Chapter 15

Stormwater management in transition in Brussels-Capital Region

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15.1 INTRODUCTION

Worldwide, urban areas are being challenged to improve the stormwater management regime (i.e. the totality of beliefs, rules and practices that guide water management activities). Illustrated as the Water Sensitive City (WsC) by Australian researchers, the envisioned new regime aims to solve water problems, to adapt to future uncertainties (e.g. increase of extreme events), to create a more habitable urban environment and to reflect the aspiration of the community related to water (Brown *et al*., 2009). Research indicates that a transition towards a new regime requires changes at different levels of society: a wider adoption of innovations at local level, a destabilisation of the current practices and an increase in external pressures forcing change (Schot & Geels, 2008).

Brussels-Capital Region (BCR), the capital of Belgium and of the European Union, is a representative case for the multilevel changes required to trigger a transition towards a WsC and for the key role stormwater management plays in this process. This chapter introduces four main characteristics of the stormwater

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management in the BCR that indicate an early stage of transition towards a WsC. Firstly, a change in perception of stormwater as a resource rather a nuisance is perceived in the modification of the water infrastructure and policies throughout time. Secondly, at present, water-related hazards, such as surface water pollution and urban flooding, together with environmental standards, are driving an urgent implementation of new actions in stormwater management. Thirdly, the fragmentation of responsibilities among state actors in the BCR's water sector often leads to failures in communication, but it sometimes enables new collaborations as well. Fourth and finally, in the BCR, civil society is particularly active in elaborating alternative actions by pressuring local and regional administrations to recognise them as relevant practices.

15.2 STORMWATER AS A SOURCE OF DAMAGE FOR THE URBAN ENVIRONMENT

In the middle of the 19th century, the rising rate of urbanisation increased the quantity of runoff. Stormwater, when combined with the Zenne River and its tributaries, became a constant nuisance in the urban environment. The Zenne watershed influenced in a large measure how rainwater infiltrates – favoured by sandy soils – and how it is drained easily on a flat topography. The eastern part of the BCR has a high declivity and a sandy soil, while the western part is relatively flat with a soil composed mostly of clay (Figure 15.1). Furthermore, the reduced space for the river due to urbanisation, and the lack of proper maintenance, led to several disastrous flooding events for the city (Deligne, 2003; Demey, 1990).

Inspired by similar initiatives in Paris and in London at the time, between 1867 and 1871, the Zenne River was covered in the central parts of the city with a large boulevard (Demey, 1990). It was not just the Zenne that received this type of treatment, but in parallel, or soon after, its tributaries were also covered. Covering the Zenne brought an important change in stormwater drainage. Underground pipes were placed alongside the culvert containing the river to capture stormwater and wastewater. This moment in the history of the BCR represented a change in the management of stormwater from a resource integrated in the urban environment to a source of damage at the same level as wastewater.

The model of a *tout-à-l'égout* (all to the sewer) infrastructure – to remove storm and wastewater as fast as possible in a combined underground sewer network – was well developed starting at the end of the 19th century in other large European cities, such as London and Paris. The underground sewer infrastructure was implemented in parallel with the water distribution network starting with 1850s (Yante, 2005). While the underground sewer system captures the excess of rainwater (runoff), the arrival of the water distribution network did not have an immediate impact on the use of rainwater as a resource for households. Rainwater harvesting was a common practice in the city for a much longer period. A study from the beginning of the 20th century reveals that up to 80% of the population were

