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Abundant water, abundant knowledge: Cognitive patterns for policy changes in Brussels' water management system

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Abstract

Knowledge plays an essential key role in the policymaking process for interpreting the available information, defining policy issues at stake and evaluating possible solutions – especially in complex policy issues like water management. However, for city-regions, knowledge is often a scarce resource due to the small size of the policy community, context-specific issues, limited availability of resources and experts, as well as the challenge of addressing complex issues that are often supra-local. This paper explores which patterns of local knowledge promote policy change and learning. Starting from the 'policy paradigm' concept, a cognitive–evolutionary approach is applied to analyse Brussels' water management policy, which aims to address the major challenge of flooding. The variety of knowledge by local actors, the role of the policy paradigm of the local policymaking community in vetting information and evaluating alternative solutions, and the importance of local governments for retaining knowledge, are the main dimensions to understanding policy change and learning. City-regions benefit from direct contacts between actors facilitating exchange of knowledge, while supra-local decisions (e.g. EU directives) and local accidents can also trigger major changes. Based on my findings, policymakers tend to rely on technocratic patterns using already available knowledge, mainly whether decentralisation reshapes the policymaking community. While a technocratic pattern determines only minor changes and institutional instability undermines policy learning, policy entrepreneurs and participative patterns can promote major changes and learning if they are able to engage in dialogue with the dominant policy paradigm.

Keywords

Policy change and learning, knowledge, policy paradigm, Brussels, water, decentralisation, policymaking, city-region

Introduction

In policymaking, knowledge plays an important role in understanding the available information, defining policy issues at stake, and scanning and evaluating potential solutions (Capano, 2009; Radaelli, 1995). Following this definition, knowledge shapes stakeholder perceptions and influences their preferences

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for particular solutions, but it does not act in isolation. It interacts with other dimensions such as political consensus, financial resources, legal competence and ownership of key assets (Dente, 2014). While the relationship between knowledge and policymaking is already complex (Hoppe, 2005), for city-regions knowledge is an even more scarce resource: at the local level, policymakers can meet frequently facilitating information exchanges, while the small scale undermines the possibilities for developing a research agenda for addressing context-specific challenges. Despite their limited resources, city-regions have to deal with complex policy issues, such as water management, which cover a broad spectrum of concerns: technical infrastructures, socio-economic issues and ecological impacts.

The large body of literature on urban water management, developed since the 1980s, emphasises the importance of 'social learning', i.e. sharing knowledge across stakeholders to achieve sustainability (Armitage, 2007; Jordan, 2008; Pahl-Wostl et al., 2007; Van Kerkhoff, 2013). In policy studies, the notion of 'policy paradigm' (Hall, 1993) was proposed to explain how knowledge shapes policy change and learning: new knowledge that is too close to the dominant paradigm can evoke only minor improvements; knowledge that is too far from the dominant paradigm and questions its fundamental values and beliefs is likely to be rejected (Capano, 2003, 2009; Capano and Howlett, 2009; Hall, 2013; Kay, 2009; Zohlnhöfer, 2009). Yet, this literature pays limited attention to geographical scales, and their influence on the size of the policymaking community, the availability of resources and experts and the influence of supra-local factors.

The objective of this paper is to introduce a city-region perspective on the role of knowledge for policymaking. For this purpose, the cognitive–evolutionary approach proposed by, among others, Tilman Slembeck (1997), is re-interpreted to explain how new knowledge can trigger policy change (see also John, 2003; Witt, 2003; Wohlgemuth, 2002). In the case of policymaking at the level of city-regions, variation is structurally limited, due to the relatively small size and limited resources for developing a context-specific research agenda, to the small policymaking communities, which engage in direct and regular face-to-face contact; and to the risk of policy lock-in (Entzinger and Scholten, 2015; Hassink, 2005; Pahl-Wostl, 2009). While policymakers have limited resources to scan and acquire new knowledge to develop their policy paradigm (Pohl, 2008), preservation through policy learning relies on a few members who monopolise the discourse, thus creating potential bottlenecks (Maybin, 2015). Furthermore, the city-region perspective introduces two more elements on dynamics of policy change: the influence of external factors and local accidents. First, upper tiers of government can introduce new laws pushing city-regions to change their policy and reshape the local institutional framework (Cettner et al., 2014). Second, accidents can open 'windows of opportunity' (Kingdon, 1984), and at the local level even small events can trigger policy change (see also Marsden et al., 2011).

Based on this cognitive–evolutionary approach, an innovative taxonomy of patterns of knowledge for policy change is proposed and discussed in the case of the Brussels water policy. In this case study, the main policy changes since the creation of the Brussels-Capital Region in 1989 are discussed to show how a city-region has managed new EU Directives imposed to increase water policy standards, has coped with recurrent flooding, and with limits imposed by administrative boundaries smaller than the river basin. When policymakers have followed a technocratic pattern relying on knowledge already available within their community, only minor and incremental changes are possible. Contrarily, policy entrepreneurs and civil society participation can provide new sources of knowledge with a higher potential for policy change, though these patterns might not succeed. The relationship between external sources of knowledge and the dominant policy paradigm is the key to understanding when knowledge can trigger policy change, in interactions with political dynamics and other contextual factors.

The paper is structured as follows. The literature review in the next section provides a theoretical framework on urban water governance and policy change. In the third section, patterns of knowledge for policy change are defined, based on evolutionary policymaking theory. The Brussels case study is presented in the fourth section, providing some

background information and then identifying four policy phases. Finally, the fifth section summarises the lessons learnt and conclusions.

Policy change and learning: The role of knowledge

Knowledge–policy dynamics are commonly associated with the idea of 'speaking truth to power' (Wildavsky, 1979): researchers, academics and experts 'know' what to do, and thus politicians and decision makers should listen to their advice when deciding on policies. However, this very simplistic, linear and normative idea is challenged by a large body of evidence that asserts that knowledge–policy dynamics are much more complex and non-linear, and involve multiple actors as well as different types of knowledge (Dunlop and Radaelli, 2013; Entzinger and Scholten, 2015; Radaelli, 1995).

