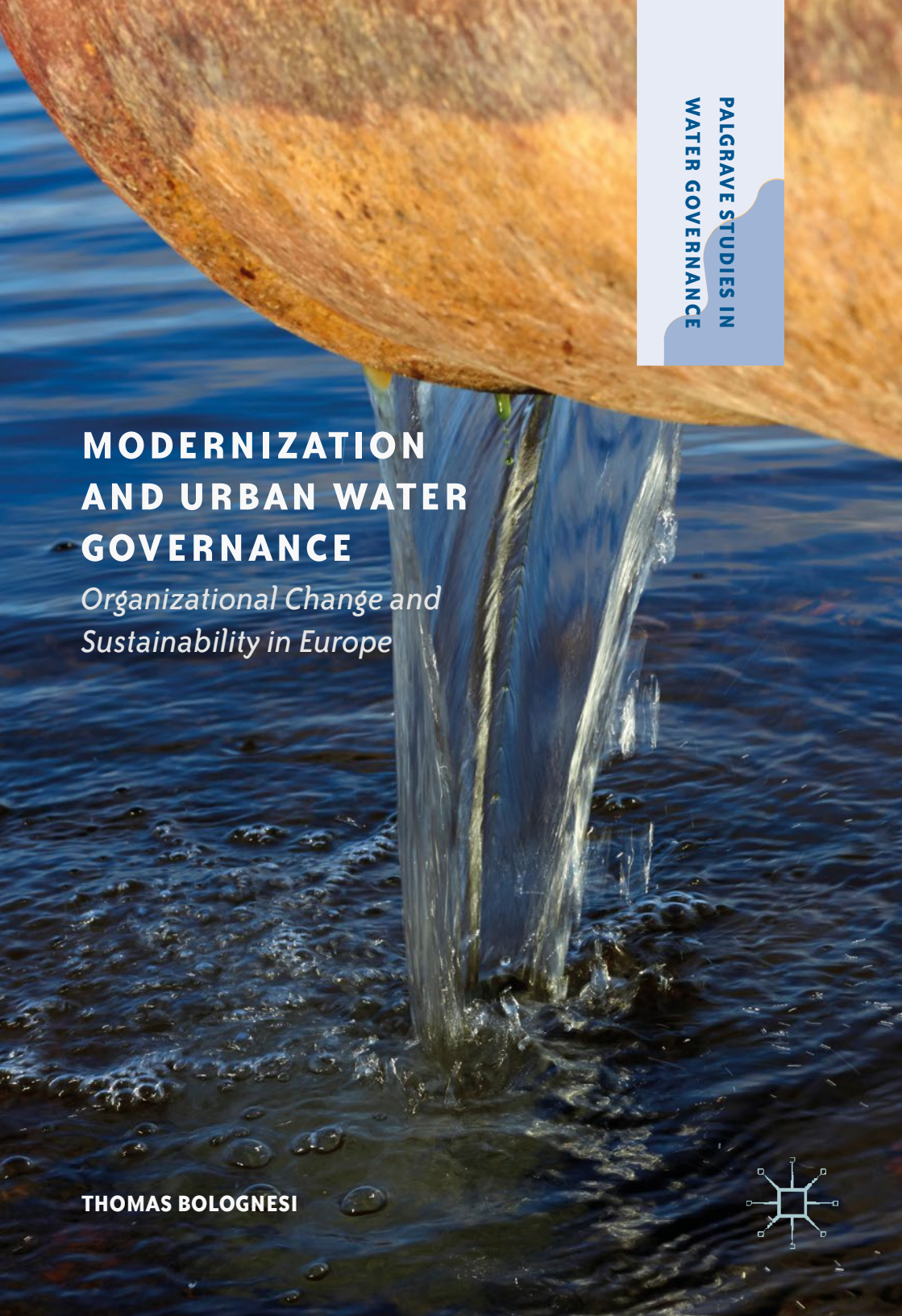

PALGRAVE STUDIES IN WATER GOVERNANCE

MODERNIZATION AND URBAN WATER GOVERNANCE

Organizational Change and Sustainability in Europe

THOMAS BOLOGNESI

Palgrave Studies in Water Governance: Policy and Practice

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Thomas Bolognesi

Modernization and Urban Water Governance

Organizational Change and Sustainability in Europe

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1

General Introduction

While reinforcing the economic and environmental constraints on network industries (telecommunications, rail, energy, post, water), the countries of the EU-15 have agreed on the need for a re-regulation of those industries. This process is taking place following a partial and timely restoration of the system of natural public monopolies that characterized the organization of these industries in the 1980s. But more often than not, re-regulation proceeds from a combination of increasing reliance on the market combined with a changing level of state intervention, instead of the disappearance of the latter (Finger et al. 2007; Ménard and Ghertman 2009). Prescribed rules take into account sectoral specificities, and seek to attain a high level of quality in those services known as services of general interest. These reforms are part of the 'Europe 2020' strategy, which is designed to support economic growth and to integrate the environmental impacts of human activity. In both respects, drinking water supply and sanitation services are part of this general process. They represent the last re-regulation project and they benefit from special treatment due to the special status of these services within European regulation.

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Following the European political agenda, this 'modernization' of European Urban Water Systems (UWSEs) dates from the mid-1990s, and the enactment in 2000 of the Water Framework Directive (WFD) marks its formal inauguration (European Commission 2003; Gee 2004). This regulatory shock has been the subject of numerous publications and, after a period where other topics were explored, the academic and business worlds have today reintroduced it at the forefront of their concerns. There are three reasons for this need to refocus. Firstly, the guiding principles of the modernization of UWSEs have now been transposed into different national rights, which renew the interest in these topics. Next, by the time the first deadlines for the achievement of the WFD's objectives had come around, regulation had evolved, and this new state of affairs made it necessary to look at potential policy readjustments. Finally, in many cases, the observed condition of UWSEs does not match expectations and the diagnosis of the action required for modernization needs to be redefined. These three factors have encouraged research to be undertaken on the process of modernization of UWSEs, especially as this process appears to be less informed than the re-regulation of the other network industries.

We will seek to identify and explain the effects of the modernization of UWSEs on their organization and sustainability. To do this, we will make use of institutional economics and the explanatory models of new institutional economics (NIE), mainly in relation to organizational impacts, and institutional resource regimes (IRR), predominantly regarding the impact of sustainability.

We support the theory that modernization leads to a change in the modalities of coordination of UWSEs, while intensifying and polarizing issues of sustainability based around the economic dimension. On an organizational level, we defend the notion that modernization tends to *depoliticize* the UWSEs and is linked to an increase in their *socio-institutional* resilience. By depoliticization we mean a change in the scope of intervention and less direct control of the state over the UWSEs. Resilience refers to the capacity for a quick socio-institutional auto-reorganization of UWSEs following a shock, in order to maintain the stakeholders' level of satisfaction. These two phenomena result mainly from a *hybridization of institutional arrangements* which tends to result in a specialist market. With regard to the impact of modernization on the

potential for sustainability, a lack of coherence in developing the re-regulation of UWSEs explains the relatively pessimistic outlook. In fact, the efficiency, integrity and sustainability of UWSEs remain threatened. For example, the good qualitative and quantitative condition of the resource is not assured; the infrastructure is deteriorating, primarily because of a lack of investment in renewal. We are seeing the appearance of a *paradox* manifesting in the intrinsic inability of modernization to maximize the potential for sustainability of UWSEs, though is the latter is nevertheless one of the primary objectives of the reform.

After this initial presentation, we shall address three items: (1) the contours of the field of investigation; (2) setting out the research problem; and (3) the specificities of theoretical choices. Afterwards, we will take a look at the business approach and expected results in order to justify the structure of this book.

1 Delimitation of the Field of Investigation: The Modernization of UWSEs

The analysis covers a transformation of the regulations in the specific context of the Urban Water Systems in Europe (UWSE). By using the term UWSE, we suggest a specific approach to the sector of urban water in Europe, which relies on the integration of concepts of polycentric multilevel governance (Ostrom et al. 1961) and the complex system (Morin 2008). The UWSE articulates an economic component, the *urban water cycle*, and an institutional component, *water institutions*. As has been shown in other works, this division facilitates an analysis of the modalities of coordination within the water sector (Arrus 2000; Swyngedouw 2009; Buchs 2012).

The urban water cycle represents a deviation of ressources from the larger water cycle in order to satisfy urban usage (Erhard-Cassegrain and Margat 1983). We focus on the urban water cycle and pay little attention to its relationship in terms of resource flow to the larger water cycle. This sense of the economic component of UWSEs is an interpretation of the economy-environment interactions specific to the ecological economy model, rather than a model based on the relation of the economy to the

environment, as defined by A. Vatn (2005). This model reflects the characteristics of the exchange of masses of water between service providers and users, and such characteristics as price, volume and technical specifications. Water institutions bring together all of the rules regulating the practices of the key players in the urban water cycle: this definition is inspired by the work of M. Saleth and A. Dinar (2004, 2005). These institutions represent a set of constraints and opportunities for the key players in all UWSEs. The concept of the complex system allows interactions between these components to be characterized.

The term modernization is inspired by text specific to the European Union, including the recommendation by Gee (2004). We define the modernization of UWSEs as a regulatory reform that modifies the modalities of coordination and improves the effectiveness of the regulation of UWSEs, especially from a sustainability perspective. This notion characterizes the re-regulation of network industries such as those we have observed within the UWSE since the 1990s.[1] The reformist momentum relies on three founding pillars[2]:

- a rationalization of public procurement;
- an increasing reliance on market mechanisms; and
- an awareness of environmental constraints in order to set out a sustainable path for systems.

On the basis of these pillars, the modernization of UWSEs is the formulation, initiated by members of the European institutions, of a specific response to the difficulties encountered. The first two pillars require us to take into account questions relating to budget constraints, the effectiveness of public policies or even the stimulation of economic growth. The third pillar reflects the growing importance of the environmental variable within the development of our societies. It is part of a comprehensive approach set out around the principles of Integrated Water Resource Management (IWRM).[3]

The terms of the formal acts that constitute the modernization of UWSEs are a testament to a classical approach to regulation and a liberal economic orientation, intended to create a sustainable pathway for UWSEs (Kallis and Butler 2001; Kaika 2003). As a result, in the WFD,

the role of economic incentives is strengthened. The process of rationalization of the public order therefore echoes work in terms of new public management (Hood 1995; Ventriss 2000; Page 2005; Schubert 2009). The goal is to respond to the efficiency problems and failure of public action by combining managerial principles originating from the private sector with individual administration control (economic instruments, information and so on). The second pillar gives direction to the search for efficiency in the sector through industrial organization based on the theory of contestable markets (Baumol et al. 1982) and that of the de-integration of industries (Demsetz 1989). This organizational reform is part of a general climate that favours public–private partnerships (Williamson 1990).

However, the various works on the condition of European water and the challenges in managing the sector lead us to consider that modernization is struggling to achieve its objectives (WWF 2010; Massarutto 2007; Finger et al. 2007; European Environment Agency 2012; Bolognesi 2014; Lieberherr and Truffer 2015). This finding emphasizes the fact that economic incentives not only drive coordination, but are necessary to integrate the institutions into an analysis of the structure and effectiveness of any regulation (Ménard 2001a; Spiller 2013).[4] Also, considering that the institutions constitute and establish the rules of the game for key players (North 1990), we find ourselves within an institutionalist approach, inclusive of the modernization of network industries as applied in the instance of water.[5] This is not about refuting the principles of modernization, but grasping the complexity of the phenomenon, in order to incorporate the need to restate the issue of regulation of urban water supply and sanitation services—as called for by some policy-makers and practitioners (Keller 2011; Centre d'analyse stratégique 2013; Lesage 2013).

In terms of geographical area, our field of investigation is limited to the UWS's of the EU-15. This area provides a level of homogeneity between UWSEs that is sufficient to allow a comparative approach, while including enough diversity and irregularities for the approach to be relevant. The modernization of UWSEs is a difficult subject to grasp. For each UWSE, it is about taking into account the specificity of the city and components that come out of the borders of the city, while also capturing the effect of a common evolution. We look at the modernization of UWSEs

by means of a comparison of three ideal-types, German, French and English, since these allow existing diversity to be framed (Lorrain 2005; Ménard and Peeroo 2011). Then, while the acronym UWSE specifically refers to 'urban' water systems, the analysis is not limited to administrative cities nationwide.[6] Indeed, in terms of the concept of polycentric and multilevel governance, the UWSE includes elements from different levels, from local to international. The analysis undertaken therefore highlights several geographic scales, all competing to define a UWSE.

2 Issues, Working Hypotheses and Theoretical Positioning

The formulation of the issue is the result of a double observation: the partial failure of modernization in the light of its stated objectives and the need to renew this process of re-regulation. We propose to question and probe the modernization procedures of UWSEs within an institutionalist perspective, structuring our work around the following issue: *How to characterize and explain the impact of modernization on UWSEs in terms of their organization and their sustainability?*

Our research question therefore leads us to address the impacts of modernization, and not its genesis, from a dynamic perspective. Modernization is understood as an institutional shock and this book aims to contribute to the characterization and explanation of institutional change induced within the UWSE by this shock. To mark the starting point for the research, we will use the categories suggested by M. Saleth (2006) on institutional change, hypothesizing that modernization is an economic and political type of reform that constitutes an exogenous factor of institutional change of UWSEs.

In order to provide an answer to this issue, we accept three propositions as starting points.[7] The first two focus on institutional dynamics in general and the third on UWSEs in particular. The first assumption looks at the meaning of causality within the UWSEs and suggests that institutions shape behaviour. Water institutions therefore determine the economic, technological and environmental characteristics of the urban water cycle. The explanatory model of the effects of modernization thus

considers institutions to be an explanatory variable of the form and the result of interactions between the key players of the urban water cycle. An analysis of the institutions of UWSEs per se occupies a predominant place in the analysis.

The second postulate concerns the way in which institutions guide behaviours. This link points to functionalism, since we consider that institutions aim to improve the coordination of key players and that, over the medium-to-long term, institutions that persist are likely to be the most effective (North 1990; Ostrom 2005). The corollary proposition is that a variation in the terms of coordination is an attempt by the key players to satisfy preferences while labouring under the strain of modernization. This assumption is justified in two respects. Firstly, from a teleological perspective, we see that modernization includes targets based on modalities and the coordination results of UWSEs. Then, since we have considered the regulatory impact of modernization as a given, the genesis of the coordination does not become part of our analytical field. Consequently, the contribution made by taking a realistic direction, perceiving institutions to be a result of the balance of power, provides little by way of answer to our problem. We will focus on the form and quality of the coordination solution proposed by the water institutions in the face of a given collective action problem.[8]

It appears that these two postulates are connected and consistent with each other. E. Brousseau et al. (2011: 7) illustrate the interest and the consequences of such a combination in this approach:

> Firstly, from a normative point of view, economic efficiency can be one of the criteria used to assess the social desirability of alternative institutions or institutional reforms. Secondly, from a positive perspective, the efficiency criteria are often those that decision-makers rely upon to compare the different institutional designs when they try to influence institutional evolution.

The third assumption relates to the structure of our research and establishes the need to think in terms of complex systems (Morin 2008; Wells 2012). We postulate that complex thinking offers a new look at research subjects that include numerous interactions and which are subject to a

great deal of uncertainty, as is the case for UWSEs. To justify this method, E. Morin (2008) returns to G. Bachelard's epistemological comments. 'As Bachelard had understood half a century ago […] it is the forward movement on all fronts of contemporary science that is faced with complexity' (p. 1053), so 'complex thinking is the thought process that wants to think together in combination with dialogic/polylogic realities' (p. 1050). Our approach is largely based on this assumption.

With regard to the postulates and the analytical objectives of our approach, we have chosen to make use of two theoretical frameworks, that of new institutional economics (NIE) and institutional resource regimes (IRR). These two frameworks are compatible with our ontology and promote a comparative analysis that will produce easily replicable results (Table 1.1). In addition, these two frameworks are particularly complementary, with the NIE particularly useful for the analysis of institutional mechanisms and the IRR for studying the link between governance and the environment. As C. Ménard highlighted (2001b: 89–90):

> The development of comparative case studies [is] particularly relevant as part of the NIE framework. […] A growing number of neo-institutionalist studies proceed in a comparative way, either by analyzing tradeoffs between the different governance structures or by examining and explaining the impact of the different institutional environments on the methods chosen to organize the transactions.

Table 1.1 Advantage of theoretical frameworks in light of the general approach to research

Theoretical frameworks	Ontological similarity	Methodological advantages	Empirical relevance
New institutional economics	Multilevel and polycentric governance	Very transposable results (Théret 2000; Ménard 2006)	Focus on organizational mechanism
	Focus on formal institutions		Thinking in terms of governance structure
Institutional resource regime	Institutional functionalism	Comparative analysis	Institutions and environment
	RIR enhanced by Ostrom's work	Distinction between micro and macro factors	Scope simultaneously addresses property rights and public policies

The NIE is used to explain the evolution of the modalities of coordination of UWSEs following their modernization (organizational dimension). The characterization of the modernization highlights the fact that the phenomena we want to explain fit into the three parts of the 'domain of the NIE', as selected by C. Ménard and M. Shirley (2005): the dynamics of institutional change, industrial organization and transaction costs. Neo-institutionalist concepts therefore put us in a position to explain the evolution of the coordination of UWSEs. The originality of this work lies in the analysis of the micro and macro mechanisms of institutional change. To carry out this analysis, we propose looking at the theory of transaction costs (Williamson, 1985) in combination with an examination of the institutional environment (North 1990; Ostrom 2005).

The use of IRR highlights the potential for sustainability, the key to the modernization of UWSEs. This analytical framework is dedicated to the study of the relationship between methods of coordination and the potential of sustainability. It therefore fits naturally within an extension of the NIE to address the sustainable dimension of modernization of UWSEs. The application of IRR provides an institutionalist explanation of the discrepancy between the objectives of modernization and its results, while simultaneously addressing the issue of the rights of property and public policies (Gerber et al. 2009). The rise of sustainable development issues within the regulation of UWSEs allows us to site ourselves within an area of research that addresses environmental issues from the perspective of institutionalist economics (Ostrom and Janssen 2004; Vatn 2005; Ménard 2011; Marshall 2013).

3 Approach and Rationale for the Structure of the Book

The book has empirical and theoretical ambitions and opts for a mode of empirico-formal demonstration. Using this mode requires two methodological choices to be made based on:

1. the way in which the two components, empirical and formal, are articulated in the demonstration; and
2. the level of abstraction retained for the empirical component.

Over the course of the analysis, we will formally separate the empirical and theoretical phases. Each responds distinctly to an issue, the initial empirical phase ensuring characterization of the modernization of UWSEs, followed by the theoretical phase that explains its impacts. To link these two phases, we will become progressively more abstract, working first with salient facts, then stylized facts and finally concepts.

With regard to the level of abstraction, we have chosen to analyse the UWSE as a form of national ideal-type. Two considerations justify this choice. The empirical component can either be a singular and very specific case study, or a case study achieved by means of comparison, which is therefore less sensitive to contingency. We prefer this second form of study. In addition to providing an answer to our problem, it facilitates the generalization and transferability of the results both to other UWSs and to other networked public services. In addition, this choice does not prevent more precise empirical enrichment in the future. As C. Ménard points out (2001b: 89–90):

> Another way is the development of comparative case studies. These are particularly relevant within the framework of the NIE because of the need to deal with a limited number of forms of transactions, both at the micro level and at the level of all the institutions that characterize a society. This type of comparative approach has been particularly fruitful in other disciplines.

We will adopt a comparative approach between the German, French and English models.

* * *

This book is therefore structured in two parts and seven chapters.

– Part 1 is the empirical component and leads to the formulation of three stylized facts that characterize the modernization of UWSEs. The proposed characterization is based on the identification of salient facts over the course of the first two chapters. Chapter 2 focuses on the impact of modernization on the coordination terms of UWSEs (organizational dimension). Chapter 3 discusses the impact of modernization of UWSEs through the prism of sustainability.

– The three following chapters constitute Part 2 and add to the theoretical phase of the argument. Chapter 4 proposes micro-institutional factors and explanatory mechanisms for the organizational stylized facts. Chapter 5 complements this by looking at macro-institutional aspects. Finally, Chap. 6 sets out the theoretical mechanisms that help to explain the stylized facts regarding the sustainability of UWSEs.

Notes

1. For more information on preceding periods please see: Barraqué (1995), Correia (1998), Kissling-Näf and Kuks (2004), Guerin-Schneider (2011).
2. The terms of this qualification are essentially taken from community texts (Green and White Papers, statutory instruments, and so on).
3. For an overview of the concept of IWRM see: GWP (2009), Biswas (2004), Ward (2009), of IWRM and Europe and Euromarket (2003), Aubin (2007); and with regard to the evolution of literature on IWRM: Gallego-Ayala (2013).
4. By way of illustration, recent institutionalist interpretations of public-private partnerships (PPPs) further refine understanding of this mode of coordination and go beyond the barren opposition between public or private property (see special edition of *Revue d'économie industrielle*, 2012, No. 140, 2013, No. 141; *Journal of Economic Behavior & Organization*, 2013, No. 89).
5. To read further on the regulation of network industries in general, please see: Crocker and Masten (1996), Economides (1996), Armstrong and Sappington (2006), Glachant and Perez (2008), Finger and Künneke (2011), Baldwin et al. (2010), Decker (2015); specifically on water: Chong et al. (2006), Schneier-Madanes (2010), Masten (2011), Beecher (2013), Maziotis et al. (2013), Porcher (2016).
6. For an overview of the main dimensions of the theme of urban water, please see: Maksimovic et al. (2001), special edition of *Water Resources Development* (2006), Leflaive (2009), Pflieger (2009), Van de Meene et al. (2011), Grafton et al. (2015).
7. To construct the argumentative structure of the research, other assumptions, both axiomatic and conjectural in type, will be formulated during the development of the argument. The main focus is on the ontology of UWSEs (Chap. 2) and the rationality of the key players (Chaps. 4 and 5).