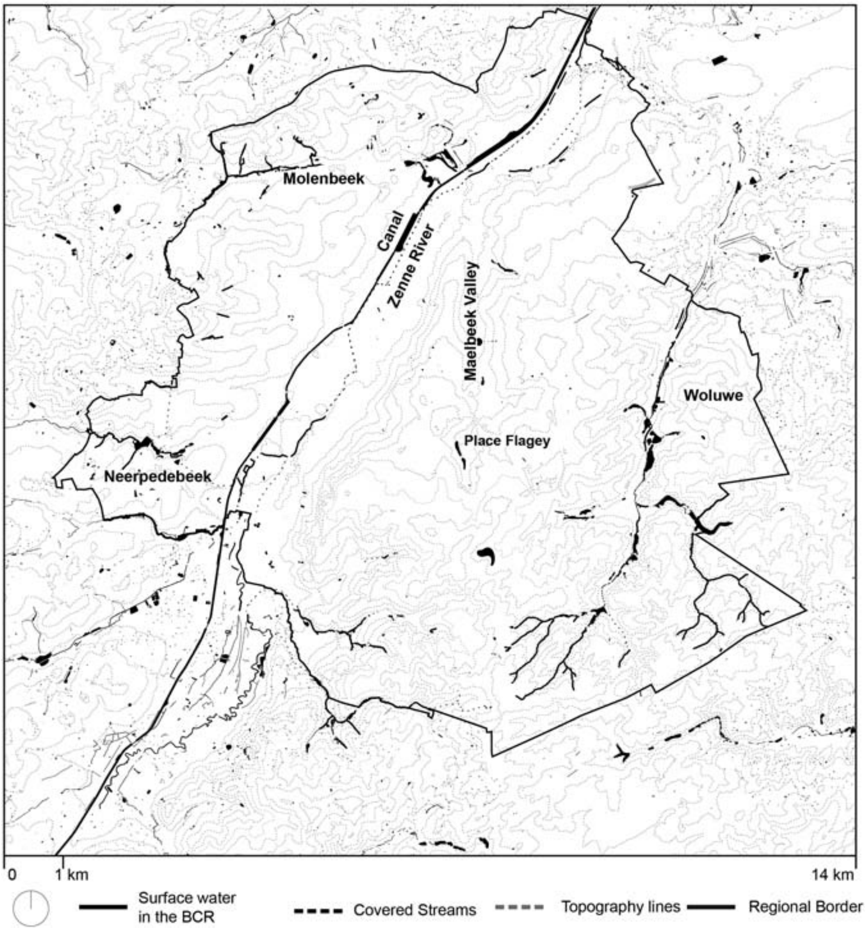

Figure 15.1 Map illustrating the urban streams and surface water part of the Zenne watershed located in the BCR. Map based on open source data from UrBIS BCR (topography, regional and municipal borders) and Bruxelles Environnement (watershed and hydrological network).

using rainwater tanks as an alternative to drinking water in the Brussels urban agglomeration and in the Flemish Region (Cornut, 1999).

Starting in the 1950s, the first signs of failure began to appear in the underground sewer system. The level of pollution in the Zenne River, the point of discharge of the runoff, became a cause of concern (Deligne, 2017). Moreover, between 1950 and 1978, four intense storm events are mentioned in a study carried out by the Ministre des Travaux Publics (1978). Among the mentioned causes were the expansion of impervious surfaces and the high quantity of runoff the sewer system needed to manage, together with an increase of wastewater, because of population growth. The study of the Ministre des Travaux Publics (1978) also points out a critical drop in quality of stormwater runoff as a result of industrial and urban activities. This study introduced the underground retention basin as an action to mitigate urban flooding by retaining stormwater during the pick of the storm and to release it in the sewer system afterword.

Urban flooding events and the pollution of the surface water network led to the laws of 1950 and 1967 that changed the ownership of surface water from private owners to the state administration to facilitate monitoring and dredging (Yante, 2005). The relatively slow implementation of surface water protection laws was due to the changes that occurred between the 1950s and 1990 in the administrative structure of Belgium. Together with the creation of the three regions – first Flanders and Wallonia, and later the BCR in 1989 – the administrative management of the water sector moved from the national to the regional level (Aubin & Varone, 2001). An important moment in the development of water institutions in the BCR also occurred in 1989. The creation of the *Institut Bruxellois pour la Gestion de l'Environnement* (IBGE) (Brussels's Institute for Environmental Management), today referred to as *Bruxelles Environnement* (BE) (Brussels Environmental Agency), followed the application of European Directives in environmental-related issues including surface water protection (Yante, 2005). Together with the creation of BE, reconsideration of actions to avoid surface water pollution began, such as the building of two treatment plants (Deligne, 2017). However, the actual implementation of actions took ten more years after the creation of BE (Aubin & Varone, 2001). Only in 2000, the BCR commission constructed a functioning wastewater treatment plant – South Station (approximately 20% of the wastewater) – and in 2007, the North Station completed the required capacity to treat all the wastewater in the region.

