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# Stormwater management in Brussels-Capital Region: in transition towards a Water Sensitive City

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1 Brusseau (short for Brussels sensible à l'eau) is an action-research project (2017–2020) coordinated by a team composed of one non-profit organisation (EGEB), three research centres (Hydr - VUB, Lieu - ULB and Habiter (ULB)), two urban design offices (Latitude Platform and Arkipel) and one private enterprise (Ecotechnic). It activates in two municipalities of the Brussels-Capital Region: Forest-Vorst and Jette. Brusseau investigates how to bring about a more resilient institutional environment that embraces the co-creation of knowledge together with citizens. The core practice of Brusseau is to coordinate local actions and to propose alternative actions in stormwater management through spatial, hydrological and social analysis. Website: [brusseau.be](http://brusseau.be)



# Abstract

Worldwide, urban areas are being challenged to improve the conventional stormwater management regime (i.e. the totality of beliefs, rules, and practices that guide the activities of water management). Illustrated as the Water Sensitive City, the envisioned new regime aims to solve water problems, to adapt to future uncertainties (e.g. increase of extreme events), to create a more liveable urban environment, and to reflect the aspiration of the community related to water (Brown, Keath, and Wong 2008). Research indicates that the existing regime embodies strong convictions on how to develop and use the existing technology to manage water (Smith, Stirling, and Berkhout 2005). Thus, a transition towards a new regime requires changes at different levels of the society: a wider adoption of innovations at the local level, a destabilisation of the current practices of the regime, and an increase in external pressures forcing change (Schot and Geels 2008).

Brussels-Capital Region (BCR) is a representative case for this phenomenon on how external pressures and disruptions in the regime create the conditions for the emergence of alternatives. The regional administration still relies on a centralised decision-making process to extend the current infrastructure by using conventional actions, such as underground retention basins. Meanwhile, the overflow of the combined (with wastewater) sewer system during large precipitation events – lead to urban flooding in the streets and households' basements, and pollution of surface water – reveals a weakness of the current regime. As a reaction to these problems, at the local level, neighbourhood committees, non-profit organisations, and municipal public administrations propose alternative actions to harvest, infiltrate, and drain surface stormwater by including various stakeholders (citizens as well) in the process of co-production.

The main question of this thesis arises: to what extent can these alternative actions trigger changes in the stormwater management regime to move towards a new stormwater management regime or a Water Sensitive City?

The thesis addresses this question by (i) illustrating the characteristics of the existing regime in BCR, (ii) by analysing changes proposed by alternative actions developed in three case studies in BCR (Ilot d'eau design initiative, Forest-Vorst municipality, and Molenbeek Valley), and (iii) by discussing the lessons learned in order to understand whether the diffusion of knowledge and the transition roles of the involved actors are signs of transition. This research opens up the hypothesis of how alternative actions contribute to a transition in the water regime in dense urban areas with a low level of water-related hazards. The implementation process for alternative actions is as important as the actions' output.

Alternative actions are punctual endeavours (in terms of time and space), making their influence on a wider transition fit contextual conditions. Nevertheless, several findings from the case studies indicate favourable conditions in which alternative actions are produced and diffused: (i) economic incentives for private areas adapted to physical conditions and the needs of citizens, (ii) good coordination of private and public water-related projects, (iii) decentralised processes to produce action supported by formal network, and (iv) hybrid processes (expert-based and participatory) to create fit-for-propose evaluation frameworks — moreover, the thesis emphasised two critical issues about the diffusion of actions. Firstly, the support of regime actors increases the diffusion of practical knowledge from one action to another but often leads to incremental, rather than radical, proposals to change the regime. Secondly, intermediary actors' role in transition is profoundly impacted by their endeavours (e.g. changes in position relative to transition levels or timespan of their involvement) and by their complementary activities (in different sectors and at the various geographical scales).

More specifically, the co-production of alternative actions provides viable solutions to the current challenges and set the conditions for a dialogue about the envisioned regime among state and non-state actors. The new stormwater management regime that derives from this process leads to an adaptable infrastructure, as well as to a different type of practice on how and who plans, designs, constructs, and manages this new infrastructure.

## Résumé (in French)

Dans le monde entier, les zones urbaines font face au défi de faire évoluer le régime conventionnel de la gestion des eaux pluviales (l'ensemble des croyances, règles et pratiques qui guident les activités de gestion de l'eau). L'apparition d'un « nouveau » régime, désigné par le concept de la « ville sensible à l'eau », a ainsi pour objectif de résoudre les problèmes techniques liés à la gestion des eaux, de s'adapter aux incertitudes futures (par ex. l'augmentation des catastrophes naturelles), de créer des environnements urbains plus accueillants et de matérialiser le lien direct que les habitants veulent retrouver avec l'eau. D'après certaines recherches (Truffer et al. 2010; Smith, Stirling, and Berkhout 2005), le régime de gestion de l'eau actuel fait preuve d'une profonde inertie de part les habitudes bien ancrées des acteurs quant à la façon de développer et d'utiliser les technologies existantes. Ainsi, la transition vers un nouveau régime nécessite des changements à différents niveaux de la société : une adoption plus large des innovations au niveau local, un renouvellement des pratiques actuelles et une augmentation des pressions externes forçant le changement (Schot et Geels 2008).

La Région de Bruxelles-Capitale (RBC) illustre parfaitement comment les pressions externes et les perturbations du régime peuvent constituer des conditions propices à l'émergence « des pratiques alternatives » dans la gestion des eaux. En effet, l'administration régionale s'appuie encore sur un processus décisionnel centralisé ayant pour objectif d'étendre les infrastructures existantes au moyen des pratiques conventionnelles, telles que les bassins d'orage. Or, les débordements récurrents du réseau d'égouts (qui combinent eaux de pluie et eaux usées) lors des fortes précipitations sont une preuve de la faiblesse de ce régime de gestion : des inondations urbaines surviennent régulièrement dans les rues et les sous-sols des ménages, associées à une pollution des eaux de surface. En réponse à ces problèmes, des comités de quartier, des associations et des communes de la RBC ont proposé la mise en place des pratiques alternatives en matière de collecte, d'infiltration et de drainage des eaux pluviales en surface, rassemblant divers acteurs (dont les habitants) dans un processus de co-production.