In the case of governance of common resources like water, knowledge plays a major role. Complex systems require advanced understanding, and socio-economic systems such as city-regions have to learn how to interact with ecological systems (Armitage, 2007; Pahl-Wostl, 2009). Identifying cognitive patterns that promote policy changes that foster sustainable development poses a considerable challenge (Geels, 2004; Jordan, 2008; Smith et al., 2005). These so-called 'complex adaptive systems' (Armitage et al., 2008) are defined as a 'long-term management structure that permits stakeholders to share management responsibility within a specific system of natural resources, and to learn from their actions' (Ruitenbeek and Cartier, 2001: 8). The collective process of integrating knowledge from different sources and for the benefit of different stakeholders is defined as 'social learning' (Armitage et al., 2008; Garmendia and Stagl, 2010; Kallis, 2010; Pahl-Wostl et al., 2007; Tippett et al., 2005; Van de Meene et al., 2011). The water management literature defines social learning through three progressive loops.

> In single-loop learning actors question if they do things right. In double-loop learning they start to reflect if they do the right things. In triple-loop learning they call into question if rightness [is] buttressed by mightiness and/or mightiness [is] buttressed by rightness (Pahl-Wostl, 2009: 359).

The notion of the three loops in the water management literature fits into the broader debate on policy change and learning (Capano and Howlett, 2009), although one finds surprisingly few, scarce, connections between water management and policy studies. A seminal paper by Peter A Hall (1993) defines policy change through three progressive orders that are very similar to the three loops of social learning. The first-order change is an ordinary adjustment based on short-term experiences. The second-order change is a modification of policy instruments 'without radically altering the hierarchy of goals behind policy' (Hall, 1993: 282). The third-order change is the most complex case of 'policy paradigm shift', where the policy goals also change radically. The third-order change is based on an analogy with Kuhn's idea of a scientific paradigm shift (Kuhn, 1962): it is rare and often unpredictable, and the dominant paradigm tends to be selective, to exclude non-compatible approaches and to allow only minor variations (first- and sometimes second-order changes). A policy paradigm is developed through policy learning that is a collective process of learning from past experiences and development of shared values and beliefs (see also Hall, 2013).

According to Hall, first- and second-order policy changes usually happen due to dissatisfaction with past policies or from new knowledge acquired by the policymaking community: new information can provide a new definition of policy issues or new tools to be used, triggering policy change (Capano, 2009; Capano and Howlett, 2009). All of this knowledge is accumulated through policy learning (Dunlop and Radaelli, 2013; Hartlapp, 2009). For instance, a first-order change regularly happens with routinely adjustments of governments' annual budgets; second-order changes are more rare and the EU multi-annual programming periods are good examples (Bachtler et al., 2013; Hoekman et al., 2012; Kengyel, 2016). While new knowledge can be acquired through internal learning, exogenous imposition or change of policymaker, the dominant policy paradigm plays a crucial role, functioning as a filter for new perceptions, different understanding and

acceptance of alternative ideas. Nevertheless, policies can also change due to other factors such as competition between policymakers, imitation across policymaking communities, political conflicts, institutional changes, crisis and accidents (Barzelay and Gallego, 2006; Capano, 2003, 2009; Kay, 2009; Krause, 2010). Focusing on cognitive factors,

> Knowledge utilization studies also showed a fairly large number of cases of the tactical or selective use of research as a political weapon legitimizing an already advocated political position (Hoppe, 2005: 203).

Accordingly, knowledge about policy change is not neutral because its use depends on policymakers; thus, several different mechanisms were identified in the scientific literature to describe when and how knowledge is used for policy change (Armitage et al., 2008; Hoppe, 2005). These were: 'knowledge on-demand', i.e. explicitly produced for policymakers as consultancy; knowledge produced for other purposes and then shared by researchers with policymakers; and general theoretical knowledge produced by researchers and then applied by other intermediaries for policy purposes (Lyall et al., 2004; Rogers and Jordan, 2011). Pohl (2008) distinguishes between the two extremes: re-organisation of existing knowledge and co-production by researchers and policymakers. The former refers to the case of translation, adaptation and use of already available knowledge for policy purposes, such as when researchers, academics or experts are called upon to provide advice on already defined policy questions; the latter refers to policy-oriented research programmes funded by policymakers and carried out together with researchers, academics or experts. Furthermore, knowledge can also be used for 'the substantiation of pre-existing political preferences' (Caponio et al., 2015), whereby a political actor uses knowledge to reinforce its legitimacy vis-à-vis competitors without substantial learning (see also Entzinger and Scholten, 2015).

In order to understand how knowledge contributes to policy change, the role of the dominant policy paradigm is fundamental. It shapes perception and comprehension of policymakers; it frames their capacity to consider and evaluate alternative solutions, and influences their learning capacities to acquire additional knowledge. A dominant policy paradigm is often the main explanation behind policy inertia, especially when the local policymaking community is small with few external connections (Cettner et al., 2014; Jeffrey and Seaton, 2004; Walker, 2000). The imposition of policies from an upper tier of government can be seen as a potential remedy to this lock-in effect (Busch and Jörgens, 2005; McCann, 2011), but the interaction with the local policy paradigm could prove to be problematic. In this perspective, a recent strand of the literature has identified the emerging role played by 'boundary organisations' (Caponio et al., 2015; Hoppe, 2005) in shaping the knowledge–policy nexus (see also Meyer, 2010). All of these elements of knowledge for policymaking open the meta-challenge of 'knowledge governance' (Gerritsen et al., 2013; Lebel et al., 2006; Van Kerkhoff, 2013; Van Kerkhoff and Lebel, 2006), i.e. how to manage knowledge to achieve social learning for policymaking:

> Most of them agree that social learning can be considered as a way of shifting dominant ideas and belief systems that drive policymaking…. Learning is here more than information acquisition; it is rather the development or change of the mental models of the world (Garmendia and Stagl, 2010: 1713).

Patterns of knowledge for policy change and learning: The case of city-regions

The discussion on policy change and policy learning was developed mainly at the national and supranational levels (i.e. the EU), with little attention paid to scaling down at the level of city-regions. In order to develop an urban and regional perspective, I propose to apply the cognitive–evolutionary approach (Slembeck, 1997) to the dynamics of knowledge for policymaking, since it combines the already discussed notion of policy paradigms with sources of knowledge and interactions among policymakers. While the cognitive–evolutionary approach is theoretically built on Hall's contributions (see also John, 2003), the exercise of scaling down assuming a urban and regional perspective is definitely new, at least to the best of my knowledge.