In parallel, the programme *Maillage Blue* (Blue network) initiated by BE started at the end of the 1990s, and since then, it has been included in all water and urban policies developed by the region. The programme aims to bring to daylight parts of the Zenne River and its tributaries and to ensure their flow by harvesting existing streams and springs. The connection of surface waterbodies has reduced the quantity of water the sewer system has to drain, and it has reduced the risk of flooding. Future water and urban policies influenced by the European Directive will integrate issues of surface water protection and public participation in close connection with stormwater management.

15.3 STORMWATER BOTH AS A RESOURCE AND AS A SOURCE OF DAMAGE IN WATER AND URBAN POLICIES

Influenced by the Earth summits on sustainable development (Rio de Janeiro in 1992 and New York in 1995), the European Water Framework Directive (WFD) came into force in October 2000, and it was designed to enhance the implementation of sustainable water management practices in the European Member States (Hering *et al*., 2010). As it was located in the Schelde river basin, the BCR was required to follow the WFD guidelines and to release a river management plan in collaboration with other regional administrations located in the watershed – the Flemish Region, the Walloon Region, France, Germany and the Netherlands.

In 2006, the BCR's regional government agreed on delivering a *Plan de gestion de l'eau* (PGE) (Regional water management plan) (Bruxelles Environnement, 2015). Before the first PGE was finalised, in 2008, the region released a plan specifically for stormwater management – *Plan Pluie* (Stormwater Plan). Besides identifying the main causes of flooding in the region, the plan established a series of actions to diminish the risk of flooding (Bruxelles Environnement, 2008). According to the budget, conventional actions, such as the construction of underground retention basins or the maintenance of the existing combined sewer network, were the priorities. However, the plan supported a decrease in impervious surfaces by placing additional limitations on the design and construction of streets and buildings.

Eventually, the BCR's regional government adopted the first PGE in 2012, and it remained in force until 2015. The main objectives of the BCR's first PGE included the reduction of pollutants in surface and ground water, the qualitative restoration of the surface water network, the prevention of pluvial flooding and the integration of water into the urban environment (Bruxelles Environnement, 2015). The first PGE followed the principles of the WFD, and it was designed to minimise the impact of urban activities on the water cycle, considering that damage created by urbanisation to the surface water in the BCR can no longer be reversed (Mahaut, 2009). Visible changes were made to the structure and to the choice of measures implemented in the second PGE (2016–2021) (Bruxelles Environnement, 2015). For the first time in the programme, alternative stormwater management actions are recognised as complementary to conventional actions. Thus, the two PGEs recognised the different impacts of stormwater in the urban environment both as a resource – put in place through alternative actions – and as a nuisance, continuing to be managed under the approach of *tout-à-l'égout* in conventional actions.

While water policies have focused particularly on stormwater in relation to surface water protection and urban flooding, the urban regulations developed in parallel were designed to reintegrate stormwater as a resource into the built environment.

In 2018, the objectives included in the BCR's second PGE had few effects on urban regulations. In the RRU (regional urban regulations), there are mandatory regulations on stormwater management that are meant to follow the PGE in terms of water infiltration and retention: green roofs are obligatory for projects with a footprint larger than 100 m^2, water tanks of 33 l for every square metre of the roof surface and the maintenance of 50% of permeable areas (Brussels-Capital Region, 2019). Moreover, the current proposal to modify the RRU introduces mandatory regulations about the management of stormwater at the level of the parcel for new construction as well as for the extension of existing buildings (Brussels-Capital Region, 2019). At the municipal level, the Forest-Vorst local council delivered the first example of a plan of protection against flooding in 2012, and adopted a new RCU (municipal regulation) at the beginning of 2015. The RCU released by the Forest-Vorst municipality follows the obligations of the RRU with a more detailed explanation of stormwater infiltration and retention before it reaches the sewer system (Forest-Vorst Municipality, 2015).