La principale question de cette thèse est de savoir dans quelle mesure ces pratiques alternatives peuvent entraîner des changements dans le régime conventionnel de gestion des eaux pluviales.

La thèse aborde cette question en illustrant, tout d'abord, les caractéristiques du régime conventionnel actuel de la RBC. Elle examine, ensuite, les changements proposés par les pratiques alternatives menées au sein de trois cas d'études sur la RBC (l'initiative de co-design « Ilot d'eau », la commune de Forest et la vallée de Molenbeek). Finalement, la thèse tire quelques leçons de ces trois cas, tentant de voir si la diffusion des savoirs pratiques développés à ces occasions, de même que le fort engagement des acteurs impliqués ne seraient pas d'ores et déjà annonciateurs d'une transition de régime.

Cette recherche part ainsi de l'hypothèse que les pratiques alternatives peuvent contribuer à une transition du régime de l'eau dans les zones urbaines denses ayant un faible niveau de risques liés à l'eau, les processus d'élaboration et de mise en œuvre de ces mesures alternatives étant tout aussi important que leurs résultats. En tant qu'initiatives ponctuelles (aussi bien en termes de temps que d'espace), les actions alternatives n'ont qu'une influence limitée au regard d'une transition qui se voudrait plus large, leur impact variant fortement d'un contexte à l'autre. Cette thèse fait toutefois émerger certaines conditions favorables à la concrétisation et à la diffusion de ces pratiques : (i) des incitations économiques pour les espaces privés, adaptées aux conditions matérielles (espace disponible ou perméabilité du sol) et aux besoins des citoyens en matière d'eau ; (ii) une bonne coordination des projets privés et publics liés à l'eau ; (iii) des processus décentralisés soutenus par des réseaux formels/officiels pour porter les actions ; (iv) des processus hybrides (alliant experts, administrations publiques et société civile) pour créer des grilles d'évaluation adaptées aux contextes. En outre, la thèse met l'accent sur deux « nœuds » limitant la capacité de ces actions à transformer le régime actuel. Premièrement, si la participation des acteurs peut accroître le partage des savoirs d'une action à l'autre, elle conduit souvent à des propositions de changement « incrémentales » plutôt que radicales, ayant un impact bien plus faible. Deuxièmement, le rôle des acteurs intermédiaires dans la



transition dépend fortement de leurs engagements individuels (par ex. la durée de leur participation) et de leurs activités complémentaires (dans différents secteurs et à différentes échelles géographiques).

Ainsi, la possibilité pour des pratiques alternatives de provoquer des changements dans le régime conventionnel de gestion de l'eau dépend principalement des processus au travers desquels ces dernières se réalisent, et de leur capacité à engendrer de nouvelles actions par la suite. Le nouveau régime de gestion des eaux pluviales qui en découle mène non seulement à des infrastructures plus adaptables, mais aussi à des formes de pratiques différentes et ce, tant au regard des manières de planifier, de concevoir, de construire et de gérer ces infrastructures, qu'au regard des personnes que ces pratiques peuvent ou doivent prendre en considération.



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# Chapter 1

## Introduction

« Ideas that first considered outrageous or ridiculous or extreme gradually become what people think when they've always believed. How the transformation happened is rarely remembered, in part because it's compromising: it recalls the mainstream (...) in a way it no longer is; and it recalls that power comes from the shadows and the margins, that our hope is in the dark around the edges, not the limelight of center stage.» (Solnit 2016, xiv)

This thesis addresses a challenge facing cities worldwide: how to avoid water-related hazards and at the same to adapt the city to future uncertainties, to create more liveable urban environments and to reflect the aspirations of the community related to water? Several research indicated that a means to reach this challenge is to foster a transition from the conventional stormwater management regime towards a new regime (one of the possible presentation is the concept of the Water Sensitive City [WsC]) (e.g. Rijke and Farrelly 2012; de Graaf and van de Ven 2012). Nevertheless, there is a gap in the literature on transition studies about how actions produced as a result of a collaboration between state and non-state actors can trigger changes to the regime (Köhler et al. 2019). Furthermore, while a wide range of empirical studies focused on the barriers behind the adoption of alternative actions (e.g. Novotny, Ahern, and Brown 2010; Bos and Brown 2013; Wong 2007), there is an urgent need to recognise the added value brought by these actions in early cases of transition, in order to understand how they can support the transition process. The main research question of the thesis is: to what extent alternative actions can trigger changes in the stormwater management regime to move towards a new regime? The thesis aims to answer this question by looking at the changes proposed by alternative actions to the conventional stormwater management regime in three case studies located in the Brussels-Capital Region (BCR). This chapter provides an overview of the studied phenomenon, the emergence of alternative actions as a catalyst for transition in stormwater management (Section 1.1), the selected case studies to investigate this phenomenon (Section 1.2), research questions and methodology (Section 1.3) and the structure of this thesis (Section 1.4).

## **1.1 Background and Context**

### *The conventional stormwater management regime*

The stormwater management regime represents the totality of rules, norms and values embedded in infrastructure and institutions that steer the activities of managing stormwater (Rip and Kemp 1998; Pahl-Wostl 2008, 2015). The



conventional regime is, firstly, characterised by a command and control approach that relies on predictable variations of natural processes (e.g., the water cycle) to make the problem (e.g., urban flooding) easier to control (Holling and Meffe 1996). Secondly, the regime responds to urban flooding with a tout-à-l'égout (all to the sewer) approach to drain stormwater and wastewater as fast as possible outside urban areas, in underground combined sewer systems (Jacquemet 1979). Thirdly, the regime tackles pollution by end-of-pipe control technologies, such as large treatment plants (Pahl-Wostl 2002). Lastly, the regime favours a large scale, centralised infrastructure (Werbelloff and Brown 2011) steered by a centralised expert management (i.e., top-down reliance on expert-based knowledge and less on local and informal knowledge) (Nelson, Howden, and Smith 2008).