8. However, by keeping this assumption, we do not want to refute the interest of a realistic approach. As an example of this type of method, in the present case it would present an acutely clarified formulation of the terms of modernization and provide a comprehensive interpretation of the emergence process of the modernization of UWSEs (Kallis and Butler 2001; Kaika 2003; Kaika and Page 2003; Page and Kaika 2003).

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Part 1

Three Stylized Facts on UWSEs' Modernization: Depoliticization, Resilience and Sustainability

This first section has a dual purpose. Firstly, it is responsible for 'polishing' the empirical material available on the modernization of urban water systems in Europe (UWSE) in order to enable us to consider it from a theoretical viewpoint. Secondly, it provides an empirical analysis of the modernization of UWSEs, gathering and updating the partial knowledge available in literature relating to the theme, to offer a comprehensive interpretation of that modernization process. Essentially, it is about an empirical characterization of the impact of modernization (explanatory variable) on the organization, dynamic and sustainability of UWSEs (explained variables). To this end, the section is divided into four items for observation: facts, salient facts, stylized facts and phenomena. Facts are direct observations, whilst salient facts tend to be those that are remarkable and, a priori, useful for characterization. Stylized facts, however, reflect the phenomenon of modernization. They emerge as a result of a rise in generality and their construction is dependent upon ensuring the consistency of several salient facts.

Thus, this section deals with the facts relating to the modernization of UWSEs, highlighting the salient facts. Next, these salient facts are raised to the level of qualitative variables in order to logically put together stylized facts that represent a formulation of phenomena pertaining to the modernization of UWSEs. The results of this first section are found in the formulation of stylized facts that reflect phenomena for the purposes

of the organizational (coordination method) and sustainable (effective coordination) dimensions of the modernization of UWSEs. These stylized facts present the relationship between the explanatory variable and each of the explained variables in an empirical manner. Thus, they will then be subject to a theoretical explanation, the conclusions of which are intended to be general in character, regarding the determinants of institutional coordination and evolution.

The construction of the results of the observation stems from a general methodology, the constituent parts of which should be defined. We propose a presentation of this methodology in two stages in order to distinguish areas of consistency of the analysis from its implementation; because they are subject to the strengths and weaknesses. With regard to consistency, a general approach is adopted relating to a formal-regional ontology[1] compatible with the identification of phenomena (Husserl 1952; Nef 2009). From this perspective, the analytical element of observation "is an abstract object, a single ontology at the same time as a piece of space and time, a piece of a property. […We perceive] obvious properties, qualities entangled with objects and intertwined with each other" (Nef 2006: 197). Thinking about objects therefore comes down to their properties, and the use of ontological elements helps shape the definition of phenomena.[2]

In this context, recourse to the principles of formal ontology on the one hand fixes the point of view and perception of the observer, and on the other, provides a basis for the construction of the research subject (modernization of UWSEs) (Lawson 2003). In order to minimize the risk of tautology and confusion of the observation with its effect, we will first construct the research subject in a generic and theoretical manner in the form of an urban water system (UWS). Then, a regional analysis of the UWS will be followed by an observation of UWSEs in general and their modernization. The identification of regularities, irregularities and so on feeds the following observation: 'it is about clarifying what can be called a "*thing*" or what could be "*ownership of something real*", with its basic relationship to actual circumstances' (Husserl 1952: 123). Finally, the pooling of these observation elements results in the formulation of phenomena relating to the modernization of UWSEs.

In practical terms, the implementation of these general methodological principles takes the form detailed below. Firstly, we define the notions of UWSs and modernization. These notions are then analysed in the case of the EU-15 Member States (EU-15), as well as within their organizational and sustainable dimensions. These two dimensions refer to the two main objectives of institutional economics. The first relates to the modernization of UWSEs in terms of structure, and the second in terms of performance (Williamson 2005; Brousseau et al. 2011). The analysis takes the form of 'storytelling', which describes the organization of the UWS under discussion. Strictly speaking, storytelling is a mode of communication that is based on narrative and the alignment of concepts unique to the author. This is integrated into a holistic approach, which comes closer to this first mode of the pattern model in the sense that: 'an event or action is explained by identifying its place in a schematic model that characterizes the process of change at work in the whole of the system' (Wilber and Harrison 1978: 73).[3] This characterization then results in an interaction between the UWS and the specificities of UWSEs.

In this way, the highlighting of salient facts punctuates this storytelling process as a way of improving the transparency of the construction phenomena (Wilber and Harrison 1978). Indeed, in the conclusion of this section, the salient facts become variables and are logically connected in such a way as to enunciate the stylized facts relating to the modernization of UWSEs. Following this statement, we can collate and recall all of the salient facts of the first part. This enables the reader to assess the strength of the wording of the phenomena and to verify the relevance of the analysis by comparing it to the list of seven verification points proposed by B. Ward (1972: 189):

1. Are the facts and theories properly presented?
2. Are important facts or theories omitted?
3. Is it possible to find different stories that use the same facts and theories as those of the proposed story?
4. Are the facts and theories relevant or essential to the story?
5. Do the experts of the various elements of the story believe the story itself?
6. Has the data been processed correctly?
7. Has all relevant data been included?

There are three main advantages to this method, the first at a general level and the other two at the level of application. Firstly, the analysis is framed and methodically organized by means of ontological principles. Secondly, the use of intermediate salient facts creates transparency in developing the results of the observation, which highlights the coherence and relevance of the analysis. Thirdly, it is possible to make generalizations. These benefits justify the use of this methodology. Nevertheless, we are aware of various issues in employing this approach. The main two pertain to its relationship with reality. Firstly, at the general level, the ontological principles limit *ex ante* the field of observation and therefore prohibit the identification of a number of, nevertheless real, salient facts. Then, in terms of application, it would appear that the full richness of the contingency is neither exhausted nor addressed in such a way that it is possible to trace it back to generality.

Part 1 is comprised of two chapters, both constructed in the same way. The observation proceeds by applying a method presented in the first section of each chapter. The first chapter addresses the organizational dimension and the dynamics of UWSEs. On the basis of the analytical categories already in place, the second chapter focuses on the dimension of the sustainability of UWSEs.

Notes

1. Here, regional is specific to a defined domain; the terms contrasts with the notion of 'universal'.
2. This note is crucial in terms of overall coherence, for in some cases ontology and phenomenology are radically opposed to each other (Nef 2009). In this sense, the approach that is adopted does not fundamentally contradict itself.
3. The notion of the pattern model is taken from A. Kaplan (1964). In this way, storytelling is not in opposition to a mathematically formalized demonstration, but turns out be a supplement containing the notional architecture into which the simulation fits. The research of B. Ward (1972), as discussed by A. Gruchy, R. Solow, S. Karsten and O. Morgenstern in the *Journal of Economic Issues* (1973) is the basis for this thought process. D. McCloskey (1990) revisited the connection and is the current reference on these issues.

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2

UWSEs' Organization and Modernization: Similarities and Variations

Part 1 deals with observations on the modernization of urban water systems in Europe (UWSE) in order to characterize its effects on the explained variables. This first chapter begins this observational work by focusing on the organizational aspect and the dynamics of UWSEs. On this basis, Chap. 3 will assess the potential for sustainability.

This chapter is the first observational phase and delimits the object of the empirical analysis, the UWSEs and their three ideal-types—English, French and German (Bolognesi 2014a). The organizational aspect study of the modernization of UWSEs allows the components of UWSEs to be identified and defined and for their evolution to be viewed as a consequence of modernization. The chapter uses international comparison as its method of analysis.

This choice allows us to understand the effects of modernization in both a synchronic and diachronic manner, an issue which takes on new relevance in light of the incompleteness and lack of robustness and uniformity of the existing data on the modernization of UWSEs. For example, the database of the European Union on Water (WISE) still contains numerous incomplete entries and the indicators included in the country reports do not seem to have been consolidated in a robust manner

T. Bolognesi, *Modernization and Urban Water Governance*, Palgrave Studies in Water Governance: Policy and Practice, DOI 10.1057/978-1-137-59255-2_2

(Beniston et al. 2012). Each comparison method can therefore only relay to the other when the data is not available if the coherence of the findings is not to be sacrificed. To avoid tautological risk in the empirical analysis, a generic analytical framework has first been defined—the urban water system (UWS)—so the essence of modernization is presented without making reference to UWSEs. This first stage gives direction to the rest of the empirical analysis, offering a mobile framework for the various case studies. Through systematic use of this framework, the empirical results are put together and various phenomena are identified that will be explained throughout the second part of the book.

This chapter is set out in three stages to aid with an analysis of the organizational aspect of the modernization of UWSEs. Firstly, the analytical framework is laid out (Sect. 1). Then, the first identifiers of the modernization of UWSEs are highlighted by defining a European model of a UWS (Sect. 2) from the basis of a global comparison. Finally, a study of the variations surrounding this model will define and complete our first conclusions by highlighting three ideal-types: English, French and German (Sect. 3).

1 Framework for the Purpose of the Study: Definitions of the Urban Water System and Modernization

This section details in turn the concept of the UWS (section "The Urban Water System: A Uniting Representation of Municipal Water Management") and that of modernization (section "The Shock of Modernization: Content, Dynamics and the Goal of Reforming UWSEs").

The Urban Water System: A Unifying Representation of Municipal Water Management

The structure of a UWS is based on three axioms of formal ontology (Bunge 1977; Husserl 1913; Nef 2009): the idea of a complex system (Morin 2005, 2008; Wells 2012), the essential role of institutions (Coase

1998) and polycentric multilevel organization (Ostrom et al. 1961). The first axiom is that a system is a comprehensive unit built by a network of complementary and antagonistic interrelationships between the components, constituents and actors.[1] The second axiom comes from R. Coase (1998), who notes the link—intrinsic in nature when viewed realistically—between the microeconomic and institutional dimensions. He recalls that the economic analysis traditionally focuses on learning exchanges and links between actors, but is cautious of dealing with determinants of choices and behaviour, quoting the viewpoint of Roy Campbell (Coase 1998: 73):

> I see the bridle and the bit alright,
> but where's the bloody horse?

The third axiom, the perception of a system as a polycentric multilevel organization, leads to the crossroads of the first and second axioms, adding depth to the system as an object. Polycentrism implies that the institutional components exist at several points and the multi-level character adds variety to the dimensions and the temporal, geographical, institutional and organizational scales for the location of the components (Williamson 2000).

Box 2.1: Institutional Integration

Williamson (2000) posits the concept of institutional integration in order to clearly show that an institutional structure is both polycentric and multilevel. Four levels can be distinguished by means of their pace of change, from the slowest to fastest, with each level restricting the level below (Table 2.1). The first level includes the informal dimensions as part of the social theories. The institutional environment is located on the second level and the economy of property rights and positive political theories encompass it. The governance structure is the third level and can be analysed by means of the economics of transaction costs. Finally, the fourth level pertains to the allocation of markets, is constantly evolving, and is the subject of neoclassical economics. New institutional economics (NIE) addresses the first three levels and their interactions. The neo-institutionalist method moves away from individuals and returns to group objects, going backwards to the dynamics of integration. The analysis of level 3 therefore comes before that of level 2, and so on. Pragmatism is the reason for choosing this method, with details being dealt with before the more general.

Table 2.1 Representation of institutional integration

Level	Frequency (years)	Relevant theory
Level 1: Embeddedness: informal institutions, customs, traditions, norms, religion	100–1000	Social theory
Level 2: Institutional environment: formal rules of the game—esp. property (polity, judiciary, bureaucracy)	10–100	Economics of property rights, positive political theory
Level 3: Governance: how the game is played—esp. contracts (aligning governance structures with transactions)	1–10	Transaction costs economics
Level 4: Resource allocation and employment (prices and quantities; incentive alignment)	Continuous	Neoclassical economics, agency theory

Source: Williamson (2000: 597)

The conjunction of these three axioms provides an original formal ontology for UWS.[2] Taken independently, these axioms appear in various models intended to aid the understanding of water management. The hydro-social cycle (Swyngedouw 2009)[3] and the social-ecological system (Walker et al. 2002; Folke 2006) emphasize the inseparable relationship between the biophysical and the social spheres. Notwithstanding the centrality of the recursive loops included in the framework, they refer to the form of a complex system. Then, in relation to the second axiom, the mode of water usage and its derivatives (Arrus 2000; Buchs 2012) place economic-institutional interaction at the heart of the subject of the analysis. Finally, in the literature, the idea of polycentrism and multilevel architecture aggregate to these generic models in order to flesh them out (Pahl-Wostl et al. 2010; Ferguson et al. 2013). When we compare it to these existing models, we can see that the concept of UWS has various traits in common with them. It is important to specify that the originality of the concept comes from the aggregation of the three axioms as described. This singularity involves a form and structure that is specific to the UWS.

These principles of formal ontology guide the perception and definition of the object of study. An *urban water system* is a complex system that has components interacting at different levels (Bolognesi 2014a). The nature of the components varies because the UWS distinguishes between two elements, the first being technical and economic (the *urban water cycle*) and the second institutional (*water institutions*). We also define a UWS as the dynamic articulation of an urban water cycle and of the water institutions that coordinate it (Fig. 2.1). The concept reflects the economic operations related to the allocation of water resources, as well as to the governance process of the related activities in a given city. Even if the idea of a complex system tends to understand them as a whole, we can distinguish the components of a UWS (Fig. 2.1) from their dynamic nexus.

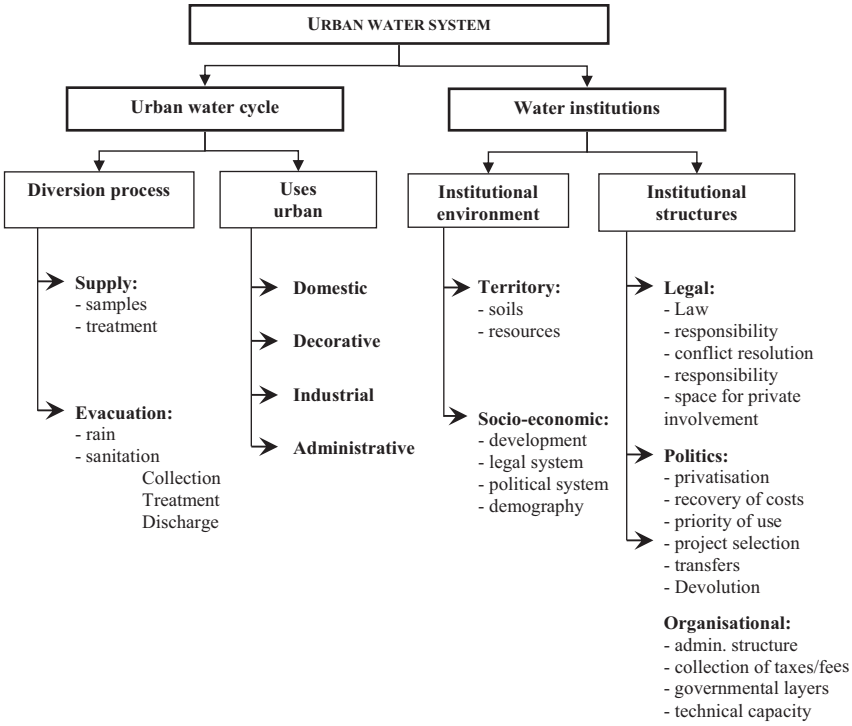


Fig. 2.1 Architecture of an urban water system

The first component, the urban water cycle, is the economic engine of a UWS. Institutional integration as defined by O. Williamson (2000) is in fact a component of the fourth institutional level, which is the most specific to the system being studied, and which contains the (non-institutional) economic modalities of the allocation of resources. The urban water cycle is the process whereby water from the natural water cycle or the larger water cycle is diverted with the intention of satisfying urban uses of water. This notion refers to the conventional microeconomic analysis of water. The urban water cycle takes the form of a water market, inside of which, supply (the deviation process) meets demand (urban uses). The water deviation process is broken down into a supply phase (samples, treatment, distribution) and an evacuation phase (storm water and sanitation) (Mailhot and Duchesne 2005). The distinction we have made here between selected urban uses is the broadest and loosest possible in order to facilitate access to data and compatibility with other studies. The uses are divided according to four categories: domestic, industrial, administrative and decorative (Butler and Parkinson 1997; Maksimovic et al. 2001). The key descriptive elements of an urban water cycle that will be used are as follows:

- the price of water;
- the volumes exchanged;
- the technical characteristics of the provision (technology, infrastructure, and so on);
- the quality of service (yield, rate of access, and so on).

The second part of a UWS, the water institutions, comprises all the higher elements of the institutional framework constituting its governance. We will use the definition put forward by M. Saleth (2006: 4), which states that water institutions are the:

> rules that define action situations, delineate action sets, provide incentives and determine outcomes both in individual and collective decision setting in the context of water development, allocation, use and management.

There are two reasons for adopting this definition. Firstly, it is widely used, both in research contexts and by international organizations. It is therefore used to define the indicators of the main databases likely to provide information for a UWS. Secondly, the definition also refers to the work of J. Commons (1934), D. North (1990) and E. Ostrom (1990) and, theoretically speaking, is the most neutral definition possible. In summation, this will reduce the tautological risk between the characterization of the phenomenology of modernizing UWSEs and the theoretical explanation.

Within the water institutions and because of their level of specificity, the *institutional environment* differs from institutional structures. The institutional environment comprises the most generic elements of a UWS, which consequently appear to be the most structural and the slowest in terms of their evolution. We differentiate two dimensions of the institutional environment, the *territorial dimension* and the *socio-economic dimension*. The territorial dimension includes the physical features into which the urban water cycle is incorporated, and this is particularly reflected in the indicators of the urban structure and the characteristics of the resource. Its integration into the institutional environment is testament to the fact that we consider, in part, the structure of a territory and its ecosystem to be the fruits of a socio-institutional construct. The socio-economic dimension brings together the socio-economic characteristics in which the urban water cycle operates, such as the mode of development. Its main indicators take the form of macroeconomic, social and political aggregates.

Three elements shape the *institutional structure*: *legal*, *political*, and *organizational* structures. These structures are more specific to the UWS under analysis than those of the institutional environment. The normative elements of a UWS form part of its legal structure, such as the contractual composition, the definition of bonds and so on. The political structure defines the orientation of the UWS; this orientation can in most cases be viewed as largely taking a public service approach, with an accepted level of public–private balance. The organizational structure is a kind of flow chart of the key players and organizations involved in a UWS, since it sets out the administrative arrangements that have been implemented (Muller 2011; Boussaguet et al. 2010).

A UWS is also a complex multilevel system, the components of which fit each other and interact with each other in a non-linear and recursive way. We will consider the UWS in light of this set of complex links that makes each one of them individual, despite the existence of similarities between UWSs (Fig. 2.2).[4] It is by using this basis in particular that we can think of variations around a generic model with which to analyse the phenomenology of the modernization of UWSEs. The state of water management in cities is the result of an interaction between the water institutions on the one hand, and the key players in the urban water cycle on the other. Water institutions constrain and regulate the urban water cycle because they deals with collective action issues. Within these institutions themselves, the institutional and sectoral structures that are specific to the UWS in question fit within an institutional environment that helps shape them. In this way, institutions can offer solutions to the coordination problems faced by the key players in the urban water cycle. These players, providers and users all interact as part of the exchange of urban water services, but they also interact with the institutional component. The water institutions therefore act as a constraint or an opportunity for the key players but the latter can, in the long term, have an influence on these institutions in turn, by virtue of the principle of organizational recursion.

The origin of any functional evolution of a UWS is either the static or the dynamics of the system. In this way, the origin of the change is internal to the components of the UWS. A change in the institutional environment can produce an exogenous shock that destabilizes the functioning of the UWS (Saleth and Dinar 2000). Such events as a macroeconomic shock, the ratification of an international agreement or the emergence of an environmental problem could contribute to this type of shock. In fact, the UWS modernization process constitutes an exogenous shock, the consequences of which are observed in this work. Furthermore, an internal malfunction, for example a heavy administrative burden or a coordination problem, illustrated by a contradiction between public policies and property rights, may contribute to the creation of failures within the institutional structure, resulting in the UWS malfunctioning. Finally, readjustments as a result of the urban water cycle are behavioural in nature, in particular due to limited or technical rationality.