For this purpose, the categories used by the 'evolutionary economic geography' to explain the role of proximity for innovation in economic terms (Boschma, 2005) will be extended to the case of knowledge for policymaking.

According to the 'cognitive' part of Slembeck's framework (Slembeck, 1997), the starting point is the individual's capacity to perceive a problem through the elaboration of information based on personal preferences and beliefs, and to thereafter propose alternative solutions. Once an individual perceives a problem, collective mobilisation is necessary to achieve a shared understanding, thus the individual's perception is transformed into a political issue. This process of collective re-interpretation is the engine of policy change. Yet, the dominant policy paradigm shapes the policymakers' perceptions and interpretations, strongly influencing the potential pathways for policy change, while policy learning is the way to keep the memory of past experiences, potentially reinforcing the dominant policy paradigm, since only 'understood' lessons are retained. Referring to the previous section, water management is clearly challenging: mobilisation of policymakers is needed at an early stage before flooding, when perception of policy problems is difficult; otherwise it would risk being too late.

In the 'evolutionary' part of this framework, three mechanisms are fundamental: variation, selection/competition and preservation of knowledge (Uyarra, 2010; Van den Bergh, 2007; Witt, 2003; Wohlgemuth, 2002). In the case of policymaking at the level of city-regions, variation is the availability of different ways of perceiving problems and the various solutions for addressing them. Selection implies the collective capacity to understand emerging political issues and to choose between alternative solutions. Preservation is the capacity of the policymaking community to learn from emerging knowledge. At the level of city-regions, variation is structurally limited due to their relative small size in comparison to a supra-local scale; selection is made by small policymaking communities with direct and recurring face-to-face contacts as well as a significant risk of lock-in; and preservation of knowledge through policy learning can rely on a few members who become kinds of monopolists, with potential bottlenecks. While city-regions have few actors able to provide new knowledge (limited variety), the change of a few members of the local policymaking community can reduce the risk of lock-in as well as wasting context-specific knowledge for policymaking.

The focus of this cognitive–evolutionary approach is on the relationship between the policymaking community and the dominant paradigm (Witt, 2003). Clearly, any paradigm has limitations determining discontent with the way it is (un-)able to deal with certain issues: it can present ambiguities that open up space for the emergence of new ideas and potential conflicts. Nevertheless, 'Selection can only "capture" variations that exist' and 'Agents explore only a minor range or subset of the opportunity space, which is reflected by the notion of bounded rationality' (Van den Bergh, 2007: 538). Therefore, policymakers can demand knowledge to reinforce their position against competitors, but under specific conditions, such as local availability (variety) and intelligibility (selection based on already available knowledge, i.e. their dominant paradigm). Policy entrepreneurs and collective mobilisations, aimed at bringing new knowledge into the policymaking community to spur policy change, have to consider the political dynamics as well as the interaction between the new knowledge and the dominant policy paradigm.

In order to identify how knowledge can trigger policy change, the proximity between new knowledge and dominant paradigm is the key element. For this purpose, categories used by the evolutionary economic geography to explain economic innovation (Boschma, 2005) provide useful elements to be adapted. New knowledge that is too close to the dominant paradigm can stimulate only minor incremental changes (first-order change). New knowledge that pushes for a comprehensive redefinition of perceptions, values and beliefs (third-order change) will likely be rejected by the dominant policy paradigm as being too radical. Knowledge in-between the two extremes will likely promote second-order change, provided that it can penetrate into the policy community (see the notion of 'related variety' in Boschma and Iammarino (2007)). The resulting framework is an inverted-U relationship where knowledge that is neither too close nor too far from

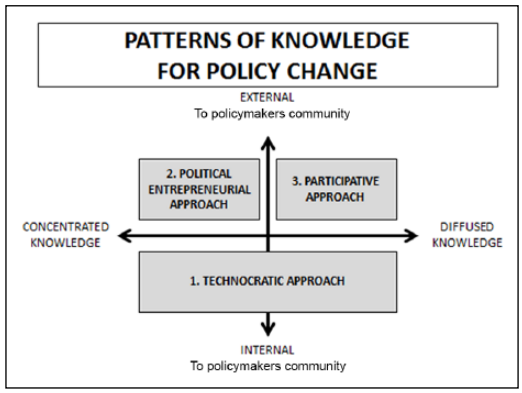

Figure 1. Patterns of knowledge for policy change.

the dominant policy paradigm has a high potential for triggering the most relevant policy changes.

Introducing the city-region perspective, contextual and exogenous factors become very relevant, further challenging the limited variety of local knowledge for context-specific issues, and the capacity by the local policymaking community to scan and select new knowledge and to preserve this learning from new sources. For instance, city-regions are subject to upper tiers of government (e.g. national government), and this have both positive and negative influences, with explicit or unintended effects. Furthermore, the role of local accidents is also more relevant: small events that would not affect national policymakers can have major effects on city-regions. Both supra-local policy interventions and local accidents can open 'windows of opportunities' for policy change (Kingdon, 1984). Although all these elements have already been discussed in the literature, assuming a city-region perspective, the distinction between local and extra-local factors makes clear that policy can change due to exogenous variables or endogenous dynamics associated with policy learning.

Based on this framework, a new taxonomy with three different patterns of knowledge for promoting change in policymaking is proposed, based on two dimensions: knowledge internal or external to the policymaking community (i.e. actors sharing or not sharing the dominant policy paradigm), and knowledge concentrated or diffused across actors (see Figure 1).

In the technocratic pattern, new knowledge emerges from within the policymaking community. Internal circulation of knowledge is easier thanks to direct contacts among policymakers in the same city-region, but information will very likely follow the dominant policy paradigm. This limits the possibility of policy change to the first order because the dominant paradigm heavily shapes how new knowledge emerges and how alternative solutions are developed and evaluated. While variety is very limited, selection is much faster, since this knowledge already belongs to policymakers. In this pattern, the distinction between concentration and diffusion of knowledge has limited importance since new knowledge is already within the policymaking community, which tends to be small in city-regions, yet it might be relevant when scaling-up at the national and European level.