There are several criticisms of this regime in the literature. The command and control approach reduces the natural variations of the urban water system and leads to a lower resilience to natural or human-induced shocks (Holling and Meffe 1996). As a result, it decreases the chances of the regime to address future challenges such as climate change and urban sprawl (Pahl-Wostl 2008). Furthermore, the end-of-pipe approach to pollution is costly (Grafton et al. 2015), and it is reinforcing the fragmentation of expertise (Erkman 2004). In addition, a centralised expert management focused only on scientific knowledge cannot fully represent the complexity of urban water systems (Nelson, Howden, and Smith 2008). The conventional stormwater management regime treats stormwater as a source of damage. From this perspective, stormwater is the main cause of surface runoff, of combined sewer overflows in households, streets and rivers, and the principal reason for the disturbance of the wastewater treatment plants, all creating urban flooding and surface water pollution (Engen, Kampe, and Tjallingii 1995).

Since the 1990s, influenced by the environmental movement of the 1970s and the development of the concept of sustainability, a new water paradigm has emerged that proposes a move of the water management regime (i) from understanding water systems as purely technical, to socio-technical and social-ecological systems (Brodnik and Brown 2018), (ii) from command and control, to learning

by doing through feedback loops (Kato and Ahern 2008), (iii) from end-of-pipe, to source control solutions to pollution (i.e., to manage pollution close to its source) (Hamel, Daly, and Fletcher 2013), (iv) from centralised, top-down expertise, to problem-solving strategies based on integration, dialogue and the human dimension (Schoeman, Allan, and Finlayson 2014) and (v) from reliance on a large scale, centralised infrastructure, to a multi-scale and decentralised infrastructure adapted to local conditions (Yu, Brown, and Morison 2012).

*The emergence of alternative actions and the Water Sensitive City*

The challenges of the conventional regime and the change in the water paradigm led to the emergence of alternatives. Alternative actions in stormwater management have been developed under different terminologies in several European countries (e.g., sustainable urban drainage systems in the UK and alternative techniques in France), the United States (low-impact developments) and Australia (water sensitive urban design [WSUD]) (Fletcher et al. 2014). I employ the term alternative actions because it puts the accent on the need to complement conventional actions through radical innovation. The reference to alternative actions also allowed the inclusion of soft (e.g., raising awareness activities) and green (on-ground works) actions as equally important to the transition process. The benefits of these actions are multiple, as they manage stormwater as a resource on the ground and as close to the source as possible (e.g., Ashley et al. 2013). Moreover, I focus on the actions that are co-produced with the participation of various actors, including citizens, not just as users in the water sector, but also as experts on their own environment (Yu, Brown, and Morison 2012). This thesis does not aim to improve the technical aspects (e.g., materials used or dimensioning of devices) of how alternative actions manage stormwater. I deliberately left aside these questions, as they are already addressed by a wide range of research (e.g., Ashley et al. 2011; Woods Ballard et al. 2015; Bevington et al. 2013).

An illustrative case of how alternative actions in stormwater management can lead to changes in the regime is the transformation of the Australian water sector. WSUD was developed as a reaction to the damaging effects of urban runoff on

surface water (Mouritz 1991). It was designed to integrate green actions (e.g., swales and rainwater gardens to manage urban runoff on the streets) in urban planning and design with the support of soft actions (e.g., raising awareness campaigns and regulations) (Lloyd, Wong, and Chesterfield 2002). WsC was derived from the term WSUD as the representation of a desirable new regime (Rijke et al. 2013). In the Australian case, the millennium drought in the 2000s drove the integration of WSUD and WsC into national policies to use stormwater as a resource in order to compensate for the decrease in natural water resources (Brown and Clarke 2007). While cities like Melbourne and Sydney have an increased recognition of the benefits alternative actions bring in stormwater management, cities have a long way to go to embrace the full vision of WsC (McCallum and Boulot 2015).

The Australian case indicates two ways in which alternative actions in stormwater management (e.g., WSUD) can trigger changes in the regime. A first factor is the wide uptake of WSUD leading to a representation of a new regime – WsC – where water management is integrated into urban planning and design. A second factor is that the existing regime encounters disturbances (e.g., water scarcity) and strong external pressures (e.g., the millennium drought). Nevertheless, the case also shows that even with these conditions, the urban water system – understood as the tangible representation (e.g., infrastructure and institutions) of the rules set by the regime – changes very slowly. Thus, a key point for the thesis is that urban water systems are characterised by inertia to change even under favourable conditions.

### *Transitions and the multi-level perspective*

The inertia of the urban water system lies in its behaviour as a complex system – its components respond to external pressures in a non-linear way: small stimuli can cause large effects in the system, while large stimuli can have little to no impact (Rotmans and Loorbach 2009). In the literature, the complexity of the urban water system is represented by the concepts of a sociotechnical system (i.e., composed of institutions, actors' networks, user relations and social expectations) (Smith, Voß, and Grin 2010) and a social-ecological system (i.e., composed of

human behaviours, biodiversity, resource scarcity and resource consumption) (Binder et al. 2013). Thus, the modifications required are not only technical, but also social, affecting both the institutional level and the natural ecosystem.

A common factor in research, focusing on how sociotechnical and social-ecological systems change, is the relationship between innovations and the regime. The process of change is defined in the literature in terms of transformation or transition. The term transformation is mostly used when the focus is on the interaction between human and biophysical systems in large-scale societal changes (Hölscher, Wittmayer, and Loorbach 2018). I employ the concept of transitions, which derives from the field of sociotechnical systems, because of its particular focus on institutions, technology and actors. During the transition process, the regime being changed passes through different phases during the appearance, adoption and stabilisation of innovations (Brodnik and Brown 2018).