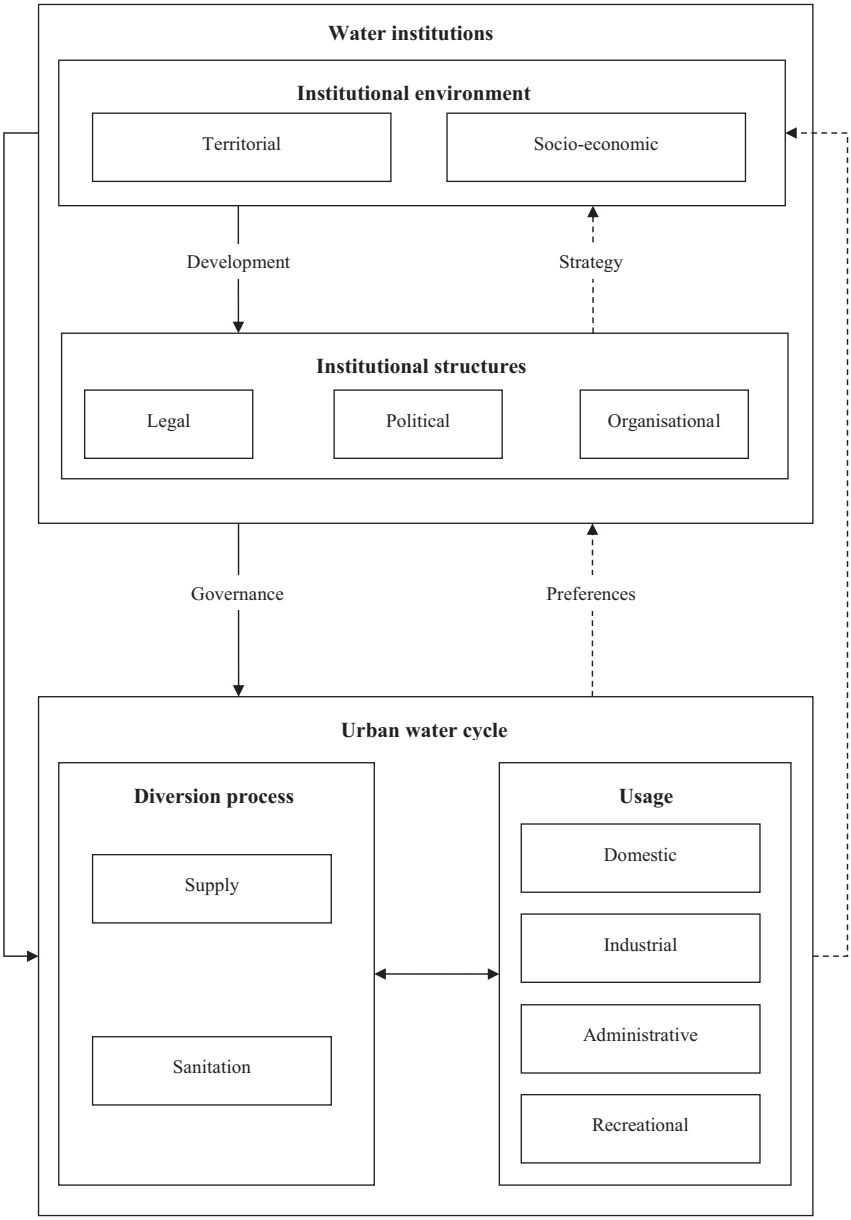


Fig. 2.2 Organic representation of an urban water system (Source: Bolognesi 2014a: 58)

Observing the relationship between its components allows the variations, redundancies and unevenness of the dynamics of the UWS to be identified. As a result of characterizing these observations, the modernization of UWSEs can be dealt with in the form of a collection of phenomena. The formulation of the studied phenomena relies on the systematic understanding of *salient facts*, which are then synthesized as *stylized facts*. Some might perceive these phenomena as a simplification of the complexity of modernization and of UWSEs; however, under the constraint of the research process, this fine tuning is necessary to ensure the clarity and finesse of the characterization. For this same reason, this approach to UWSEs does not cover the notion of the UWS in its entirety. We will therefore focus on domestic usage and the classic technical procedures used to achieve this, and will not distinguish between the different hydrological categories of water resources, thereby not assuming the somewhat confrontational character that can be inherent in a governance process. This chapter will deal with the stylized facts that characterize the organization of UWSEs, in particular the transformation of their components and links.

The Shock of Modernization: Content, Dynamics and the Goal of Reforming UWSEs

The modernization of UWSEs is an institutional evolution of the governance of UWSEs that was essentially driven during the second part of the 1990s by European institutions, then subsequently reflected on a local level by means of a subsidiary principle.[5] It signified a change in the objectives, tools and actors in the governance of UWSEs, and fits into the European political priorities of the time: the implementation of a common market, the harmonization of European policies, the efficiency of the Eurozone and the integration of environmental issues into governance objectives (Maastricht Treaty 1992; Commission européenne 2003; Euromarket 2003; Kaika 2003). Initiated by the signing of the Maastricht Treaty, this new era of European governance has been one of

obedience to neoliberal values. Consequently, the modernization of UWSEs is a process aimed at addressing the problems of collective action by focusing on the functioning of market mechanisms and framing them with reference to general interest.

The modernization of UWSEs thereby corresponds, as in other areas, to a re-regulatory model for systems, rather than a deregulatory model.[6] It is about supporting the increasing reliance on the market by means of a mutation of state intervention, instead of the disappearance of the latter (Finger and Varone 2006; Finger et al. 2007). Policies take into account sectoral specificities, and are aimed at attaining a good level of quality for those services known as services of general interest. In addition, the modernization of UWSEs is a sectoral variant and a specific example of a more general process of modernization taking place in network industries in Europe, which involves the intervention of the state. By way of illustration, when looking at the market organization of network infrastructures, to which the UWSEs belong, the European Commission recalls in its press releases that these proposals form part of a package for 'modernizing public procurement'.

> In December 2011 and as announced in the Act on the Single Market, the Commission has adopted its proposals for EU rules on public procurement. These proposals form part of a comprehensive programme aimed at the in-depth modernization of public procurement in the European Union. (Website of the European Commission, accessed on 27 March 2013)[7]

Ultimately, the modernization of UWSEs is the last project of a general programme intended to modernize European economies and sectors of network infrastructure (rail, telecommunications, energy and postal services) (Finger and Künneke 2011; Euromarket 2004; Finger et al. 2007).

Despite being part of this general framework, the modernization process studied here applies to specific services: the UWSE and services exchanged within the urban water cycle. Modernization modifies the UWSEs and the review process takes into account their singularities. Let us now briefly highlight these differences between USWEs. The first

network infrastructures due for modernization (communication, postal services, energy, transport) provide 'services of general economic interest' and are subject to:

> 'a comprehensive regulatory framework for these services which specifies public service obligations at European level and includes aspects such as universal service, consumer and user rights and health and safety concerns'; this is with the aim of 'improving the smooth functioning of the internal market and strengthening social and economic cohesion'. (European Commission 2003: 10–11)

The services being analysed do not belong to this category, but to that of 'other services of general economic interest', just as the management of waste does, for example. There is no comprehensive regulatory regime at the European Union level that controls these services. These tasks:

> are subject to internal market, competition and State aid rules provided that these services can affect trade between Member States. In addition, specific Community rules, such as environmental legislation, may apply to certain aspects of the provision of these services. (European Commission 2003: 11)

This multiplicity of regulatory sources confirms the polycentric and multilevel essence of UWSEs and their modernization. In addition, the quote allows us to identify two components in the modernization of UWSEs, an economic and an environmental component. The variety of the sources of European regulations implies that these two dimensions of the governance of UWSEs can develop independently of the other, and prove a posteriori complementary or opposing, as induced by the dialogical principle inherent in UWSEs.

In its economic dimension, modernization brings about an opening up of UWSEs to new key players and a modification in the terms of public regulation. Liberalization and the opening up of the deviation process to private operators follows the guiding principles of the report by the European Commission on the liberalization of network industries (1999).

It corroborates the idea of re-regulating the sector and the report shows the need for regulation of network services that is a priori satisfied by the attainment of the seven objectives of the following public policies:

1. To introduce competition wherever this would enhance welfare.
2. To protect customers and suppliers from abuse of dominant positions.
3. To achieve optimal use of costly infrastructure.
4. To ensure that there are adequate incentives to invest, reduce costs, improve quality and innovate.
5. To prevent serious disruptions of service or supply.
6. To ensure the provision of defined levels of certain services at 'affordable' prices (variously known as 'services of general interest', 'public service obligations' and 'universal service').
7. To ensure an adequate level of consumer protection (e.g. complaints handling and dispute settlement).

These general principles characterize the modernization process and apply as far as possible to UWSEs. Indeed, the specificities of UWSEs impede the proper conduct of a classic liberalization of network infrastructures in the urban water sector. Three factors suggest that the water industry will be liberalized in a singular way (Lorrain 2003; Gee 2004; Finger et al. 2007). Firstly, in the case of water, opportunities for introducing competition are limited to winning a contract and benchmarking. To compensate for this specificity, the separation of infrastructure and service builds in a level of additional competition. Next, the absence of major technological innovations reduces the radical transformative potential of the sector. Finally, the perception of water as a resource by consumers is a hindrance to the total liberalization and privatization of the sector. With the risk of rejection high, these measures represent an important political cost for decision-makers.

The origin of the use of the word 'modernization' with regard to UWSEs originates from these sectoral impediments specific to liberalization, insofar as the word means a refutation of the search for a higher degree of competition in the UWSE. Indeed, A. Gee, a member of the 'Competition' division of the Commission, noted that '"liberalization"

is probably not the best approach at this stage', although the principles of competition and transparency should not be discarded. The European Parliament adopted this view and 'called in its resolution on the Green Paper on Services of General Interest for modernization, not liberalization of the water sector' (Gee 2004: 40). For illustration purposes, maintaining the organization of the sector around a vertically integrated incumbent operator is tolerated, while the incentive for de-integration is otherwise strengthened (European Commission 2003). In addition, the economic component of the modernization of UWSEs boils down to two main structural objectives: the limitation of the scope and duration of public monopolies on the one hand, and the implementation of a competitive market on the other. The first objective will be framed by the 'Directive on Procurement by Entities Operating in the Water, Energy, Transport and Postal Services Sectors', which reforms the procedures for obtaining public procurement (European Commission 2011).[8] The second objective relates to the rules of the Common Market and the procedures for introducing a competitive environment.

The second priority of Europe 2020: A Strategy for Smart, Sustainable and Inclusive Growth is 'promoting a more resource-efficient, greener and more competitive economy' (European Commission 2010: 5). Since environmental regulations can affect 'other services of general interest', the modernization of UWSEs supports the economic component and a no less structured environmental component. This second component incorporates environmental objectives, such as the good environmental status of water and the sustainable development of the modernization process of UWSEs. In addition, the management approach towards water is changing; it intends to be more holistic and promote the principles of integrated water resource management (IWRM), whereas, previously, normative acts were only of a very limited scope, and were not linked to each other. Regulation took the form of a system of 'command and control' (Kallis and Butler 2001; Kaika 2003; Allouche et al. 2007).

The modernization of UWSEs is therefore part of a general philosophy of economic and environmental governance. At the same

time, the Water Framework Directive (WFD) sets out legislation specific to the water sector (European Commission 2000, DIRECTIVE 2000/60/EC).[9] Since economic measures are mainly within the purview of other European institutions, as will be illustrated, the WFD focuses on the specifics of the preservation and the protection of the resource[10]:

> The purpose of this Directive is to establish a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater. (WFD (EU, 2000) art. 1)

It adopts an integrated approach to physical and socio-economic issues, an approach that includes ensuring the quality of the resource; in other words, emission control, that is, checking of above-ground emissions and protection of aquifers (WFD (EU, 2000) §40 of the preamble and article 2 §36). By focusing on results rather than the procedures involved in water management, the WFD is radically changing the European regulation mode (Kallis and Butler 2001; Kaika 2003; Bolognesi 2014b). Its aim is to streamline the governance of the sector and to protect resources by way of economic incentives and market mechanisms (WFD (EU, 2000) art. 9). In this way the conservation and restoration of the environment are the other key priorities of European institutions in the modernization process of UWSEs.[11]

Ultimately, the modernization of UWSEs is a polycentric process that aims to modify the ways in which water in the urban water cycle is managed. It is the driving force behind re-regulation of the systems, and is built around three founding principles:

- A rationalization of public procurement;
- Increased use of the market and its mechanisms;
- An awareness of environmental constraints in order to set out a sustainable path for systems.

The level of penetration achieved by the modernization process in UWSEs is determined on the basis of these three principles.

2 Singularization of the European Model of UWS in Global Diversity

The international comparison of the features of the urban water cycle brings up a European peculiarity that we will explore by charting the technical and economiccontours of a European UWS model. Before we place emphasis on these contours, we will first zoom in twofold on the UWSEs in a twofold manner, first of all within a global field and then in a field limited to developed countries (more economically developed countries—MEDCs).

From Global Diversity to European Uniqueness: The Technical and Economic Features of European Urban Water Cycles

The UWSs of developed countries and those of developing countries (DCs) stand out because of the technical methods used for providing services in their urban water cycles (section "Technical Peculiarities of the Provision of Services: Mature and Accessible Infrastructures"). Then, within MEDCs, the comparison of economic variables of water markets s between two groups, one of which is American, and one European (section "Economic Singularities of Usage: High Prices and Relatively Low Volumes").

Technical Peculiarities of the Provision of Services: Mature and Accessible Infrastructures

The deviation process of the urban water cycle is designed to satisfy various urban uses of water (domestic, administrative, industrial and recreational). The characteristics of this process within UWSEs are relatively common to those throughout MEDCs and strongly differ from those of DCs. In DCs, the process of deviation is unable to ensure universal access to technologically advanced services. This failure can be interpreted as a symptom of underdevelopment, something which the Millennium Development Goals (MDGs) are trying to resolve (Nelson 2007).

With the Millennium Declaration (2000), members of the United Nations agreed on eight goals and 18 targets to be achieved by 2015, with the intention of removing people from the situation of underdevelopment. The seventh Millennium Goal relates to environmental sustainability. Integrated in this objective, goal 7.C aims to 'halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation'. This statistical goal is used to measure the difference, in terms of the level of access to services, in the deviation process of the urban water cycle between DCs and MEDCs, primarily for services linked to drinking water and sanitation.

In terms of drinking water supply, access to it in DCs is not as widespread, nor of as good quality as that in MEDCs (Fig. 2.3). In 2015, 98% of urban dwellers in MEDCs had access to drinking water via a private connection to a supply system. In developing countries, this figure falls to 72%. This gap is slowly being reduced. Since 1990, the coverage level of the network has only progressed by one point in cities in developing countries; nevertheless, in absolute terms, this increase has affected more than 1 million people. The reason behind this small improvement can be primarily explained by a rate of urbanization that is stronger than the rate of economic growth in those cities (Varis et al. 2006).[12]

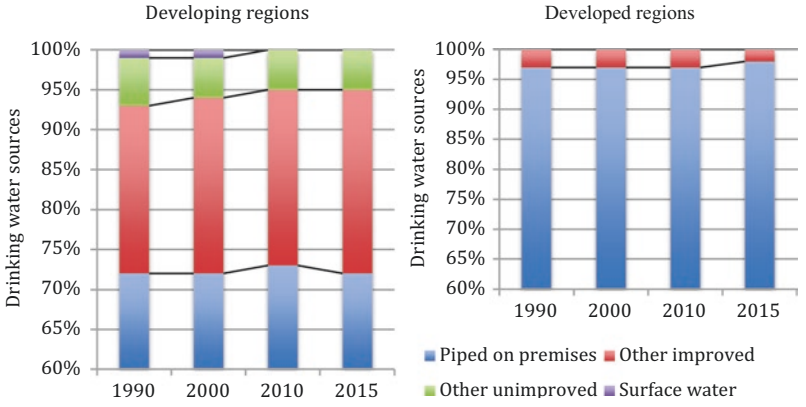


Fig. 2.3 Evolution of urban water supply methods in the world, 1990–2015 (Source: Based on data from UNICEF)

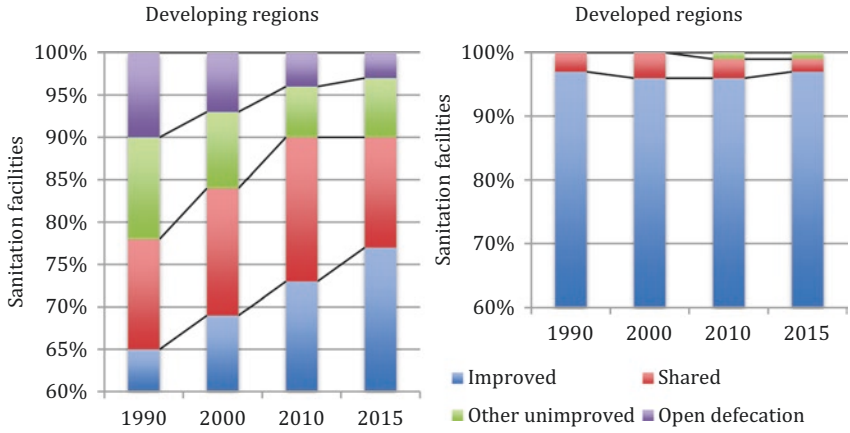


Fig. 2.4 Evolution of methods of urban sanitation worldwide, 1990–2015 (Source: Based on data from UNICEF)

Trends noted in the urban water sanitation sector are the same as those in the drinking water supply sector. Indeed, service provision takes place by means of an infrastructure based on advanced technologies in developed countries, but not in developing countries (Fig. 2.4). In MEDCs, almost all urban dwellers use improved sanitation facilities. By way of contrast, in DCs in 2015, this type of facility was only accessible to 77% of the population and 3% of citizens had no access at all to such facilities, even basic ones. It should be noted however, that progress continues to be made. Since 1990, the coverage level of appropriate services has increased by 12 points.

The technical characteristics of the UWS differ between MEDCs and DCs. The difference is apparent in the deviation process of the urban water cycle. It is related to the first salient fact relating to UWSEs in Europe:

Salient Fact 1: *The technical characteristics of the deviation process in developed countries contribute to the universal provision of services via a mature network infrastructure.*

In UWSEs, the quality of service remains broadly similar across the country. During the eighteenth century, European states paid a part of their tax revenue to municipalities in order that they could enjoy universal access to water (Pflieger 2009). B. Barraqué (1995, 2007) traces the development of drinking-water distribution in Europe and attributes the high coverage rate of the European network at that time to municipalism (Appendix 2). The infrastructure of the deviation process of European urban water cycles is both extensive and ancient. Currently, the supply network covers approximately 878,000 km in France, 530,000 km in Germany and 335,000 km in England (IFEN 2007; German Ministry for the Environment 2011). Just like all principal European cities, 75% of urban pipes in major English cities are over 100 years old (Water UK 2011).

In differentiating MEDCs from developing countries, we started to compile a list of singularities of the European model of UWS. The following section extends the work undertaken in this area by discerning European specificities among MEDCs, in particular regarding the economic modalities at play in the exchange of urban water services.

Economic Singularities of Usage: High Prices and Relatively Low Volumes

The details of the economic features of the urban water cycle of MEDCs give rise to two different models, one of which is American,[13] and one European. The singularities of the two models are microeconomic: the volume and price of using the urban water cycle. These characteristics are important because they play a role in defining the constraints and economic opportunities of the sector, structuring the evolution of the UWS, the exchange volume, price, profitability and so on.

M. Falkenmark and J. Rockström (2004) illustrate the intermediate placement of Europe on the global scale of consumption levels of water (excluding agriculture). According to their data, Europeans are relatively moderate consumers of water compared to other MEDCs. In 2000, their consumption per capita equalled two-thirds of that of Americans.

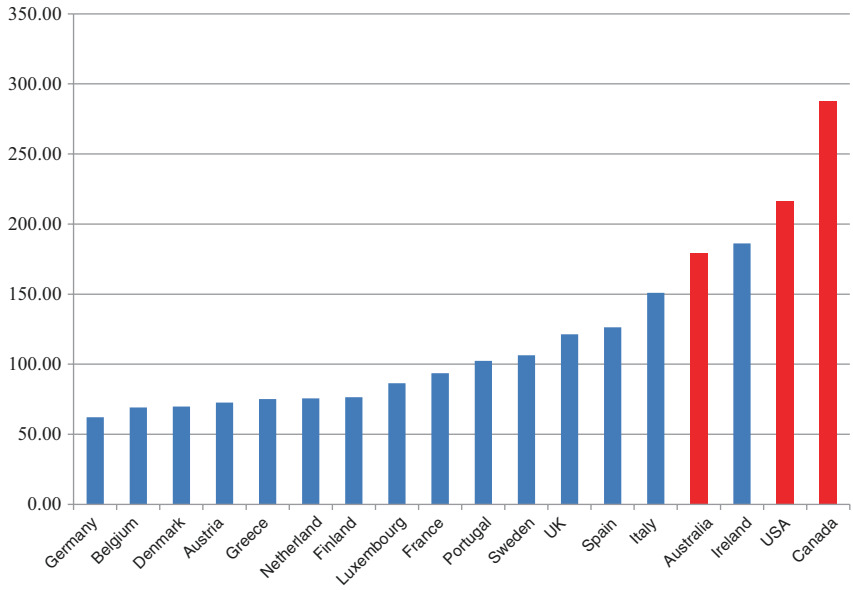


Fig. 2.5 Municipal water withdrawal per capita (total population) (m^3/person/year), 2008–2012 (Source: Based on data from Aquastat http://www.fao.org/nr/water/aquastat/main/indexfra.stm)

Recent data on the annual volumes of municipal water used per capita, collected as part of the Aquastat database, confirm this first observation (Fig. 2.5). They measure the total volume of water drawn through the public distribution system, which may include the proportion relating to industrial users who are connected to the local network. Except for Australia, where values are available from 2000, values relate to the period 2008–2012 of the Food and Agriculture Organization of the United Nations (FAO). This data shows that with 62.15 m^3/person/year, the Germans use the lowest amount of water in the sample. Canada is located at the other end of the sample, with urban withdrawal of 287.40 m^3/person/year. More generally, all the countries of North Americacombined use over 200 m^3/person/year. Average European usage hovers around 100 m^3/person/year, which is less than half of American water withdrawal. This low level of usage is explained by the historical scarcity of the resource compared to population density. Thus, in terms of volume of usage, the European urban water cycle differs from that of North America.

