications of the multilayered water safety discourse for the distribution of costs and benefits. Its public officials are in favor of encouraging flood protection measures at property level and are taking the first steps to achieve this, but it has not yet been explicitly defined whether citizens should take the financial responsibility for this protection as well. A political debate on this topic still needs to take place within Flemish and provincial governments. Amongst governmental authorities, a wide variety of viewpoints exist on individual flood risk responsibilities. In general, local authorities show more reluctance towards citizen co-delivery in FRM, most likely because they are more sensitive to the possible electoral consequences of the new approach and thus argue from a legitimacy perspective rather than an economic perspective. Public officials at all levels acknowledge that the emerging discourse is not in line with the dominating attitude amongst the population. Although formal law does not grant property owners in residential areas an automatic right to build, informal norms make it almost impossible to refuse building permits in these zones. Some of the interviewed officials argued it would be ‘unjust’ to refuse owners a building permit on a plot they had bought for residential purposes, despite its flood vulnerability.

On the other hand, residents that have been affected by floods are not entirely hostile to individual protection measures either. Seventy-two percent claim to have taken some form of precautionary action, of which 32.5% were structural measures. Residents of Overboelare state that only when the government takes sufficient action, would they make an additional effort. Hence, they do not outright refuse private responsibility, but expect it to be preceded by governmental commitment. Although residents mention ‘flood protection is a government responsibility’ as one of the principal reasons for not taking measures, our research data revealed that 54% would be willing to take measures themselves.

These bridging points offer opportunities to align the divergent discourses. This will be necessary to maintain and enhance the effectiveness and legitimacy of the current policy on flood risk.

7.3.5 Shared responsibilities

From the perspective of co-evolutions between state and society, FRM is the product of the interactions between these two groups. In each of these subsystems, actors develop their own flood risk strategies. The strategies that are decided upon are influenced, amongst other things, by developments taking place in the other subsystem. Because FRM has long been presented as a governmental responsibility in Flanders, citizens have invested little in developing active flood risk strategies themselves. In the context of increasing flood risk, however, this co-evolution appears to have become suboptimal; while residents take little or no action, water managers are increasingly faced with the fact that they can no longer manage flooding on their own. Therefore, policy-makers argue that responsibilities should be shared between state and society by including them in the delivery of FRM. That way, a more fruitful co-evolution could emerge.

Following the framework of Mees et al. (2012), however, the division of public-private responsibilities needs to consider fairness, effectiveness, efficiency and legitimacy. Current discourses amongst public officials and citizens generally emphasize efficiency while having a limited focus on the effectiveness/efficiency or the fairness/legitimacy criterion, which challenges the shift pursued by the government.

Today, Flemish FRM is focused on input/output rather than throughput legitimacy; i.e. it legitimizes its FRM through authorized institutions delivering effective output rather than including citizens in its decision-making (see Hartmann and Spit, 2016). Although active public involvement is strongly encouraged by the EU FD (Art. 10), public participation in Flemish FRM is generally limited to later phases of the decision-making process and more passive forms of interaction (Mees et al., 2016a; Van Rossen, 2003). Overall, the Flemish population accepts its limited participation possibilities since FRM is considered exclusively the competence of the government. But if the government proceeds to transfer flood risk responsibilities to private actors, it will weaken its input and output legitimacy because it relies on actions taken by these actors for its effectiveness. Considering the currently prevailing attitude amongst the population of the Dender basin, it is unlikely that residents will accept this new role without more intensive opportunities for participation.

Indeed, several scholars point out that a shift towards sharing flood risk responsibilities with private actors cannot be accomplished without including them in the decision-making as well (Roth and Winnubst, 2014; Steinführer et al., 2009; White et al., 2010). Hence, a plea is made for a shift from input and output to throughput legitimacy (Hartmann and Spit, 2016). In their comparison of the U.S., Australia, the U.K. and the Netherlands, Meijerink and Dicke (2008) observed that shifts towards FRM based on private interests are accompanied by increasing possibilities for private actors to participate in policy-making. Whereas Dutch flood risk policy remains strongly directed to public interests but is limited in its opportunities for public participation, the opposite applies to the U.K.

Remarkably, we do not witness a similar trend in Flanders. While the Flemish government strives for enhanced citizen involvement in the implementation of its policy, no corresponding involvement is provided for in its decision-making. In its 'progress report on water nuisance' of 2015, the government announced that water safety plans would be drafted at catchment scale, based on the results of the FRMP study (CIW, 2015). While this could be a good opportunity to open up the decision-making, current pilot projects only include governmental stakeholders in the early stages. Nonetheless, the survey (chapter 4) found that about 42% of the population wishes to be involved in finding solutions to the flooding issue in the Dender basin. As discussed above, sharing responsibilities (co-delivery) without involving residents in decision-making (co-planning) challenges the legitimacy of FRM. The government should thus open up the debate and allow residents to participate in the FRM decision-making processes. However, this should be done carefully. Boonstra and Boelens (2011) argue that public participation processes set up by governments are too strongly based on governmental preconditions, in many cases resulting in a 'public support machine.'

7.4

Co-evolutionary planning

As concluded above, different actors produce FRM parallel to and in co-evolution with each other. However, under the current conditions, the actions by societal actors are often not concerned with flood risks and, therefore, rarely contribute to the overall goals of minimizing flood damages; in some cases, they even counteract these goals. Considering the empirical evidence presented in this dissertation, it is clear that a systemic change is needed to achieve co-evolutionary flood resilience.

The policy question that arises is thus: how we can make the interactions between land and water, and those between government and society, fruitful and effective so that the outcomes for the overall management of flood risks complement and reinforce each other towards a greater flood resilience? How can FRM enable and support societal actors to actively and constructively contribute to the management of flood risks?

First, we discuss some of the limitations of the current integrated FRM approach. Then, formulate some building blocks for a co-evolutionary FRM approach inspired by the impediments observed in the empirical chapters of this dissertation. We then discuss two simultaneous and complementary tactics for policy-makers to navigate the interactions between land and water as well as and between government and society in order to make them more fruitful and achieve flood resilience through its FRM.

7.4.1 The limitations of current flood risk management practices: integrated water management and uncertainty

Integrated water management has been of great value to advancing the integration of land and water, and the integration of state and society. In line with the co-evolutionary approach, it handles a broad definition of the flooding system and the scope of flooding impacts. Flood risks are conceptualized based on a whole-system approach, leading to a wide range of potential FRM actions, such as land-use planning, controlling runoff, buffering water, flood warning, insurance, improving flood resistance of properties, and flood defence (Hall et al., 2003). However, integrated FRM is less adequate to respond to the co-evolutionary aspects of the interactions between different actors in the spatial development and management of flood risks. More specifically, integrated FRM:

- mainly brings together policy-makers. Due to the high fragmentation of competences in policy-making for FRM, a lot of effort goes into bringing together different governmental actors. Land users and other individual societal actors are usually far away from these processes.

- is centrally coordinated by policy-makers/water managers. While institutionalized actors are consulted, policy-makers determine goals and strategies.

- is based on consensus and agreement on common goals and how to achieve these. Due to the high number of visions and interests in FRM, a lot of effort goes into deliberation.

- selects and prioritizes solutions based on technical expert knowledge. It focuses on uncertainties related to flood risks. As such, it ignores relational uncertainties social issues such as responsibilities and perceived risk. For example local governments sometimes chose suboptimal solutions because they feel that it is their responsibility to protect their citizens.

Integrated water management works well under conditions of reduced complexity. It focuses on uncertainties related to the system (i.e. flood risks). However, it does not deal well with uncertainties related to e relative autonomy of land users and other societal actors. In this respect, Brugnach et al. (2008) discuss there types of uncertainty:

- ontological uncertainty: inherent variability or unpredictability of a system
- empistemic uncertainty: the imperfection of knowledge about a system
- relational uncertainty: the ambiguity that results from the simultaneous presence of multiple frames of reference about a certain phenomenon

The relative aunotomy of land users and other societal actors thus create relational uncertainty. Brugnach et al. (2008) show that the discussion on uncertainty in integrated water management focuses on unpredictability and lack of knowledge about the system (i.e. flood risks), and not on the relational uncertainties arising from the multiple knowledge frames of different actors. Taking this relational uncertainty into account would lead to different interpretations of the problem, as well as different solutions. The co-evolutionary approach can extent integrated FRM to deal with relational uncertainty. In what follows, we argue that co-evolutionary planning is more suited to deal with conditions of uncertainty both in the system and the actor field.

7.4.2 Integrating actors in integrated flood risk management

The co-evolutionary approach developed in the theoretical framework put actors central. However, not all planning issues ask for a co-evolutionary approach. In conditions of reduced complexity, where the object and/ore the context are relatively certain, existing approaches have proven their value. In line with this, it is important to note that there are also circumstances where integration of different systems and participation of different actors are not needed.

Terryn et al. (2016), Boelens (2015) and Verbeek and Boelens (2016) provide a framework on different planning approached that deal with different types of uncertainty (see Table 9). They define two types of uncertainty: uncertainty related to the object, and undercainty related to actors. It shows the co-evolutionary approach can complement other planning approaches under conditions of inherent uncertainty related to both the system and the actors involved.

		object of planning **SYSTEM**	
		known fixed	unknown changing
context of planning **ACTORS**	unknown changing	**collaborative planning** e.g. integrated water management	**co-evolutionary planning**
	known fixed	**path-dependent planning** e.g. flood protection	**adaptive planning** e.g. adaptive water management

Table 9 Planning approaches according to differing degrees of uncertainty related to the system (or object of planning) and the actors (or the context of planning), with examples from FRM (adapted from Boelens, 2015)

– path-dependent planning: Planners encounter a relatively fixed actor field with a relatively well-known object of planning. Under these circumstances, established procedures of command-and-control flood protection approaches work well. This management of flood risks is supported by objective data.

– collaborative planning: For planning issues where more and ever-changing actors are involved, a more participatory collaborative planning approach is needed. This approach deals with all the interests involved, within the boundaries of predefined objectives.

– adaptive planning: In this context, volatile and changing objectives occur over time as the system itself changes. Because the object is new, possible solutions could change over time. Under these circumstances, planning approaches need to cope with these changing settings in space and time by adapting to them.

– co-evolutionary planning: For a discussion on the principles of co-evolutinoary planning, see section 7.4.3.

The development of the co-evolutionary approach thus does not refute the validity of other approaches to managing flood risks. These types of FRM activities are also essential for the development of flood resilience, for example, to provide robustness. Instead, this framework promotes a problem-driven selection of the most appropriate planning approach to deal with flood risks. Depending to the concrete framing and nature of the problem and the related (perceived) uncertainties, the appropriate planning approach can thus be selected.

7.4.3 The principles of a co-evolutionary flood risk management approach

So what is then a suitable planning approach for conditions of uncertainty related to both the system and the actors? Co-evolutionary planning is characterized by a reciprocal collaboration between a changing set of actors without fixed aims or aobjectives. Important processes hereby are self-organization and learning by doing (Verbeek and Boelens, 2016). Some conceptual principles of a co-evolutionary approach to managing flood risks in spatial planning are:

- to consider a broad range of actors involved in the spatial development and management of flood risks.

- to embrace the diversity of FRM actions as performed by the different actors that are involved in the spatial development and management of flood risks. These include both purposeful and unconscious as well as positive and negative aspect to managing flood risks. They do not necessarily align with each other or pursue common goals.

- to assume the relative autonomy of these different actors (Kemp et al., 2007). The co-evolutionary framework starts from the observation that each actor makes and implements his own strategies to deal with (perceived) flood risks. Land users' FRM actions thus sometimes counteract with formal FRM. This leads to inherent relational uncertainty (Brugnach et al., 2008).

- to consider the interlinked nature of these different FRM actors. These strategies are in co-evolution with each other, meaning that they influence and are influenced by (amongst other factors) the FRM strategies of others. As such, it also considers the systemic impacts of formal FRM, including unintentional effects, such as passive attitudes amongst residents.