This thesis looks at a contemporary type of transition orientated towards sustainability. The challenge of triggering sustainability transitions lies in its “wicked problems”: “groups of related problems, with high levels of uncertainty and a range of competing values and decision stakes” (Pahl-Wostl et al. 2006, 19). For instance, a sustainability transition must reach an overall objective (sustainability), to focus on collective benefits, to propose actions that require new policies and economic conditions and to adapt to sectors that are usually monopolies of large firms, such as those in the water sector (Geels 2011). The field of sustainability transition has emerged in the literature in the last decade as a way to bring together research on transition from a system’s perspective with a close connection to socio-technical transitions (engages a variety of actors in a long period of time) (Farla et al. 2012).

Sovacool and Hess (2017) characterised the different conceptual frameworks used in research for analysing sociotechnical change. For example, their analysis pointed out that social construction of technology does not allow the analysis of the temporal dimension (see more Madsen et al. 2017) and actor-network theory (see more Latour 1996) is highly relevant for actors’ interactions, but less on the

infrastructure and the different levels of interaction. The multi-level perspective (MLP) framework is the most encountered conceptual framework to analyse sociotechnical change because it allows understanding the interaction between niche, regime and macro-level (Sovacool and Hess 2017).

The MLP framework indicates that changes occur as a result of the interaction of the regime with innovations created in niches and pressure coming from the macro level (sociotechnical landscape) (Rotmans, Kemp, and van Asselt 2001). According to the MLP framework, innovations developed in niches (i.e., isolated and autonomous environments) can trigger changes under certain conditions (Schot and Geels 2008). They need to happen at the same time as a decrease in the rigidity of the regime. Moreover, at the macro level, windows of opportunity become external pressures (e.g., increase in precipitation or changes in international policies) favouring innovation (Geels and Schot 2007). Nevertheless, several critical issues of the MLP framework have been pointed out in the literature about its empirical application, such as the difficulty of defining the signs of transitions (e.g., the start and the end) or a reduced application in early-stage cases of contemporary transitions (Genus and Coles 2008; Geels 2011).

This thesis employs the MLP framework by focusing the analysis on the conditions for alternative actions that trigger changes in the regime. Previous studies carried out to analyse the adoption of alternative actions in the stormwater management regime, reveal the adaptability of the MLP framework to provide an understanding of how sustainability transitions occur (Mguni 2015; Van Der Brugge, Rotmans, and Loorbach 2005). Furthermore, the MLP allows us to conceptualise the interactions between innovations created in niches (alternative actions), the disturbances existing in the regime and external pressures coming from the macro levels.

## **1.2 Brussels-Capital Region Towards a Water Sensitive City**

The case of the BCR illustrates the practical relevance of the MLP framework to understand how external pressures, internal challenges of the conventional

stormwater management regime and local innovations create the conditions of a transition towards a WsC.

On the macro-level, three types of pressure force a change in the existing stormwater management regime. The first external pressure is the high rate of urbanisation that, through impervious surfaces, disturbs the balance between rainwater that naturally infiltrates the soil and runoff, increasing the quantity of stormwater that needs to be managed by the infrastructure. As a result, the overflow of the conventional infrastructure during heavy precipitation leads to urban flooding in the streets and households' basements, together with water pollution (Bruxelles Environnement 2011). A second type of pressure, as the effects of climate change on precipitation patterns may lead to a multiplication of extreme phenomena, is the fact that water-related hazards might increase in the future (Baguis et al. 2009). A third external pressure comes from water policies at the European level. For instance, since 2000, the European Water Directive has required the BCR government to collaborate with the neighbouring regions and with its municipalities to tackle surface water pollution as fast as possible.

These problems seem unsolvable by the current stormwater management regime, as it also faces internal disturbances. The aging sewer infrastructure cannot adapt to these pressures without large financial investments (Bruxelles Environnement 2016). Moreover, the BCR's conventional regime is renowned for its slow response to challenges. For instance, the region did not build its first wastewater treatment plant until 2000, several years after the European legislation. In addition, the fragmentation of responsibilities between water agencies and public administrations makes the coordination of a common reaction to the external pressures even more difficult (Ranzato 2016).

At the local level, alternative actions have emerged and are similar to the ones occurring in cities that are moving towards WsC, such as Melbourne (Rijke et al. 2013), Copenhagen or Johannesburg (Mguni 2015). This thesis analysis three case studies at different geographical scales (building block, municipality and valley) situated in the BCR that each illustrate alternative actions in stormwater management.

(i) The *Ilot d'eau* design initiative focused on the co-planning, co-designing and co-construction of alternative actions (e.g., collective rainwater tanks) with citizens living in the same building block.

(ii) The Forest-Vorst municipality is renowned in the BCR for the multitude of alternative actions that get adopted due to the collaboration between state and non-state actors (Kohlbrenner 2015). The case illustrates the application of the principles of WsC, such as mitigation of water-related hazards and adaptation to future uncertainties, in many types of actions.

(iii) In the Molenbeek Valley, I participated in a process of elaborating a theoretical framework of evaluation for urban water systems in close collaboration with a steering committee, entitled Comité d'accompagnement du Bassin versant solidaire du Molenbeek (CAM).

In this thesis, the BCR is an illustrative case of a broader phenomenon – the pressures faced by the stormwater management regime create conditions for transitioning towards a WsC. The thesis does not focus on all the alternative actions implemented in the BCR, but it selects specific cases. It left aside actions that may have had more impact in transforming the physical space and the urban water system (e.g., a municipality in the BCR – Uccle – is also active in implementing alternative actions). However, as the thesis investigates processes rather than outcomes, the selected cases are richer from this perspective. The same judgement could be made for the pertinence of analysing the stormwater management regime in the BCR. From a transition perspective, in comparison with other renowned cases (e.g., Rotterdam, Copenhagen or Melbourne), the BCR presents few visible changes. Consequently, the findings of this thesis refer only to early phase cases of transition. Nevertheless, as previous research has pointed out, the majority of cities in developed countries struggle to move from an early phase of transition (Chesterfield et al. 2016). Thus, for dense urban areas with low levels of water-related hazards, the BCR is an illustrative case for analysing transition.