15.4 PRESENT WATER-RELATED HAZARDS

15.4.1 Sewer system overflows as the main source of surface water pollution

Despite the construction of the wastewater treatment plants in 2007, the water quality of the Zenne River still presents a challenge for the BCR. As the natural flow of the river is small in comparison with the quantity of treated water that it receives, the level of pollution in the river is dependent on the functioning of the sewer infrastructure, including the wastewater treatment plants (Brion *et al*., 2017).

A study carried out between 2009 and 2014 revealed how the pollution in the river is linked to the functioning of the sewer system (Brion *et al*., 2017). During periods of heavy precipitation, both water treatment plants switch to the rainwater-operating mode: they only perform primary treatment to ensure they can treat a large volume of water. Furthermore, if the level of precipitation is very high, the water treatment plants completely stop functioning. The sewer infrastructure has a backup system to avoid overcharging the water treatment plants. There are 45 points of overflow, where the sewer infrastructure is linked directly to the river within the BCR (Bruxelles Environnement, 2015). The frequency of these overflows can reach 100 episodes per year in one single place (Le *et al*., 2014).

15.4.2 Pluvial urban flooding

Overflow of the sewer system occurs not only into surface waters, but also into streets and household basements, creating the phenomenon of urban flooding. The drainage capacity of the underground sewer infrastructure is put to the test by the variable quantity of stormwater depending on the level of precipitation and the ability of the soil to infiltrate rainwater.

An analysis of the Royal Meteorological Institute on the precipitation level in the BCR between 1981 and 2010 revealed that most extreme storm events occur during the summer months (June, July and August), and that the annual precipitation averages 852.4 mm per square meter (relatively high for European cities, but similar to Amsterdam) (Tricot & Brouyaux, 2015). Nevertheless, scenarios for climate change in the region suggest possible changes in precipitation patterns:

during winter, many storms with large volumes of precipitation in short periods, and throughout summer, longer droughts that diminish the capacity of the soil to infiltrate rainwater (Tricot & Brouyaux, 2015). These studies indicate that soon, the combined sewer infrastructure of the city will need to drain more stormwater in shorter periods.

The quantity of stormwater to be drained also depends on the runoff, the excess of water that does not infiltrate into the soil. Research on the infiltration capacity of the soil in the BCR reveals that there are now fewer areas of the city that are not built up and that can allow infiltration (DeBondt & Claeys, 2010). Furthermore, research carried out in 1995 pointed out that 57% of the precipitation in the BCR area represents runoff (Verbanck, 1995). The results from 1995 are considerably different from the current situation, because the percentage of runoff increases with urbanisation, due to its larger impervious surfaces. In these conditions, the quantity of runoff the sewer system needs to manage increases exponentially.

Besides the level of precipitation and the quantity of runoff, there are other causes that exacerbate the risk of flooding, such as an aging sewer infrastructure, the disappearance of natural flooding areas and the fragmentation of the surface water network (Bruxelles Environnement, 2018).

15.4.3 Conventional actions to mitigate urban flooding

Developed in the 1970s, the underground retention basins are still the preferred action to mitigate urban flooding by the public administration. A study carried out by the Ministre des Travaux Publics (1978) pointed out the negative and positive aspects of implementing underground retention basins in the BCR. The high construction costs, problematic maintenance and technical difficulties in avoiding the formation of gas are critical points. The same problems of the underground retention basins are emphasised by more recent research. Mahaut (2009) considers them technical devices detached from urban reality. These devices are not easily accessible, they are larger than the human scale, they lack light and they do not follow the natural laws of gravity (they rely on electric pumps to empty them after the storm passes).