The difference thus lies not so much in the potential measures (i.e. content in the conceptual framework of FRM), but rather in the process through which they are developed, in relation to the context of institutional frameworks and other actors' actions. While integrated water management starts from a rational and communicative approach, co-evolutionary planning starts from the inherent diversity of not only opinions, visions and goals in FRM, but also in agency. As such, the co-evolutionary approach focuses more on a society-wide learning process.

7.4.4 Transition towards co-evolutionary FRM

Addressing these issues requires some fundamental changes. The co-evolutionary nature of different FRM strategies implies that reciprocity is a fundamental element for to managing flood risks.

a A better understanding of systemic impacts

The lack of insights into the FRM choices of land users impedes the government in sharing responsibilities with them. There is currently a limited understanding of the systemic impacts of formal FRM. Therefore, there is a need to analyze the interactions and feedback loops between the different subsystems as well as between the elements of formal FRM and how the wider society deals with flood risks in particular. An example of this is to understand and monitor the effects of autonomous spatial developments on the formal FRM options. It is important to monitor and evaluate these societal effects and implications of policy choices, both in the short and long run, in order to develop a learning, adaptive system. This requires a more elaborate consideration of the spatial development of flood risks and the effects policy instruments have on them.

Such insights could be used to create levers to influence these subsystems in order to increase the possibility that these subsystems become more resilient to flooding. The incorporation of this kind of knowledge is new to formal FRM, and its development will require some time and adjustment.

b Enabling well-informed individual decision-making

To enable an open discussion on who could and should take up which responsibilities, it is important that the government provide societal actors with sufficient information on different aspects of FRM. Although knowledge on the flood risks is an important condition for citizen involvement, merely informing them on these risks is not sufficient. It is also important to provide information on the level of protection the government provides to enable an open discussion on responsibilities. Finally, information is also necessary on the actions residents need or can take to protect themselves, and what the options enables residents to act on the flood risks.

This communication towards citizens and land users needs to be clear. Currently, the highly fragmented powers lead to confusion. An example of this is the variety of available flood risk maps. The differences between the various maps may cause confusion on the flood risks, thus not only questioning the credibility of the content of these maps, but also the need and necessity to take (self-organized) action. If the knowledge developed by specialists in the context of policy-making could be translated towards societal actors, that could encourage them to consider their FRM options more actively.

Furthermore, this information should also be honest about how governments manage flood risks and what citizens can and cannot expect from their governments in terms of FRM.

c Starting a dialogue

There is a need for more dialogue and coordination between societal actors and policy-makers in FRM. In a co-evolutionary process, policy-makers inform societal actors on their knowledge and actions, and societal actors share their insights and actively collaborate or contribute by taking private measures. Of course, there will always be conflicting interests and opinions on how to solve the problem; but it seems that, at the moment, the essence of the debate is overshadowed by misconceptions and passive attitudes, not only between governmental and societal actors, but also between higher and lower levels of government.

d ***Deliberate transformational change at lower scales***

A last element is to include deliberate transformational change at lower scales as a catalyst to facilitate eventual change on a larger scale. Currently, most interventions in FRM are conservative, aiming to preserve the current situation; deliberate transformational change at a larger scale is most likely too costly, undesirable or socially unacceptable. However, transformational changes on a smaller scale can trigger larger processes as well (Folke et al., 2010). Such experiments at the small scale enable learning processes through their feedback and help in developing transformative capacity, thus strengthening an adaptive approach.

BOX 3

The water consultant – an example of dynamic interactions between formal FRM and society

An example of a dynamic interaction between formal FRM and societal actors is the 'water consultant' project of the architects' association. This project is set up in deliberation between the building sector and the government. It is conducted by a Flemish architects' association and (financially) supported by the Department of Environment, Nature and Energy of the Flemish government. The aim is to create awareness on flood risks in the building sector and eventually make buildings in flood-prone areas less vulnerable to flooding. The water consultant plays an intermediary function between the construction industry and policy-makers in water management. She supports architects in the design and construction of property level protection and in managing water in building projects by providing information. In deliberation, the governmental steering committee and the water consultant decide which topics need communication with the construction industry. Furthermore, the water consultant also provides the policy-makers (water managers and spatial planners) with feedback and input for their policies based on practical experience.

7.4.5 Two complementary, simultaneous roles for spatial planning

How can spatial planners, taking on both the potential and the limitations of their position in the actor network, manage these processes of co-evolution and navigate the interactions between land and water as well as between government and society? How can they shape these processes of co-evolution in order to develop flood resilience among the broader society? How can they make the direct and indirect interactions and the cause-effect-cause loops with other actors more fruitful?

Inspired by the different levels of transition management as a model to shape co-evolutionary processes towards sustainability goals (Kemp et al., 2007), we here propose two roles for spatial planners. Each role assumes two different positions in navigating the co-evolutions between different actors, with the goal of making a systemic change towards fruitful co-evolutions: (a) indirectly, by creating conditions that will influence but not determine the FRM actions by societal actors and, (b) directly, by engaging with societal actors in open-ended local processes.

Both roles should be considered as complementary and simultaneous processes aimed at strengthening the adaptive capacity of urban developments in flood-prone areas. This means moving away from exclusive and restrictive permission-oriented planning, with its fixed standards of what can and what cannot be allowed; instead, it means moving towards a planning policy that sets sharper conditions under which certain developments are allowed and, at the same time, interacts with actors in an open process. Through a dialogue between these two roles, strategies could be built and further developed.

a Regulatory framework: setting adaptive conditions

In the empirical research, we saw that, currently, a lot of the societal mechanisms that contribute indirectly to the development of flood risks – such as insurance and real estate markets – do not contribute to a diversification of responsibilities. As such, the institutional framework does not produce fertile conditions for the development of flood resilience.

However, by changing the institutional setting and creating conditions that enable societal actors to take up responsibilities, these mechanisms could be turned around. Through these conditions, planners could indirectly encourage land users and other non-governmental actors to contribute to managing flood risks.

These conditions can take on many forms. Some conditions can be aimed at restricting certain options, such as laws, regulations, etc. Others could take the form of incentives that encouraging desirable behavior, such as subsidies, support, etc. It is important to note here that, while the effects of these conditions are always highly uncertain, the establishment of these conditions often envisions normative positions on desirable outcomes or futures. It is important to carefully take into account who is deciding on these conditions and why. Furthermore, policy-makers need to clearly communicate what can and cannot be expected from the government in order to avoid giving false expectations on, for example, protection standards or the anticipated effects of climate change.

To create these conditions, different (policy) frameworks – such as spatial, environmental, civil engineering, legal and welfare policies – need to mutually reinforce each other. Conditions in spatial planning should be complemented with conditions regarding, for example, economic mechanisms such as the abolishment of excessive damage compensation regulations and/or the provision of subsidies, information dissemination, the support of the technical development of adaptive building techniques, etc. in order to improve shared responsibilities and resilience.

b Planning projects: local co-evolutionary interventions

In co-evolutionary interventions, planners engage more directly with societal actors through open-ended processes. The aim is to create outposts at hotspots of flood risk areas, where the government situationally in time and place takes up the role of a partner to the present civil and business actors in order to jointly stimulate improved social resilience through time- and location-specific solutions. In this situational and circumstantial area-based approach, it is important to start from the local (perception of the) flooding issue and the role and positions that the actors assume. Area-specific knowledge development (such as this research) can be a starting point to bring local actors together to gain attention for the existing and future flood risks in specific situations and start a discussion on more effective and resilient solutions or levels of acceptance in the near future. Again, it is important to address these various fields of policy and social (self-)organization simultaneously in order to use the resources (time, money, expertise, social support, etc.) in a mutually reinforcing way.

Instead of assuming pre-definined objectives and measures, water authorities and spatial planners would engage with the dynamics that are in place in other FRM subsystems in an open process. The exact ways in which societal goals (such as lowering flood damage) are reached are thus unknown beforehand. This 'planning of undefined becoming' is not aimed at developing policies, but at building networks and dynamics of mutual action (Boelens and de Roo, 2016). In contrast to the hierarchical structure in place today, sharing responsibilities requires a horizontal governance system (Boonstra, 2015). In deliberation, authorities and citizens should define their mutual roles and responsibilities in FRM. Instead of introducing top-down objectives and solutions or exclusively supporting bottom-up initiatives, policy-makers horizontally cooperate with other stakeholders to capitalize, strengthen and complement existing social and economic capital. All the actors involved, i.e. authorities, residents and other societal actors, have relative independence in their particular sphere of action. Therefore, policy-makers should acknowledge and interact with the discourses and framing of problems and solutions prevalent amongst non-governmental actors. Consequently, the results of these processes are not fixed, but emerge in the co-evolving domains of actors, their networks and changing surroundings.

c Building strategies: dialogue between these two roles
This dual approach thus sets out two complementary roles for governments. On the one hand, policy-makers set legitimized conditions for increased personal flood risk responsibilities. On the other hand, governments participate in co-evolutionary interventions so that FRM is not only a matter of governmental action, but so that all actions influencing flood risk – including those of societal actors – align.

It is important that these two roles are in a constant dialogue with each other. If a co-evolutionary intervention results in conditions that impede the development of such co-evolutionary projects, these conditions can be altered based on evidence from the intervention. On the other hand, if certain unwanted or inappropriate tendencies arise from the conditions, alternatives can be tested and developed through co-evolutionary interventions. In this way, a strategy could be built and adapted in a co-evolutionary manner.

7.5

Conclusion

In this chapter, we introduced the concept of co-evolution to, on the one hand, explain the interactions between actors observed in chapters four to six, but also to guide the development of alternative strategies. From the empirical findings, it seems that the co-evolutionary process between the different actors involved in FRM is currently not fruitful. FRM seems to be entrenched in a one-sided technocratic approach. This is evidenced by five co-evolutionary mechanisms: (a) the dominance of structural and protective measures, (b) the emphasis on economic damage, (c) responsibility and decision-making, (d) insurance and compensation systems and (e) knowledge on flood risks and its institutionalization.

In order to break away from this negative spiral, two main policy issues arising from the co-evolutionary processes between actors are discussed from a co-evolutionary perspective: the dilemma of flexibility versus robustness, which arises from the interaction between land and water, and the issue of shared responsibility, which arises from the interaction between state and society actors. The observed gap between society and FRM and the lack of fruitful co-evolution can be overcome by a dynamic, two-way interaction between government and society. This approach is elaborated in two complementary, simultaneous roles for spatial planning: to creating supporting conditions (adaptive condition planning) on the one hand, and to engage in processes (co-evolutionary interventions) on the other.

8

Conclusions: a co-evolutionary approach to flood resilience

This dissertation starts from the observation that FRM in Flanders, as in many Western European countries, is entrenched in a technocratic protection-oriented approach. Within this approach, spatial developments are often seen as being an external condition for FRM, which limits the operating field to manage flood risks within the confines of the water system. Especially considering the expected overall increase of flood risks due to climate change and urbanization, the associated uncertainties, and the limited monetary and technical capacities to prevent flooding, this approach is becoming problematic. Furthermore, in the current financial and social context, governments can no longer guarantee sufficient protection in the light of its limited power for solutions; multiple parties are needed for this. Although water managers are experiencing that the technocratic approach has reached its limits and are looking for alternatives, there are still some reservations about other types of more socially embedded measures. Moreover, it proves difficult to engage other actors – non-governmental actors in particular.

Therefore, this dissertation has been an endeavor to understand the role of different actors in the spatial development of flood risks and how these different roles relate to each other to produce overall resilience to flood risks. We sought a framework that provides a broader perspective on how flood risks spatially develop through time, and explored what the role of spatial planners could be in bringing the different parties that are involved in this development of flood risks together.

8.1 Conclusions

The three objectives of this research were (1) to review the state of the art in research and policy on flood resilience, (2) to analyze flood resilience, specifically the role of different actors in FRM and how this contributes to overall resilience, and (3) to suggest elements and strategies for spatial planning to improve resilience to flooding. In what follows, we provide an overview of the main overall findings of this dissertation, according to these three aims[6]. Based on this, we can then aswer the overall research question: how can spatial planning contribute to flood resilience?