The second pattern is the policy entrepreneur, who pushes for policy change based on her knowledge, her resources and her capacity to mobilise a collective understanding in favour of her alternative solution (Huitema and Meijerink, 2010; Witt, 2003). This second pattern is potentially much more innovative but has to pass the filter of the dominant paradigm since it comes from a source that is external to the policymaking community. The policy entrepreneur can be very efficient due to limited coordination and activation costs; however, it relies on the capacities and resources of the entrepreneur to interact with the policymaking community and her dominant paradigm. This pattern has a strong potential for policy change (i.e. second- and even third-order change), yet limited resources weaken the possibilities for success. Finally, in city-regions the availability of policy entrepreneurs risks being limited due to a lack of critical mass in terms of the number of experts on complex and context-specific issues like water management.

Finally, the participative pattern has a broader potential that is inversely proportional to collective action costs (Olson, 1965). Similarly to the policy entrepreneur, a participative pattern can provide new knowledge with a major potential for innovation (second- and third-order changes). However, a participative pattern has more resources than an individual entrepreneur, but it requires higher costs of collective

mobilisation, political leadership and a capacity to interact with the policymaking community.

In the case of city-regions and complex issues like water management, technocratic approaches often rely on inputs from a small policy community with a limited capacity to develop a specific research agenda able to provide new knowledge for the understanding of emerging issues and the elaboration of new alternatives. While knowledge that is already available can be easily 'demanded' even from external experts, the co-production of context-specific knowledge is much more difficult. On the other hand, policy entrepreneurs do not emerge often, but can be potentially more effective due to their proximity with the policy community; meanwhile, participative approaches can be facilitated by the local scale reducing coordination costs. The last two patterns can provide knowledge that potentially triggers policy change endogenous to city-regions. Due to the limited size of city-regions, the variation of cognitive patterns is limited, and policy change is likely to follow mainly technocratic patterns. While direct and recurrent contacts facilitate an exchange of information, the possibility to scan for alternative solutions and the capacity to develop a context-specific research agenda are limited. Finally, the preservation of policy knowledge relies on a small and cohesive policymaking community, where a change in a few members can avoid lock-in as well as undermine long-term policy learning. These patterns will be explored in the empirical case of water management policy in the Brussels city-region.

The case of Brussels

Context and methodology

The Brussels-Capital Region (BCR) is a fully urbanised area of 160 km^2, encompassing 19 municipalities with a population of about 1.2 million in 2015. The BCR is an enclave within Flanders, while the metropolitan area of Brussels is bigger than the BCR and includes parts of Flanders and Wallonia as well (although its formal definition is still debated) (Annoni and Dijkstra, 2013; De Maesschalck et al., 2015; Dotti et al., 2014; Hubert et al., 2013). For the purpose of our analysis, the focus is limited to the BCR, which is the regional authority in charge of water policy since its creation in 1989. Similarly to other city-regions, Brussels is a heavy consumer of water and a heavy polluter, and the BCR's boundaries are much smaller than the water basin.

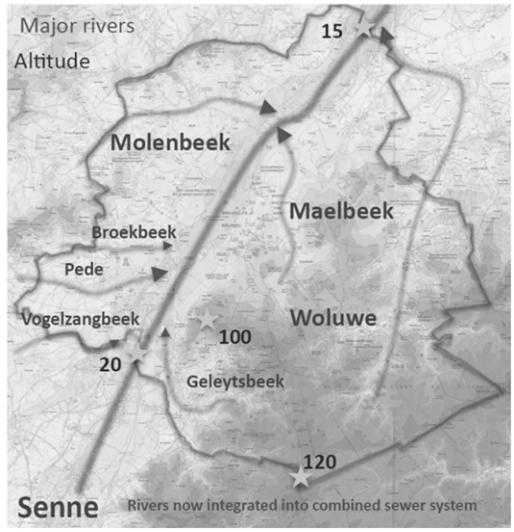

Figure 2. Hydrogeological map of the Brussels-Capital Region (Source: De Bondt and Claeys, 2011). The figure shows the rivers that are now integrated into the combined sewer system; numbers refer to altitude of starred locations.

From a hydrogeological point of view (see Figure 2), the city of Brussels originated in the valley of the Zenne River (or Senne in French), which flows from south to north about 100 km towards the basin of the Scheldt River through the Dyle River, and then the Rupel River. Historically, Brussels has always faced flooding: the name 'Brussels' has uncertain origins, but it is surely related to the ancient word 'broek-' meaning marsh, swamp or wetland. The numerous efforts to canalise the Zenne River culminated in the creation of a 'canal' in the 19th century, providing a waterway to Charleroi and Antwerp.

The current boundaries of the BCR include several valleys of small tributaries of the Zenne River. Among the tributaries, the Woluve River in the east of the BCR is the most important one; and there are many other minor tributaries such as the Molenbeek,

the Geleytsbeek and the Maelbeek, which shape Brussels' morphology (Claeys and De Bondt, 2008; De Bondt and Claeys, 2011). These small tributaries of the Zenne River are called 'beek' (meaning 'stream' in an ancient Brussels' dialect) and are important because since the 19th century they have been serving as collectors of wastewater. In the early 20th century these streams were covered for health and hygiene reasons. Today, these wastewater collectors are undersized for the large city-region of Brussels. Rainwater flows towards the bottom of these valleys into streams already saturated with urban wastewater, resulting in increased flood risks.

From an institutional point of view, managing the water supply has been a competence of the Belgian municipalities since the Napoleonic period. In 1889, the Brussels municipalities set up a public company (CIBE/BIWM,[1] and today called Vivaqua). At the present time, Vivaqua is owned by 38 municipalities: 19 from the BCR and the rest from the surrounding areas across Flanders and Wallonia. The 19 municipalities of the BCR have created Hydrobru, which serves as their interface with Vivaqua. Looking at water management policy, the Belgian state adopted two main bodies of legislation in 1974[2] and in 1976,[3] both dealing with water for civil and industrial use. In 1984, the Belgian state adopted the first Zenne River Plan, which is the first policy document introducing environmental protection measures in water management, in line with increasing environmental concerns in Europe. In 1989, Belgium went through a major process of regionalisation, during which the BCR was created. After 1989, water competences were transferred to the BCR, but it took one decade before the establishment of the Brussels institute for environmental management, commonly called Brussels Environment (IBGE/BIM).[4] The policymaking community is completed with the Port of Brussels (a regional authority in charge of the canal), and the regional water management company (SBGE/BMWB),[5] mainly in charge of storm water basins. The BCR is directly involved in the international basin authority for the Scheldt River together with the other two Belgian regions, as well as French and Dutch partners.