Box 2.2: Evaluation of Volume of Usage

Water usage is the notion of water needs transposed into economic terms. (Gleick 2003). Water usage is the mobilization of resources in light of certain purposes. In the UWS, we retain four of them: domestic, decorative, industrial and administrative. The demand thereby reflects the amount of water that a buyer acquires at a given price. There are two coexisting meanings of demand. The first—the traditional meaning—includes demand for supply and drainage of water. The second, in its broadest sense, refers to the volumes that are collected and returned to the resource system.

The traditional estimate of demand therefore turns out to be somewhat difficult to achieve. Indeed, although MEDCs widely use a wet meter in order to manage demand in terms of supply or drainage, some populations does not have them.[14] For example, in England, many homes do not have a water meter since the price of water tariffs, which are included in local taxes, depends on the living area and not the volume consumed. In addition, because of high installation prices, many new households do not want to have a meter (ABS 2010). At a global level, however, a broad understanding of the demand can be measured more easily. In addition, as the estimated gap between net total consumption and water withdrawal varies from 5% to 15% in urban areas (Aquastat[15]), the selected variable reflects the subject of the study reasonably well. Thus, in order to account for the volume of urban uses of water, we observe volumes withdrawn as a result of urban water demand.

Despite this, collection and interpretation of data remains difficult. 'Compared with data on the hydrologic cycle, such as rainfall, runoff, and temperature, data on water use are inadequate and incomplete, and pressures are growing to cut back collection for financial reasons' (Gleick 2003: 281).

If in substance this statement remains true, it should be noted that, since 2003, in terms of UWSEs, data on water and its usage has developed considerably, in particular due to the impetus provided by WISE. This increase in the amount and quality of data has led to the modernization of UWSEs, particularly pursuant to the first two pillars of that process, which relate to the methods of coordination. This information assists with the rationalization of water management in UWSE.[16] However, given that the initiative of producing and sharing common information is recent and that there is still work to be done, the statement by Gleick still remains pertinent.

There are four main difficulties regarding access to reliable data. Firstly, systematic collection of data remains rare. The majority of data deals with the hydrological condition of the resource and not what it is being used for. Next, a proportion of usage or needs is not measured or is not quantifiable. For example, an evaluation of recreational use or ecosystem services would be faced with serious methodological and

practical problems A third difficulty lies in the strong regional disparities in terms of the quality and quantity of the data. Finally, numerous pieces of data are estimated rather than actually measured. Added to that is the fact that this present analysis is equally confronted with issues of comparability. In fact, we wanted to compare different towns throughout the world, but there is as yet no useful harmonization of definitions or calculation methods between the different indicators in the existing data. In order to better deal with these difficulties, the only works that can be used are those of M. Falkenmark and J. Rockström (2004), and the Aquastat database. The pioneering study by Falkenmark and J. Rockström posits methodological bases that still make reference to water usage in terms of international comparison. The FAO Aquastat database is the only one to date that identifies urban withdrawal volumes in the different countries of the world.

Box 2.3: Evaluation of the Price of Water

When it comes to comparing the price of water in MEDCs, even greater difficulties are encountered than those related to the volume of the demand. Little data has been publicly released and there is a high cost of self-conducted studies. The existing studies also present a real problem of comparability given that different methods of calculation have been used. By way of illustration, the study on the price of water and wastewater published by the OECD in 2010 contains no less than seven different methods of calculation, besides the different exchange rates used by way of parity of the purchasing power of the dollar. The method used to conduct the investigation and analyse the data of the aforementioned study recognizes that (OECD 2010: 34): '(i) pricing, cost and other relevant data on water-related services is fundamentally local, that any aggregation or averaging exercise implies a loss of information; (ii) choices regarding sampling and aggregation affect national values; and (iii) extreme care should therefore be taken in proposing cross-country comparison on such variables'.

For three reasons, our analysis nonetheless makes use of it. Firstly, among the studies available to date, it takes into account the most comprehensive number of countries. Next, the historical tracking spans 10 years, almost going back to the start of modernization. Finally, the authors of the study are aware of these difficulties, which is why they discuss and report the parameters limiting the comparability of estimates in order to finally reprocess the data, thereby allowing a rigorous international comparison to be made.

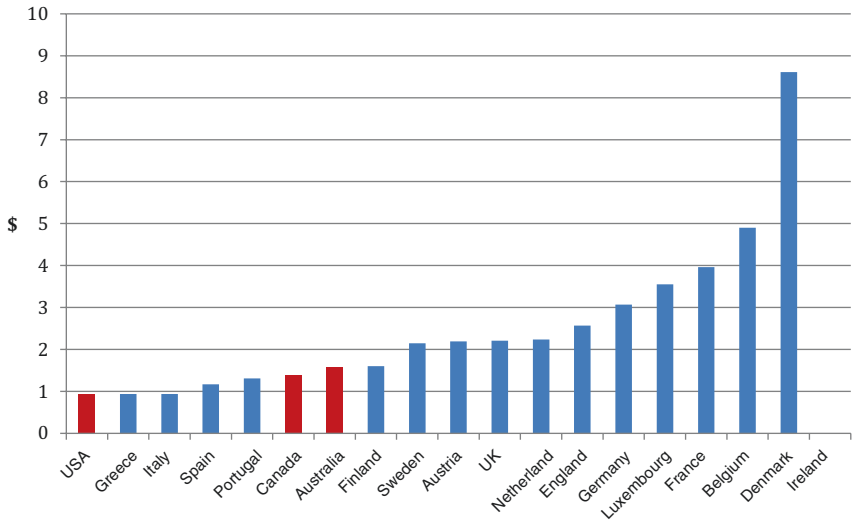


Fig. 2.6 Price of a cubic metre of water supplied to households in developed countries, in USD Public-Private Partnereships (PPP) in 2008 (Source: Based on data from OECD 2010)

Figures 2.6 and 2.7 respectively show the price of supplying the service and the total price of water applied to households in MEDCs.[17] Again, the average in European countries is different from that of America. The data indicates that the price of a cubic metre of water in America is close to $1. In Europe, only the Mediterranean countries function at this level. For the others, the price of a cubic metre exceeds $2, increasing to $8.61 in Denmark. In this way, the average price of water in Europe amounts to $2.76 per cubic metre, making it worth almost three times the value of a cubic metre on the US market. An observation of total costs (supply and sanitation) delivers the same result. Indeed, the average price of a cubic metre in America, about $2, is half that for water distributed in Europe, where the equivalent is about $3.50. Once again, the Mediterranean countries offset the high Danish prices, dragging the average down. The price distribution of water in MEDCs underlines the uniqueness of the European model of UWS, by distinguishing Europe from North America.

By combining prices and quantities, we can see that the water bill paid by European households represents two thirds of the bill received

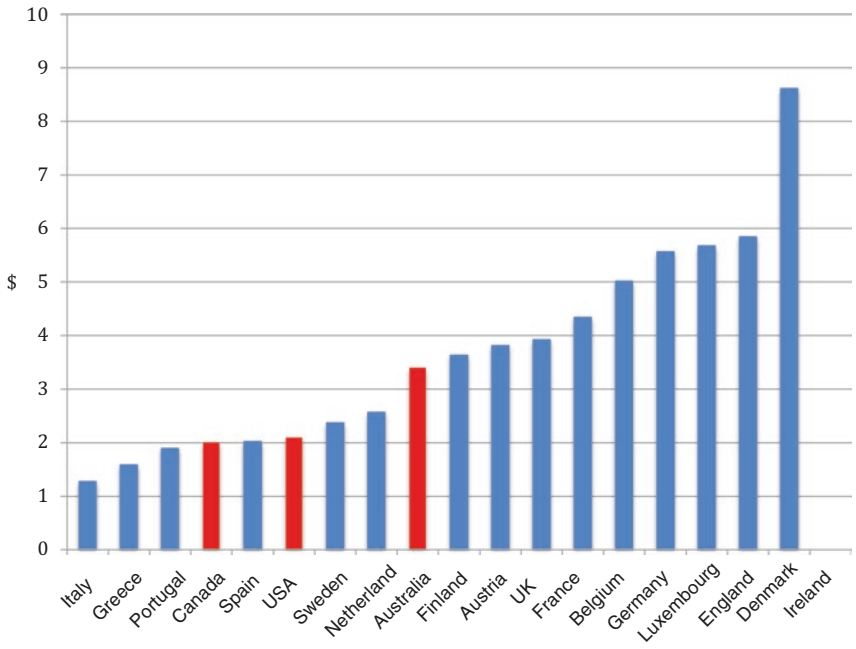


Fig. 2.7 Total price of a cubic metre of water supplied to households in developed countries, in USD PPP in 2008 (Source: OECD 2010)

by US households (Fig. 2.8). Average annual bills amounted to $316 in Europe and $516 in North America during the year 2008. Canadians consume on average $577 worth of water per year, while in half of European countries, the consumption of water accounts for less than $300 in the budgets of city dwellers. Thus, despite a relatively similar deviation process, there is a real difference in terms of structure between the European and American urban water cycles. This demarcation of the two models is established by using the economic dimension of urban usage.

By way of summary, Diagram 2.8 represents the water bill distribution of users of UWS in the countries of the OECD. As an isoquant represents all pairs, then by price and quantity, giving a set value, there are two advantages to this diagram. Firstly, it allows a comparison to be made between the amounts of the bills relating to the degree of

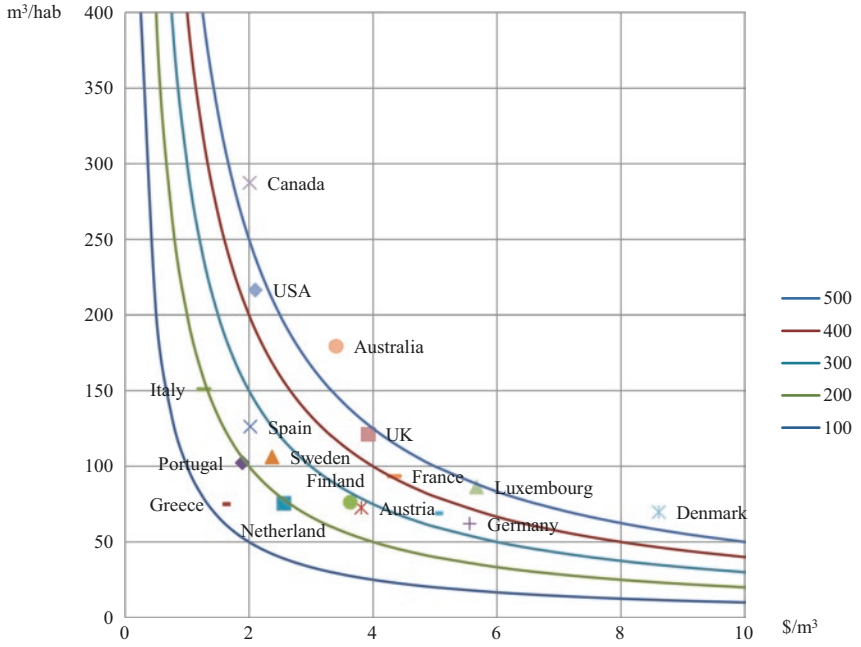


Fig. 2.8 Estimate of the average water bill in America and Europe in 2008 (Source: Created by the author using the Aquastat database and data from the OECD 2010)

remoteness of the point of origin and through the different isoquants. Secondly, it allows the composition of the bills to be compared, because every point is a price–quantity exchange pair in the UWS. The singularities of the European model are therefore brought together in this diagram, in which we see that the 'collection of volumes consumed', is particularly noteworthy: the European countries are concentrated around 100 m³/person. Moreover, the figure looks like the classic market relation between supply and demand, plotting an inversely proportional evolution of prices and quantities. It should be noted that the points are exceptions to the rule, which only serves to confirm the relevance of an institutional approach and the singular understanding of the services provided within the UWS (Shaw 2005; Hanemann 2006). Exceptions, such as Greece, Portugal and Spain for example, demonstrate that the

market does not itself fix the level of the variables of exchange of an urban water cycle; other parameters and regulatory mechanisms such as those of the market must therefore be taken into account.[18] OECD (2010: 45) therefore notes that:

> The data shows large discrepancies across countries: prices can vary from a factor of 10 or more. This derives from differences in the cost of provision of the service. This reflects policy choices as well.

On the basis of this international comparison of urban water cycles, we can thereby specify the features of UWSEs.

Salient Fact 2: *The microeconomic features of the urban water cycle differentiate the European model of UWS; with relatively moderate consumption and relatively high prices, the average per capita water bill is equivalent to 2/3 of that of the American model.*

Macro-specificities of the European Model of UWS: Common Characteristics of the Institutional Environment

We have just illustrated the specificities of the water supply in terms of price and volume, outlining the urban water cycle in Europe. We are now going to focus on the institutional characteristics of UWSs, particularly at the level of the institutional environment. Given that the institutional environment is structural and moves to a very slow dynamic, we will not study the direct impact of modernization upon it. Instead, we will consider that the institutional environment is, to a certain extent, a fixed entity and constitutes a set of constraints and opportunities to which any implementation of modernization must conform.[19] The analysis conducted here divides the institutional environment of the UWS in two parts.[20] The first describes the territory of the UWS (section "Jurisdictional Dimension: Gargantuan Urban Fabric and Artificialized Land") and the second their socio-economic organization (section "Socio-economic Dimension: The Importance of the European Rule and

the Use of Market 'Laws'"). The territory is analysed using three different scales: macro (geophysical structure), meso (urban systems) and micro (urban form). The presentation of the socio-economic organization of UWSEs follows the same logic, ranging from the larger (supranational) to the specific (sectoral).

Jurisdictional Dimension: Gargantuan Urban Fabric and Artificialized Land

The composition of each UWS is affected by the structure of the urban fabric in which it is integrated. In fact, it helps to define the constraints and means facing each UWS when organizing service provision. In order to identify some of these territorial characteristics, we conducted a comparison of all cities that have more than 750,000 inhabitants as identified by UN-Habitat in 2008 (Bolognesi 2015). These 595 cities have been studied through the lens of 31 variables that reflect the different realities of the territories: economic, demographic, geographic, climatic and hydrological. This basis allows a comparison to be made between the different cities of the world in terms of their structural dimensions. The underlying trends of the dynamics of cities and therefore the territorial dimension of the institutional environment of the UWS emerges from this analysis. A multivariate analysis of the constructed base enables the territories to be differentiated from each other in accordance with three structural characteristics, which are, by order of statistical significance: level of maturity, degree of artificialization and the degree of centrality (Bolognesi 2015). The first characteristic relates to the level of development, the second to the spatial structure and the third to the centrality of cities.

The first factor, accounting for 33.4% of the total variance, is the *maturity level* of the development of the country and the place of the city in this development, as well as the role of the city in the urbanization phase of the country. It measures the ripple effect of the cities on national development. The second factor, the *degree of artificialization*, accounts for 29.8% of the total variance of the sample. It provides an excellent representation of the variables informing usage and land cover of a

catchment area, for example: density, or the proportion of the land dedicated to agricultural or industrial activities and so on in relation those areas untouched by human encroachment. This factor gauges the extent to which the catchment area is used by humans and quantifies the artificiality of the territory. The more the value assigned to a city rises, therefore, the more human activity has changed its territory, making it artificial. The *degree of centrality*, the third factor in the analysis, accounts for 18.8% of the total variance of the sample. It gives rise to an excellent projection of variables describing the cities (size, weighting of the city in terms of national population, and so on). This factor measures the degree of centrality of each city, that is, the weighting factor throughout the country.

Six *regional urban models* emerge from the distribution of the sample cities according to these three factors: African, Asian, Russian, North American and European (the latter including both Western and Eastern Europe). African cities are located in less-developed countries and occupy catchment areas that have been preserved by human endeavour, low degree of artificialization. Equally, in terms of less-developed countries, Asian cities are located in modified catchment areas. Russian cities are in a developed country and are not central. North American cities are found in the same quadrant as Russian cities, but have the added benefit of a greater level of development. Finally, European cities are in their own quadrant. They are central and can be found in artificial territories within developed countries. These characteristics are more pronounced in Western Europe than in Eastern Europe. By means of appropriating the quadrants taken from European cities, we have been able to deduce the third salient fact.

Salient Fact 3: *The territorial structure of the institutional environment of UWSEs is unique in that it combines high levels of development, the artificialization of land and centralized cities.*

Corroborating the notion of the role of artificialization of land in the institutional environment of the UWSEs, control of the land appears to be a major concern for the development of European societies.[21] For example, during the eighteenth century, European land was modified to

promote human development. To this end, in France, the Decree of the 14 Frimaire year II (4 December 1793) was passed on marsh drainage in the Republic in order to prevent mosquitoes from breeding and thereby the diseases that they carry, and to develop agriculture in order to provide food for the booming cities (Mathevet 2011). The second pillar of the Common Agricultural Policy illustrates the perpetuation of this process of artificialization. In fact, it recognizes the multifunctionality of agriculture and assigns farmers the role of maintaining nature. It presupposes that the latter requires human intervention in order to remain in a good condition. By way of contrast, in the USA far more attention is given to the creation of large-scale national parks that limit any human footprint by implementing programmes such as 'Leave No Trace'. It is for this reason that American catchment areas have low degree of artificialization.

Now let us focus more closely on the French, German and English territories, the case studies developed in this work. The French territory, which is heavily artificialized, has a small number of mature cities, organized in accordance with an extremely hierarchical centre–periphery model around Paris, with the capital standing out from other megalopolises in the country. The degrees of maturity and anthropization, in fact, prove to be homogeneous in the territory, respectively 1.23 and 0.87, with Paris reaching 1.28 and 1.08. The level of centrality is zero with the exception of Paris, which reaches 1.60, a high value in relation to the overall sample. This gap characterizes the strong urban asymmetry of the territory. In Germany, the centre–periphery structure is far less obvious. The territory is polycentric and relatively homogeneous, with a centrality indicator oscillating between –0.02 and –0.04. There are lower values for the level of maturity than there are for France, at between 0.60 and 0.96, as opposed to the degree of anthropization, which is bracketed between 0.87 and 1.24. The English territory cannot be taken into account in this analysis for there are no large catchment areas in England. According to existing literature and our data, England is a territory where the urban network is monocephalic and does not follow Zipf's law. Indeed, London occupies a very central place, creating an extremely clear dissymmetry within the urban grid (Cristelli et al. 2012). Equally, the cities are relatively dense and it is possible to distinguish three population centres:

the principal one is around London, the second around Liverpool and Manchester, and the third around Birmingham, which is situated between the two aforementioned centres (Arcaute et al. 2015).

The results of the analysis by D. Jenerette and L. Larsen (2006) support this theory by identifying a growth in territorial control of European cities. These analyses assess the water footprint of urbanization in different regions of the world. The water footprint allows the ecological footprint to be used as an approach when discussing water (Wackernagel and Rees 1996; Folke et al. 1997). This approach calculates the link between human activity and its ecosystem by estimating the surface required to provide sustainable ecosystem services (Wackernagel et al. 2002; York et al. 2003).[22] D. Jenerette and L. Larsen calculate the surface area necessary to meet the usage of water in cities with a population of more than 750,000. According to their estimates, the urban footprint is increasing worldwide. Rated on average at 29,937 km^2 per city in 1950, it spanned 35,397 km^2 in 2000, which is a growth of 18%, and was estimated at 38,400 km^2 in 2015, an increase of 28% compared to 1950. Globally, the expansion of the water footprint of megacities is accelerating. In regional terms, Indian and Chinese cities had the largest footprint in 2015, while European cities were in the lower average. However, given that European urban network grid squares are tighter than elsewhere, European megacities mark the whole of the Western European territory with their water footprint. Thus corroborating the previous classification, the European territory is more artificialized than territories in other regions of the world, with the exception of China and India. This structure affects the types of problems that need to be regulated by the UWSE because the levels of artificialization of the land, for example, and of water risks such as floods and droughts, are positively correlated (Haase 2009; Bolognesi 2015).

On the meso level, the degree of centrality of cities emerges as an essential concept in urban characterization (Gibrat 1931; Christaller 1933; Pumain 2006; Huriot 2009). We have emphasized the high degree of centrality of European cities. This means that a centre–periphery structure prioritizes territory. Just like Lisbon, Vienna and Paris, which are among the 15 cities that are the most central to our analysis, the European urban fabric is characterized by macrocephaly. It consists of a small number

of large cities constituting important national centres and many small and medium-sized towns that lie close to each other (Wackermann 2000; Carrière 2008). 'When it comes to an urban population 30% greater than that of the USA, the only European agglomeration has three times the number of built-up areas with more than 10,000 inhabitants (3500 compared to 1000)' (Cattan et al. 1994: 23). Due to the large number of towns and their close proximity, Europe is therefore characterized by the high density of its urban coverage (Le Galès 2011). Finally, the different urban systems of Europe do not harmoniously distribute the cities in accordance with Zipf's law (1949), in contrast to systems such as that of urban America, for example.