8.1.1 Flood resilience

In the fields of both natural hazards and urban planning, the resilience concept is gaining attention. It is emerging quickly and has become widespread in academia, policy-making and practice over the last decade. Resilience relates to the way systems deal with adversity, change or shock. What is then considered to be resilient, is a matter of definition and interpretation; while earlier conceptualizations focus on the ability of a system to return to its original state (engineering resilience), the most recent conceptualizations incorporate three elements: stability/robustness, adaptability and transformability (socio-ecological resilience).

6 For the answers on the individual research questions, we refer back to the conclusions of the individual chapters.

The term is often criticized for its conceptual vagueness and abstractness. Since there are multiple definitions and interpretations for resilience, each putting emphasis on different aspects, the term is used in diverging ways, often without clarity about its scope or exact meaning. Nevertheless, the intense discussions around the concept show that it does inspire new directions of thought and consideration. Its main contribution is that it provides a lens to question well-entrenched modes of thought about stability and equilibrium, and challenges them through the concepts of complexity, dynamics and non-linearity. More than just a characteristic of a system, resilience provides a broad perspective – a framework to conceptualize change that provides a different understanding of how systems develop.

The theoretical framework of this dissertation assumes the socio-ecological conceptualization of resilience, i.e. the capacity of complex adaptivesystems to change, adapt and eventually transform as a reaction to strains and stresses. It embraces the complex nature of socio-ecological systems, thus rejecting the existence of equilibria and placing systems along an evolutionary trajectory. Resilience is then no longer focused on bouncing back, but rather on the capacity for reorganization and development; and the degree of resilience is evidenced through its evolutionary development.

Within the multiplicity of theoretical and conceptual facets of resilience, this dissertation focuses in particular on the evolutionary aspect. Currently, the focus in practice is more on short-term damage reduction and maintaining function, and less on this capacity for reorganization and development. Also within FRM and spatial planning practice in Flanders, transformational change has proven to be a major challenge.

This theoretical position contributes to the field of the (spatial) management of flood risks in different ways. Resilience introduces a comprehensive view on flood risks through a systems approach. Due to the highly technical nature of FRM within the traditional Western-European flood protection approach, a broader perspective on how flood risks develop, and can thus be managed, has been lost. Systems thinking acknowledges the inherent relations between the different subsystems of water, space and society. Flood risks are then no longer conceptualized as the multiplication of exposure, damage and vulnerability. Rather, these elements are dependent variables, as they interact and mutually influence each other in complex ways. Flood risks are produced by a myriad of actors, which are interrelated with each other through policies, business and social ties.

Furthermore, with the socio-ecological resilience concept, focus shifts from stability; absorbing shocks; minimizing short-term damages; and a speedy recovery to the pre-existing condition and functions, to an evolutionary perspective. There is no such thing as equilibrium or ideal state, but rather an ever-evolving path of selection and adaptation in a changing complex and uncertain context, filled with surprise and emergence. This perspective assumes that floods can and will happen and requires trial and error through a variety of simultaneous and complementary measures, rather than efficiency and calculation.

Resilience also opens up the definition of FRM to a multi-actor perspective. If we assume that flood risks arise from the interactions between different subsystems, they are also managed in these different subsystems. Flood risks are then not only managed by water managers or spatial planners; formal FRM is just one of the subsystems that (intentionally) influence flood risks. Instead, flood risks are managed by a myriad of actors involved in the spatial development of flood risks. These actors intentionally or unintentionally, directly or indirectly, positively or negatively, and actively or passively contribute to the development of flood risks over time. The outcomes of the interactions between all of these actors will eventually determine the overall resilience to flooding. Therefore, it is important to understand how they co-evolve with each other – i.e. how they interact and mutually influence each other – and, more specifically, whether this co-evolutionary process affects overall resilience positively or negatively. By considering the role of the different actors within this co-evolutionary process, formal FRM approaches could become more effective.

Based on this co-evolutionary multi-actor perspective on flood resilience, this dissertation sets out to analyze the different actions and viewpoints of the various actors involved in the spatial development and management of flood risks, as well as the relations and interactions between them.

8.1.2 Multiple actors

Considering the actor network of flood risks allows for a more comprehensive understanding of the spatial development of flood risks. This approach takes into account a wide range of direct and indirect actions and policies. These include the spatial interventions taken in the land system by governing bodies and different land users both in and outside of flood-prone areas. Indirect actions are, for example, indirectly supporting policies, ranging from information dissemination on risks and potential measures, over market mechanisms related to spatial developments in flood-prone areas to the financial systems of damage compensation (Figure 23). This perspective broadens the possible measures for FRM to include other people and potential interventions, both directly and indirectly. These include property-level protection, incentives through insurance premiums, information dissemination by real estate actors, etc.

Based on a three-level case study (regional, catchment and local/municipal level), this research explored the role of government, business and civil society actors in Flanders. From the policy side, some elements of flood resilience, such as multilayered safety, can be noted in both the context and the process of formal FRM (chapter 3). Nevertheless, the transition is slow and there are still some gaps. However, little is done to support other actors in taking up responsibilities. Although shared responsibility is an important element of the policy discourse, few elements of formal FRM support the development of adaptive capacities.

In the pilot case study in Geraardsbergen (chapter 4), we observe some tendencies of non-governmental actors to take up responsibilities. For example, some real estate agents provide potential clients with information on flood risks and on the measures they can implement to protect themselves. In another case, residents

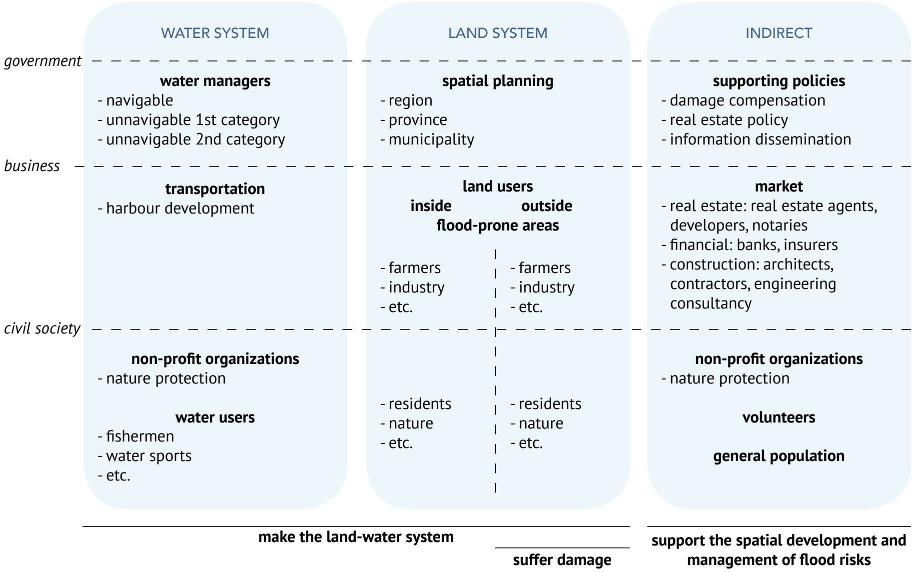

Figure 23 Actor field for the spatial development of flood risks

took the initiative to organize themselves by forming a committee. Still, these cases remain quite limited; they are often confronted with the boundaries of their capacities due to institutional restrictions (e.g. policies of the umbrella company, liability, competition) or regulatory restrictions (e.g. limited participation options).

The survey showed a predominantly passive attitude of residents (chapter 5). They pay little attention to flood risks in their location choice and often put all responsibility on the government. Also most other non-governmental actors consider the mitigation of flood risks to be a governmental task (chapter 6). The regional professional associations maintain a rather conservative attitude and only see a very limited role for themselves in FRM. For example, the insurance and real estate sectors consider their role limited to fulfilling the legal obligations imposed by the government, as they currently encounter few problems. The building sector actors are more supportive, especially the architects' association, which is part of a government-supported program to provide architects with information on limiting the impacts of building on the water system and in flood-prone areas. They consider it desirable to develop technical knowledge on building in flood-prone areas, although the demand for such solutions is very low at this point.

It can be concluded that the strategies to deal with flood risks of non-governmental actors in Flanders are generally passive and, as such, often negatively contribute to the development of flood risks. Considering the lack of support for self-organization or responsibilization of other actors in the institutional context (chapter 3), the overall limited degree of initiative and responsibility of non-governmental actors (chapters 4, 5 and 6) is not entirely surprising. Even though it is not legally defined, FRM has become the exclusive responsibility of governmental water managers throughout the last decades. Furthermore, there are no institutional structures available to foster self-organizational initiatives; there are few incentives or structures for residents or other societal actors seeking to minimize flood risks themselves. For example, there is virtually no financial responsibility to manage flood risks or the financial damage due to flooding individually, and neither is there a real public debate on the issue of individual responsibility. Residents that do take a proactive attitude, on the other hand, are frustrated that there is no support for their initiatives and feel they are not heard. Although sharing responsibilities with other actors is an explicit policy goal for water managers, most non-governmental actors, especially on the regional scale, assume the government to be responsible for organizing FRM.

Nevertheless, there are signs of a certain social capital. Citizens play an important role in the dissemination of knowledge on flood risks. Furthermore, residents with flood experience often know more about individual measures, and they effectively take measures within their own capacities to manage risks. For other non-state actors, there are similar signs of a certain potential for social capital. Real estate agents inform potential buyers about locations in flood-prone areas, and some agents also provide technical information about potential protection measures — although this is certainly not common practice. Insurance premiums capitalize flood risks up to a legally defined maximum. The architects' association actively distributes information on building techniques to manage flood risks. So, to a certain extent, civil and business actors do take up responsibilities in FRM, although it is limited and often only in the worst-affected areas. So the shift towards shared responsibilities is taking place in some sense, but institutionalization and support on the regional scale are lacking. There is thus a certain 'dormant' social capital present that can be addressed to develop more social resilience.

The prevailing policy, however, does not sufficiently appeal to this capital. The current planning system with its rigid land-use allocations cannot respond adequately to the uncertain conditions and new or changing knowledge on flood risks. The way formal FRM is currently organized generally seems to be counterproductive for the development of social resilience. For example, citizens behind high dikes often get a false sense of security. Considering the fact that more and more planners and policy-makers are convinced that the government cannot manage floods alone, and that taking exclusively technical measures is not sufficient, social resilience is deemed to become more and more important. Some recent policy initiatives try to active this dormant capital; but so far, they have not proved to be very effective.

8.1.3 The co-evolutionary approach to managing flood risks

The interactions between the different actors are thus central to the overall resilience, as they define how society as a whole deals with flood risks. Individual strategies are influenced by the environment or context of each actor, including the rules and actions set out by other actors. The different actors' FRM strategies are then in co-evolution with each other – the actions of one actor are influencing the environment for the actions of another; and through these actions, feedback mechanisms are produced. Co-evolution forms a new theoretical lens through which to analyze the role of spatial developments in FRM. Not only is it important to consider the full actor network in the management of flood risks, but it is also important to consider their interactions. The idea that actors, technical systems, flood risks and other societal interests co-evolve through time, and thus shape the way flood risks are managed, provides a framework to reflect on policy strategies to develop flood resilience. This perspective can help explain the effects and unwanted side effects of FRM actions – such as the dike paradox or the increasing damage figures despite investments in flood protection – by taking into account the responses to flood protection of other actors, i.e. the lack of awareness of flood risks and the further development in flood-prone areas.