In parallel to conventional actions, alternatives have also been developed. Usually referred to in the French-speaking communities under the name of *mesures alternatives* (alternative actions) or *à la source* (at the source), they promote the infiltration, harvesting and use of stormwater as close to the place it falls as possible. Alternative actions, also known in Australia as water-sensitive urban design, use devices such as rainwater tanks, rainwater gardens or swales. Alternative actions are being developed in the region for new constructions or during the redesign of public parks. Referred to as a *Maillage Pluie* (Stormwater Network) by BE, these interventions remain punctual and are usually located in the low-density areas of the BCR.

15.5 FRAGMENTATION OF RESPONSIBILITIES BETWEEN REGIONAL, INTER-MUNICIPAL AND MUNICIPAL ADMINISTRATIVE LEVELS

The responsibilities in the water sector are highly fragmented between actors from the municipal, intermunicipal, regional and national level.

In relation to stormwater, non-profit organisations from the civil society intervene on the small scale in private spaces by using rainwater tanks or gutters to direct stormwater towards the street drains or sewer systems. The municipality manages the street drains, where the stormwater flows into the sewer network. Vivaqua oversees the small retention basins and the sewer network in which stormwater is harvested. The SBGE (Brussels's water management agency) manages underground retention basins larger than 5000 m^3, the main sewer collectors and the wastewater treatment plants. BE is responsible for the surface and ground water. All the actors managing the infrastructure are public entities at different levels of the administrative structure. SBGE and BE operate at the regional level, and they are directly linked to the regional government, while Vivaqua is an intermunicipal organisation.

The connection between the different levels of public administration is highly complex. The link between the regional and the municipal levels is made by each of the parliamentarians of the BCR, who also have a mandate at the municipal level (Delwit & Deschouwer, 2009). Intermunicipal organisations have similar types of structure. As an example, Vivaqua has an administrative board composed of municipal counsellors from each of the nineteen municipalities in the BCR and one mayor from a neighbouring municipality outside the region. At the municipal level, all the national, regional and language communities' legislation is coordinated. Representatives of municipal administration are crucial in the region, as they diminish the gap between the two levels of administration. Furthermore, the municipal administrative level has two main key values: proximity to the citizens, and operational efficiency in implementing trans-sectorial actions (Lagasse, 2012). However, the differences in total population, density of citizens are significant among the nineteen municipalities that compose the BCR (Delwit & Deschouwer, 2009). Thus, the capacity of each municipality to carry out all its functions is limited.

At the time of writing this chapter, no regulation stipulated which actors were in charge of stormwater management in the BCR (Bruxelles Environnement, 2018). The present complex structure of the BCR's public administration makes it almost impossible to identify one single actor in charge of stormwater management. Considering that stormwater is still mainly combined with wastewater in the sewer infrastructure, the lack of a separate responsibility for stormwater management does not come as a surprise. This should not be interpreted negatively. The lack of centralised coordination allowed the development of an integrated approach as opposed to the traditional sectorial approach in water management. The weaknesses of the fragmentation of responsibilities, such as inconsistency of the projects put in place, can be overpassed by a closer collaboration between actors. Moreover, with the integration of alternative actions in water policies and urban regulation, the fragmentation has allowed a wide range of actors to become involved, especially from civil society.

15.6 DYNAMISM OF THE CIVIL SOCIETY AS A LINK BETWEEN URBAN PLANNING AND STORMWATER MANAGEMENT

In parallel to the struggle to find the right balance among the state actors at the regional, intermunicipal and municipal level, civil society in the BCR has emerged as a means of counteracting the fragmentation and complexity of the institutional structure. To illustrate the impact of civil society in the water sector, a project in the public space, Place Flagey, is particularly illustrative.