The research methodology relied on existing document research of policy documents and reports, supplemented by 18 in-depth, semi-structured interviews with policymakers, researchers and other stakeholders (conducted May–July 2014). The starting point is the regional Water Management Plan (WMP) adopted by the BCR on 12 July 2012, which includes a list of the main actors involved in the Brussels water sector. The list of interviewees was further vetted with key stakeholders, who also provided background materials such as unpublished reports, studies and official documents. The results were validated though expert consultations and participation in local workshops on water in Brussels (Dente, 2014; Peters, 2015).

Phase 1 (1989–2000): Towards a BCR water policy driven by Europe

After the creation of the BCR in 1989, the first relevant step was the EU Urban Waste Water Directive (1991/271/EEC), adopted in 1991. This Directive assigns the BCR with the clean-up of urban wastewater within its boundaries by 1998. This exogenous constraint led to two policy changes. First, the BCR initiated an upgrade of the water infrastructure with two new water treatment plants, major works to adapt the sewer network and a new system of storm water basins. Second, the BCR had to find an agreement with the Flanders Region on the management of interregional flows.

Progress along the first policy change was particularly slow, and the 1998 deadline was not met. Vivaqua completed the first water treatment plant (Brussels-South), with a processing capacity of about one-third of urban wastewater, only in 2000. The second plant (Brussels-North) came into operation in 2007 and only thanks to a public–private partnership with Aquiris (the Belgian branch of Veolia, a French corporation specialising in public utilities). The Brussels-North station is more advanced and larger, requiring major works for both construction and connection to the sewer network. Meanwhile, the BCR created the SBGE/BMWB for the construction of a system of storm water basins, to deal with the intense water flows from heavy rain, which are quite common in Brussels. Accordingly, Vivaqua also started major works to upgrade the sewer network. The aim behind the new water infrastructure is

to dramatically reduce the environmental impacts by processing all urban wastewater before it flows into the Zenne River.

This first policy change was determined by an exogenous constraint and follows a technocratic pattern driven by Vivaqua, which is the main (probably, the only) policymaker having any knowledge of Brussels' water system at that time. As a newly established body, the BCR's administration was not fully functional, with only a few offices in operation (i.e. Brussels Environment and the SBGE/BMWB will come later). In order to meet the requirements and deadline imposed by the 1991 EU Directive, Brussels policymakers had to rely on Vivaqua extending its mission from water supply (pipeline and sewer) to also include treatment of wastewater (Brussels-South) and supervision of Brussels-North. Under pressure from the major delay, Brussels policymakers made only incremental changes (first-order) adapting the already available knowledge of Vivaqua. The creation of the SBGE/BMWB for the storm water basin system and the involvement of Aquiris in the Brussels-North station were ways of reinforcing the approach proposed and developed by Vivaqua to address the mounting delay in implementation of the Directive (almost 10 years). The main reason for this decision was the instability of the recently regionalised policymaking community. In summary, the policymaking community relied on knowledge proposed by and concentrated in the main actor (Vivaqua) in response to an exogenous shock (the 1991 EU Directive), since they had no time and no resources to learn new knowledge, due to unstable institutional conditions.

The second policy change refers to the regulation of interregional water flows, with two critical areas: the Woluve Valley in eastern Brussels and Flemish municipalities in northern Brussels. The Woluve River flows mainly within the BCR but empties into the Zenne River in Flanders. Politically, it is unacceptable to clean Brussels' wastewater in Flanders, although this would be technically the easiest solution. Since each region has to clean wastewater within its own boundaries, the BCR decided to build a complicated sewer network to bring wastewater from the Woluve Valley towards the Brussels-North station, which partially explains its construction delays. In northern Brussels, the situation is symmetric because water flows from Flemish municipalities into the BCR. For this second area, the two regions found an agreement quantifying the amount of Flemish wastewater to be cleaned by the BCR based on the 10-year old Zenne River Plan (adopted in 1984). This agreement was also necessary for determining the required capacity of the Brussels-North station.

For the second policy change, the pattern is again technocratic. Policymakers rely on already available knowledge as codified in the Zenne River Plan, while the adaptation for the Woluve River is related to the first policy change, thus reducing the complexity of interregional negotiations. The Zenne River Plan is also seen as a guarantee because it was conceived with the support of hydrology departments from universities on both sides: a Flemish Dutch-speaking university (Katholieke Universiteit Leuven – KUL) and a Brussels French-speaking university (Université Libre de Bruxelles – ULB). The involvement of universities from both regions and both linguistic communities is seen as a necessary political guarantee, mixing political arguments (regional and linguistic interests) with scientific ones. Furthermore, the plan is 10 years old, well-known by all policymakers and seen as being beyond the newly established regional interests. This is an example of instrumental use of knowledge to deal with conflicting regional interests. In the 1980s this co-production of knowledge was a way of acquiring new knowledge while overcoming potential political conflicts; in the 1990s this knowledge is not even updated and used instrumentally only for political reasons. In summary, this second policy change reflects a technocratic pattern as this knowledge was already available and shared across the two regional policymaking communities, though there is no acquisition of new knowledge.

The two policy changes, introducing new water infrastructures (treatment plants, storm water basins and sewers) and managing interregional water flows, rely on and further develop a 'hydrological' policy paradigm. The fundamental idea of this policy paradigm is to manage the entire water cycle through infrastructure: from water catchment and supply to the new water treatment plants, the storm water

basins to store water in the case of heavy rains, and upgraded sewers overcoming limitations determined by the use of streams as main collector channels. In Brussels, this paradigm was proposed and developed mainly by Vivaqua, with the scientific support of the ULB Hydrology Department (co-author of the Zenne River Plan in the 1980s). As a newly created entity lacking a well-established administration (Brussels Environment would be created later), the BCR entrusted Vivaqua with these tasks, which was seen as the most efficient way of meeting the EU Directive. The BCR even set up the SBGE/BWMB, further reinforcing the hydrological policy paradigm.

> What has been done, it was indeed not acceptable in the sense that there were no water treatment…. Brussels did not have the institutions and the administration that could work out the policy [Interview n. 10].