In general, the co-evolutionary perspective contributes to existing FRM approaches by considering the wider group of people that (spatially) construct flood risks, rather than focusing on (technical) measures. These actors have their own strategies or tactics to deal with flood risks in relation to their context. As such, it allows for a more comprehensive and integrated view on the spatial development and management of flood risks, in which the influence of actors that indirectly, passively or unintentionally contribute can also be taken into account. Focus then shifts from eliminating risk (which turns out to be impossible anyway) to fostering the capacities of these actors to deal with flood risks. Furthermore, it places these actors in relation to each other, thus adding a social perspective to FRM by acknowledging the interactions between these actors. This widens the scope of FRM to not only include elements of content (e.g. measures, instruments, plans, policies, etc.), but also elements of process (e.g. participation and deliberation, adaptive management, etc.) and context (e.g. damage compensation, real estate markets, etc.).

Through the case study research, we observe that, in Flanders, this co-evolution currently has a negative effect on overall resilience. Responsibilities are imposed on the government, while other actors do not feel capable or responsible to contribute to managing flood risks. The case study on different levels and with different types of actors has shown that, on the one hand, there are some signs of social capital on the local scale, while on the other hand, the (regional) policy framework does not encourage or support non-governmental actors to take up responsibilities. The main elements of this negative spiral are (a) the dominance of structural and protective measures, (b) the emphasis on economic damage, (c) the high degree of government responsibility, (d) the low degree of incentives in insurance and compensation systems, and (e) the strong specialization and institutionalization of knowledge on flood risks.

So how can the co-evolutionary perspective provide guidance in designing FRM strategies to improve flood resilience, thus turning this negative spiral into a more fruitful and positive one? How can policy-makers stimulate societal actors to be more involved and to actively and constructively contribute to managing flood risks? The co-evolutionary perspective can inspire new FRM approaches by explicitly taking into account, and even actively strengthening, co-evolutionary mechanisms in the spatial development and management of flood risks. By anticipating the potential effects of actions on other actors in the design of a FRM strategy, they might become more effective. However, as these co-evolutionary mechanisms are complex, it is impossible to base strategies solely on prediction. Also, room for trial-and-error, emergence and incremental processes will play an important role when designing co-evolutionary FRM strategies.

8.1.4 How can spatial planning contribute to flood resilience?

Achieving the three above ojectives enables us to answer the research question: how can spatial planning contribute to flood resilience?

1 From a co-evolutionary understanding of the spatial development of flood risks…

Since resilience is a characteristic of complex adaptive systems, it can only be developed in strategies that deal with the complex nature of such systems. Spatial planning, therefore, needs to embrace the complexity of flood risk management in order to achieve flood resilience. This means that flood risks are considered the outcome of the complex interactions between different actors and systems, and are thus highly non-linear – and, therefore, uncontrollable. This leads to different types of inherent uncertainty in the spatial development of flood risks related to the natural, technical and social system.

The relations and interactions between the actors contributing to the spatial development and/or management of flood risks influence overall resilience against flooding. To address the relations between different systems and actors, we apply the theoretical framework of co-evolution. Flood resilience then emerges out of the co-evolutionary interactions between the FRM strategies of these different actors. Co-evolution means that two systems shape but do not determine each other (relative autonomy). While spatial planning has the spatial competence (e.g. setting rules), land users have the territorial competence (e.g. performing interventions). Spatial planning thus shapes but does not determine the actions of individual land users.

Planning strategies that seek to contribute to flood resilience thus need to acknowledge the relational uncertainty arising from these co-evolutinoary interactions. Depending on the degree of uncertainty, different planning approaches may be used. Under conditions of reduced complexity – where the system and/or actors are relatively well known – rational, collaborative or adaptive planning are more suitable. However, if both the system and the actors are unknown, a co-evolutionary planning approach to flood risk management can contribute best to flood resilience.

2 … to a co-evolutionary spatial planning approach to managing flood risks

Current formal FRM practices in Flanders do not contribute to overall flood resilience because they do not support societal actors (i.e. land users and market actors) in developing resilience. As such, while water managers produce resilience through their own FRM practices, overall resilience does not increase due to the passive attitude of social actors. By considering the co-evolutionary nature of FRM strategies of different actors and the irreducible uncertainty related to this, spatial planning can play a crucial role in turning these co-evolutionary mechanisms around.

To make these interactions more fruitful, spatial planners need to support land users in managing flood risks. As resilience emerges from the interactions between different actors' FRM strategies, spatial planning needs to engage in the co-evolutionary mechanisms taking place between these actors. Spatial planners need to stimulate diversity in FRM strategies while maintaining consistency. Different land users do not necessarily need to agree on FRM strategies or pursue the same goals; however, their strategies should align in the sense that they do not counteract each other. This diversity of relative autonomous strategies could then be able to produce resilience. As such, spatial planners can indirectly support the overall development of flood resilience.

This can be achieved through two complementing roles for spatial planning in order to navigate the co-evolutions taking place between the different systems and actors involved in the (spatial) management of flood risk. On the one hand, conditions should be created that enable, encourage and support non-governmental actors to contribute to FRM in a positive way (adaptive condition planning). Through generic conditions and incentives, non-governmental actors can be indirectly stimulated to take up responsibilities. This is possible through economic mechanisms such as damage compensation or subsidies, practical support for individual structural measures, information dissemination, the support of market developments, etc. On the other hand, policy-makers can enter directly into dialogue with non-governmental actors through co-evolutionary interventions. These interventions are more action-oriented and are focused towards creating pilots on flood risk hotspots, where the government – together and on equal footing with the citizens, civil society and business actors – looks for resilient solutions, dependent on circumstances (time and place).

8.2

Practice-oriented suggestions: building a reciprocal relationship between land users and policy-makers

The conclusions above set out a perspective that can support the development of strategies for flood resilience. In what follows, some more specific challenges and associated suggestions are discussed. How can such a co-evolutionary approach be adopted in practice? The empirical research reveals the negative co-evolutionary spiral of a one-sided government responsibility in managing flood risks and a passive attitude of societal actors taking place. But what is needed to break through this spiral? By reconsidering the mechanisms that are currently contributing to a negative spiral, co-evolutions in FRM can become more fruitful. The analytical insights in these co-evolutionary mechanisms developed through the evidence in this dissertation provide guidance in developing flood resilience strategies. These practice-oriented suggestions go into how policy-makers could support the development of resilience in other actors, while still fulfilling their responsibilities in managing flood risks.

Currently, most of the effort for the spatial management of flood risks is put into solving problems that have been created in the past, such as allocating urban land uses in flood-prone areas and allowing excessive soil sealing in urbanization. Given the inherent uncertainty and complexity in risks, climate change and spatial developments, we should be aware that similar problems will inevitably re-emerge in the future if planning instruments are not changed. Rational decisions, which might have been the best option under certain circumstances and based on the knowledge available at the time, can turn out to be ‘wrong’ under changed circumstances. Under conditions of complexity and inherent uncertainty, there is no such thing as fail-safe options. Instead, it is important to anticipate change by enabling adaptations that allow for incremental knowledge, surprise and emergence. The option to evaluate the suitability of policies based on context and reconsider them accordingly should be included in the conception of the policy-making process. As such, change can be anticipated without having exact knowledge on how it will occur. By building flexibility into spatial planning regulatory frameworks, strategies can be adjusted to better fit the changed conditions at the moment they occur.

These changing circumstances are related to factors outside of the action range of policy-makers, but can also be induced by formal FRM choices through co-evolutionary feedback mechanisms. To understand these societal feedback mechanisms, it is important to monitor and understand the social context and, in particular, the societal impacts of different FRM measures. These impacts include both direct effects (e.g. flood perceptions, compliance with regulations and effects of incentives) and secondary effects (e.g. contingent urbanization and subsequent needs for further protection under increasing or changing flood risks). For example, little is known about the distributions of the costs of flood damages or the capitalization of flood risks in housing prices. By taking these effects into account in policy-making, we could move towards a more socially embedded way of managing flood risk.
If residents are excpected to manage their flood risks themselves, they should be better supported in doing so. Considering the strong government responsibilities in flood risk management over the last last decades, one cannot expect residents to be self-reliant. Therefore, spatial planners should promote the empowerment of local societal stakeholders. Different elements can contribute to this.

First, understandable and realistic information should be provided on flood risks and flood risk management. The survey showed that, despite information dissemination, flood risks are not well understood or are even underestimated by residents. To enable an open discussion on who could and should take up which responsibilities, policy-makers should disseminate information on:

- Flood risks — to include not only the elements of exposure, but also the uncertainties related to this knowledge. Information on flood risks is aready being shard, but is often oversimplified in the communication to land users.

- Provided safety levels – to include not only communicating on what water managers and spatial planning are doing to protect people, but also the level of protection this provides and the (inherent) limitations of the chosen approach. Currently, this information is often not available. By informing land users on the FRM activities of the government and how this affects flood risks, land users can become more aware of the limitations of flood protection.

- Individual FRM management options — giving land users an overview of the measures they can implement themselves to reduce individual flood risks.

This enables residents to make realistic assessments of the residual risk they are exposed to and how they can manage this residual risk. However, policy-makers should be aware that the availability of information of flood risks and FRM does not necessarily mean that land users will take up responsibilities to manage flood risks. Currently, there is very little communication between governmental actors and residents or other non-governmental actors. This closed communication on flood risks might give the impression that the government has the flood risks under control – or at least it should have – and that, therefore, land users have no responsibility in managing flood risks. Therefore, information dissemination should be deployed to start an open dialogue on the distribution of responsibilities in managing flood risks.

Information dissemination and communication on responsibilities are both indispensable for sharing responsibilities, as they can activate land users to think about the flood risks they are exposed to. However, in order to able to respond to this information and take action, land users need to have the capacity to do so. Therefore, policy-makers should support land users in developing such capacities. This can be done directly, through capacity-building classes, training related to specific topics, organizing individual land users to implement common solutions, etc. Incentives such as risk-based insurance premiums, subsidies, etc. could also encourage land users to act.

At the same time, the regulatory framework should safeguard the public interest on the river basin scale. Contributions of land users in managing flood risks are, per definition, local. In emphasizing contributions on the local level, there is a danger that all responsibilities to manage flood risks are shifted to the individual level. The role of policy-makers is to safeguard the public interest of the water system on the river basin scale, as they are the only actors that have a higher-level perspective. They have sufficient expert knowledge on the water system to understand high-level implications of local interventions. Societal actors cannot reasonably be expected to have this perspective, as they are interested in solving their own local problems.

Therefore, spatial planners should provide guidelines on interventions that will lower flood risks on the local scale and also lower flood risks on the higher level, so that flood risks are not merely shifted to other places/people. These guidelines can, according to the specific context, take different forms (e.g., contract, charter, voluntary cooperation) and be created in different ways (e.g., through participation, regulatory framework). They can guide the processes to create conditions for local empowerment.

8.3

Contributions

The main scientific contribution of this work is the theoretical consideration of the co-evolutionary approach as both an explanatory framework (i.e. to understand observed change) and as an action-oriented tool for FRM (i.e. to develop strategies and shape change). The co-evolutionary approach sets a framework to draw a holistic picture on the spatial development and management of flood risks.

Apart from the theoretical considerations, the analysis of FRM in Flanders can also provide an example of the societal side effects of FRM decisions and the associated difficulties of breaking the consequential path dependencies. In casu, the stongly government-centered approach causes a passive attitude amongst land users, whereby societal capacities to deal with flood risks are lost. Similar observations are made in the Netherlands (Terpstra and Gutteling, 2008) and Germany (Grothmann and Reusswig, 2006). In contrast, self-initiatives are abundant in the Anglo-Saxon world, where the government bears less formal responsibility in terms of protecting residents (van Raak, 2004). As such, the case study can be seen as a cautionary tale on the side effects of technocratic FRM approaches, especially relevant for countries that are at the beginning of developing formalized flood protection schemes.

For further contribution, the research takes the perspective of land users and other societal actors in managing flood risks. As such, it responds to the need to look at the land users' perspective and incorporate this in policy-making; which is, for example, expressed in the European Floods Directive, but is also increasingly becoming part of the societal debate following recent flood events.