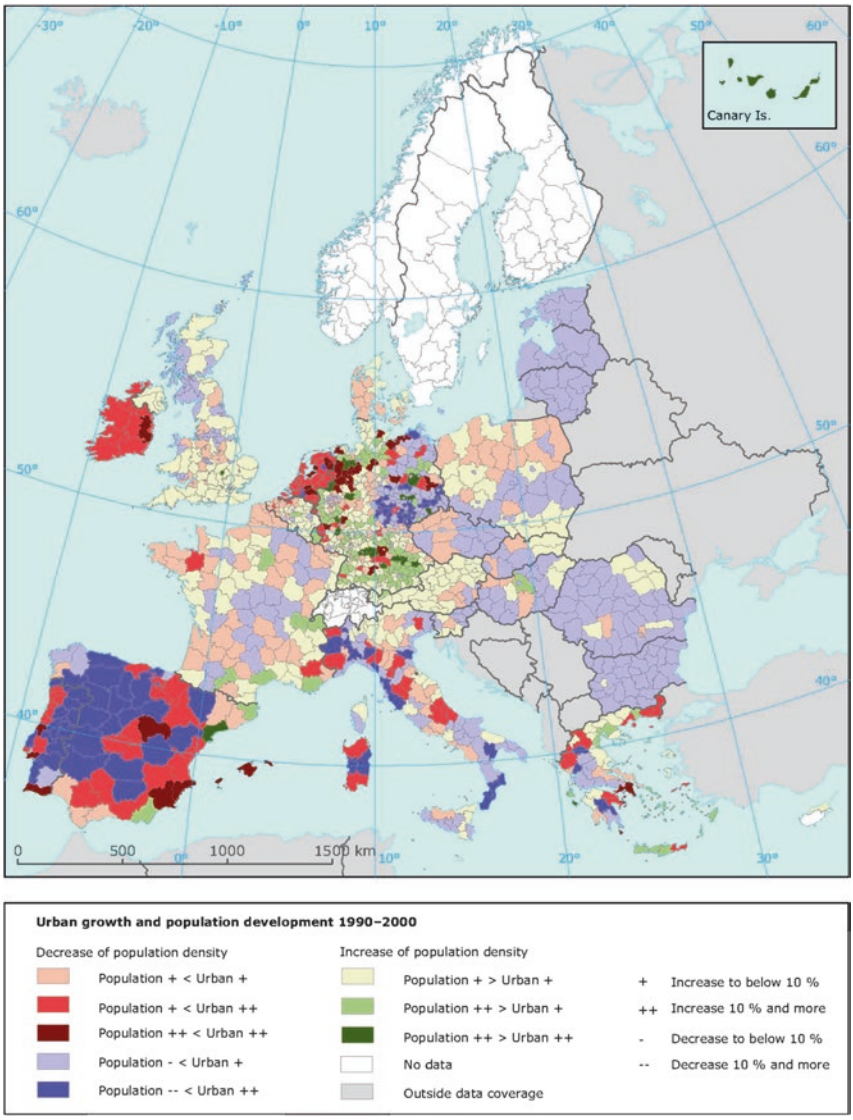
The structuring of the European urban system confirms the hypothesis put forward by Le Galès (2011) in *Retour des Villes Européennes* (Sassen 1991; Bretagnolle et al. 2000; Pumain 2006), which defends the idea that the European urban preserves its form over time with a dense network of cities of an average population size of between 200,000 and 1–3 million. This is how those cities important during the Middle Ages still remain centres today. Next, because of this stability and the gargantuan character of the system, European cities have won their autonomy from the state when it comes to managing local affairs. However, they do not stand in opposition to national power. We will now see that the structural characteristics of the European urban system have an effect on the management of UWSEs, in particular at the level of division of responsibilities in the polycentrism of those key figures involved in governance.

An analysis of the territory of UWS on a micro level focuses on the urban form. Since developments in the recent dissemination of satellite data (NASA, Global Land Cover Facility), the typical urban form of different regions of the world can now be observed. Quantitative methods can then be mobilized in order to describe and classify those urban forms being analysed. This new information refines the opposition between the sprawling American city and the somewhat more compact European city (Ewing 1997; Brueckner 2000; Johnson 2001). Much of the work concentrates on developed countries and urban sprawl; R. Wassmer (2000) presents the methodological framework that is most often used to measure and compare this phenomenon. Then, indicators are constructed in

order to capture different facets of the phenomenon (Galster et al. 2001; Arribas-Bel et al. 2011) or allow its measurement, in particular in the USA (Torrens and Alberti 2000; Ewing et al. 2002).

We have identified two reasons why secondary literature primarily concentrates on the urban sprawl of the USA and only recently has considered those instances found in Europe. First of all, the process is both very old and significant in the USA. As a result of this, and the link between NASA and various research organizations, there has been a strong and steady output of data characterizing this phenomenon. T. Nechyba and R. Walsh (2004) have analysed this data and demonstrated that a reversal of the distribution of the American urban population took place between 1950 and 1990. In fact, over this period, the figures went from 65% in city centres and 35% in suburbs to 20% in city centres and 80% in suburbs. At the same time, the area occupied by the suburbs increased by 250% and the population density in city centres fell by 25%, from 10,000 inhabitants/km^2 to 6000 inhabitants/km^2. Strong economic growth, the development of infrastructures that required car travel and the expansion of residential areas were all key factors contributing to this development. At the same time, European cities did not benefit from the same type of expansion. They remained marked and moulded by war, engaging instead in a process of reconstruction that saw public transport ensuring mobility within cities. By way of illustration, the number of cars in relation to the number of households in Germany in 1970 was the same as the number in America in 1920 (Glaeser and Kahn 2003).

However, since the beginning of the 1990s, the phenomenon of urban sprawl has spread throughout Europe (European Environment Agency 2006). Between 1991 and 2001, the space occupied by European cities has grown on average by 7.46% while their population has only increased by 0.34%, (Patacchnini and Zenou 2009). Urban sprawl does not affect all parts of Europe in a uniform manner. The map drawn up by the European Environment Agency (EEA) (see Map 2.1) shows that the quartile of cities with the greatest populations is also the quartile that tends to see its inhabitants leave, –1.05%, and its areas stagnate, 0.30%. Conversely, cities of the other quartile, who see a weak swelling of population of 2.47%, see strong geographical developments of 23.28%. Finally, it should be noted that Western Europe



Map 2.1 Detail of urban sprawl in Europe during the 1990s (Source: European Environment Agency 2006: 15)

can be divided into two zones, depending on the intensity of the ongoing urban sprawl. On the one hand, there are the cities of the north, which are already large in size and which experience little evolution; shrinking East German cities are perfect illustrations of this phenomena, with cities dwindling and contracting. On the other hand, cities found in the south of the zone, which were originally smaller, now appear to be very dynamic.

The work of J. Huang et al. (2007) synthesizes the various debates regarding sprawl and urban form before proceeding to propose a characterization of the internal structure of cities to highlight distinctive traits other than the existence or not of a tendency to sprawl. Finally, Huang et al. present a global characterization of cities based on up-to-date data and, as with the result of our multivariate analysis, they identify regional profiles in which the EU-15 occupies a unique place. Five criteria are retained: the complexity, centrality, compactness, porosity and density observed in each city. Complexity measures the level of irregularity found in the outline of the city; centrality refers to the centrality of the degree of proximity between the urban fringe and the inner city[23]; the compactness is the fragmentation of the urban landscape; porosity is the ratio between open space and urban areas; and density is the population density of the city.

The results demonstrate a clear divide between those cities in MEDCs and those in developing countries. The cities in MEDCs are the most complex, being less compact, more porous and less dense in nature. These groups are then subdivided into three subgroups for the MEDCs (USA, Australia/New Zealand, Europe/Japan) and into two for the developing countries (Asia, Latin America). Again, a European profile emerges that is more compact, dense and regular than that of American cities. The levels of spatial centrality and the porosity of European cities, however, do not reach those levels found in American cities. These results indicate the initial diagnosis.

Salient Fact 4: *European cities are characterized by their compactness and have only recently developed in terms of structure under the impetus of urban sprawl.*

Observing the territorial aspect of the institutional environment of UWSEs therefore highlights the singularity of the European model. The territory of UWSEs is artificialized and the cities, with their important political role, gradually spread out. Now, we must address the socio-economic dimension of this environment, which is related to the organizational structure of governance.

Socio-economic Dimension: The Importance of the European Rule and the Use of Market 'Laws'

The socio-economic component of the institutional environment consists of the political and legal systems of the country as well as the strategies employed for economic development. Firstly, any commonalities in the characteristics of these European political and legal systems are shown. Next, economic development strategies are discussed insofar as they are of relevance to the water sector.

European states are led by democratic governments, many of which use different ways in which to organize powers. For example, Germany is a federal parliamentary republic, whereas France is a semi-presidential republic and England has a parliamentary monarchy. In order to clarify the specifics of governance of European states, it is necessary to elucidate the expression of power beyond this democratic character. In building its 'Institutional profiles' database, the French Agency for Development (AFD) has therefore developed a tool for a cross-country comparison of systems and methods of governance of states in a non-prescriptive way. The authors of this project do not prejudge the existence of good institutional standards, but recognize the diversity of institutional frameworks and their quality. What is highlighted is the capacity of institutional frameworks to evolve according to their context, risks, and opportunities (Meisel and Ould Aoudia 2007: 9).

The authors adopt the most generic definition possible to erase any deterministic bias. They return to the definition put forward by the World Bank (1998), itself inspired by the work of D. North (1990), where institutions take the form of a formal and informal playing field that structures incentives based upon which individuals adopt certain

behaviours. The only institutions taken into account are those related to the economy, economic policies and political economy. This approach corresponds to our ontology of UWSEs and the aim of our the research; in other words, a characterization by way of an international comparison of UWSEs perceived from an institutionalist perspective and with the intention of representing, in a phenomenal form, their modernization as an institutional evolution.

The AFD database includes 85 countries and 356 variables. Three surveys, conducted in 2001, 2006 and 2009, provided guidance on the variables, which are then grouped into nine institutional functions:

- political institutions;
- security and public order;
- functioning of administrations;
- freedom of market conditions;
- coordination of key players and expectations;
- security of transactions and contracts;
- market regulation and corporate governance;
- outward-looking;
- cohesion and social mobility.

By conducting a multifactorial analysis of the sample, it was possible to extract the main components of the institutional systems, positioning the country on the diagram that was created. This analysis took into account two factors. The first distributes the countries according to the extent to which their control systems are regulated, and the second according to the relative role played by the state with regard to social, economic and political regulations.

The first factor explains 35% of the total variance of the sample and the fact that European countries get a high score. This is the foundation for the fifth salient fact.

Salient Fact 5: *European countries enjoy a style of governance that is based on very formal regulatory systems.*

What is meant by this is that the written, or formal rule constitutes the principal tool in European regulatory systems. In this respect, European countries are at the opposite end of the spectrum from countries such as Mauritania, on the far left of the axis, where regulation predominantly comes in the form of informal rules (traditions, values, illegal actors and so on). This same constant holds true for a global comparison. A focus on Europe allows two groups to be defined. The first brings together Anglo-Saxon and Nordic countries, based around a focus on stronger measures and the importance of formal rules (Germany, the UK and so on). The second, more associated with weaker measures, is indicative of the Mediterranean countries (Italy, Spain, Greece), whereas France occupies the middle ground.

The second factor moulds the centralized character of the regime and accounts for 9.5% of the total variance of the sample. Countries that are ruled by dictatorships get high score, such as Iran or Cuba. In contrast, countries characterized by anomie, as in the case of Bolivia or Benin, get a low score. European countries are not found at the extremes and instead oscillate around the intercept. Norway, Germany, France and Sweden have a positive intercept, while it is negative for the other European countries. Despite that spread in the diagram, the group forms a homogeneous whole. In Europe, the role of the state is important, but not all-important, and the democratic character of European countries explains the position they take up in the middle ground. This is why there is a division of responsibilities in Europe between the different clusters and key players in society. In fact, like the role of civil society, other forces than those of the state participate in the development and implementation of governance. This results in the following salient fact.

Salient Fact 6: *A strong polycentric and multilevel character shapes the organization of governance within European countries.*

The intersection of the two axes establishes a typology of the modes of governance split into four quadrants: informal authoritarian, informal fragmented, tempered liberalism and pure liberalism. According to the

general classification of the authors, European countries fall into the liberal quadrants. In particular, the Mediterranean and Anglo-Saxon countries combine a high degree of freedom with formalized rules. They are located at the bottom right of the diagram and can therefore be found in the pure liberalism quadrant. The German, French and Nordic systems take the form of tempered liberalism; in other words, public mechanisms to protect citizens are accompanied by a high degree of formalized regulation. They appear at the top right of the diagram. This distribution is echoed in the literature on the diversity of capitalism (Albert 1991; Amable 2003; Lorrain 2005) and constitutes the seventh salient fact.

Salient Fact 7: *In Europe, governance follows a liberal model, which gives rise to a variety of enforcement methods ranging from a tendency towards pure liberalism (Mediterranean and Anglo-Saxon systems) to moderate liberalism (German, French and Nordic systems).*

This moderate importance of the role of the state is explained in part by the implementation of multilevel and polycentric governance. This structure is structured around four main levels: supranational, national, regional and local. Rules are set at the supranational and national levels, while the responsibility for implementation is delegated to the regional and local levels. The initial level of management is therefore communal in UWSEs but, for those in the Mediterranean area, managers reinforce the regional level. Indeed, the variability of the climate complicates the balance between supply and demand. Regional supply management thereby allows variations in volume to be smoothed out. Just like the case of the Provence canal, which is not under the control of the Société des Eaux de Marseille (a water-distribution company), a regional water supply system adds to the urban infrastructure. Organizing the management of water is a pragmatic endeavour.

The polycentric and multilevel character of governance gives rise to a range of variations on the European model, with each UWSE implementing a solution contingent upon the problems of collective action. These may manifest themselves beyond the scope of the open water cycle. Massardier (2011) illustrates the disjunction between the

top-down standards produced at a European level and the local, cobbled-together institutions that put them into practice.

Let us dwell on this point because it represents an essential perspective in analytical and methodological terms. Firstly, Massardier (2009) validates the relevance of the form of UWS that is based on ontological principles (cf. section "The Urban Water System: A Uniting Representation of Municipal Water Management"), whilst emphasizing the importance of institutions (axiom 2) and the polycentric and multilevel form of an UWS (axiom 3). The idea of disjunction between two components—on the one hand, 'a European machine' and, on the other, 'multiple territorialized concoctions' who *translate* the result of the first—refers to the premise of the idea of complex systems: various components interact, in order and disorder, to organize the system. Since our ontology is a complex system, it is necessary to go further in the identification of this disjunction by means of dialogic (complementarity and antagonism) and holographic principles (the singular is in everything and everything is within a whole). These analytical assessments that are based on empirical observations reinforce the relevance of the chosen methodology. In fact, looking at modernization from the point of view of phenomena established by means of international comparison, before explaining it in the second part of the book, is necessary because UWSEs have 'different communal characteristics'. In other words, UWSEs have a lot of common features, their differences are variations between these common features. A comparative approach therefore allows the regularities and irregularities of the modernization of UWSEs to be highlighted in such a way as to capture the essence of the process:

> If you compare them overall by voluntarily reducing the details that would make the comparison impossible due to the excess of uniqueness, it becomes possible to identify regularities; they follow the contours of internally coherent sets that are capable of transformations, but are based on a number of invariants. (Lorrain 2005: 234)

Therefore, because of the increase in European regulations, the supranational level is an increasingly important hub in the polycentrism of the governance of UWSEs.[24] European states transpose the regulations

decided by the European Community authorities into their own national legislation. On 6 May 1968, Europe proclaimed its first charter on water (Table 2.2). Since then, European regulations have broadened in scope, taking into account specific challenges related to water (agriculture, quality, technology and so on) but in particular by proposing rules known as procedural rules. The objective is to create a set of common means that are able to respond to the various problems. This is why, in 1991, Directive 462 established guidelines on the pan-European management of water, and the charter of 2001 updated that of 1968. The Water Framework Directive (WFD) of 2000, amended in 2001, 2008 and 2009, set out the basic principles for the management of water in Europe: integrated management through the catchment area, transparency, PPP, and so on. Its philosophy is part of an anthropocentric approach to sustainable development. The WFD therefore essentially aims to protect the resource in both a quantitative and qualitative manner, whilst ensuring that the efficiency of the sector is not sacrificed.

At a European level there have been three successive generations of regulation (Allouche et al. 2008). The first generation (1973–1988) allows for rules that protect the quality of water used by humans. Notably, it includes standards on drinking quality and thresholds for polluting substances. Then, second-generation regulations (1988–1995) imposed measures in pursuit of these objectives, but concentrating on specific domains (urban waste water, and so on). They established the 'command and control' type of regulation. Finally, the current generation of regulations (1995 to present) have completely reversed these paradigms and instead advocated integrated management of water resources (IWRM). This relies heavily on the WFD. Because of this reversal and the impact of the WFD, this third generation of European regulations is considered to be the principal constituent of the current socio-economic institutional environment that is common to UWSEs. In fact, it structures the regulatory framework within which the institutions of UWSEs are evolving, in addition to establishing the general organizational principles of the management of water in Europe.

The WFD radically changes the European mode of regulation because it focuses as much on results as on the processes used to manage the water

Table 2.2 Principal normative act regarding water enacted at a European level

Text	Year	Purpose
First generation		
European Water Charter	1968	The first charter on water
Directive 75/440/EEC	1975	Surface waters
Directive 76/464/EEC	1976	Hazardous substances
Directive 80/68/EEC	1980	Groundwater
Directive 80/778/EEC	1980	Quality of water intended for human consumption (revised by 98/83/EC)
Second generation		
Directive 91/271/EEC	1991	Urban waste water
Directive 91/462/EEC	1991	Guidelines for a pan-European water resources management policy (supply and quality)
Directive 91/676/EEC	1991	Nitrates from agricultural sources
Recommendation 1224	1993	Protection and management of freshwater resources (originally under the 'Blue Europe' action programme)
Recommendation 1232	1994	Water and agriculture
Third generation		
Directive 96/61/EC	1996	Integrated pollution prevention and control
Directive 98/38/EC	1998	Quality of water intended for human consumption
Resolution 1222	2000	Water and agriculture
Recommendation 1471	2000	Link between science and technology for balancing supply and demand, especially in the Mediterranean countries
Directive 2000/60/EC	2000	Water Framework Directive (amended by decision 2455/2001/EC and directives 2008/32/EC, 2008/105/EC, 2009/31/EC)
European Water Charter	2001	European charter of water resources (update of 1968 charter)
Directive 2004/17/EC	2004	Procurement procedures in the water, energy, transport and postal sectors
Directive 2006/7/EC	2006	Quality of bathing water
Directive 2006/11/EC	2006	Pollution caused by certain hazardous substances
Directive 2006/118/EC	2006	Groundwater protection
Directive 2006/118/EC	2008	Environmental quality standards
Directive 2010/75/EU	2010	Industrial emissions: integrated pollution prevention and control

(Moss 2003). It therefore aims to integrate the three pillars of sustainable development with the management methods that it imposes (Kaika 2003; Bolognesi 2014b). For example, the objective of achieving a good environmental status for water by 2015 corresponds to the environmental pillar. The measures that are recommended to ensure the self-financing of the sector (total recovery of costs, the user-pays principle, and so on) meet the expectations of the economic pillar. Finally, the increase in the participation of the public in management must ensure social and ethical sustainable development dimensions are taken into account. We can now summarize the content of the WFD, basing it on the eight crucial principles for the management of water (as set out in Kaika 2003; Massardier 2011):

1. Water is a common resource: 'Water is not a commercial product like any other but, rather, a heritage which must be protected, defended and treated as such' (Preamble §1);
2. Adoption of an integrated approach: 'An effective and coherent water policy must take account of the vulnerability of aquatic ecosystems' (Preamble §17); contributing to 'the provision of the sufficient supply […] as needed for sustainable, balanced and equitable water use' (Art. 1. (e));
3. Qualitative objectives for protecting the resource: 'Environmental objectives should be set to ensure that good status of surface water and groundwater is achieved' (Preamble §25), for example, good environmental status by 2015;
4. Quantitative targets on usage: 'Control of quantity is an ancillary element in securing good water quality' (Preamble §19), calculation of the minimum flow of rivers, for example;
5. Polluter pays principle (Preamble §11).
6. Principle of cost recovery; 'water pays for water' (Art. 9);
7. Governance in districts covering the catchment areas (Preamble §13 and 7);
8. Increased participation: 'The success of this Directive relies on close cooperation and coherent action at Community, Member State and local level as well as on information, consultation and involvement of the public, including users' (Preamble §14).