Researchers consider the case of Place Flagey as a critical moment when urban planning met stormwater management in relation to the historical development of the Maelbeek Valley (the source of the Maelbeek River is currently entering the sewer system, but the valley is still visible in the topography of the territory and in the activities of the local associations) (Kohlbrenner, 2010) and to citizens' involvement in urban projects in the BCR (Houlstan-Hasaert, 2019).

In 1978, large flooding events were caused by sewer overflows in the nearby streets of Place Flagey (rue Gray) close to the centre of the BCR, towards the south-eastern part (Kohlbrenner, 2010). In the same year, a study carried out by the Ministre des Travaux Publics (1978) provided the first sets of actions to respond to the increase in flooding events: increase the discharge and storing capacity of the sewer system by the use of retention basins and to implement overflow systems so that the excess of water went directly into the surface water network. In the years to come, the local and regional municipalities often reflected upon the best approach to tackle the issue. A highway project in the Maelbeek Valley, together with the construction of a larger underground sewer system, was rejected and blocked by civil society, but a regional plan in 1991 to build a retention basin under the Ixelles ponds near the Place Flagey was better received by the inhabitants (Vantroyen, 1991). In 1996, the location of the retention basin was set to be under the Place Flagey, but the urban permit for construction was delivered only in October 2000 because of financial constraints at the regional level (Houlstan-Hasaert, 2019).

A collective composed of local inhabitants, Comité Flagey, considered the project as an outdated water management practice, without a clear understanding of its impacts on the neighbourhood's life (Comité Flagey, 2005). In response to the criticism of the project, the mayor of Ixelles mentioned in a newspaper article by Moyart (2002), after a storm event:

> This is quite catastrophic. The entire length of rue Gray was under 10 cm of water. (…) This is the first and true answer to those who say that the basin (the underground retention basin) is not useful.

Nevertheless, what was more important for the opposition was the way in which, on top of the retention basin, a new public square was going to be built. The administration considered an architectural call for projects a waste of time and money, and it proposed that the company assigned to build the retention basin should also design the public square. Inhabitants and NGOs expressed their anger towards the project, in part to the underground retention basin, but mostly to the lack of consultation on how the public square should be renovated.

> We had to accept the underground retention basin. We had to accept also the (underground) parking, the technical constraints (…) but why also the public square? (…) We had to propose alternatives while they (the regional and local administration) were proposing preposterous choices. (Comité Flagey, 2005, p. 24)

Urban activism in the BCR usually focused on opposing the view of the public administration. However, there was a perceived change in the case of Place Flagey, where the uptake of alternative actions evolved towards proposals for new solutions (Kohlbrenner, 2010). The collective Parcours Citoyen, active since 1997 in the Ixelles municipality, proposed public meetings to reflect upon alternatives to the underground retention basin (Houlstan-Hasaert, 2019). Furthermore, a new collective was created, Platforme Flagey, between neighbourhood committees, NGOs, a research centre and the nearby institute of architecture. The collective organised a call for projects that received intense public coverage and an impressive number of entries. The jury, composed of researchers, professionals, activists and inhabitants, analysed all of them and highlighted the important ideas that emerged for the future design of the square. During the proclamation of the jury, the head of the municipal council explained the struggles faced by the administration in relation to the project of the square:

> We were so busy with what was underneath (the retention basin) that we lost track of what was happening on the surface (public square Place Flagey). (Head of the municipal administration cited in Comité Flagey, 2005, p.27)

After this process, the regional administration took into account the conclusions of the jury, and it integrated them in a new international call for projects to select the architect to design the square (Houlstan-Hasaert, 2019). This process was also aimed at driving a change at the level of urban regulation, and at the same time repositioning architecture as a tool of interaction among various stakeholders, with particular attention given to citizen participation. Nevertheless, public participation in the urban revitalisation of Place Flagey ended there. Platforme Flagey transformed into a local point of information for the public without any ability to intervene in the selection of the architect (Kohlbrenner, 2010). The selected architects – Latz & Partner and D + A International, a collaboration between a German and a BCR-based landscape office – proposed a new design for the square that was built in four years and that was inaugurated in 2009 together with the underground retention basin (Figure 15.2).