8.4

Avenues for further research

This dissertation could inspire further research into co-evolutionary mechanisms in the spatial development of flood risks, in terms of both understanding oberserved change and shaping change. In relation to the first, i.e. co-evolution as an explanatory framework, research could benefit from a historic perspective. The research presented reflects a momentary snapshot. Insights in developments over longer periods of time could help to understand factors that maintain stability and induce change in these co-evolutionary mechanisms. This would not only deepen the understanding of how co-evolution can influence development in general, but also improve the comprehension of path dependencies in specific situations, which can help in navigating co-evolutions in transition processes.

Furthermore, the research also raises some critical questions on agency. Further research could look into different types of co-evolutionary processes between formal flood risk management and societal actors. What determines whether the outcome of the co-evolutionary process is benificial to both groups? What is the role of power relations in unbalanced co-evolutions? How does, for example, the distribution of (collective) resources in planning affect different actors' capacities?

In relation to shaping change (i.e. strategy making), further research can provide scientific evidence on how to navigate these mechanisms in order to give substance to the co-evolutionary FRM approach and develop it from a conceptual to an operational model. Since co-evolutinoary processes are complex and uncontrollable (i.e. an action might have a different outcome each time), how can policy-makers influence other actors' FRM strategies? What are successful practices to interact with co-evolutionary mechanisms? How do we, for example, deal with the inertia due to socially constructed land use allocations?

In conclusion, we hope that this research inspires more attention on the role of land users in managing flood risks. After all, flood resilience is not determined by infrastructures, but by the way people use these infrastructures.

Appendices

Appendix 1: Questionnaire survey

Enquête **Y5T46**

Bewoners overstromingsgevoelige gebieden

Bedankt voor uw interesse in deze enquête!

De opbouw van de vragenlijst is als volgt:
1. Woning
2. Kennis overstromingsrisico
3. Ervaring met overstromingen
4. Individuele maatregelen
5. Bereidheid om maatregelen te nemen
6. Visie
7. Algemene gegevens

We herinneren u er graag aan dat u de vragenlijst ook kunt invullen via de link http://edison.ugent.be/amrp. De vragenlijst dient uiterlijk tegen **dinsdag 30 september 2014** online ingevuld of per post teruggestuurd te worden.

Instructies:

- Lees de vragen en bijgevoegde commentaren goed.
- Geef één antwoord per vraag, tenzij anders vermeld.
- Bij sommige vragen en antwoorden staat aangeduid dat u vragen mag overslaan. Volg hiervoor de in **rood** aangegeven instructies naast de vraag of het antwoord, bijvoorbeeld **(➔ 2.5)**. Indien er niets vermeld staat, gaat u gewoon naar de volgende vraag.
- Vul bij elke vraag *iets* in. U hebt altijd de optie om “niet van toepassing”, “geen mening”, “ik weet het niet”, “geen van bovenstaande” of “andere” in te vullen. Een vraag waar niets bij aangeduid is, is ongeldig.

Voor vragen in verband met deze enquête kunt u contact opnemen met Barbara Tempels via barbara.tempels@UGent.be of 09/331 32 60. Ook indien u hulp nodig hebt bij het invullen van de vragenlijst kunt u hier terecht.

Alvast bedankt voor uw medewerking!

1 Woning

1.1 **In welk jaar werd uw woning gebouwd?** ______________
Vul een jaartal bij benadering in indien u het niet precies weet.

1.2 **In welk jaar bent u hier komen wonen?** ______________
Vul een jaartal bij benadering in indien u het niet precies weet.

1.3 **In wat voor woning woont u?**
- O eengezinswoning (huis) open bebouwing
- O eengezinswoning (huis) halfopen bebouwing
- O eengezinswoning (rijhuis) gesloten bebouwing
- O bungalow (één verdieping)
- O appartement, studio, kamer, loft op gelijkvloers
- O appartement, studio, kamer, loft op bovenverdieping
- O woonwagen, caravan
- O andere: ______________________________________

1.4 **Hoeveel slaapkamers heeft uw woning?** ______________

1.5 **In welke staat is uw woning?**
- O grondige renovatie nodig
- O lichte renovatie nodig
- O licht verouderd, maar niet direct renovatie nodig
- O modern, woonklaar

1.6 **Bent u eigenaar of huurder?**
O eigenaar.................................OF.....................................O huurder

↓

1.7 **Hebt u een bestaande woning gekocht?**
O ja O nee

1.8 **Hoeveel heeft de aankoop of bouw van uw woning gekost?**
Indien u het niet precies weet, vult u een bedrag bij benadering in.
€ ____
of BEF ____
- O ik heb niet betaald (vb. schenking, erfenis)
- O ik weet het niet of ik wens dit niet mee te delen

↓

1.9 **Wie is de eigenaar van uw woning?**
- O particulier
- O sociale huisvestingsmaatschappij
- O gemeente of OCMW
- O privévennootschap
- O ik weet het niet
- O andere: ______________________________

1.10 **Hoeveel huur betaalt u maandelijks (zonder bijkomende kosten)?**
€ ____
- O ik betaal geen huur
- O ik weet het niet of ik wens dit niet mee te delen

1.11 **Hebt u een brandverzekering die overstromingsschade dekt?**
O ja O nee (➔1.13)

1.12 **Hoeveel bedraagt uw jaarlijkse brandverzekeringspremie?**
- O minder dan € 100
- O tussen € 100 en € 199
- O tussen € 200 en € 299
- O tussen € 300 en € 399
- O tussen € 400 en € 499
- O tussen € 500 en € 599
- O tussen € 600 en € 699
- O tussen € 700 en € 799
- O tussen € 800 en € 899
- O tussen € 900 en € 999
- O tussen € 1000 en € 1249
- O tussen € 1250 en € 1499
- O meer dan € 1500
- O ik weet het niet of ik wens dit niet mee te delen

1.13 **Hoe graag woont u hier?**

helemaal niet graag	eerder niet graag	neutraal	eerder graag	erg graag
O	O	O	O	O

1.14 **Hoe lang bent u van plan hier nog te blijven wonen?**
- O minder dan 1 jaar
- O 1 à 5 jaar
- O 5 à 15 jaar
- O meer dan 15 jaar
- O de rest van mijn leven
- O ik weet het niet

1.15 **In welke mate waren de volgende redenen belangrijk om hier te komen wonen?**
Vul één antwoord per regel in. Indien bepaalde aspecten niet van toepassing zijn (bv. indien uw woning niet in uw geboortestreek gelegen is, niet uw ouderlijke woonst is of niet nabij het water ligt), duidt u voor die regel 'n.v.t.' aan.

	helemaal niet	eerder niet	neutraal	eerder wel	heel erg	n.v.t
vlotte bereikbaarheid	O	O	O	O	O	O
nabijheid van werk	O	O	O	O	O	O
nabijheid van familie/vrienden	O	O	O	O	O	O
nabijheid van voorzieningen (school, hobby's)	O	O	O	O	O	O
geboortestreek	O	O	O	O	O	O
ouderlijke woonst	O	O	O	O	O	O
groene omgeving, natuur	O	O	O	O	O	O
ligging nabij het water	O	O	O	O	O	O
rustige omgeving (geen hinder, veilig, net)	O	O	O	O	O	O
kenmerken van de woning (omvang, type, kwaliteit, comfort)	O	O	O	O	O	O
goedkope grond/woning	O	O	O	O	O	O
goedkoper dan gelijkaardige grond/woningen in de omgeving	O	O	O	O	O	O
andere: ______________________________	O	O	O	O	O	O

1.16 **Duid aan hoe uw woning bouwtechnisch uitgerust is (in relatie tot overstromingen).**
Meerdere antwoorden mogelijk.

☐ woning opgehoogd of dijkje/muurtje rond woning
☐ waterbuffer voorzien (vb. vijver)
☐ vloerniveau woonruimtes op veilige hoogte
☐ geen ondergrondse constructies (vb. kelder, tank)
☐ fundering op kolommen
☐ overstroombare kelder
☐ wegneembare schotten voor deuren of ramen
☐ buitenmuren waterdicht (vb. waterwerende stenen of bepleistering, coating, voegen en barsten afgedicht)
☐ noodstroomgenerator aanwezig
☐ terugslagkleppen op waterafvoer, waterdichte en verankerde deksels op putten, stookolietank verankerd
☐ geen van bovenstaande
☐ andere: ______________________________

2 Kennis overstromingsrisico

In dit deel wordt eerst het huidige overstromingsrisico en uw kennis ervan besproken. Vervolgens komt de kennis van het overstromingsrisico op het moment dat u hier kwam wonen aan bod.

2.1 **Is uw woning volgens u gelegen in overstromingsgevoelig gebied?**
O ja O nee O ik weet het niet

2.2 **Hoeveel weet u over het overstromingsrisico van uw woning?**
O erg weinig O weinig O veel O heel veel

2.3 **Hebt u zelf initiatief genomen om u te informeren over het overstromingsrisico?**
O ja O nee

2.4 **Van wie hebt u informatie verkregen over het overstromingsrisico?**
Meerdere antwoorden mogelijk.
☐ verkoper of verhuurder
☐ buren
☐ vrienden of familie
☐ notaris
☐ vastgoedmakelaar
☐ verzekeraar
☐ gemeente (vb. bouwaanvraag)
☐ Vlaamse overheid (vb. website)
☐ eigen kennis
☐ ondervinding of ervaring
☐ architect
☐ andere: ______________________________

2.5 **Welke van de volgende bronnen hebt u reeds geraadpleegd in verband met overstromingsrisico's?**
Meerdere antwoorden mogelijk.
☐ Watertoetskaarten
☐ website www.waterinfo.be
☐ andere website overheid (VMM, CIW, Vlaams Gewest, gemeente)
☐ andere website (geen overheid)
☐ bouwaanvraag
☐ nieuwsbrief of brochure
☐ informeel gesprek
☐ infodag
☐ geen van bovenstaande
☐ andere: ______________________________

2.6 **In welke zone ligt uw woning volgens de Watertoetskaart?**
- ○ ik ken de Watertoetskaart niet
- ○ ik weet het niet
- ○ niet overstromingsgevoelig
- ○ mogelijk overstromingsgevoelig
- ○ effectief overstromingsgevoelig

2.7 **Wanneer denkt u dat de <u>volgende</u> overstroming hier zal plaatsvinden** *(bovenste regel)*, **en om de hoeveel jaar denkt u dat overstromingen hier <u>over 40 jaar</u> zullen voorkomen** *(onderste regel)***?**

	< 5 jaar	5 jaar	10 jaar	25 jaar	50 jaar	100 jaar	>100 jaar	ik weet het niet
volgende overstroming	○	○	○	○	○	○	○	○
over 40 jaar	○	○	○	○	○	○	○	○

2.8 **Hoe hoog ten opzichte van het vloerniveau (gelijkvloers) komt het water hier <u>momenteel</u> maximaal bij een overstroming** *(bovenste regel)*, **en hoe hoog denkt u dat het water hier <u>over 40 jaar</u> maximaal zal komen** *(onderste regel)***?**

	< 25 cm	25 à 49 cm	50 à 74 cm	75 à 99 cm	100 à 150 cm	> 150 cm	ik weet het niet
momenteel	○	○	○	○	○	○	○
over 40 jaar	○	○	○	○	○	○	○

2.9 **Was u op de hoogte van het overstromingsrisico <u>toen u hier kwam wonen</u>?**
- ○ ja
- ○ nee **(➔2.11)**

2.10 **In welke mate waren de volgende aspecten bepalend om toch voor een woning in overstromingsgevoelig gebied te kiezen?**
Indien bepaalde aspecten niet van toepassing zijn, duidt u 'n.v.t.' aan.

	helemaal niet	eerder niet	neutraal	eerder wel	heel erg	n.v.t.
het risico is laag	○	○	○	○	○	○
ik was me niet echt bewust van het risico	○	○	○	○	○	○
ik dacht dat het risico lager was	○	○	○	○	○	○
de verzekering dekt de schade	○	○	○	○	○	○
goede prijs-kwaliteitverhouding	○	○	○	○	○	○
toen ik hier kwam wonen was het hier nog nooit overstroomd	○	○	○	○	○	○
kenmerken van de woning (omvang, type, kwaliteit, comfort)	○	○	○	○	○	○
ligging van de woning	○	○	○	○	○	○
ik kan geen duurdere grond/woning betalen	○	○	○	○	○	○
andere: ______________________	○	○	○	○	○	○