Article 9.1 of the WFD states that 'water-pricing policies provide adequate incentives for users to use water resources efficiently, and thereby contribute to the environmental objectives of this Directive'. Thus, it recommends the use of economic incentives and market mechanisms in order to organize the management of the sector. The project of liberalization of the sector, initiated in the 1990s throughout the entire network infrastructure, continues (Finger et al. 2007). However, the structure of the market makes atomicity difficult to achieve over a small territory. The aim of attaining water sector efficiency in Europe, therefore, has led to an organizational method based on the theory of contestable markets (Baumol et al. 1982) and on the de-integration of the sector (Demsetz 1989). The contestability of markets should ensure the optimal allocation of resources and de-integration creates new spaces in which competition can occur. Operators are legal entities under private law, in lieu of public monopolies. Although European countries all buy into this process of liberalization, we will see how its very implementation leads to a diversity of organizational modalities (Finger et al. 2007; Ménard and Peeroo 2011).

In this way, with the third generation of European regulation and the budgetary constraints of UWSEs both deal with common reform. The modernization of UWSEs, especially where it takes on board the recommendations of *the New Public Management*, encourages the rationalization of the management of UWSEs and recourse to market mechanisms (Finger et al. 2007; Allouche et al. 2008; Pflieger 2009; Marcou 2012). In corroboration of the diagnosis of variations based around the European model, G. Marcou (2012) notes that the principles of modernization have been more integrated in Anglo-Saxon and Nordic countries than in Germany and France. The eighth salient fact takes this into account.

Salient Fact 8: *The modernization of UWSEs does not unfold in the same way in all countries, giving rise to three ideal organizational variants typical of the European model in Germany, France and England (in order of appropriateness in relation to the organizational principles of modernization).*

European UWSs have some similarities in their institutional environments, the most prominent features of which are the artificialization of land, the importance of towns and the liberalization process of the water sector. In addition, the European UWS model is also reflected in the technical and economic characteristics of the urban water cycles and the institutional environment. However, it is possible to see how there is still diversity within the three variations. By studying this diversity, we are able to complete the construction of the stylized facts of the modernization of UWSEs.

3 Three Variations on the European Model: German, French and English Ideal-Types

The preceding section illustrates a water situation that is relatively common in Europe but, upon closer reflection, it is possible to discern a number of differences between the countries (section "Heterogeneity of Water Situations in Europe"). In part, the differences can be explained by the emergence of three models of UWSEs. These models differ from each other in terms of their political structure (section "Political Structures: Societal Guidance and UWSEs"), legal structure (section "Legal Structures: Legal Diversity of the Relationship between Private Behaviour and Public Interest") and organizational structure (section "Organizational Structures: Multilevel Architecture Between Local Management and National Regulation").

Heterogeneity of Water Situations in Europe

The national water situation is one component of the territorial dimension of the institutional environment of a UWS. National water budgets provide information on this dimension and demonstrate the disparate conditions between one country and another (Table 2.3). Countries that enjoy strong agricultural production and irrigate in an intensive manner use a greater supply of water. By way of illustration, in 2006, Spain and Portugal used a supply of more than 850 m^3/person (OECD 2009). In

Table 2.3 Total gross withdrawal in European countries between 1980 and 2013

	1980	1985	1990	1995	2000	2006	2013 or last year	2013 or last year available (m^3/person)
Austria	3342	3580	3807	3449	3668	3816	N/A	N/A
Belgium	N/A	N/A	N/A	8221	7538	6654	*6005*	N/A
Czech Republic	3622	3679	3623	2743	1918	1936	*1650*	*157*
Denmark	1205	*1705*	1261	887	726	680	*652*	*117*
England and Wales	13,514	11,533	12,052	12,117	15,022	12,990	N/A	N/A
Finland	3700	4000	2347	2586	2346	2319	N/A	N/A
France	30,972	34,887	39,323	40,671	32,715	33,715	*30,008*	*458*
Germany	42,206	41,216	47,873	43,374	40,590	35,557	N/A	N/A
Greece	5040	5496	7030	8695	*9924*	*9654*	N/A	N/A
Hungary	4805	6267	6293	5976	6621	5818	*5051*	*508*
Ireland	1070	N/A	N/A	1176	N/A	N/A	N/A	N/A
Italy	*56,200*	N/A	N/A	N/A	41,982	N/A	N/A	N/A
Luxembourg	*38*	67	59	57	60	N/A	*43*	*80*
Netherlands	9198	9349	7984	6507	8915	10,325	*10,724*	*641*
Norway	N/A	2025	N/A	2420	2348	2476	N/A	N/A
Poland	15,131	16,409	15,164	12,924	11,994	11,522	*11,241*	*295*
Portugal	10,500	*2003*	8600	10,849	8808	N/A	N/A	N/A
Spain	39,920	46,250	36,900	33,288	37,071	38,158	*37,349*	*798*
Sweden	4106	2970	2968	2725	2688	2676	N/A	N/A
Switzerland	2589	2646	2665	2571	2564	2507	*2005*	*252*

Source: Based on data from WISE and OECD (2009)
Key: Data in italics are compiled from WISE

the same year, the water withdrawal was 240 m^3/person in the UK, a country that has a weak agricultural sector. In France and Germany, the other two European models, there was a respective supply of 560 m^3/inhabitant and 430 m^3/inhabitant in 2006. Like the majority of European countries, they come close to the global average, which was calculated by the OECD in 2006 to be 610 m^3/inhabitant. The German example shows a 13.43% increase in total gross withdrawal during the 1980s. By 2006, there had been a reduction to 25.73%, whereupon they reached a lower level than that of 1980. There was little variation in France's withdrawal at this time, whilst in England and Wales, the supply volumes remained stable over the period 1980–2006. This stability can be explained by the fact that a reform of the water sector was undertaken just previous to the data being collated, while reform took place after the

collation in Germany and France. In countries where there is strong agricultural production and/or Mediterranean countries, this downward trend is also less pronounced.

Salient Fact 9: *The withdrawal trend has followed that of consumption, decreasing since the 1990s.*

The availability of the resource is low in England, while in Germany and France it is good. In general, Germany does not suffer from major quantitative problems. Out of the 188 billion m^3 available per year, less than 20% was withdrawn in 2007 (German Federal Agency 2011). The level of precipitation is good, large rivers flow through the country and the capacity of the aquifers is significant; they also provide 65% of supply needs. Looking at it from a federal point of view, this share varies from 40% in Westphalia to 100% in Bavaria (OIEau). The authorities therefore place a great importance on protecting groundwater resources. The remainder of the withdrawal takes place from surface water (29%) and sources (9%) (Mohajeri et al. 2003). With 204 billion m^3 available per year, France is also country that is richly endowed with water (Aquastat). Out of the 31 billion m^3 withdrawn in 2007, 82% came from surface water and 18% from groundwater. Eighteen per cent, or 5.8 billion is intended for the supply of drinking water (eaufrance.fr, 30 August 2011). Conversely, England and Wales stores little water. Its rivers flow at a rate equivalent to that of the medium-sized French rivers and the key aquifers that provide the urban supply lie in the driest areas of the country (Environment Agency 2008).

This diversity of water situations partially explains the differences in the institutional structures of UWSEs. Institutional structures are another main explanatory element.

Political Structures: Societal Guidance and UWSEs

The political structure of water institutions influences the organization of water management. It prioritizes the uses of water,[25] undertakes a process of devolution and privatization and defines the cost recovery policy, and so on. Three major phases of water policy led to the modern system used

for managing water in Europe (Aubin 2007). During the nineteenth century, water supported agricultural and industrial endeavours. Major works were undertaken to prevent a quantitative lack of resources. The second phase was rolled out from 1900 to 1970 and this concerned the development of supplies for the population. As a result, from 1900 to 1945, hygiene and public health awareness improved the sanitary quality of water. Then, from 1945 to 1970, the development of networks allowed this quality to be shared more widely by raising the quantitative limits. Finally, from 1970 to 1990, environmental concerns began to emerge leading to the construction of a new relationship between the service and the resource. The WFD has responded directly to these new needs. Indeed, the objective of the directive is to achieve good environmental status for all water by 2025. The liberalization of the sector is then thought to be the ideal mechanism with which to bring about this situation.

B. Barraqué (2015) clearly identified the above changes within the political structure of UWSEs through the technical evolution of the provision of services. Inspired by work undertaken on the electric sector by T. Hugues, he delineates three successive stages, each one shaped by the prominence of a type of 'engineering': civil, sanitary and environmental. Civil engineering is the first phase in the development of water systems. Significant installations feed the cities with relatively good-quality water that is stored remotely. The age of sanitary engineering was marked by breakthroughs allowing water to be stored close to liberalization cities, where it could be treated in order to make it drinkable (by means of filtration, chlorination, and so on). As a result, for the sake of saving money, the length of supply systems during this phase tends to be reduced, while efforts focus on improving the quality of water for consumption. Finally, faced with environmental imperatives and costs related to the interdependence between the social and ecosystem spheres, we see the emergence of environmental engineering.

The following fact, therefore, is based on this interpretation of the evolution of urban water cycle management and its validity in light of the content of the WFD.

Salient Fact 10: *Modernization brings UWSEs into the age of environmental engineering.*

To achieve its objectives, the WFD borrows from the standard paradigm of environmental economics. 'Environment-related economic tools such as environmental impact assessments, life-cycle analysis, energy and water control, management or product standards and the implementation of multipartnership, local Agenda 21 type processes allow resources for development to be mobilized and managed to optimum effect' (Velikov 2004: sect. 2 §50). The directive promotes multilevel governance and an increase in user participation. Political participation expresses itself through a bottom-up approach. Committees of users present at various territorial levels collaborate with the state, which establishes the rules (authorizations, permits, planning) (EAU&3[E] 2013). The increase in the user's financial contribution can be seen in full-cost pricing, which prohibits government subsidies.[26] The WFD encourages resorting to PPP, but the participation of the private sector remains very variable within Europe (Fig. 2.9).

UWSEs follow a common trajectory of liberalization and decentralization, the finer details of which then vary according to the institutional environment and the political structure of the UWS. As is also true of liberalization, the degree of privatization in particular is markedly

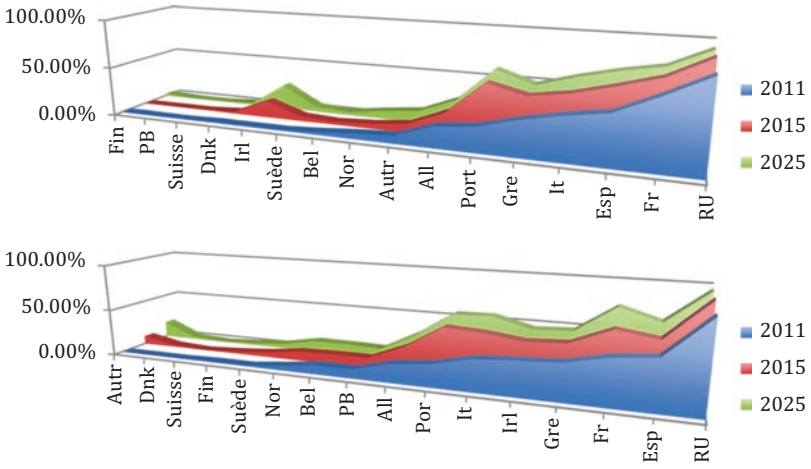


Fig. 2.9 Proportion of PPP in Europe for the supply and sanitation phase (Source: Pinsent Masons 2012)

different. In Spain, direct governance and state-owned entities still exist, while a complete privatization of services is underway in England. In France, thanks to public–private partnerships, the degree of privatization of UWSEs is also very high. Germany, however, occupies a middle ground. German UWSs are developing public companies that are responsible for providing the service—this process is known as corporatization (Ménard and Peeroo 2011). In parallel, the OECD (2006: 32) demonstrates that the UWS market is already mature in the UK, while this process of maturation is still ongoing in France and Germany. From this, the two following salient facts can be noted.

Salient Fact 11: *Modernization tends to empower services through decentralization and the devolution of organizational processes.*

Salient Fact 12: *The integration of modernization in the political structure tends to be stronger when the UWSs agree to participate in the private sector.*

A further point to note is the impact of the water situation, since the countries that are more centralized are also those that are relatively poor in terms of water resources (for example, those in southern Europe). Conversely, in Germany, where resources are abundant, a large amount of responsibility is conferred on local authorities. As discussed in section "Organizational Structures: Multilevel Architecture Between Local Management and National Regulation", the German organizational tradition is a strong factor in explaining the importance of the local level.

In Germany, the decision has been made in favour of local management and a full cost-recovery policy. Service provision falls to the *Querverbunden* or the *Stadtwerke*. These cross-functional municipal enterprises are formally private, but remain under public control (EAU&3^{E} 2013). Their transversality increases the company's room for manoeuvre and improves the quality of the service (by means of guarantees of preferential rates, cross-sector compensation strategies, and so on).

J. Wackerbauer (2009) noted that there were 6400 supply services and 7000 sanitation companies in the country.[27] On the other hand, given that the companies pay few taxes but a high level of business taxes, the money circulates at a local level. This additional emphasis on the local level in the water institutions of the German UWS builds on a tradition of 'local democratic and pragmatic management' (Lorrain 2005; EAU&3E 2013). By way of illustration, in Germany voting at a municipal level dates back further than voting on a state level. Restricted to their municipalities, businesses are small and pose financing problems for local authorities. Privatization is therefore used as a means of response to those problems, but it remains contained and only affects the federal state of Berlin, as well as Rostock, Leuna and the town of Gustrow (OIEau; Mohajeri et al. 2003). The other answer can be found in the total recovery of supply costs; this results in high water prices.

The origin of the English privatization process can also be found in a climate of great financial difficulty (Bakker 2000). The Water Act of 1973 initiated a process of decentralization. Ten regional authorities were created and they took on responsibility for managing the sector. The country then experienced an economic crisis and, under the leadership of Mrs Thatcher, underwent a period of fiscal authority that exacerbated the budgetary equilibrium. The 1989 Water Act then privatized these regional authorities with the aim of cleaning up operator accounts. Thirty-two companies were regulated and now jointly manage the supply and drainage of water (forming the body known as Ofwat, or the Water Services Regulation Authority). The role of the state was simply one of overall control and local authorities no longer held any responsibility. The English political structure was therefore regionalized and then privatized. There are fewer operators and their size is relatively large compared to the operators of urban German water cycles.

The French model is deconcentrated, decentralized and places great importance on the private sector. As in Germany, the sector is very fragmented. In 2012, 35,160 water services, including 13,806 services for supplying drinking water, were managed by 24,162 entities (Onema 2015).[28] Over the last 150 years, PPPs have developed in France and today they account for the majority of services provided to users (Guérin-Schneider and Nakhla 2012; BIPE 2015). By way of illustration, 66% of

municipalities with more than 4000 inhabitants are served by delegated management, with a respective figure of 57% in terms of sanitation (BIPE 2015). In addition, it is apparent that the average size of service providers managed by delegation is almost three times larger than that of direct management services. Five principles form the framework for the management of services in France: budgetary equilibrium, 'water pays for water', responsible users, transparency and management on the basis of catchment area. The French management system was the first to use the catchment area as a means of organization. David Aubin (2007) illustrates how sustained public problems have given rise to the evolution of property rights and public policies aimed at the integrated management of water resources. Thus, management initially evolves in order to allow the development of human activities (agricultural and industrial). Then, we must take into account environmental limits and quality-control procedures (pollution thresholds) as well as quantitative control procedures (the fight against over-exploitation) that are applied to the resource.

Salient Fact 13: *The modernization of UWSEs tends to reduce the number of operators within a national territory and, consequently, there is more of a focus on the 'big' operators who have reached a substantial critical mass.*

Legal Structures: Legal Diversity of the Relationship Between Private Behaviour and Public Interest

We will first of all present the general and generic aspect of the legal structures (section "Generic Aspects of Legal Structures") followed by details on the German, French and English models (section "The Diversity of Legal Structures: Details of the German, French and English Models").

Generic Aspects of Legal Structures

The legal structure of water institutions sets out the rules that provide a framework for conduct. This is the formal framework regulating the UWS. In the instance of water, this structure consists of the law, its

legal structure, dispute resolution processes, apportionment of responsibility and liability and the delimitation of space for private participation, and so on (Saleth and Dinar 2005). There are two competing classifications of the comparative analysis of the major systems of contemporary law, that of R. David (2002 [1964]) and that of K. Zweigert and H. Kotz (1998). We will use the classification by R. David as this was the first, and because the criticisms levelled at him and which justify the emergence of the second classification have proven in part to be unfounded and do not ultimately call into question the relevance and consistency of his conclusions (Cuniberti 2011). It should be noted that Glenn (2014) created a similar classification while also deepening knowledge of the social and historical construct of these great legal traditions. R. David founded his delineation of rights on legal technique (the hierarchy of legal sources and methodology) and social organization (the design of the social order—of a political, economic or religious nature). On this basis, it is possible to distinguish four legal groupings: Romano-Germanic law (civil law), common law, socialist law and religious and philosophical systems. Only the first two groupings apply in Europe. Romano-Germanic law applies in Continental Europe while the common-law structure is the Anglo-Saxon legal system.

Romano-Germanic law is based on Roman law and emerged at the end of the twelfth century under the influence of European academics who, 'on the basis of compilations made by the Emperor Justinian, [founded] a scientific law common to everybody […] that addressed the relationship between citizens' (David 2002: 17). The origin of these standards is a theoretical base and their aim is to formulate general rules of conduct. Laws themselves are the main legal source and appear in codified form from the nineteenth century. These legal structures are often supported by a complex legal administration; laws, such as procedures, are written and fixed, unlike those of common law. There is no theoretical basis to common law. Less abstract than Romano-Germanic law, it is passed down by judges in a pragmatic form in order to 'provide a solution for a trial, [and] not to formulate a general rule of conduct for the future' (David 2002: 18). Case law is the main legal source; the

law and the constitution are also significant but, in contrast to the Romano-Germanic system, they are less important and more flexible. As a result of this pragmatism and the great evolutionary capacity of the legal structure, under this system, legal proceedings are seen to be as important as the substance of the law; the central objective is to quickly restore order and not to build the foundations of society. Finally, common law is like a right, which leaves more room for economic considerations and is more flexible than Romano-Germanic law (Fairgrieve and Muir Watt 2006; Cuniberti 2011).

B. Barraqué integrates these systemic aspects into his analysis of water law in Europe (Barraqué 2001, 2007). Looking at the work of D. Caponera (1992), he distinguishes two main principles in the regulation of water: 'There are two major principles of sharing water around the world, namely ownership (right to own) and the rule of usage (right to use)' (Barraqué 2001: 216). In light of civil law,[29] the first principle allows the separation of private water from public water, while the second principle renders ownership impossible. B. Barraqué thus defines Romano-Germanic law in the case of water. The customary law of Germanic tribes, to which the English notion is related, is the non-destructive differentiated right to use the resource; however, the flipside of this is civil law, which reserves the common right to small watercourses.[30] Ownership rights apply to public waters, such as rivers and aqueducts, and to private waters, enjoyment of which belongs to the owners of the land.

There are two possible forms of the 'usage rule' (Barraqué 2007). A legacy of the history of common law, it is exercised in a centralized form in the UK, while in Germany, the Netherlands or Switzerland, it is applied through the *Länder*, the Water Boards and the cantons according to the subsidiary principle. The 'ownership rule' operates under three different modalities in Europe. In Spain, it takes the form of statism: bureaucratized hydrographic confederations and the development of large-scale hydraulic engineering give rise to it. The approach adopted in Portugal and Italy make the organization more flexible since water-basin institutions coexist with conventional territorial powers. In France, the imprint of Roman law is manifested through the water agencies. It all comes

down to decentralized and regionalized organization. The modernization of UWSEs therefore permeates within a variety of legal structures that contribute to determining how deeply the modernization principles will penetrate the UWSEs. In addition, we can state:

Salient Fact 14: *The principles of modernization diffuse better in structures that are derived from common law: they are more flexible and less bureaucratized.*

Salient Fact 15: *There is a connection between the degree of integration of modernization and the capacity of the legal structures to focus on the individual and favour the resolution of disputes, rather than defending abstract and/or moral principles in the name of general interest.*

The organization of responsibilities and the place of the private sector in UWSEs is the product of the debate on the clash between public and private that began in the eighteenth century and which still continues to this day (Mohajeri et al. 2003; EAU&3[E] 2013). All European countries resort to dual solutions. In the majority of cases, the ownership of the infrastructure remains almost entirely public, with England being the notable exception. Since regulatory tightening took place in 1999 as a result of the drought crisis in Yorkshire, pension funds bought up PPP contracts or part of the debts of operators, thereby increasing the decision-making power of financiers (Bakker 2000; Lorrain 2008). In contrast to the system of ownership, the management burden for the functioning of water infrastructures is increasingly incumbent upon private operators (Roche 2001). The proportion of private operators has doubled from 1988 to 1998, but the sector remains largely public. In the UK, where the UWSs are the most advanced in Europe in terms of modernization, 90% of the population is served by a private operator. In 1988, this proportion was 5%. In contrast, Germany remains overwhelmingly served

by public operators, although the share of the population served by a private operator has increased with modernization, from 4% in 1988 to 17% in 2005. Consequently, it can be said that:

Salient Fact 16: *Modernization supports the notion of the public sector no longer managing the urban water cycle.*

The Diversity of Legal Structures: Details of the German, French and English Models

In Germany, there are two branches of water law. The first legislates the protection of waters and the second, inland waterways. Three normative acts structure the management of urban water in Germany: the decree on safe drinking water (2001), the decree on sanitation (2004) and federal laws on water (1992, 2002, 2009). The decrees on safe drinking water (*Trinkwasserverordnung* 2001) and on sanitation (*Abwasserverordnung* 2004), impose technical standards to ensure the quality of the water, partly for reasons of public health. The decree on safe drinking water (*Trinkwasserverordnung* 2001) deals with public health. It also determines the existence of supply stations, introduced the WFD into German law, and so on. It requires operators to inform the consumer about the quality parameters for the water supplied, as well as the substances used during its treatment. Finally, the decree on sanitation (*Abwasserverordnung* 2004) provides thresholds and standards applicable to all drinking water. In 2015, public law regulated 80% of services and 45% of users. Private law accounted for the remaining 55%.