These two policy changes followed a technocratic pattern, relying almost exclusively on Vivaqua's knowledge, determining two first-order changes. Despite the requirement and push for a major new policy change (i.e. the 1991 EU Directive), BCR reacted slowly and relied on extending the already existing instruments (the new water infrastructures) and information (the knowledge codified in the Zenne River Plan). This technocratic pattern is seen as the most efficient way of solving the exogenous constraint of the 1991 EU Directive. In this phase, policy learning was limited because the process of regionalisation had dramatically changed the policymaking community from national to regional actors, and Brussels policymakers then relied mainly on already available knowledge, consolidating the already existing 'hydrological' policy paradigm. Referring to Pohl's definition (Pohl, 2008), this is just a re-organisation of available knowledge, since institutional instability and exogenous constraints prevent co-production of new context-specific knowledge.

Phase 2 (2000–2006): A transition phase setting the regional scene

The year 2000 was the fundamental turning point for water policy across Europe, with the adoption of the EU Water Framework Directive (EWFD) (2000/60/EC). This Directive provides a detailed framework for water policy: fixing objectives, quality standards, purification rules and planning tools. In Brussels this triggered a process of re-organisation that lasted until 20 October 2006, when a regional ordinance formalised the new water governance. Brussels Environment was formally established as the main policymaker, upgrading the previous administration for Nature and Environment incorporating competences and functions previously spread across regional offices. This process of internal reorganisation was already ongoing for several years and did not change the role of the other policymakers (Vivaqua, Hydrobru, SBGE/BMWB and the Port of Brussels).

The water policymaking community was now legally defined and consolidated, overcoming weaknesses previously determined by institutional instability. Two platforms were established to connect policymakers: regular consultation meetings of the five public bodies; and Aquabru, a wider association also involving academics to represent the Brussels water sector at the national level.

The 2006 regional ordinance was the outcome of a new political context determined by two main events. In 2004, after a positive result in regional elections, Evelyne Huytebroeck, the leader of the Green Party, was appointed as regional Minister for the Environment. In 2005, there was a major flooding of Flagey square, a very popular neighbourhood at the bottom of the Maelbeek Valley. This is a well-known high-risk flood area, and the SBGE/BMWB was already building there the biggest storm water basin in Brussels. Unfortunately, in July 2005 extremely intense rain resulted in heavy flooding due to the construction yard on the square (see e.g. La Dernière Heure, 2005). This flood had a major impact on public opinion, raising awareness and leading to claims for urgent intervention: a local committee was already active before the accident, and it became the centre of a network of local committees concerned with flooding across the entire city. The so-called 'États Généraux de l'Eau de Bruxelles' (EGEB) were able to mobilise many citizens, intellectuals and academics, becoming the main civil society actor engaged with water policy across all municipalities of the BCR.

During this period, several elements came together and created the momentum of a window of opportunity, while the 2006 regional ordinance put into place the legal framework enabling action. Vivaqua and SBGE/BMWB continued their works on the sewer network and new storm water basins (not only in Flagey), and the water treatment plants become fully operational. The hydrological policy paradigm that emerged during the 1990s was now showing tangible outcomes, improving the quality of wastewater processing and reducing pollution. However, flooding remains a major problem and the hydrological paradigm does not seem able to fully solve this problem, even more after the 2005 flooding in Flagey.

Phase 3 (2006–2012): The creative planning phase

In this window of opportunity determined by a well-defined policymaking community and political urgency to intervene, two initiatives emerged with one being successfully implemented. In the successful case a policy entrepreneur pushed for a second-order change, while the other initiative followed a participative approach seeking a third-order change.

In 2003–2004, after one of the recurrent floods in the Geleytsbeek Valley, a professor of geology from the Dutch-speaking university Vrije Universiteit Brussel (VUB), one of the many inhabitants directly hit by the flooding, took on the role of policy entrepreneur. Relying on his international expertise as a geologist, he argued that the problem of flooding in Brussels was due to soil sealing, which prevented the percolation of rainwater. Using his academic position, he started campaigning on local media using purely technical arguments and proposing a new 'geological' policy paradigm. He had no prior involvement in water management policymaking in Brussels. In other words, a policy entrepreneur had emerged due to the emergency of recurrent flooding and adapted his already available knowledge to context-specific issues.

Due to the political pressure of mounting flooding concerns, the newly established Brussels Environment welcomed the contribution of this professor (and his department) and initiated an intense phase of water planning. Two main documents were prepared and adopted: the Rain Plan in 2008 (Région de Bruxelles Capitale, 2008), and the Water Management Plan (WMP) in 2012.[6] While the Rain Plan was the political answer to recurrent flooding in Brussels (mainly the Flagey incident), the WMP adapted the Rain Plan to the new requirements introduced by the EWFD. Both documents point out the link between soil sealing and flooding (see Figure 3), corroborated by several preliminary studies commissioned by Brussels Environment with the supervision of the professor of geology to validate the new 'geological' approach (Van Tenderloo et al., 2004; Vanhuysse et al., 2006). Differently from Phase 1, Brussels Environment led an intense process of co-production with local researchers, acquiring new context-specific knowledge explicitly for policy purposes.

The other initiative associated with the EGEB was not successful, despite the organisation's capacity to involve an impressive network of local committees and intellectuals in a discussion on water topics in Brussels. They proposed an approach based on water as a 'commons' and as an element of the redesign of public spaces, summarised by the concept of 'new urban rivers' (see Mahaut, 2009). In order to prevent flooding, Brussels should rediscover her roots grounded in the relationship with water, as shown by the city topography. The EGEB organised several workshops, exhibitions and initiatives explicitly calling for a policy paradigm shift. They enjoyed significant attention at the political level but were criticised for lacking practical solutions.

> These people are very good to get participation… they have brought a lot of poetry, but not much relevant information…. It's really poetic! What they did is really interesting because they did a lot of exhibitions and they have really tried to make people aware about water in Brussels, but… well… their role for dissemination to people was good, but for the policy it was zero [Interview n. 08].