(na deze vraag ➔2.12)

2.11 **Wat had u anders gedaan indien u wel op de hoogte was van het overstromingsrisico?**
Meerdere antwoorden mogelijk.
- ☐ aanvullende maatregelen treffen
- ☐ een lagere koop-/huurprijs onderhandelen
- ☐ hier niet komen wonen
- ☐ ik zou niets anders gedaan hebben
- ☐ ik weet het niet
- ☐ andere: ______________________

2.12 **Denkt u dat uw brandverzekeringspremie hoger is ten gevolge van het overstromingsrisico?**
- ○ ja
- ○ nee
- ○ ik weet het niet

2.13 **Denkt u dat uw woning minder waard is ten gevolge van het overstromingsrisico?**
- ○ ja
- ○ nee **(➔3.1)**
- ○ ik weet het niet **(➔3.1)**

2.14 **Hoeveel minder waard?**
- ○ minder dan 5 % minder
- ○ tussen 5 en 10 % minder
- ○ tussen 10 en 15 % minder
- ○ tussen 15 en 20 % minder
- ○ tussen 20 en 25 % minder
- ○ meer dan 25 % minder
- ○ ik weet het niet

3 Ervaring met overstromingen

3.1 **Hoeveel keer is uw woning, kelder of tuin sinds u hier woont overstroomd?** ____________________ **('0' → 3.4)**

3.2 **Hierna volgen enkele vragen over de verschillende individuele overstromingen. Vul bovenaan het jaartal in.** *Indien u het jaartal niet precies weet, vult u een jaartal bij benadering in. Indien uw woning meer dan drie maal overstroomde, vult u de drie zwaarste overstromingen in.*

jaartal:	______	______	______
Welke delen zijn overstroomd geweest? *Meerdere antwoorden mogelijk.*			
woning (gelijkvloers)	☐	☐	☐
kelder	☐	☐	☐
tuin	☐	☐	☐
water uit de woning gehouden dankzij zandzakjes, dompelpomp enz.	☐	☐	☐
Hoeveel materiële schade was er? (zowel gebouw als inboedel en tuin)			
geen	○	○	○
tussen € 1 en € 999	○	○	○
tussen € 1000 en € 4999	○	○	○
tussen € 5000 en € 9999	○	○	○
tussen € 10.000 en € 49.999	○	○	○
tussen € 50.000 en € 99.999	○	○	○
meer dan € 100.000	○	○	○
ik weet het niet	○	○	○
Wie heeft de schade betaald? *Meerdere antwoorden mogelijk.*			
zelf	☐	☐	☐
brandverzekering	☐	☐	☐
gemeentelijk fonds	☐	☐	☐
Rampenfonds	☐	☐	☐
andere: ______________________________	☐	☐	☐
ik weet het niet	☐	☐	☐

3.3 **In welke mate vond u de volgende aspecten erg bij deze overstroming(en)?**
Indien u bepaalde soorten hinder niet ondergaan hebt, duidt u 'n.v.t.' (niet van toepassing) aan.

	helemaal niet erg	eerder niet erg	neutraal	eerder erg	heel erg	n.v.t.
lichamelijke letsels	○	○	○	○	○	○
evacuatie	○	○	○	○	○	○
ontregeling dagelijks leven	○	○	○	○	○	○
moeilijke bereikbaarheid woning	○	○	○	○	○	○
moeilijke bewoonbaarheid woning	○	○	○	○	○	○
vuil, moeite om op te ruimen	○	○	○	○	○	○
traag verloop herstelling	○	○	○	○	○	○
traag verloop terugbetaling	○	○	○	○	○	○
administratie en onderhandelen met verzekeraars / aannemers	○	○	○	○	○	○
onzekerheid, angst, schok, hulpeloosheid	○	○	○	○	○	○
materieel verlies	○	○	○	○	○	○
financieel verlies	○	○	○	○	○	○
verlies emotioneel waardevolle voorwerpen	○	○	○	○	○	○

3.4 **In welke mate…**	helemaal niet	eerder niet	neutraal	eerder wel	heel erg
hebt u reeds last ondervonden van het overstromingsrisico?	○	○	○	○	○
hebt u angst voor overstromingen?	○	○	○	○	○
maakt u zich zorgen over het overstromingsrisico?	○	○	○	○	○
hebt u spijt van uw keuze om hier te komen wonen?	○	○	○	○	○
voelt u zich in de steek gelaten?	○	○	○	○	○

3.5 **Welke delen van uw woning/perceel zijn voor u er woonde overstroomd geweest?**
Meerdere antwoorden mogelijk.
☐ geen ☐ woning (gelijkvloers) ☐ tuin
☐ ik weet het niet ☐ kelder ☐ onbebouwd perceel

4 Individuele maatregelen

4.1 **Welke maatregelen hebt u genomen om de schade of hinder in geval van overstroming te beperken?**
Meerdere antwoorden mogelijk.

☐ bouwtechnische maatregelen (zoals in vraag 1.16)
☐ waterbestendige inrichting (vb. meubels, vloeren, schrijnwerk, muurbekleding of isolatie)
☐ waardevolle zaken hoger geplaatst of makkelijk verplaatsbaar (vb. elektrische infrastructuur of toestellen, meubels)
☐ zandzakjes of pomp(installatie) aangeschaft
☐ extra verzekering aangeschaft
☐ ingeschreven op een waarschuwingsdienst
☐ aangesloten bij buurtcomité om belangen te verdedigen
☐ ik heb geen maatregelen genomen (➔4.7)
☐ andere: ______________________________

4.2 **Hebt u deze maatregelen individueel of samen met anderen genomen? (vb. groepsaankoop, gemeenschappelijke infrastructuur)**
Indien u zowel individuele als collectieve maatregelen hebt genomen, duidt u beide aan.
☐ individueel ☐ collectief

4.3 **Hoeveel hebben deze maatregelen samen gekost?**
○ niets ○ tussen € 500 en € 999 ○ tussen € 5000 en € 9999
○ tussen € 1 en € 499 ○ tussen € 1000 en € 4999 ○ meer dan € 10.000

4.4 **Wat was/waren de aanleiding(en) om deze maatregel(en) te nemen?**
Meerdere antwoorden mogelijk.

☐ voorbereiding voor een voorspelde overstroming
☐ tijdens een overstroming
☐ hoge schade na overstroming
☐ herstellingswerken na overstroming
☐ nieuwe informatie over overstromingsrisico
☐ nieuwe informatie over maatregelen
☐ subsidie
☐ afsluiten verzekering
☐ verbouwingen (niet gerelateerd aan overstroming)
☐ geen oplossing geboden door de overheid
☐ andere: ______________________________

4.5 **Hebt u sinds deze maatregel(en) reeds een overstroming meegemaakt?**
○ ja ○ nee

4.6 **In welke mate gaat u akkoord met de volgende uitspraken?**

	helemaal niet akkoord	eerder niet akkoord	neutraal	eerder akkoord	volledig akkoord
Ik ben tevreden over de genomen maatregelen.	○	○	○	○	○
Deze maatregelen beschermen mij voldoende tegen overstromingen.	○	○	○	○	○
Ik voel mij sinds deze maatregelen meer op mijn gemak.	○	○	○	○	○

4.7 **Hoeveel weet u over maatregelen die u zelf kunt nemen tegen overstromingsschade?**

erg weinig	weinig	veel	heel veel
○	○	○	○

4.8 **Hebt u zelf initiatief genomen om u te informeren over maatregelen die u zelf kunt nemen tegen overstromingsschade?** ○ ja ○ nee

4.9 **Van wie hebt u informatie verkregen over de maatregelen die u zelf kunt nemen tegen overstromingsschade?**
Meerdere antwoorden mogelijk.
☐ verkoper of verhuurder ☐ notaris ☐ gemeente ☐ aannemer
☐ buren ☐ vastgoedmakelaar ☐ Vlaamse overheid ☐ eigen kennis
☐ vrienden of familie ☐ verzekeraar ☐ architect ☐ media
☐ andere: ______________________________

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4.10 **Welke van de volgende <u>bronnen</u> hebt u reeds geraadpleegd in verband met de maatregelen die u zelf kunt nemen tegen overstromingsschade?**
Meerdere antwoorden mogelijk.

- ☐ brochure 'Overstromingsveilig bouwen en wonen' van de Coördinatiecommissie Integraal Waterbeleid (CIW)
- ☐ andere brochure of nieuwsbrief
- ☐ website overheid (VMM, CIW, Vlaamse gewest, gemeente)
- ☐ andere website (geen overheid)
- ☐ informeel gesprek
- ☐ infodag
- ☐ andere: ______________________

4.11 **In welke mate zijn de volgende uitspraken voor u van toepassing?**

	helemaal niet	eerder niet	neutraal	eerder wel	heel erg
Ik durf mijn woning niet voor lange tijd te verlaten.	○	○	○	○	○
Ik zou graag per sms geïnformeerd worden over aankomende overstromingen.	○	○	○	○	○
Ik spreek geregeld met mijn buren over de overstromingsproblematiek.	○	○	○	○	○
Ik ben bang voor diefstal tijdens een overstroming.	○	○	○	○	○
Ik wil graag verhuizen.	○	○	○	○	○
Ik verplaats spullen naar boven bij een overstroming.	○	○	○	○	○
Ik controleer geregeld de waterstanden.	○	○	○	○	○

5 Bereidheid om maatregelen te nemen

5.1 **In welke mate bent u bereid om maatregelen te nemen om de schade door overstromingen te beperken <u>onder de volgende voorwaarden?</u>**

	helemaal niet bereid	eerder niet bereid	eerder bereid	volledig bereid
in de huidige situatie	○	○	○	○
mits subsidies van de overheid	○	○	○	○
mits praktische ondersteuning van de overheid (vb. informatie, contacten)	○	○	○	○
indien uw brandverzekeringspremie daalt	○	○	○	○
indien uw belastingen dalen	○	○	○	○
indien u enkel hoeft te betalen (niet zelf uitvoeren)	○	○	○	○
indien de rest van de buurt dat ook doet	○	○	○	○
indien het hier in de toekomst vaker overstroomt	○	○	○	○

5.2 **In welke mate bent u bereid om de volgende maatregelen te nemen?**
Indien bepaalde maatregelen in uw geval niet mogelijk zijn, duidt u 'n.v.t.' (niet van toepassing) aan voor die regel.

	helemaal niet bereid	eerder niet bereid	eerder bereid	volledig bereid	n.v.t.
bouwtechnische maatregelen (zoals in vraag 1.16)	○	○	○	○	○
tuin aanpassen (vb. vijver of dijkje aanleggen)	○	○	○	○	○
extra verzekering aanschaffen	○	○	○	○	○
noodscenario voorbereiden (vb. waardevolle zaken hoger plaatsen, makkelijk verplaatsbare meubels)	○	○	○	○	○
zandzakjes of (dompel)pomp aanschaffen	○	○	○	○	○
inschrijven voor waarschuwingsdienst	○	○	○	○	○
collectieve maatregelen met buurtbewoners	○	○	○	○	○
verhuizen	○	○	○	○	○

5.3 **Hoeveel bent u bereid te betalen voor maatregelen om de schade door overstromingen te beperken?**
Duid één antwoord aan.