### 1.3 Research Questions and Methodology

The main research question of the thesis is to what extent alternative actions can trigger changes in the stormwater management regime to move towards a new regime. The hypothesis of this thesis is that the capacity of alternative actions to support changes in the regime is conditioned by the processes that produce them and by their influence on the emergence of subsequent actions. This hypothesis implies both an empirical and theoretical research, constantly influencing each other in a circular feedback loop.

The empirical research of this thesis looks at this phenomenon in three cases of the BCR. The main question is adapted to the empirical study as follows: to what extent the alternative actions from the *Ilot d'eau* design initiative, the Forest-Vorst municipality and the Molenbeek Valley contribute to the process of transition. Furthermore, I divided the research in three parts: understanding the characteristics of the existing stormwater management regime in the BCR, investigating how alternative actions are produced and diffused in the three case studies and discussing the lessons learned from the case studies that influenced other actions.

RQ1. What are the main characteristics of the current stormwater management regime in the BCR?

RQ2. How are alternative actions produced and diffused?

2.1. Based on the *Ilot d'eau* design initiative, how and why does citizen's involvement change from one phase to another during the co-production of decentralised stormwater systems?

2.2. In the case of the Forest-Vorst municipality, how have the technical and governance attributes of alternative action influenced their diffusion and therefore contributed to wider change processes?

2.3. According to the case study in the Molenbeek valley, to what extent does a hybrid process (expert-based and participatory) create a fit-for-purpose theoretical framework for assessing water systems?



RQ3. What are the lessons learned (practical knowledge) about the production (from planning to implementation) of alternative actions from the three case studies that inspired new actions in the BCR?

3.1. How is knowledge diffused from one case study to other alternative actions?

3.2 Who were the involved actors, and what transition roles did they play in the process of change?

In order to answer these questions, the research approach has two main characteristics. Firstly, the thesis includes an interdisciplinary research located at the intersection between stormwater management and governance together with urban planning and design. This approach influenced the conceptual framework of the thesis. I framed the studied phenomena in sociotechnical transition studies and, more particularly, as a contemporary sustainable transition. The thesis contributes to understanding transition processes, firstly, by applying the framework to analyse changes in a stormwater management regime in a dense urban area with a low level of water-related hazards, the BCR (RQ1). Secondly, it complements the MLP framework by proposing analytical lenses from different studies to understand the process of producing and diffusing alternative actions: (i) co-production of public services (Bovaird and Loeffler 2012) (RQ2.1), (ii) governance configurations and multi-phase perspectives on transitions (Rijke et al. 2013) (RQ2.2) and (iii) participatory evaluation (Reed et al. 2005) (RQ 2.3). Thirdly, the thesis employs the concepts of knowledge diffusion (Vreugdenhil 2010) to characterise the relationships between niches and the regime (RQ 3.1.), and the concepts of intermediary (Moss 2011) and frontrunner (Brown, Farrelly, and Loorbach 2013) to analyse the transition roles of actors (RQ 3.2). A detailed description of the conceptual framework is located in Chapter 2.

Secondly, the thesis investigates a contemporary, dynamic phenomenon where the researcher is a participant in the process. This position required a careful balance between the different roles I played during the development of the case studies: researcher, architect, tutor and facilitator of interactions between stakeholders. I

wrote this thesis from the perspective of an outsider in collaboration with insiders . My double position as an observer and a participant is reflected in a hybrid methodology using both traditional social science and action research methods (characterised as a process that brings together action and reflection in a close collaboration with others (Reason and Bradbury 2008). The contribution of the hybrid approach to the research questions of the thesis is explained at length in Chapter 3.

## **1.4 Structure of the Thesis**

The first part of the thesis regroups the three main chapters of the thesis. Chapter 2 starts with a literature review of the historical development of the regime for stormwater management, in terms of both infrastructure and the actors involved, defining what alternative actions are. It continues by exploring the literature on sociotechnical and sustainability transitions as a guiding theory for understanding how changes in the regime occur. The overall conceptual framework of the thesis closes Chapter 2. Chapter 3 goes in depth into the research approach and methodology employed in the thesis, and it puts an emphasis on the challenges and benefits of integrating traditional, qualitative social science methods with action research methods. Chapter 4 sets out the context in which the empirical research is carried out – the stormwater management regime in the BCR (RQ1). The second part of the research includes Chapters 5, 6 and 7, which are dedicated to the individual analysis of the three case studies. Each chapter is written in the form of a scientific article comprising both theoretical and empirical research (Chapters 5 and 6 have been published) (RQ2). The last part of the thesis is focused on reflections. Chapter 8 provides responses to RQ3. This chapter is intended to interrelate the findings from the three case studies to have an in-depth understanding of the transition process, rather than to compare them. The conclusion chapter emphasises the theoretical and empirical contributions of the thesis, and it suggests directions for future research.

# Chapter 9

## Conclusion

*“Now, it is also necessary to reflect on our work because money comes less easily. The question now remains to see how we can render the same service with less cost. People are not used to changing, but if they are smart, they can become the engine of change.”<sup>1</sup>*

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1 Extras from an interview with a municipal water representative in June 2018.

## 9.1 Theoretical Contributions

This thesis has investigated the extent to which alternative actions can trigger changes in the stormwater management regime. While the majority of research in water management focuses on on-ground works (e.g., Ahern 2007; Sharma et al. 2012), this thesis has considered a wide range of actions that exist in practice (green, grey and soft). I relied on the complexity of the stormwater management in the BCR to illustrate that the variety of actions is a sign of an early phase of transition. BCR indicates a high resistance of the regime to integrate change, but also a new perspective on alternative actions that are the result of a collective endeavour (understood as co-production). By doing so, the thesis brings three sets of contributions to transition studies.

### *The Production and diffusion of alternative actions*

The first set of contributions emerges from the individual analysis of the three case studies by following the question: How are alternative actions produced and diffused?