Even though the two approaches were partially overlapping (new urban rivers can be a way to reduce soil sealing), Brussels Environment welcomed the contribution from the VUB Geology Department,

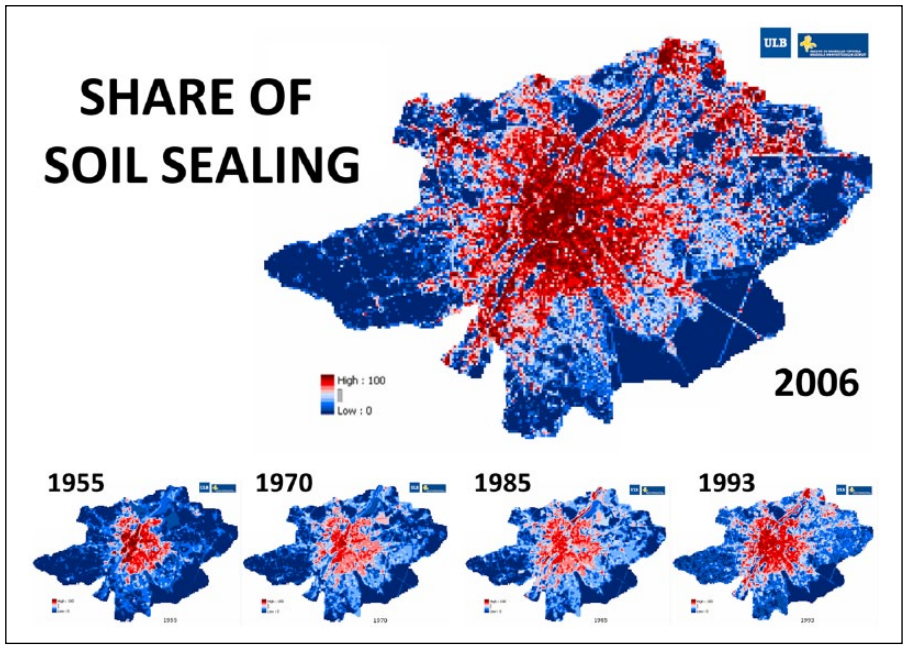

Figure 3. Evolution of soil sealing in Brussels since 1970 (Source: Vanhuysse et al., 2006).

and discarded EGEB's arguments. The two approaches have very different narratives and push for different orders of policy change. The VUB Geology Department is purely technical and the narrative won legitimacy on purely geological arguments, calling for a second-order change; conversely, the EGEB used a narrative explicitly questioning values and beliefs. Even though the EGEB was able to mobilise important resources both politically and intellectually, the policymaking community rejected their claim for a policy paradigm shift, as expected. On the other hand, the geological approach was presented in a way that made a dialogue with the dominant policy paradigm possible, without questioning main values and beliefs. This period saw the emergence of a strong variety of new knowledge about water as well as political pressure both locally (the Flagey flooding) and externally (the EWFD). In this context, the policymaking community was pushed to acquire new knowledge while looking for alternative solutions to cope with flooding, since the dominant policy paradigm did not seem to be adequate. Brussels Environment understood this window of opportunity and explicitly pursued a strategy of policy learning for policy change, through co-production with local experts.

Brussels Environment accepted the 'geological policy approach' promoted by the policy entrepreneur for three main reasons: receptivity of the administration, political strategy vis-à-vis other actors, and the possibility of improving the dominant paradigm. First, the staff of Brussels Environment had backgrounds in disciplines such as hydrology, geology, engineering, natural sciences and chemistry, and the natural science argument posed by the geology policy approach was a familiar discourse. Furthermore, Brussels Environment showed a proactive attitude, scanning external knowledge and promoting intense cooperation with Brussels' universities, not just the VUB Geology Department. Minister Huytebroeck supported this approach and explicitly pushed for the development of internal expertise by refusing to outsource the preparation of water plans to consultants.[7] Second, Brussels Environment had a strategic interest in reinforcing its expert resources within the policymaking community. Supported by the 2006 regional ordinance, Brussels Environment could finally challenge the predominant role of Vivaqua, the struggle

being implicit between the regional administration and an intercommunal company. The geological approach of facilitating underground flows was appreciated by Brussels Environment because it reduced the cost of the storm water basins (paid for by the BCR to the SBGE/BMWB). However, this opened a potential conflict with the regional administration for urban planning, which had to deal with a demographic boom, increasing demand for housing with limited space within regional boundaries. Third, the new geological approach provided a new way to conceptualise water, flooding and soil sealing in Brussels 'without radically altering the hierarchy of goals behind policy' (Hall, 1993: 282), backed mainly by Vivaqua. The result was the development of a hydro-geological policy paradigm where the two main approaches could debate and vie for influence.

Brussels Environment was able to understand the new knowledge proposed by the VUB Geology Department, bringing this into the policymaking community, where they now had a well-established role. The new policy paradigm integrated geological arguments into the infrastructure-oriented policy: if rain water percolates into the ground, the risk of flooding is decreased, also reducing the cost of new infrastructure. Crucial elements for this second-order change were the large variety of local knowledge about water (the policy entrepreneur as well as other researchers involved by Brussels Environment), the extensive mobilisation in light of recurring flooding (i.e. the political pressure determined by the EGEB after the Flagey flood), a well-defined legal context (the 2006 ordinance), and the proactive role played by a policymaker like Brussels Environment. Local knowledge was selected according to the dominant policy paradigm, and retained by Brussels Environment staff thanks to cooperation with several local scholars (not only the policy entrepreneur). It is also relevant to mention that Brussels Environment decided not to engage in open conflict with Vivaqua, favouring a more dialogue-oriented approach.

Phase 4 (after 2012): The current situation and open issues

In the current situation, flooding has been dramatically reduced thanks to the network of storm water basins built by SBGE/BMWB. Municipalities that are still severely hit by flooding (Forest, Jette and Molenbeek) are experimenting with innovative local plans, mainly facilitated by the EGEB. The regional urban development plan has partially integrated the idea of reducing soil sealing, at the least promoting more space for the 'blue network' as proposed by Brussels Environment. In 2013 major works to upgrade the Brussels-South station started, while its management was going to be transferred from Vivaqua to the SBGE/BMWB. In the same year, Brussels obtained a loan from the European Investment Bank to revamp its sewer network.

After the adoption of the WMP in 2012, Brussels Environment underwent an internal re-organisation. The 'new' water department was only in charge of managing and implementing the EWFD, which was a particularly heavy task. A new department for 'sustainable neighbourhood' was created to develop innovative solutions to built environment challenges, including reduction of soil sealing, improving water percolation. In 2014, Brussels Environment started the preparation of the new WMP, substantially updating the previous version. In the same year, due to a poor performance in the regional elections, the Green Party was left out of the governing coalition and the ministry for the environment passed to the Christian–Democratic Party that was already a part of the ruling coalition.