- ○ niets
- ○ eenmalig tussen € 1 en € 99
- ○ eenmalig tussen € 100 en € 449
- ○ eenmalig tussen € 500 en € 999
- ○ eenmalig tussen € 1000 en € 4999
- ○ eenmalig meer dan € 5000
- ○ jaarlijks tussen € 1 en € 99
- ○ jaarlijks tussen € 100 en € 249
- ○ jaarlijks tussen € 250 en € 499
- ○ jaarlijks tussen € 500 en € 999
- ○ jaarlijks meer dan € 1000

5.4 **Waaraan zou u dit geld besteden?** ____

5.5 **In welke mate gaat u akkoord met de volgende uitspraken?**

Ik wil niet verhuizen of ben nog niet verhuisd omdat…	helemaal niet akkoord	eerder niet akkoord	neutraal	eerder akkoord	volledig akkoord
ik met het overstromingsrisico kan leven	O	O	O	O	O
het overstromingsrisico te laag is	O	O	O	O	O
ik een emotionele band heb met het huis	O	O	O	O	O
ik opzie tegen de rompslomp van een verhuis	O	O	O	O	O
ik geen gelijkaardige woning in de omgeving vind	O	O	O	O	O
ik financieel verlies zou lijden bij verkoop van de woning	O	O	O	O	O
het hier goedkoop wonen is	O	O	O	O	O
andere: ______________________	O	O	O	O	O

5.6 **Na hoeveel ernstige overstromingen denkt u dat u zou verhuizen?**

O 1
O 2
O 3
O meer dan 3
O ik zou niet verhuizen omwille van overstromingen

5.7 **In welke mate gaat u akkoord met de volgende uitspraken?**

Ik neem geen maatregelen omdat…	helemaal niet akkoord	eerder niet akkoord	neutraal	eerder akkoord	volledig akkoord	geen mening
ik niet weet wat ik (nog meer) kan doen.	O	O	O	O	O	O
ik betwijfel of de maatregelen goed werken.	O	O	O	O	O	O
ik individueel niets kan doen tegen overstromingen.	O	O	O	O	O	O
het risico te laag is.	O	O	O	O	O	O
ik al veel geïnvesteerd heb in maatregelen.	O	O	O	O	O	O
het mijn verantwoordelijkheid niet is.	O	O	O	O	O	O
de verzekering de schade dekt.	O	O	O	O	O	O
de overstromingsproblematiek beter collectief opgelost kan worden.	O	O	O	O	O	O
de overheid mij moet beschermen.	O	O	O	O	O	O
het de moeite niet is voor zolang ik hier nog ga wonen.	O	O	O	O	O	O
ik te oud ben.	O	O	O	O	O	O
het te veel tijd en moeite kost.	O	O	O	O	O	O
de maatregelen te duur zijn in verhouding met het risico.	O	O	O	O	O	O
ik de maatregelen niet kan betalen.	O	O	O	O	O	O
ik nog niet echt stilgestaan heb bij het overstromingsrisico.	O	O	O	O	O	O

5.8 **In welke mate gaat u akkoord met de volgende uitspraken?**

	helemaal niet akkoord	eerder niet akkoord	neutraal	eerder akkoord	volledig akkoord
Ik ben hier komen wonen, dus ben ik verantwoordelijk om mij te beschermen tegen overstromingen.	O	O	O	O	O
Aangezien de overheid mij de toelating gegeven heeft om hier te komen wonen, moet zij mij beschermen tegen overstromingen.	O	O	O	O	O
Het is mogelijk om zelf maatregelen te treffen om zich te beschermen tegen overstromingen.	O	O	O	O	O
Ik zou verhuizen naar een gelijkaardige woning buiten overstromingsgevoelig gebied mocht het mij geen geld kosten.	O	O	O	O	O
Ik wil graag betrokken zijn bij het zoeken naar oplossingen voor de overstromingsproblematiek.	O	O	O	O	O
Als ik verhuis, zal dat ten minste gedeeltelijk omwille van het overstromingsrisico zijn.	O	O	O	O	O

6 Visie

6.1 **Stel dat de overheid of anderen zouden investeren in overstromingsbeheer in uw wijk, waarin zou dat volgens u moeten gebeuren? Kies <u>maximaal 5 antwoorden</u>.**

- ☐ overstromingsvoorspellingen (korte termijn) communiceren
- ☐ overstromingsrisico (algemeen) communiceren
- ☐ financiële compensatie van schade
- ☐ noodhulp (vb. verhuizen van goederen en personen)
- ☐ financiële ondersteuning van private maatregelen (vb. subsidies)
- ☐ zandzakjes en mobiele dijkjes voorzien
- ☐ woonwijk indijken
- ☐ dijken en stuwen bouwen langs de waterlopen
- ☐ lokaal netwerk van natuurlijke grachten en vijvers aanleggen
- ☐ lokale verharding verminderen
- ☐ verharding bovenstrooms verminderen
- ☐ bestaande infrastructuren overstroombaar maken
- ☐ herlokaliseren (verhuizen en afbreken) van gevoelige infrastructuren (gebouwen enz.)
- ☐ bufferbekkens bovenstrooms aanleggen
- ☐ andere: ____________________
- ☐ ik weet het niet

6.2 **Op welke manier moeten volgens u overstromingsgevoelige gebieden verder ontwikkelen? Kies <u>maximaal 2 antwoorden</u>.**

- ☐ niet meer bouwen
- ☐ overstromingsbestendig bouwen (vb. op palen, overstroombare woningen)
- ☐ normale ontwikkelingen toelaten mits de ontwikkelaar of bouwheer geïnformeerd wordt en de volledige verantwoordelijkheid voor schade neemt
- ☐ enkel functies toelaten die compatibel zijn met overstromingen (vb. watergebonden landbouw)
- ☐ normale ontwikkelingen toelaten en die beschermen tegen het water
- ☐ andere: ____________________
- ☐ ik weet het niet

6.3 **Vindt u dat de volgende partijen <u>voldoende doen</u> in de overstromingskwestie?**	helemaal niet	eerder niet	neutraal	eerder wel	zeker wel	ik weet het niet
uzelf	○	○	○	○	○	○
verkoper/verhuurder	○	○	○	○	○	○
buren	○	○	○	○	○	○
notaris	○	○	○	○	○	○
vastgoedmakelaar	○	○	○	○	○	○
verzekeraar	○	○	○	○	○	○
gemeente	○	○	○	○	○	○
Vlaamse overheid	○	○	○	○	○	○
architect	○	○	○	○	○	○
aannemer	○	○	○	○	○	○

6.4 **Wat zouden ze volgens u moeten doen of gedaan hebben?** ____________________

____

____

6.5 **In welke mate denkt u dat de volgende partijen…**

	<u>verantwoordelijk</u> zijn voor de bestaande overstromingsproblematiek?					**u kunnen helpen bij het <u>oplossen</u> van de overstromingsproblematiek?**				
	helemaal niet	eerder niet	neutraal	eerder wel	heel erg	helemaal niet	eerder niet	neutraal	eerder wel	heel erg
bewoners	○	○	○	○	○	○	○	○	○	○
notarissen	○	○	○	○	○	○	○	○	○	○
vastgoedmakelaars	○	○	○	○	○	○	○	○	○	○
verzekeraars	○	○	○	○	○	○	○	○	○	○
gemeente	○	○	○	○	○	○	○	○	○	○
Vlaamse overheid	○	○	○	○	○	○	○	○	○	○
architecten	○	○	○	○	○	○	○	○	○	○
aannemers	○	○	○	○	○	○	○	○	○	○

7 Algemene gegevens

7.1 **U bent een…** ○ man ○ vrouw

7.2 **In welk jaar bent u geboren?** ________________

7.3 **Hoeveel personen (buiten uzelf) wonen er op dit adres?**

_____ partner
_____ kind(eren)
_____ ouder(s)
_____ ander(e) familielid/-leden
_____ andere(n)

	ja	nee
7.4 **Hebt u een niet-Belgische nationaliteit?**	○	○
Hebt u ooit een niet-Belgische nationaliteit gehad?	○	○
Heeft een van uw ouders ooit een niet-Belgische nationaliteit gehad?	○	○

7.5 **Wat is uw hoogst behaalde diploma?**

○ geen diploma
○ lagere school
○ middelbare school
○ bachelor / graduaat / A1
○ master / licentiaat
○ doctoraat

7.6 **Wat is het totale maandelijkse netto-inkomen van uw huishouden?**

Hieronder vallen beroepsinkomsten (werknemersbezoldiging, vervangingsinkomsten, pensioen enz.), inkomsten uit onroerende goeden (kadastraal inkomen, huur) en diverse inkomsten (kinderbijslag, alimentatie enz.).

○ minder dan € 1000
○ tussen € 1000 en € 1999
○ tussen € 2000 en € 2999
○ tussen € 3000 en € 3999
○ tussen € 4000 en € 4999
○ tussen € 5000 en € 7499
○ tussen € 7500 en € 9999
○ meer dan € 10.000
○ ik weet het niet of wens dit niet mee te delen

7.7 **Wat is uw beroep?**

○ zelfstandige
○ arbeider
○ bediende
○ ambtenaar
○ huisman/-vrouw
○ student
○ werkzoekende
○ gepensioneerd
○ beroepsonbekwaam

Bedankt voor uw tijd en medewerking!

Indien u nog opmerkingen, bedenkingen of andere ideeën hebt in verband met deze enquête of de overstromingsproblematiek, kunt u deze hieronder kwijt.

____
____
____
____
____
____

Bent u bereid om een aanvullend gesprek te hebben over de overstromingsproblematiek? Vul dan hier uw contactgegevens in! Het gesprek zal tussen de 30 en 60 minuten duren.

naam: ____

adres: ____

e-mailadres: ____

telefoonnummer: ____

Appendix 2: Statistical analysis of the survey results

p	knowledge			
	risk awareness (2.1)	initiative knowledge flood risk (2.3)	risk awareness at location choice (2.9)	initiative knowledge measures (4.8)
age of the residence (1.1)	0,084	0,152	0,419	0,312
length of residence (1.2)	0,647	0,336	0,184	0,005**
state of the residence (1.5)	0,522	0,427	0,652	0,132
ownerships (1.6)	0,864	0,521	0,097	0,242
age (7.2)	0,620	0,457	0,046*	0,090
income (7.6)	0,406	0,151	0,893	0,274
number of floods experienced (3.1)	0,001**	0,941	0,385	0,000**
flood experience (3.1-2)	0,007**	0,799	0,368	0,000**
risk awareness (2.1)	/	0,029*	0,430	0,162
knowledge risk (2.2)	0,190	0,000**	0,000**	0,000**
risk awareness at location choice (2.9)	0,430	0,028*	/	0,835
knowledge measures (4.7)	0,243	0,000**	0,007**	0,000**
suffering (3.4a)	0,000**	0,046*	0,529	0,000**
fear (3.4b)	0,000**	0,725	0,031*	0,003**
worrying (3.4c)	0,000**	0,321	0,227	0,000**
pleasure of living (1.13)	0,710	0,007**	0,321	0,889
intended length of residence (1.14)	0,696	0,340	0,561	0,314
regret (3.4d)	0,002**	0,617	0,016*	0,001**
desire to move (4.11e)	0,121	0,390	0,033*	0,018*
responsible: residents (6.5a1)	0,201	0,052	0,006**	0,996
responsible: government (6.5a6)	0,325	0,472	0,023*	0,594
solution: residents (6.5b1)	0,932	0,005**	0,007**	0,527
solution: Flemish government (6.5b6)	0,001**	0,086	0,766	0,775
taking measures (4.1)	0,000**	0,039*	0,300	0,000**
willingness to take measures (5.1a)	0,106	0,010*	0,145	0,002**