Firstly, Ilot d'eau design initiative provided new insights into transition studies about the role of citizens during the transition process. The initiative positioned citizens as more than just passive users of the water service or respondents to mandatory regulation, but as active actors in co-producing alternative actions. Citizens provided localised knowledge about the cause of flooding and reflected upon possibilities of storing stormwater at the level of the household in collaboration with their neighbours in co-design activities. They adapted a device, for instance the *citerne mur*, to their own needs, as Schot, Kanger, and Verbong (2016) also pointed out as being an essential activity of users in the transition process. Thus, citizens become frontrunners of innovation. Furthermore, the chapter contributed to the field of co-production of public services, on the one hand, by supporting previous studies stating that citizen engagement changes in time as a result of the activities carried out (Loeffler et al. 2008; Krütli et al. 2006). On the other hand, the analysis identified how to maintain citizen involvement during the process of co-producing decentralised stormwater

systems by adapting economic incentives to the requirements of the citizens and the physical conditions, and by closely coordinating private and public water-related projects.

Secondly, the case of Forest-Vorst municipality was illustrative of the conditions, more particularly the governance and technical configurations, enabling the scaling-up of alternative actions. This perspective provides new insights about the conditions of scaling-up needed in transition studies (Köhler et al. 2019). In terms of governance configurations, the adoption of alternative actions leads to the emergence of collaborations, both formal and informal, between state and the civil society. As suggested by previous studies, this is a sign of an early phase case of transition (Rijke et al. 2013; Rotmans, Kemp, and Van Asselt 2001). Moreover, the analysis provided new insights into the scientific literature about the critical role played by soft actions in the transition process (Ashley et al. 2011; Taylor and Wong 2002). The case pointed out that soft actions developed in a decentralised decision-making process by formal networks are more often diffused in different contexts in order to favour the implementation of green actions.

Thirdly, the case of Molenbeek Valley explored the normative world of transitions by proposing a hybrid process to bring together place-specific views on the objective of the transition. More particularly, it advanced a means to adapt the concept of the Water Sensitive City (WsC) through SIs to the local context. The primary outcome was a theoretical framework of objectives to evaluate urban water systems. This theoretical framework addressed a practical necessity of the public administration and non-profit organisations in the BCR to reveal that alternative actions create a link between different sectors on water-related issues and trigger critical structural changes. Furthermore, this process revealed the challenge to translate the complexity of water systems into SIs, a current challenge in the quest of new methodologies for transition studies (Köhler et al. 2019). The hybrid process in Molenbeek Valley pointed out that it is more important to adapt a concept to a particular place rather than to represent the whole complexity of the water system.

*Practical knowledge and the transition roles of actors*

The second set of contributions responds to the research question: What are the lessons learned (practical knowledge) about the production (from planning to implementation) of alternative actions from the three case studies that inspired new actions in the BCR?

Chapter 8 offered a development of the MLP framework about the interactions between niche and regime in terms of the diffusion of accumulated knowledge and the transition roles of the actors involved in the diffusion.

Firstly, while numerous studies focus on learning processes as support for transitions (Pahl-Wostl 2002; Kato and Ahern 2008; Hegger, Van Vliet, and Van Vliet 2007), few studies conceptualised the path of produced knowledge and how this knowledge can create changes in the regime. The results showed that producing knowledge through collaborative processes increases the chances of knowledge dissemination. Furthermore, the involvement of regime actors in the process increases the chances of institutionalisation of knowledge but often leads to incremental, rather than radical, proposals to change the regime.

Secondly, my research indicates that intermediaries and frontrunners facilitate the diffusion of radical proposals from local projects. Their role is crucial to the transition process, as they facilitate the integration of new knowledge into the daily practices of the agencies that follow the rules of the regime. The characterisation of actors developed at the end of Chapter 8 addresses a lack of conceptualisation about the leverage of actors located in-between users, producers, and regulators (Moss 2011). Moreover, the characterisation brings together two concepts rarely interconnected in the literature on the transition roles – intermediaries and frontrunners (Martiskainen and Kivimaa 2018). Constructed from the empirical study of actors' activities, it reveals that in early phases of transition, a growing number of intermediary actors support the activities of frontrunners. Moreover, the actors' leverage in transition is impacted by their endeavours (e.g. changes in position relative to transition levels or the timespan of their involvement) and by their complementary activities (in different sectors and at the various

geographical scales). Besides bringing new insights on the role of actors in the transition process (Mignon and Kanda 2018; Klerkx and Aarts 2013), this finding contributes to research focusing on the characteristics of the transition phases, in order to assist a better recognition and definition of early signs of transition (Ferguson 2013).

#### *Alternative actions as a catalyst for transition*

The third main contribution brings together the results developed in the different parts of the thesis to reflect upon the extent to which alternative actions can trigger changes in the stormwater management regime.

The capacity of alternative actions to drive social and technical changes in the stormwater management regime is influenced by the actions' potential to engage a large number of actors in their production, among which citizens as well, and to be fully embedded in the territory they modify. This finding supports current research on the uptake of alternative actions and the socio-technical implications these alternative actions bring to the stormwater management regime (e.g. Bos and Brown 2012; Madsen et al. 2017; de Graaf and van der Brugge 2010).

The thesis indicates also the limited impact of alternative actions in early-stage cases of transition. Alternative actions are punctual endeavours (in terms of time and space) that need a clear understanding of how their implementation on a larger scale can have positive effects in reducing the phenomenon of urban flooding and how a wide range of actors (state and non-state) can use these actions. Moreover, questions remain as well about how these actions can overpass the close relation with stormwater and become relevant for the whole water service cycle. Nevertheless, alternative actions exemplify how the concept of WsC works in practice.

As a contribution to the existing literature on the concept of WsC (e.g., Wong and Brown 2009; Camilleri and Trowsdale 2012), this thesis points out that at the local level, it is where the WsC is better defined. The alternative actions resulting from the collaboration between state and non-state actors in the BCR indicate

that the WsC is a city that is co-produced by and for its citizens in a sensitive symbiosis (i.e., open for change, but protected from hazards) with the urban water system. While this might be an idealised vision, in reality, it is in the mind of every activist, practitioner, civil servant, and researcher I encountered during this research journey.