The creative planning phase also animated the local scientific debate. An interdisciplinary team from both Brussels universities (VUB and ULB) created a platform for water research[8] and interaction with policymakers.[9] They have identified that the sewer network is saturated, resulting in approximately 100 overflows per year, i.e. unprocessed wastewater flowing into the Zenne River (although only in one-third of the cases is it seen as being problematic). Despite not being in the position to directly promote policy change, this initiative is a sign that researchers are seeking a more proactive involvement with the policymaking community. This confirms the large variety of available local knowledge and the possibility for the emergence of further policy entrepreneurs.

Conclusions

In this paper, patterns of knowledge for policy change in city-regions were examined through the case study of water management policy in Brussels

Table 1. Main policy decisions.

Policy change	Pattern	Policymaking community	Distribution of knowledge	Institutional context	Order of change
1. New water infrastructure	Technocratic	Internal (Vivaqua, BCR, SBGE/BMWB…)	Concentrated (mainly Vivaqua)	Unstable	First-order
2. Interregional agreement	Technocratic	Internal (BCR and Flanders with KUL- and ULB-Hydrology)	Diffused	Unstable	First-order
3. Soil sealing and flooding	Policy entrepreneur	From external to internal (from VUB-Geology to Brussels Environment)	Concentrated	Stable	Second-order
4. Water as a common	Participative	External (EGEB)	Diffused	Stable	(Failed)

(Hall, 1993; Hoppe, 2005; Slembeck, 1997; Witt, 2003; Wohlgemuth, 2002). Three policy changes were identified (see Table 1). The first two policy changes happened during the 1990s, under pressure of the EU Waste Water Directive. In this period, the BCR followed a technocratic approach to improve water infrastructures and to find an agreement with Flanders for interregional flows. These changes were driven by knowledge already available within the policymaking community, spurring small, incremental improvements in line with the dominant hydrological paradigm. Once the regional context stabilised in 2006, a policy entrepreneur emerged; he highlighted the relationship between soil sealing and flooding as a new approach and promoted a second-order policy change thanks to a creative interaction with Brussels Environment. Another initiative, a participative pattern pushing for a policy paradigm shift, failed, despite strong mobilisation by civil society.

The Brussels case presents several elements of interests for understanding how knowledge can promote policy change. The first fundamental factor is the stability of the policymaking community. Under the unpredictable dynamics of decentralisation processes in Belgium, the new fledgling policymaking community relied mainly on already available knowledge through a technocratic pattern determining only minor incremental changes. Once it was formally stabilised (with the 2006 ordinance) they were also open to learn from external sources, triggering more relevant policy changes. A second relevant factor is determined by contingency: an exogenous stimulus (EU directives) or local accident (flooding in Flagey) can introduce urgency and thus trigger policy change.

The following lessons can be drawn.

- Local knowledge can enhance policy change if institutional conditions enable the policymaking community to learn from external sources. In cases of institutional instability, the policymaking community is more likely to rely exclusively on already available and internal knowledge because uncertainty undermines the possibility to learn, thus only first-order policy changes would be possible. In this perspective, city-regions have to rely on the institutional framework decided by upper tiers of government (i.e. the national level) defining the local policymaking community. The stability of the local policymaking community is necessary for the emergence of new political issues and scanning of alternative solutions, since it is based on context-specific knowledge. Nevertheless, this does not guarantee 'successful' policy change.
- The selection of emerging knowledge depends on the dominant policy paradigm and the capacity of policymakers to learn from external actors as well as the capacity of external actors to engage the dominant policy paradigm. Nevertheless, city-regions are heavily influenced by exogenous factors like the imposition

of supra-local laws (e.g. the EU Directives and the two national water laws in 1974 and 1976).
- The presence of stable organisations (public administration, public company, university, permanent civil society organisation) is necessary for preserving the acquired knowledge.

One suggestion for future research is to examine the governance of local knowledge (Gerritsen et al., 2013; Van Kerkhoff, 2013). How do city-regions manage the various local knowledge inputs? What are the mechanisms for selecting information and understanding policy challenges? How to retain policy learning? Beyond the Brussels case, future research can focus on how to promote and stimulate local variety where knowledge is even more scarce (e.g. small cities and rural areas); how to develop the local capacity to select new knowledge from elsewhere (Lee and Van de Meene, 2012); and how to preserve it locally in city-regional administrations. This might bring to the fore more patterns of knowledge for policy change and learning, since the taxonomy proposed in this article does not pretend to be exhaustive. Furthermore, the horizontal and vertical interactions across policy paradigms pose a theoretical challenge. Referring to the Brussels case, consideration of the interregional cooperation for water planning at the scale of the Scheldt River basin as well as BCR's passive adoption of EU Directives without interacting with European policymakers need to be further examined. All these elements aim to further question the geographical dimensions of the notion of policy paradigm, beyond mainstream approaches that seem to be neglecting spatial dimensions.

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Notes

1. In French, 'Compagnie Intercommunale Bruxelloise de l'Eau'; in Dutch, 'Brusselse Intercommunale Watermaatschappij'.
2. Royal Order of 23 January 1974 on the general regulation of wastewater overflows in public sewers and surface water.
3. In 1976 several laws and orders were adopted regarding water pollution.
4. In French, "Institut Bruxellois de Gestion de l'Environnement"; in Dutch, "Brussel Instituut voor Milieubeheer".
5. In French, 'Société Bruxelloise de Gestion de l'Eau'; in Dutch, 'Brusselse Maatschappij voor Waterbeheer'.
6. The 2012 Water Management Plan consists of several documents (accessible in French only, there is no English translation available), please see http://www.environnement.brussels/thematiques/eau/plan-de-gestion-de-leau/plan-de-gestion-de-leau-2009-2015 (accessed 29 October 2016)
7. This is fundamentally a document made by Brussels Environment with its own resources, specifically with the human resources they had at that time. If you want, before this the IBGE/BIM was never involved in technical aspects of water management except for competences given by the 2006 ordinance [Interview n. 12].
8. More information on the GESZ project is available here at: http://esa.ulb.ac.be/gesz-project-towards-the-good-ecological-status-of-zenne-river-re-evaluating-brussels-wastewater-management-2/ (last retrieved: 29 October 2016).
9. The portal is available at: http://www.sennesource.be/ (last retrieved: 23 July 2015).

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