Table 10 Mann-Whitney tests for dichotomuous variables

rs	knowledge		perceptions and experience			location choice and willingness to move					
	knowledge risk (2.2)	knowledge measures (4.7)	suffering (3.4a)	fear (3.4b)	worrying (3.4c)	pleasure of living (1.13)	intended length of residence (1.14)	regret (3.4d)	desire to move (4.11e)	willingness to move (5.2h)	number of floods before moving (5.6)
age of the residence (1.1)	0,019	0,091	0,283**	0,223**	0,199**	-0,045	0,116	0,130	0,115	-0,082	0,207**
length of residence (1.2)	0,161*	0,163*	0,219**	0,199**	0,117	-0,070	0,333**	0,082	-0,025	-0,188*	0,276**
state of the residence (1.5)	-0,025	-0,110	-0,257**	-0,191*	-0,137	0,217**	-0,059	-0,224**	-0,168*	-0,081	-0,062
ownership (1.6)	0,249**	0,233**	0,094	0,094	0,031	0,062	0,320**	0,115	-0,077	-0,210*	-0,021
age (7.2)	0,093	0,110	0,034	0,104	-0,021	-0,125	0,328**	-0,006	-0,060	-0,211*	0,237**
income (7.6)	0,094	0,036	0,090	-0,016	0,064	0,203*	-0,115	0,042	-0,077	-0,163	-0,116
number of flood experienced (3.1)	0,157*	0,255**	0,591**	0,423**	0,396**	-0,131	0,084	0,424**	0,206**	0,054	0,310**
flood experience (3.1-2)	0,125	0,253**	0,612**	0,446**	0,434**	-0,142	0,057	0,494**	0,271**	0,060	0,248**
risk awareness (2.1)	0,107	0,098	0,433**	0,298**	0,306**	0,030	-0,034	0,259**	0,130	0,103	0,037
knowledge risk (2.2)	/	0,508**	0,253**	0,048	0,072	0,175*	0,239**	0,024	-0,067	-0,156	0,220**
knowledge measures (4.7)		/	0,324**	0,089	0,131	0,105	0,168*	0,050	0,050	-0,131	0,306**
suffering (3.4a)			/	0,370**	0,682**	-0,030	0,049	0,547**	0,224**	0,097	0,266**
fear (3.4b)				/	0,864**	-0,199**	0,027	0,658**	0,374**	0,285**	-0,042
worrying (3.4c)					/	-0,160*	-0,034	0,664*	0,367**	0,294**	0,002
pleasure of living (1.13)						/	0,370**	-0,382**	-0,390**	-0,353**	0,188*
intended length of residence (1.14)							/	-0,113	-0,355**	-0,501**	0,217*
regret (3.4d)								/	0,558**	0,375**	-0,140

Table 11 Spearman's rank tests for two variables, for the topics knowledge, perception and experience, location choice and willingness to move

rs	sense of responsibility					protective measures		
	responsible: residents (6.5a1)	solution: residents (6.5b1)	doing enough: yourself (6.3a)	doing enough: neighbors (6.3c)	doing enough: Flemish govern-ment (6.3h)	willingness to take measures (5.1a)	taking measures (4.1)	investment in measures (4.3)
age of the residence (1.1)	-0,032	-0,025	0,161	0,090	-0,048	0,151	0,268**	-0,052
length of residence (1.2)	0,087	-0,089	0,237**	-0,002	0,088	0,087	0,341**	-0,040
state of the residence (1.5)	-0,055	-0,079	0,128	-0,004	0,081	-0,070	-0,211**	-0,040
ownership (1.6)	0,030	0,021	-0,185*	-0,114	0,018	0,065	0,273**	0,147
age (7.2)	0,080	-0,150	0,154	-0,025	0,066	0,065	0,075	0,035
income (7.6)	-0,043	0,106	-0,054	-0,050	0,047	0,105	0,704	0,210
number of floods experienced (3.1)	-0,142	-0,016	0,407**	0,294**	-0,113	0,289**	0,542**	0,101
flood experience (3.1-2)	-0,107	0,038	0,444**	0,258**	-0,188*	0,330**	0,627**	0,308**
risk awareness (2.1)	-0,144	-0,008	0,056	0,148	-0,039	0,142	0,356**	-0,117
knowledge risk (2.2)	0,229**	0,175*	0,212*	0,061	0,047	0,031	0,216**	0,126
knowledge measures (4.7)	0,190*	0,299**	0,311**	0,245**	0,130	0,268**	0,310**	0,288**
suffering (3.4a)	-0,019	0,095	0,332**	0,343**	-0,156	0,381**	0,574**	0,133
fear (3.4b)	-0,047	0,044	0,205*	0,182	-0,254**	0,325**	0,504**	0,004
worrying (3.4c)	-0,005	0,118	0,218**	0,263**	-0,237**	0,385**	0,520**	-0,043
pleasure of living (1.13)	0,149	0,109	0,045	0,170	0,104	-0,023	0,157*	0,297**
intended length of residence (1.14)	0,111	0,043	0,234**	0,079	0,205*	0,152	0,093	0,152
regret (3.4d)	0,165*	0,052	0,190*	0,108	-0,294**	0,263**	0,434**	-0,058

Table 12 Spearman’s rank tests for two variables, for the topics sense of responsibility and protective measures

Appendix 3: Overview of interviews

Governmental actors (7)

Organization	Date
Ruimte Vlaanderen	2012/10/30, 2015/05/06
VMM	2013/09/27
Province of Oost-Vlaanderen	2013/09/11
Province of Oost-Vlaanderen	2015/11/14
Aquafin	2014/11/21
Municipality of Geraardsbergen, sustainability official	2014/02/06
Municipality of Geraardsbergen, major	2015/05/11

Societal actors Geraardsbergen (17)

Organization	Date
Independent voluntary association for nature protection	2014/04
Business in flood-prone area	2014/04
Business in flood-prone area	2014/04
Business in flood-prone area	2014/04
Farmer	2014/04
Farmer	2014/04
Citizens committee Majoor van Lierdelaan	2014/04
Citizens committee Majoor van Lierdelaan	2014/04
Citizens committee Majoor van Lierdelaan	2014/04/16
Village council Zandbergen	2014/04
Resident near flood-prone area	2014/04/29
Resident near flood-prone area	2014/04
Independent voluntary association for nature protection	2014/04
Insurance company	2014/04
Real estate & insurance company	2014/04
Real estate company	2014/04
Real estate company	2014/04

Societal actors Flanders (6)

Organization	Date
Agricultural professional association	2015/05/13
Professional association for insurers	2015/05/18
Independent voluntary association for nature protection	2015/07/01
Professional association for architects	2015/07/30
Professional association for the construction sector	2015/08/05
Professional association for the real estate sector	2015/12/01

Appendix 4: Questions for the semi-structured interviews with Flemish stakeholders

Role of the organization

1 What is the role of your organization in FRM?

2 With which actors does your organization have most contact about flood risks?

3 For your organization, who is the most important partner in FRM?

4 Are you involved in policy processes in FRM? Or non-governmental FRM processes?

5 Do you take initiatives in FRM?

6 For your organization, what are the main challenges in FRM?

Role of their profession

7 What responsibility does your profession have in relation to flood risks and damages? How do you see this evolve in the future?

8 Does your profession ever encounter problems related to flood risks and damages? (i.r.t. liability, etc.)

Future developments

9 If you could change one thing in the flooding issue, what would it be?

10 Can your profession or association help to find a solution for FRM? Under which conditions? How can this be stimulated?

11 Do you think that your organization should do more in FRM? Why?

Appendix 5: Participants and discussion statements used for the focus groups

a Focus group responsibility

Participants

Institution	Name
Ruimte Vlaanderen	Bien Weytens
VMM	Bram Vogels Kristof Decoene
Liedekerke	Pascal De Gijnst
Natuurpunt	Wim Van Gils
NAV	Julie Alboort

Statements for discussion

1 Users of flood-prone areas should protect themselves against flooding
   a both implementing and funding measures
   b irrespective of whether they are/were aware of the flood risk

2 Protection measures (such as the construction of dikes or FCAs) should only be made possible if it has been proven that there is sufficient water buffering and infiltration.

3 The compensation of flood damages (by the fire insurance and the disaster fund) should depend on compliance with the conditions of the water assessment.

b Focus group participation

Participants

Institution	Name
Ruimte Vlaanderen	Robin Desmet
VMM	Sven Verbeke Johan Schuermans
W&Z	Micheline Gruwé
stad Geraardsbergen	Guido De Padt
Boerenbond	Leen Franchois
Universiteit Antwerpen	Hannelore Mees

Statements for discussion

1. If users of flood-prone areas are expected to take up more responsibilities in FRM, they should also be more closely involved in both the decision-making and the implementation of formal FRM.

2. It should be decided on a local level how funds for FRM are used (participatory budgeting)
   a. by residents/land users
   b. by local governments

3. Users should not simply be informed of the precise protection level that the government offers them; the level of protection should be established in deliberation with the users.

c *Focus group financing*

Participants

Institution	**Name**
VMM	Annelies Huyck Kris Cauwenberghs
Provincie Oost-Vlaanderen	Boris Snauwaert
Boerenbond	Johan Sanders
Vlaamse Confederatie Bouw	Gert Huybrechts
Waterbouwkundig Labo	Fernando Pereira

Statements for discussion

1. The fire insurance should consider the effective risk in the calculation of the premium
   a. taking into account the individual measures taken.

2. In areas that flood frequently, the land-use allocation of 'residential zone' should be removed from the zoning plans. Landowners in flood-prone areas have no right to compensation if the land-use allocation of their land changes.

3. The government is not responsible for legal uncertainty due to the updates to the water assessment and federal risk maps.
   b. houses that suddenly are located in a flood-prone area
   c. houses that are no longer located in a flood-prone areas

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Publications

Academic publications

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Tempels, B., 2013, Veerkracht en ruimtelijke planning, *Agora* **29**(4)**:**40-44.

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Dewaelheyns, V., Bomans, K., Verhoeve, A., Tempels, B., 2012, Van tuinen en paarden, *Ruimte* **14**(juni)**:**24-30.

Awards

2013
Young Planner Award by the PlanDag (Stichting Planologische Diskussiedagen)

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Runner-up prize Jozef Plateau by the AIG (engineering alumni association of Ghent University)

Conferences attended

2011, *EURA conference*, Copenhagen, Denmark
2012, *Agriculture in an Urbanizing Society*, Wageningen, The Netherlands
2012, *PlanDag*, Den Haag, The Netherlands
2012, *AESOP Annual Congress*, Ankara, Turkey
2013, *AESOP Young Academics meeting*, Vienna, Austria
2013, *PlanDag*, Antwerpen, Belgium
2013, *AESOP PhD workshop*, Belfast, Northern-Ireland
2013, *AESOP/ACSP joint congress 2013*, Dublin, Ireland
2014, *Resilience in Urban and Regional Development: from Concept to Implementation*, Berlin, Germany
2014, *AESOP Annual Congress: From control to co-evolution*, Utrecht, The Netherlands
2014, *Resilience, just do it?!*, Groningen, The Netherlands
2015, *AAG Annual Meeting*, Chicago, The United States
2015, *AESOP Annual Congress: Definite space, fuzzy responsibility*, Prague, Czech Republic
2016, *WPSC World conference*, Rio de Janeiro, Brazil

ISBN
978-90-8578-950-5

cover picture
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Geraardsbergen, Belgium: Illustration shows the flooded camping site at Recreation centre De Gavers in Geraardsbergen, Monday, November 15, 2010. Heavy rainfall caused flooding in several areas in Belgium.

Internal and cover design
André Diepgrond

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Oude Kijk in 't Jatstraat 6,
9712 EG Groningen, The Netherlands

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Flood Resilience: a Co-Evolutionary Approach

What is flood resilience? At first sight, flooding presents itself as a physical issue. This could lead one to think that solutions are to be found in the physical realm – from robust, large-scale solutions (such as dikes, weirs) to flexible, small-scale ones (such as floodgates, flood proofing, floating homes). The cover picture, however, shows that there is more to the story. While caravans could be considered physically resilient, as they can accommodate changing conditions, their efficiency depends on the social structures that support them – they simply need to be moved. Resilience is thus not merely about infrastructure. It is also people, and how people use infrastructures. Flood resilience, therefore, is not only to be sought in the technical, but also in the social realm.

Therefore, this dissertation has been an endeavor to understand the role of different actors in managing flood risks. It analyzes which actors directly and indirectly contribute to the spatial development of flood risks. It then looks at how these different actors relate to and interact with each other to produce flood resilience. As such, it develops a framework that provides a broad perspective on how flood risks develop through time and place and explores what the role of spatial planners could be in bringing these different parties together.

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