Regarding the governance process, there are federal laws on water (*Wasserhaushaltsgesetz*) that are authoritative. The 1996 version provides for the intervention of public powers by prohibiting total private ownership of a supply, its sanitation services and treatment works (§18.2.a). Thus, the public regulator always retains the decision-making power in these activities. The version dated 2002 saw the introduction of partial updates. The Federal Act of 2009 on water management reformed the

regulation of water in Germany and included three new features. First, it stipulated that the regulation was to become a federal prerogative, thus reducing the responsibilities of the *Länder*; it included elements of the WFD; and finally, it aimed to unify and simplify German regulations. In addition to that, in constitutional terms (article 28–2), the burden of managing water now lies with the local authorities, who are guaranteed their independence and autonomy in §.103. This legal condition and a strong tradition of local democracy results in a form of management organized by a strong, local public power (Lorrain 2005). The result is low penetration of the private sector in the provision of urban water services.

German law recognizes four areas of responsibility for water (Krämer and Jäger 1998): the functioning of treatment works and the protection of the resource; information on the allocation of extraction rights; the organization and control of sanitation discharge; and maintenance of the resource. With regard to the three first areas of responsibility, the small and large water authorities take care of leases and extraction permits, while the health authority ensures compliance with the decree on safe drinking water. Regarding the drainage of water, it is the responsibility of the *Länder* and municipalities to ensure the protection of lakes and rivers, and the limitation of emissions.

In France, the law organizes water management at the level of catchment areas and maintains public property. The legal system, established at the national level, is inspired by the WFD and is divided into three components: the status of the water, the organization of public services and the quality of service (Mohajeri et al. 2003). Three laws have an impact on French regulations regarding the management of water: the law pertaining to the system and distribution of water and the fight against its pollution (1964), the law on water (1992), and the law on water and aquatic environments (LEMA) of 2006 (Johanet 2012). These two laws of 1964 and 1992 provide the essential framework for the status of water. Water has a status of *res nullius* and cannot be owned. What is more, in the same way as common water in England, riparian rights protect downstream usage. The second component is the organization of services, which follows six general rules. The services are provided under the control and responsibility of the municipality. The budget of the service differs from that of the municipality. It is the consumers that finance the service, with

the exception of those municipalities with a population of less than 3000. The service must be the same for everybody and must be guaranteed 24/7. Finally, the Sapin law (1993, amended in 1995) regulates PPPs. Legislation on service quality is based on European standards.

The 1964 law battles pollution using two financial incentive mechanisms, a tax on emissions and de-pollution assistance. In parallel with its enactment, six catchment area agencies were created in order to organize the collection and distribution of these financial flows. The 1992 law improved the law on water and changed its status. Water therefore became part of the common assets of the nation and its protection, which was increased, was now in the general interest. Water police were established to control the quality and level of the resource. In addition, the law continued the decentralization process that had been initiated by the decentralization laws of 1980–1983, which confirmed the ability of local actors to reasonably manage the resource (Barraqué 2007). In 2006, the Water and Aquatic Ecosystems Law (LEMA) re-established the right to water in France. It included a further extension of the prerogatives of local actors, transposed the WFD into national law, and gave further support to action on a local management level (in particular by allowing municipalities a choice of management style). French regulations became the impetus for the later adoption by the WFD of several principles, including catchment area management and the use of PPPs, which resulted in a good working relationship between the two systems. However, the notion of water provision as a public service ensured that the sector took on an important political dimension in France (Bauby 1997).

The division of responsibilities is clear. Since the decentralization laws of 1980–1983, the state has played a regulatory role. It lays down general regulations and ensures compliance by means of retrospective checking. The 1992 water law continued this process of decentralization (Barraqué 2007). All water became part of the common assets of the nation and this affirmed the state's determination to allow local actors to reasonably manage the sector by means of SAGE (Schéma d'aménagement et de gestion des eaux—development and water management scheme) and SDAGE (Schéma départemental d'aménagement et de gestion des eaux—departmental planning and water management scheme). If the municipalities already played an important role in the management of French services

from 1985, LEMA further extended their powers. The municipalities chose the mode of regulation they wish to use, and the operator was liable for the terms of the concluded contract. Delegated management contracts were predominantly used during the supply phase and were increasingly used to organize the sanitation phase. According to the Barnier law (1995), a delegated contract could not extend over more than 20 years. Previously, contracts could last for 40 years (Tavernier 2001); between 1998 and 2012, the average duration of delegated contracts changed from 17 years to 11 years (Rieu et al. 2015). Through a process of modernization, the legal structure intensified competition for the market by increasing the number of potential entrants and reducing the duration of the contract.

English regulation relies on riparian rights, which are usage rights that are very broad and mainly limited by the obligation to return the water in the same condition as it was in before use.[31] Four laws structure the regulation of urban water: the Water Acts of 1973, 1989 and 2003 and the Water Industry Act of 1999. The 1973 Water Act regionalized management by creating 10 regional authorities (RWA), thus reducing local councils' responsibilities. RWA powers extend to the overall management of water, with the exception of sanitation, which remains a municipal responsibility. In 1989, these entities became private and fell under the control of independent regulation agencies: OFWAT was responsible for the economic dimension, the Environment Agency (EA) for environmental aspects and the Drinking Water Inspectorate (DWI) took care of sanitary requirements. In order to protect property rights, the Water Industry Act (1991) prohibited the release of any substances that were liable to damage pipework or treatment plants. The Water Industry Act of 1999 protects consumers by prohibiting the sale of water that is unfit for consumption and by limiting the ability to disconnect users, for example in the case of those who have defaulted on payment.

The 2003 law on water integrated the WFD and amended pre-existing English law to achieve the following four broad aims: 'the sustainable use of water resources; strengthening the voice of consumers; a measured increase in competition; and the promotion of water conservation' (Water Act 2003: explanatory notes, no. 9, 16 and 18). This new law ensured that the principles of the modernization of UWSEs had been successfully

transposed into the legal structure of the English UWS. The two main innovations supporting this change were the reform of the licensing system and the creation of an independent body representing consumers. As a result of these legislative changes, the regional level dominates the management of urban water services in England and the chosen economic governance mechanisms correspond to those recommended by the EU.

Salient Fact 17: *Modernization has induced a shift in legal structures, allowing more freedom of contract.*

Salient Fact 18: *Modernization has induced evolution in institutions, encouraging a reduction in the duration of contracts and increasing competition in terms of the procurement of contracts and the deviation process.*

Salient Fact 19: *Modernization promotes the emergence of different state actors in the regulation process.*

Salient Fact 20: *Modernization increases the weighting of contractual relations within the institutional polycentrism of the UWSEs.*

Salient Fact 21: *Less modernized UWSEs continue to have a dependence on political or moral principles.*

Organizational Structures: Multilevel Architecture Between Local Management and National Regulation

The organizational structure links and provides a hierarchy for water institutions. It is constituted from the structure of the administration, the different layers of government, their responsibilities, prices, information and technical capabilities. In Europe, water institutions are organized according to a multilevel hierarchical structure that includes at least three

levels: the (supra) national, regional and local levels. As enacted by the legal structure, the municipality represents the initial level for managing the UWSEs. However, in the Mediterranean region, managers reinforce the regional echelon in order to accommodate climate variability, which complicates the balance between supply and demand. Service providers increasingly manage infrastructure under the control of regulatory agencies (Bauby 2011).[32] Consumption in France, and in Europe, is individual and the user pays for their consumption, whether that be measured by volumetric meter or by estimation. In addition, water now tends to be no longer paid for by taxes, but as a billable product. The price is then supposed to better reflect the costs of the service (Bolognesi 2014a). It was the implementation of the polluter-pays principle in the years 1970–1980 that led to this change, which has been strengthened by the idea of cost recovery as set out in the WFD.

There are five levels that fragment the hierarchical structure in Germany, that of *Bund* (federal government), the catchment area, the *Land* (regional level), the canton and local authorities (OIEau). As we have seen, management in Germany is carried out primarily on a local level. The federal government intervenes through the ministries: the Ministry of the Economy deals with infrastructures for supply and price, the Ministry of the Environment is responsible for the quality of the resource, and the Ministry of Health for sanitation. It has a limited liability. Although, in contrast to France, the scale of the catchment area is relatively small (with the exception of the Ruhr area), there is cooperation between the different *Länder* when it comes to managing the large catchment areas (Rhine, Elbe, Weser, Spree). The *Land* has the authority to manage the water and is thereby responsible for it. By means of three water authorities, each operating at a different level, it exercises its power on a national, regional (higher authority) and municipal (lower authority) level. The *Land* is responsible for extraction, usage, issuing sanitation licences and quality control. Finally, it manages production, while the municipality takes charge of distribution.

In Germany, there is a large number of (often small) operators: more than 6065 suppliers of drinking water and more than 6900 sanitation companies (BDEW 2015). Their activity can be organized according to seven principal modalities. In the case of an exclusively public service, the

existing forms are: state control (*Regiebetrieb*), semi-autonomous municipal agencies (*Eigenbetrieb*) and the municipal company (*Eigengesellschaft*). In the case of private participation, we come across the idea of private management under responsibility and public decision-making (*Betreibermodell*), a cooperative model (*Kooperationsmodell*), delegation (*Betriebsführungsmodell*) and a concession (*Konzessionsmodell*). J. Wackerbauer has put together a visualization of how these arrangements and their use have developed (Figs. 2.10 and 2.11). It seems that public entities remain the leading operators in the deviation process,

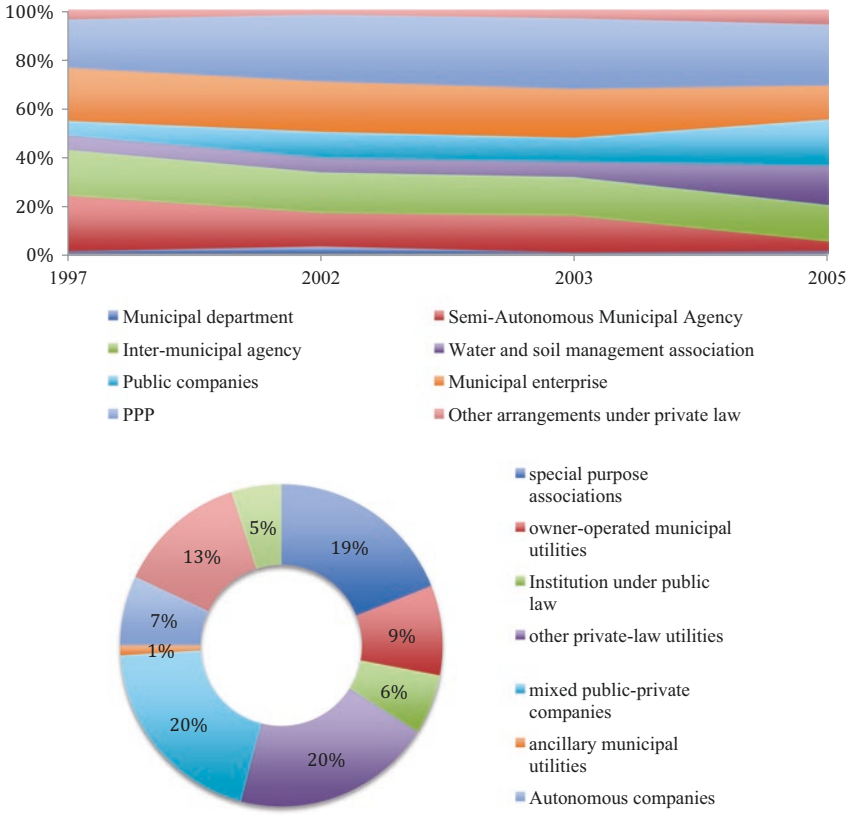


Fig. 2.10 Types of arrangements in the procurement phase in Germany, developments between 1997 and 2005 (*above*) and the situation in 2012 (*below*), in % of water provided (Source: Wackerbauer 2009; BDEW 2015)

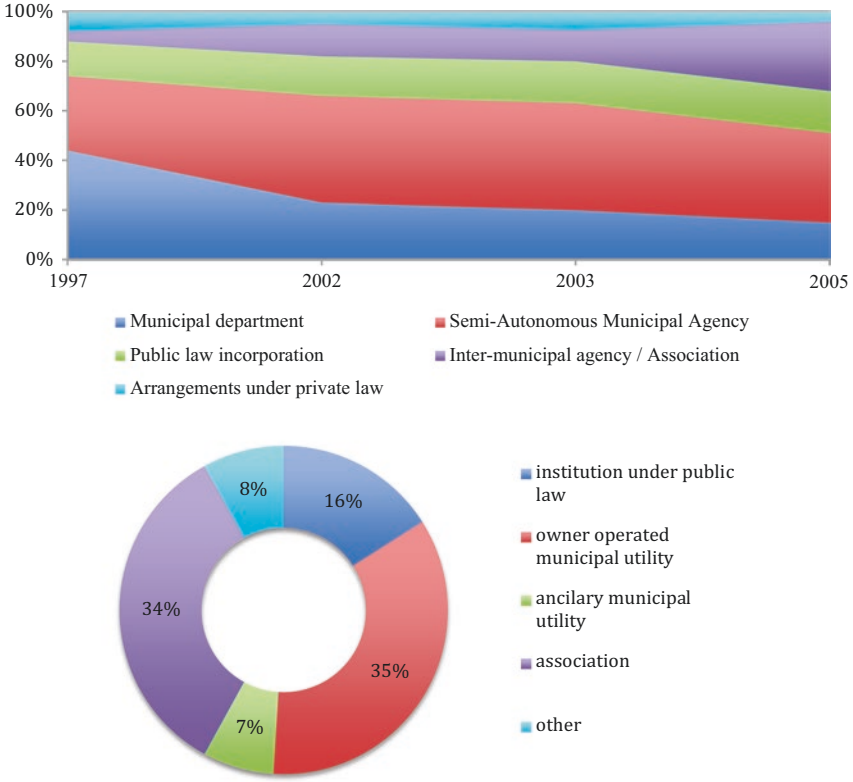


Fig. 2.11 Types of arrangements for the sanitation phase in Germany and developments between 1997 and 2005 (*above*) and the situation in 2014 (*below*), as a % of population served (Source: Wackerbauer 2009; BDEW 2015)

while there is no recourse to private operators for the drainage phase. On the other hand, operators tend to become entities of private law, i.e. ownership remains public and it is only the legal status of the company that changes. When it comes to supply, from 1997 to 2005 the decline in the share of water catchment (BDEW 2011, 2015) by municipal companies (−8%) was more than compensated for by the increase of water supplied by public companies (+13%). In the case of sanitation, the major change lies in an increase in the scale of production: inter-municipal arrangements (+24%) are a substitute for municipal arrangements (−29%).

To describe this dynamic, C. Ménard and A. Peeroo (2011) speak of 'corporatization' and highlight the political reasons for this resistance to the organizational form promoted by the modernization of UWSEs:

> Most of the water services are run under public management. Strong resistance towards liberalization developed in Germany, not only due to opposition by unions, but also because of persistent reluctance among the population to see water 'privatized'. (Ménard and Peeroo 2011: 320)

In the German UWS, the municipalities set the prices by applying the user-pays principle.[33] Prices depend on the quantity consumed and supply costs. The availability of water and treatment expenses are also incorporated into the price. VAT is 7%, and in some *Länder*, a tax on extraction is added. Regarding the evacuation phase, the price includes a charge on precipitation. Based on the place of use, this amounts on average to €0.93/m^3 (0.90 in the West and 1.01 in the East). Finally, in 2007, the average prices for a household were €1.60/m^3 supplied and €2.29/m^3 processed (German Ministry for the Environment 2011), and they have steadily risen since the early 1990s, with a peak in growth to +11.7% between 1991 and 1992.

Illustrating the holographic principle of a UWS,[34] this political structure, supported by two other institutional structures, reflects the shape of German capitalism (the socio-economic institutional environment). Indeed, we see that the local level is predominant in the polycentrism of the governance of the German UWS. The autonomy that is allowed by senior levels strengthens the power and impact of local authorities. It can be noted that:

Salient Fact 22: *In the German UWS, management is still largely in the hands of the public sphere, which monitors the supply of network services in the general interest.*

Four administrative subdivisions organize French water management: the state, the region, the *départements* and the municipalities (OIEau). On a national level, the issue of water depends on the ministry in charge

of ecology; nevertheless, matters concerning it can be dealt with on an interdepartmental level. The regions guide decisions by means of the regional planning and development scheme (SDAGE), funding choices and the creation of regional natural parks. They also participate in water management institutions (water catchment committees, water agencies, local water commissions). *Départements* get involved in the management of rural water and can contribute to the protection of natural environments. By virtue of the latter of those two activities, they have an impact on the UWS. As in Germany, the municipalities are responsible for water management.

Municipalities play a vital role in deciding contractual procedures and planning. Two patterns of organization are possible. Management can take place solely on a municipal level (through a special-purpose association) or even a possible separation between the service provider and the limited partner (through delegation, government, leasing or concession). The second option is the one most frequently adopted by cities. Therefore, there are three French multinationals in the sector who often have the share of the market: Suez, Veolia and la Saur (Lorrain 2005). Contracting with a private operator represents the main institutional arrangement in the organization of French UWS operators. In addition, it appears that the recommendations for modernization have been followed. The monitoring centre for outsourcing public services (DSP) reports that, over the period 1998–2012,[35] the duration of contracts became shorter—especially after renewal—tending towards 11 years, while the level of competition remains low and remuneration of the delegate is at approximately 20%, as a result of the 'Sapin law' procedure (Rieu et al. 2015).

Figure 2.12 is also taken from the DSP monitoring centre, but is subsequent to the report cited. It moderates the report's argument, because it is apparent that, over the period 1998–2010, competition tended to increase. In fact, on average, the number of competitive tendering proceedings increased.

The organization of water management is devolved and decentralized, and is based on five basic principles: decentralized management at the level of the catchment area, an integrated approach, consultation and coordination of action, mobilization of specific financial resources and multi-year planning (BIPE 2015; Salvetti and Canneva 2015). Institutions at the level

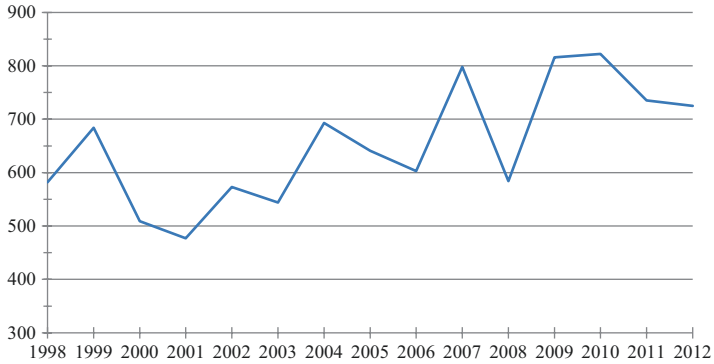


Fig. 2.12 Evolution of the number of competitive tendering proceedings between 1998 and 2012 (Source: Rieu et al. 2015)

of the catchment area are thus added to those originating from administrative subdivisions. As a result of strong decentralization, the state coordinates the water policy at different levels. It works on a departmental level with the Water Police and on a local level with the regional management organization for the environment, planning and housing (DREAL). At the level of the hydrographic basin, the *préfet* directly coordinates the various services provided by the state. On a national level, the Ministry of Ecology, assisted by the National Office for Water and Aquatic ecosystems (Onema), defines and coordinates water policy, in particular through SAGE and SDAGE.

In France, the price of water is determined locally and as a result there is a great deal of variation across the territory. The bill is made up of a fixed part and a variable part. By virtue of the principle of 'water pays for water', it covers all of the service costs after subsidies. In 2006, therefore, bills (€11.8 billion) represented 59% of spending in the sector (approximately €20 billion) (IFEN 2007). Two methods of pricing coexist. In exceptional cases, there is a flat fee but, in the majority of cases, a degressive fee is established (Fauquert and Montginoul 2011). The pricing depends on the nature of the service provider. For example, in the case of the government, it is voted on annually by the municipal council while, if the operator is private, the contract fixes the initial price as well as the calculation method for its reassessment. The average cost of supply and sanitation services has increased since the 1990s, reaching a cost of €3.85/m^3 today

(Onema 2015). The annual price growth is slowing and the share of the different services remains constant. To echo the OECD's report (2010), the price is mainly intended to cover costs; as a result, its political dimension shrinks.

In summary, management of the French UWS is predominantly incumbent upon municipal administration. This organizes an urban water cycle in which the private sector is central, by means of public–private partnerships, which most commonly take the form of delegation. The state, however, despite decentralizing management, still retains a grip on the sector in order to ensure that its citizens' expectations are met. In France, the central government remains relatively strong and 'national champions' provide the service (Lorrain 2005).