## 9.2 Directions for Future Research

### *Theoretical research*

This thesis has provided an in-depth understanding of a complex phenomenon by linking the MLP framework with multiple theoretical perspectives such as co-production (Bovaird and Loeffler 2012b), governance configuration (Rijke et al. 2013), and the transition roles of actors (Mignon and Kanda 2018; Klerkx and Aarts 2013). However, new research is needed to investigate the different approaches that derive from these case studies.

Future theoretical research should explore ways to integrate the two distinct perspectives of transition from the three case studies. On the one hand, the first view (the bottom-up perspective in the Ilot d'eau design initiative and the Forest-Vorst municipality) considers niches as crucial drivers of change related to the MLP framework, and these drivers are largely developed in the literature focusing on strategic niche management (Schot and Geels 2008). This approach relies mostly on empirical research carried out on historical transitions. Thus, this approach is limited in unravelling the complexity of contemporary sustainability transitions, which are rarely driven from the bottom up (Berkhout, Smith, and Stirling 2005). On the other hand, a more top-down perspective, illustrated by the construction of the theoretical framework in the Molenbeek Valley was designed to steer innovations according to an agreed-upon vision. This approach takes a more normative stand on transition as the basis for the elaboration of new policy, supporting local innovations. Nevertheless, this approach is open to criticism on the role of power and who creates the guiding vision and how (Berkhout, Smith, and Stirling 2005). An in-depth understanding of how these parallel transition processes can coexist requires further attention. An example



of how to balance the bottom-up and top-down positions in planning emerged under the guiding principles/guiding models approach developed by Tjallingii (1996). This approach allows setting replicable links between local knowledge, principles, and models to use in other conditions and that can become part of the future regime. They can be an inspiration for connecting the two perspectives (top-down and bottom-up) during the transition. Nevertheless, one question remains open in the context of sustainability transitions: What are the actors that should participate in the co-production of these guiding principles/guiding models?

The second set of complementary perspectives emerged from the case studies that deserve further theoretical development. The first one derives from the Ilot d'eau design initiative and the Forest-Vorst municipality, and this perspective focuses on how to make a plan (i.e., elaboration and implementation). The second perspective, in the case of the Molenbeek Valley, is closer to how to evaluate the plan, as the perspective relies on the construction of SIs. The cases point to a separation between the actors involved – the designers and users for making plans, and the public administration for evaluating plans. Nevertheless, the NPO and the researchers involved acted as intermediaries by transferring knowledge from one case to another. Further research should look at how intermediaries can contribute to planning practice and how they could link activities for making and evaluating plans. In the literature, the first perspective receives much attention in research on planning theory (Healey 2008), while the second perspective is largely developed by evaluation theory (Stufflebeam and Shinkfield 2007). The field of evaluation planning addresses this deficiency by integrating the two streams of research (Alexander 2006). Further research should investigate how the knowledge developed in this field can evolve into an inspiration to improve the assessment of ongoing transition processes.

The third proposal envisions that the two theoretical developments presented in Chapter 8 require further research to become applicable to other case studies. The proposed definition of knowledge diffusion should include the translation of knowledge from the niche to the regime and explores the role of external

conditions into this process in more depth. Furthermore, the characterisation of actors' roles in the transition process (from intermediaries to frontrunner actors) needs a closer look at how these roles link to different transition phases.

### *Empirical research*

The thesis investigated a dynamic case study where changes were frequent, leading to new possibilities for empirical research.

As a first example in the BCR, the activities of the intermediary actors are starting to receive more and more recognition from state actors, but there are several perceived challenges: (i) the impact of these actors in the decision-making process is vulnerable to funding opportunities and political changes, (ii) often the new ideas they co-produce with citizens face barriers to integration in new actions, and (iii) most of the actors involved in the water sector are not aware of all the emerging local knowledge. Local knowledge is highly relevant for decision-making in the water sector. A clear understanding of the decision-making process in the stormwater sector is needed and, at the same time, new tools are required to help intermediaries transfer the knowledge produced in collaboration with citizens, into this process.

The second example of possible future empirical research is an examination of the tensions between hydrological and administrative limits in water management. The selection of a territorial scale comes with a particular challenge, as the hydrological boundaries often do not coincide with administrative boundaries (Cohen and Davidson 2011). For instance, a reflection in this direction was started by Brusseau to operationalise the concept *communautés hydrologiques* (CHs) (hydrological communities). Recently developed, the CHs reveal an interesting approach to determine the most appropriate boundary to use in investigating water management issues. The approach combines social (the groups or associations already active in the territory), hydrological (the natural flow of water), and administrative (the structure of administrative borders) factors (Brusseau 2018b).

The third example of further research is to analyse the new signs of transition emerging in the BCR. Firstly, the terminology surrounding alternative actions are adapted and used in the BCR as a form of appropriating new ways of managing stormwater. For instance, the term *Maillage pluie* (Stormwater network) has been employed more often in the public administration. Secondly, changes of the power balance in the public administration lead to regionalising responsibilities and, as a result, the redistribution of power in the BCR's water sector continues (Garcia Quesada and Khan forthcoming). As such, the municipalities might lose their autonomy in implementing new alternative actions in stormwater management. The growing presence of civil society in several ongoing projects reveals a counterbalance. If this counterbalance is just a transitory period before the nomination of a centralised actor responsible for the BCR's stormwater management, future research will show this. Thirdly, the new regional public administration (2019–2024) recently mentioned in their future policy document a desire to reduce the construction of underground retention basins and to favour an alternative and integrated stormwater management model, by proposing a co-funding scheme with the inter-municipal water agency, Vivaqua (Brussels-Capital Region 2019a).

### 9.3 Practical Implications and Recommendations

Proposals for actions to enhance the transition towards a Water Sensitive Brussels emerged from the elaboration, implementation, and diffusion of the alternative actions encountered in the case studies.

- (i) Increase the transparency of the planning and implementation of public green actions.

As explained in Chapter 5 of this thesis, the collectives in the *Ilot d'eau* design initiative encountered difficulties in constructing their projects in private areas. One of the reasons pointed out was the lack of a clear overview of the existing public projects. Private projects can inspire from or use public projects as outlets for excess water flows. An online platform to communicate existing and future public green actions for actions in private spaces in the BCR can be a possible step forward in that direction.