For water management, the process in Place Flagey was a key point in starting to question whether underground retention basins are the most appropriate way to prevent flooding in the BCR. Inspired by the discussions surrounding the project in Place Flagey, for the first time in the BCR, a new concept *Nouvelles Rivières Urbaines* (NRU; new urban rivers) was developed, referring to alternative ways to manage stormwater on the surface to avoid flooding and to improve the urban environment (Mahaut, 2009).

Since 2009, the regional programme of constructing basins has continued, and in 2017, there were still six more basins to be implemented. Nevertheless, the case of Place Flagey received more attention than the construction of any other retention basin in the region. One of the impacts of this case was the increased involvement of the civil society in stormwater management. A new NGO, *Etats Généraux de l'Eau à Bruxelles* (EGEB), was formed in 2012 to reduce the gap between regional/local administration and inhabitants of water-related issues (Nalpas, 2011). Furthermore, what was particularly interesting and innovative for the BCR is that it was no longer possible to separate water infrastructure from the urban environment, even if it was constructed underground. More than that, the combination of water management and the redesign of public spaces opened up to new alternatives that moved the discussion from the table of engineers to the public, where multiple actors interact and have a specific expertise to share.

Figure 15.2 View of the Place Flagey in 2018 after the reorganisation of the square and the nearby lakes Ixelles. Underneath the square is located the retention basin partially used as a parking space. Photo credits: Costin Gheorghe.

Figure 15.3 Photo taken during a workshop organised during the *Ilot d'eau* design initiative. Photo credits: Meredith Dobbie.

The case of Place Flagey was just the start of several initiatives carried out by the civil society. As an example, in collaboration with the urban design office Latitude Platform and EGEB, in 2015, started in the *Forest-Vorst* municipality (southern part of the BCR) the *Ilot d'eau* design initiative funded by regional and municipal administration to facilitate public participation. The name *Ilot d'eau* (water building block) refers to the idea of a decentralised water system (*ilot* – translation in English – island) and to the traditional urban morphological unit closed by three or four streets (*ilot* – translation in English – building block).

The initiative was located in Saint-Denis neighbourhood the lower area of the municipality. The constant urban flooding events on the streets and basement (due to the overflow of the sewer system or the rise of groundwater) determined the creation in 1997 of the neighbourhood committee Stop Inondations. In this context, 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 with the support of Stop Inondation (Figure 15.3). The practical results of the initiative – the construction of a common rainwater tank between two households and the creation of new green spaces at the limit between the facades and the public space – indicated the capacity of private spaces to contribute to an alternative management of stormwater. However, the struggles of realising the projects proposed by the inhabitants revealed the low capacity of the municipality to coordinate water-related project and the lack of economic incentives to implement common projects in private spaces (Dobre *et al.*, 2019).

15.7 LOOKING TOWARDS THE FUTURE

In the BCR, alternative actions are still far from being the dominant practice in the stormwater management regime. However, signs of transition towards managing stormwater as a resource on the surface, integrating of the community's values in relation to water and adapting to future uncertainties are already visible. At the local level, various local projects involving citizens have emerged. At the municipal level, diverse actors from civil society supported by urban design offices and academia have created an important momentum to facilitate the uptake of alternative actions in the stormwater management regime. Moreover, at the regional level, public actors, such as BE, and urban regulations for private spaces have opened up windows of opportunities.

As the two case studies illustrated, changes, seen as signs of transition, are temporal and localised. As previous research already indicated changes emerge randomly in specific contexts, rather than in a coordinated way for a compact transformation of the territory (Smith *et al*., 2005). However, this does not mean that the changes do not influence one another. Actors, such as EGEB ensured the diffusion of new knowledge from the case Place Flagey to the *Ilot d'eau* design initiative. Questions remain about how both civil society and regime actors can collaborate to provide positive examples of how alternative actions can work in practice. Further research could look at their interaction in creating conditions favouring change in the way stormwater is managed in the BCR.

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