(ii) Achieve a shared vision of the desirable principles for the new stormwater management regime in a given context to understand how they might work in reality.

The setting of principles for guiding the transition is bound to affect how appropriate these principles are in a particular context. Chapter 7 of this thesis illustrated the need to adapt abstract SIs to the usual terminology employed in a particular place. The theoretical framework developed in the Molenbeek Valley offers local public administrations a concrete representation of the context in which urban water systems function. Moreover, each objective has a short explanation together with an example of action in the BCR. A handbook about the theoretical framework will be produced in French, for distribution to the municipalities in the BCR. The trial applications carried out have already indicated the flexibility of the framework for adoption in other municipalities with various goals. Civil servants can use the document as a basis for discussion among different departments on water-related issues. In addition, civil servants can employ the theoretical framework as a checklist for setting up alternative actions. In terms of its interaction with public administration, further developments should look at the possibility of integrating other tools from serious games (e.g., Huybrechts, Dressen, and Schepers 2012) during the workshops.

(iii) Facilitate dialogue between civil society and state actors on the shared recognition and responsibility of a co-produced alternative action.

In the case of Forest-Vorst municipality, one of the critical issues pointed out by stakeholders involved in producing alternative actions was the fear of appropriation. In some cases, the involvement of the public administration led to the alienation of the civil society, especially in the process of scaling up. For this reason, an agreement on how to share benefits and responsibilities between the actors involved in an alternative action can facilitate an open collaboration between state and non-state actors about how to share responsibility and recognition for alternative actions.

(iv) Create structural, financial, and juridical support to elaborate, construct, and maintain collective decentralised systems in private spaces.

The financial and juridical challenges encountered by the citizen collectives in Chapter 5 of this thesis opened up the question of how to finance and support private initiatives that propose collective management of stormwater at the scale of the building block. As current economic incentives are usually individual, the BCR will require new proposals for citizens' collectives covering material costs and juridical conventions establishing the responsibilities of each involved party.

(v) Develop methodologies for including the co-production of alternative actions citizens with a diverse socio-economic status.

In the literature, there are a variety of handbooks and guidelines on how to carry out co-design processes (e.g. Sanders and Stappers 2014), how to employ generative artefacts (e.g. Filipe, Renedo, and Marston 2017), or guidelines for public participation (e.g., Rahman 2008). The case of the *Ilot d'eau* design initiative applied a methodology composed of four week-long workshops; each workshop included one or more co-production phases (co-planning, co-design, co-construction, and co-assessment). However, long-term processes require the constant involvement of the organising team to maintain the interest of citizens and state actors. This condition can be limited by reducing the time between activities, by directly addressing the concerns of the persons present and by using generative artefacts fitted to the objectives of the discussion. In this way, the human, financial, and time resources of the involved actors, including those of the organising team, would be better balanced. A question remains on how to improve the methodology employed during the *Ilot d'eau* design initiative to facilitate giving voice to citizens with lower socio-economic status, who are usually the most impacted by urban flooding. An example in this sense was briefly described in Chapter 8 of this thesis regarding the follow-up of the *Ilot d'eau* design initiative, *Ilot d'eau Le Retour*, where performances in the public space attracted a variety of audiences.

## 9.4 Transition in the Context of Emergency to Adapt to Future Uncertainties

The current worldwide context, marked by the visible adverse effects of climate change and the growing urbanisation of water systems, raises the question of whether we have the time to wait for a transition to happen. Rotmans, Kemp, and van Asselt (2001, 15) talked about “more evolution than revolution” in introducing transition management as a way to steer change. However, this thesis has pointed out that a revolution in stormwater management will be required in particular contexts (e.g., questioning the construction of a new underground retention basin in a specific area), in the sense of a fast and radical change (e.g., deciding not to build a new basin, but instead to implement a network of alternative actions). Taking advantage of each opportunity to question the ongoing practices is a step forward in recognising and diffusing alternative actions, in order to reach the technical and social innovation desperately needed by the stormwater management regime.

In this context, a better understanding of the role of researchers as agents of change who tackle real-world problems in collaboration with stakeholders in the transition process is required (Fazey et al. 2018). My active involvement in processes of change allowed unpacking the dynamics behind producing alternative actions. Moreover, I supported activities through assisting in the practical organisation and at the same time, I influenced the process by proposing methodologies and tools for interaction. With a background in architecture and urban design, educated to become an active actor in the transformation of the city, I used my capacities to synthesise and visually represent complex concepts (such as WsC) as practical tools. To what extent this involvement led to an actual change in the regime, it is too soon to tell. As systemic intermediaries (Kivimaa 2014), researchers could have an impact on the regime if the researchers succeed in maintaining a long-term involvement in the communities where they collaborate. In the current context of project-based research funding, the long-term commitment to specific action research seems difficult to achieve.

A particular role of the researcher is, however, the role of transmitting knowledge. As Solnit (2016) emphasised in her book “Hope in the dark. Untold stories. Wild possibilities”, change comes from the limits of the central stage and might rarely be considered as a valid alternative to the current practices carried out by the mainstream. Under certain conditions, the alternative becomes standard practice, but the transformation process will, unfortunately, be forgotten. However, we should also keep in mind that the power of change is also in the actors, spaces, and water flows that are usually marginalised. For this reason, the investigation of transition processes (like this thesis) contributes to change, by making sure we do not forget how and who triggered the movement.





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ARGB of 26 January 2017, *Arrêté du Gouvernement de la Région de Bruxelles-Capitale approuvant le Plan de Gestion de l'eau pour la période 2016-2021* (governmental order of the Brussels-Capital Region approving the Water Management Plan for the period 2016-2021).

ARGB of 26 April 2018, *Arrêté du Gouvernement de la Région de Bruxelles-Capitale modifiant divers arrêtés en matière tarifaire dans le secteur de l'eau* (governmental order of the Brussels-Capital Region modifying various previous orders regarding the pricing policy in the water sector).

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