Salient Fact 23: *In the French UWS, the increase in the number of Sapin procedures and the reduction in the duration of contracts have seen competition intensify.*

In England, the organizational structure functions on three levels: national, regional and local authorities (OIEau). The national organizations, the National River Authority and Her Majesty's Inspectorate of Pollution, play a regulatory role. In accordance with modernization principles, management is carried out in an integrated manner at the level of the catchment area. The regional level is shown as being the most important. The 1979 Act installs it as a strong central framework and makes it autonomous thanks to the EA, the DWI and OFWAT. These independent agencies regulate the activities of deviation process operators who are private companies.

The EA deals with environmental regulation, the management of water quality and the implementation of drinking-water quality standards. The predominant way in which it performs these tasks is by issuing licences and controlling any discharge of waste water. Operators must provide them with a plan to balance supply and demand for the next 25 years and a report on possible solutions in case of drought (Defra 2001).[36] The DWI is responsible for drinking water. It carries out audits of operators and then publishes them in the form of reports. If operators that are considered to be outside of the norm do not take

adequate measures, the DWI can impose a compliance remediation plan upon them. This organization works with OFWAT, which is the economic regulator. OFWAT limits the evolution of prices and ensures value for money. To achieve this, it has produced a report based on the annual reports provided by the companies. This report will serve to support price setting for the next five years. It takes into account four categories of indicators: supply, drainage, consumer services and environmental impact.

Independent committees assist OFWAT in the fixing of prices. These Water Voice Committees represent users and meet four times a year. They are expressed at national and European levels, and participate in the regulation of the sector. With this interlocutor, OFWAT decides the possible evolution of prices and guides operators by means of a price cap system. The index that is then imposed represents the maximum increase in prices for the next five years. It aggregates the evolution of the price index to consumption and a K parameter specific to each company since its inception. We can see that the allowed increase decreases with each five-year plan (Table 2.4). Then, each household is charged a fee based on their estimated or measured consumption; this is determined using a meter in 23% of cases. The fee covers the supply, drainage and related services. It can vary greatly, as much as threefold, depending upon the different catchment areas. It tended to strongly increase before stabilizing at around £200 in 1999 (Mohajeri et al. 2003). OFWAT (1999) attributes this development to the fact that costs for improving water and the environment are transferred to its customers. To maintain universal access, the more vulnerable customers connected to a meter are helped by a carry-over of part of the total of their bill to other users.

Table 2.4 Average limitations of annual price increases agreed for England and Wales (in %)

	1990–1995	1995–2000	2000–2005	2005–2010	2010–2015
	Fixed to privatization	OFWAT commitments	OFWAT commitments		OFWAT commitments
Water and sanitation companies	3.9	1.5	–2	4.3	0.5
Water companies	1.9	0.6	–2.8	3.1	0.3

Source: OFWAT (1994, 1999, 2004, 2009)

In England, the markets organize the optimization of the supply of services within the UWS. The liberalization of the water industry was accompanied by a total privatization of operators but, in order to avoid a questioning of the general interest, an independent regulatory agency—OFWAT—regulates and controls the activity of the operators.

Salient Fact 24: *The organization of the English UWS formally allows operators to have more freedom and is based on the production, dissemination and control of information by autonomous regulatory agencies.*

4 Conclusion

This chapter has characterized the organizational dimension of UWSEs and the effect of modernization on them by developing an analysis based on international comparison. First of all, it depicts the singularity of the European model on the basis of a typical European urban water cycle, and the elements of the institutional environment that can be both common and specific to UWSEs. Diversity then appears within the model. We have looked at this in order to refine the results of the observations in this chapter. This diversity can be found in a variation based around three ideal-types: the German, French and English models, in order of their integration of the principles of modernization. These variations occur particularly at the level of institutional structures and in some aspects of the institutional environment. Finally, the chapter has given rise to 24 salient facts, each one presenting a basic feature, the consistency of which has allowed us, in the concluding part, to round off our observations on the modernization of UWSEs by formulating a number of effects of that modernization, which we will later explain. It seems that modernization reduces the role of the state in the governance of UWSEs in favour of new actors (private operators, civil society or third-party regulatory agencies). Similarly, it appears that the polymorphic character of UWSEs varies according to how far modernization has taken hold.

Before turning to the third chapter, the reader should take note of the principal structural elements of UWSEs and the ideal-typical characteristics of the English, French and German UWSs (Table 2.5). From a technological point of view, the urban water cycles of developed

Table 2.5 Ideal-typical features of English, French and German UWSs

	UK	France	Germany
Water institution			
Institutional environment			
Resource	Low availability	Good availability	Good availability
Territory	Urban sprawl Strongly hierarchical organization Small watersheds	Urban sprawl High maturity High anthropization Strongly hierarchical organization	Polycentric urbanization High anthropization High maturity
Socio-economic	Pure liberalism	Tempered liberalism	Tempered liberalism
Institutional structure	Privatization and monitoring	Decentralization and PPP	Local democratic and pragmatic management
Legal	Centralized 'usage regulation'	Decentralized and regionalized 'ownership regulation'	Decentralized 'usage regulation' to *Länder*
Political	Total privatization Deconcentration	High private participation (PPP)	Public and corporatization Deconcentration
Organizational	3 levels Regional management Regulatory agencies	6 water basins 4 administrative levels Local management	5 levels Local management
Urban water cycle			
Provision	34 operators Municipal withdrawal: 121.40 m^3/inhabitant/year	35,160 services 3 main operators Municipal withdrawal 93.53 m^3/inhabitant/year	13,400 services Municipal withdrawal: 62.15 m^3/hab/year
Uses	Price: 5.87$ PPA/h	Price: 4.34$/h	Price: 5.57$ PPA/h

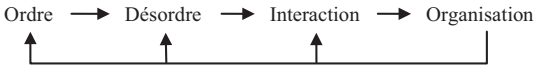
countries differ from those in developing countries. Thanks to the mobilization of a good quality network infrastructure, the UWSs of developed countries raise the supply constraint and ensure equal access to water services, something which is not the case in the rest of the world. Among developed countries, European urban water cycles mani-

fest their characteristics by means of the economic dimension (high prices and moderate usage). The institutional environment of UWSEs includes common and diverse features. The main characteristics they have in common are: the artificialization of land and urban sprawl; the territorial dimension; the importance of formal regulations, in particular European ones; and the liberalization of the economy, impacting on the socio-economic dimension. The diversity of urban capitalism, another component of the institutional environment, is reflected in the institutional structures of UWSEs. This enables us to see the emergence of three models of UWSEs. The German model is characterized by strong, public local power, the French model by cooperation between the responsibility of local public authorities and the competence of national champions, and the English model by a liberalized, privatized and regionalized sector.

This chapter constitutes the primary observation phase of the modernization of UWSEs. It offers a representation of the structure of UWSEs and the organizational impact of modernization upon it. Moreover, thanks to its generic character, the analytical framework can be reapplied and used on other empirical analyses. The next chapter relies on this basis to characterize the sustainability of UWSEs following their modernization.

Notes

1. For E. Morin, a complex system is part of a dynamic of 'auto-eco-organisation'. This notion is a "necessary complexity of the idea of self-organisation. It includes the (complementary and antagonistic) complex relationship between the autonomy of the living being and its dependence on its environment" (Morin 2008: 2430). The recursive loop is essential in understanding this dynamic and is expressed in its most abstract manner in the following diagram:



Three principles therefore allow these complex systems to be understood: the dialogical principle (complementarity and antagonism), the principle

of organizing recursion (mutual interrelation between cause and effect) and the hologrammatic principle (the component and the whole integrate with one another).

2. These three axioms have an impact on the highlighting and the structure of the salient facts. As a result of the axiom of multilevel polycentric governance, the salient facts are not all compartmentalized within the urban perimeter while providing the UWSE with information. This is because of the axiom of the complex system, which can then recombine all of these salient facts to result in a robust and consistent characterization of the modernization of UWSEs.
3. The hydro-social cycle is defined as: 'a combined physical and social process, as a hybridized socio-natural flow that fuses together nature and society in inseparable manners'. Thus, 'hydraulic environments are socio-physical constructions that are actively and historically produced, both in terms of social content and physical-environmental qualities' (Swyngedouw 2009: 56).
4. This point comes back to the ontological idea of a UWS and therefore the existence of tropes that define the specific properties of each UWS.
5. The section refers largely to Green or White Papers by the European Commission. In the vocabulary of the commission, a Green Paper is a report published by the Commission involving reflection and consultation on a specific theme at European level. A White Paper is a more advanced stage in the consultation process, since it presents a set of argued proposals intended to guide Community action about a specific topic. A White Paper often comes after the publication of a Green Paper on the same topic.
6. Deregulation is one of two models of a liberalization of network infrastructure, the second being that of re-regulation, which is presented in the body of the text. Deregulation is part of the theory of the state as it is presented by the Chicago School (Friedman 1953) or by the theory of 'public choice' (Buchanan and Tollison 1984; Lane 1985). According to this approach, the differentiation between the network industries and other industrial activities is denied. Henceforth, the market can address the failures of the state following a process of deregulation. The process consists of three stages. The first gives us a starting point: the state regulates a public monopoly. Then, during the second stage, the monopoly disappears and an independent regulatory authority controls the sector by maintaining the general interest and by organizing competition. Finally, the third stage starts when the competition has reached a critical thresh-

old. At this point, the usefulness of sectoral rules diminishes and general rules organizing competition are sufficient to regulate the sector. This vision comes into conflict with the state intervention, as its proponents consider that the state prevents the optimum allocation of resources from being achieved, and therefore must be removed. The alternative model is that of re-regulation, a strategy which is also applied as part of the modernization of UWSEs. Under this second framework, it is assumed that deregulation risks bringing about market vulnerabilities and a reduction in welfare. Consequently, corrective action by the state appears to be necessary and rather than deregulating the sector, it should be re-regulated.

7. The following link may be of interest should the reader wish to learn more about these communications: http://ec.europa.eu/growth/single-market/public-procurement/modernising-rules/reform-proposals/index_en.htm, accessed on 20 August 2015).
8. It reforms Directive 2004/17/EC pertaining to procurement procedures in the water, energy, transport and postal sectors and Directive 2004/18/EC on the government procurement of works, supplies and services.
9. In this instance, modernization is deemed to be an inevitable institutional shock. In addition, the modalities of the emergence and formulation of the WFD do not form part of the analytical focus. M. Kaika and B. Page (2003), B. Page and M. Kaika (2003) and Kaika (2003) set out a stimulating analysis of the political economy and international negotiation processes.
10. The economic component within the WFD is confined to article 9 and annex III, which constitute less than one page out of the 72 in the final document.
11. A directive on the ecological quality of surface waters had been previously proposed. Despite the growing interest in environmental issues, it never materialized. According to Hering et al. (2010), a the need for a withdrawal of socio-economic interests for the benefit of ecology is likely to have been the main stumblick block causing the deadlock in the negotiations.
12. Indeed, in the sample under observation, urban growth increased 10 points over the period 1990–2010, representing an increase of 74% in the number of city dwellers in developed countries. The challenges confronting cities in developing countries thereby surpassed their absorption capacity, thereby having significant effects on congestion. Since then, a large variety of operators and supply modes have emerged in DCS to supply those areas that are not served by the network (Angueletou-Marteau 2009).

13. For those readers interested in the American model of water management, a good starting point would be the work of Deason et al. (2001) and Brault and Pezon (2002). Also stimulating is the critical analysis carried out by R. Griffin (2012) on the relationship between developments in the economy of water and the evolution of American water policies, and those of UWSs.
14. For a critical discussion of the use of water meters please see: Barraqué (2013).
15. This information comes from the methodology used for the construction of the Aquastat database and for this specific figure please see: http://www.fao.org/nr/water/aquastat/data/glossary/search.html, accessed 14 December 2015.
16. The Water Information System for Europe is the principal database on UWSEs. This is a joint initiative by the European Commission and the European Agency for the Environment and it was launched and made available to the public via a web platform on the occasion of the fourteenth World Water Day in 2007. The platform can be consulted at the following web address: http://water.europa.eu/, accessed 14 December 2015.
17. For a specific analysis of the price of water in France see: Fauquert (2007).
18. In other respects, it should be remembered that the price of water is not determined in the same way in the different UWSs, and this very issue is discussed in the third section of the chapter.
19. At this stage, the analysis would appear to broaden on the premise of the ontological complexity attributed to the UWS, notably the recursive dimension. We make that choice because this method also reinforces another dimension of the complex character of a UWS by emphasizing holographic principles. Indeed, an identification of the structural features of a European model of the UWS shows how UWSEs construct the European model (each UWSE being independent and unique) and how this model determines the UWSE.
20. It should not be forgotten that the institutional environment is composed of the political, social and legal tenets of a society (Williamson 2000; Bolognesi 2014a) and in the case of water, the characteristics of the resource are also integrated (Saleth and Dinar 2004, 2005; Bolognesi 2014a). It is consequently considered as structural.
21. J.L Fabiani (2000) illustrates how this tendency has intensified in recent years by looking at the development of a subdiscipline—the ecology of restoration—and its link with public action. Finally, he also talks about 'techno-nature'. With regard to the management of water in particular,

Swyngedouw (2007) draws on this concept to illustrate the development of Spanish hydraulic engineering between 1939 and 1975.

22. The three main criticisms of an ecological footprint and its measurement are: (1) the confusion of several services produced by the same ecosystem; (2) difficulties with the exchange of inter-regional services; (3) problems caused by the spatial heterogeneity of consumption and service offerings (van der Bergh and Verbruggen 1999; Opschoor 2000; Andersson and Lindroth 2001).
23. In the same way, the meaning of centrality differs from the definition in the article of Bolognesi (2015), which accords it a central role. It is due to a change in the scale of the analysis; i.e. meso in Bolognesi (2015) and micro in Huang et al. (2007).
24. This observation refers to the debate on the Europeanization of the member countries of the European Union (special issue of *Politique et management public* 1997; Bauby 2002, 2011). Initially, the notion of Europeanization defends the increase in the number of European regulations by arguing that it brings together the member countries into a communal model of organization and governance (Andersen and Eliassen 1993; Muller 1994). More recently, the analysis has been more closely refined and it appears that, while member countries do indeed work with common institutions, the local level remains decisive in determining the structure of the organization and its governance (Featherstone and Radaelli 2003; Massardier 2011; Knill and Lehmkuhl 2002; Marcou 2012). For further information on how this is applied to the case of the environment and water, please see Berny (2011).
25. This dimension of prioritizing usage will not be dealt with extensively. Nevertheless, it is important to know that, in France, the *préfet* has the ability to prioritize usage. For example, if there is a drought, then they are able to issue an order restricting the volume of usage (watering, and so on). In addition, this dimension has tended to become more important in the academic field through the debates surrounding water safety/security (Barbier 2011; Cook and Bakker 2012; Bolognesi et al. 2013). For an overview of procedures relating to the prioritization of usage in Spain, the reader may find the work of Buchs (2012) to be useful.
26. Specifically, the WFD talks of 'the principle of recovery of the costs of water services, including environmental and resource costs'. This assumes that the recovery level must be the highest possible and that with the

integration of the user-pays principle, the level of subsidy can be absorbed for the most part. For more details on the technical aspects of the recovery of costs, please see Loubier and Gleyses (2011).

27. The number of important services and their small size has been criticized in a report by J. Briscoe written for the World Bank (1995), whose conclusions have been dismissed as false by B. Barraqué (1998).
28. It should be noted that there were 36,658 French municipalities as of 1 January 2015.
29. This differs from the right to water, which ensures the right of access to water and not the terms of access (Barraqué 2005).
30. Civil law establishes four categories. The *Res publica* (item of the state) and *Res propria* (private item) form the basis of modern rules of ownership in the division between public and private water. The *Res communis omnium* (common good) requires usage rules since water belongs to everyone and cannot be owned. *Res nullius* (personal item, free access) constitutes the fourth category (Barraqué 2001).
31. For further information on water regulations in the United Kingdom, please see: http://www.legislation.gov.uk/all?title=water, accessed 7 January 2015.
32. Bauby (2011) determined the development and action of agencies according to three types of separation: (1) between the service operator and regulator; (2) between the roles of shareholders and the regulator of the public authority owning the enterprises; (3) between the infrastructures and the provision of services.
33. In the case of supply, the price is suggested by the operator and then approved by the municipality. In the instance of a company that is subject to private law, it is the competition authority (*Kartellbehörde*) that controls prices (*Wasserpreise*). In the case of a company subject to public law, it is the administrative court (*Verwaltungsgericht*) that controls prices (*Wassergebühren*).
34. Remember that along with the dialogic and recursion principles, the holographic principle is one of the three principles defining a complex system.
35. At this point, the author wishes to thank G. Canneva for his assistance during the observation and analysis of contractual changes in the French UWS.
36. This report came about as a result of the management crisis in 1995 (Bakker 2000, 2003).

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3

UWSEs Sustainability and Modernization: Achievements and Main Challenges

Now that we have examined the effect of modernization on the structure of urban water systems in Europe (UWSEs), we will now move on to looking at its impact on their sustainability, the improvement of which is a formal objective of the Water Framework Directive (WFD).

An analysis of the sustainability of a system presents the risk of leading to a trivial conclusion of an unsustainable state, because of the fact that the notion of sustainability can take on an ideal status. To avoid this deadlock, we must make use of a sustainability analysis grid, which is put together by breaking down that notion. In this way, we can identify and put in order several dimensions of sustainability. This approach then addresses the components of UWSEs by means of sustainability criteria, before placing the results within the context of the different dimensions of sustainability.

This results in a double advantage. Firstly, the analysis is reproducible for other UWSEs. Then, compared to the existing literature, it produces new information by distinguishing different sustainability shortfalls in UWSEs and in particular by isolating their sources. An analysis is always done by comparison, but the comparison is now confined to the three ideal-types defined in the previous chapter, i.e. those of the German, French and English models. It should be noted that the objective of this

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chapter lies in the identification of trends that can be used to assess the effectiveness of reform-driven modernization in terms of sustainability, although it does not intend to use them to provide a detailed analysis of the sustainability of each UWSE. In fact, there is already existing literature on this very point and we do not have the tools necessary for such a multidisciplinary analysis.

This chapter will therefore develop in three stages. The first will present the framework used to analyse sustainability. The second applies it to two major issues of UWSEs that have been identified both by the literature and key players: the renewal of infrastructure and the conservation of the environment. Finally, we will discuss the effectiveness of three strong, organizational principles of modernization (pricing, liberalization and privatization) in terms of the dimensions of the pre-established definition of sustainability.

1 Framing of the Approach: Definition of Themes Studied and the Sustainability Analysis Grid

This section presents the methodology used to characterize the crisis of UWSEs. This method uses an analysis of the urban water system (UWS) to highlight the potential for a sustainability crisis to occur in terms of the governance of urban water. It does this by distinguishing the potential origins of a dysfunction in the UWS (section "Dynamics and Dysfunction of UWSEs: Identifying Current Issues of Sustainability") before applying, in various forms, the notion of sustainability to this model (section "Construction of the Analytical Framework: Definition of the Approach to Sustainability and a Breakdown of the Notion into Six Dimensions").

Dynamics and Dysfunction of UWSEs: Identifying Current Issues of Sustainability

To understand the processes that lead to the malfunction of UWSEs, it is necessary to specify the dynamic of a UWS (section "A Positive Understanding of the Link Between Dynamics and the Efficiency of a

UWS"). Then, by inference, the potential sources of dysfunction in UWSEs can be identified and isolated (section "Three Areas of Observation of the Sustainability of UWSEs: The Patrimonial State, the Environmental State and the Action of Economic Instruments").

A Positive Understanding of the Link Between Dynamics and the Efficiency of a UWS

Analysing the link between sustainability and the modernization of UWSEs leads us back to the more general question of the relationship between the dynamics of the system and its efficiency. We define effectiveness by comparing the result of the management of a UWS with its objectives. The more the result corresponds to the objectives, the more it is deemed to be efficient. This definition can be deemed to be relatively positive in that the efficiency, result and objectives are determined by the actors of the UWS and not a priori by the observer. As shown in the first chapter, a UWS formulates an urban water cycle with the intention of meeting the demands of urban water usage and, along with the water institutions, it must align with the opportunities and constraints of the key players. The functioning and dynamics of a UWS therefore depends upon the nature of these components and their interactions. The three ontological axioms used as the basis for the definition of a UWS influence the link between the dynamism and efficiency of a UWS:

- the performance of the system depends on the interaction of all of the components of the system (complex system axiom);
- the components play a variable role in determining the result of the management (polycentrism axiom);
- The water institutions are considered to be a controlling factor for system effectiveness (institutionalizing axiom).

The dynamics of a UWS depend on the dynamic interaction between its components. We have seen that the institutional environment and institutional structures have an effect on the urban water cycle by incorporating it into the long-term development process and the governance framework in particular (Dixit 2009). In this way, water institutions determine the

territorial realities (characteristics of the resource, characteristics of urbanization, and so on) and macro-social realities (the role of regulation, liberalization, macroeconomic status, and so on) in which users and operators are included. They also offer a binding support for the coordination of actors in providing contracting capabilities, management tools, etc. Although the dynamics of water institutions seem slower and give an impression of inertia in comparison with the urban water cycle, users and operators feed back to the institutions. Their behaviour reveals choices and realizes economic dynamics among the different possible alternatives. In this way they drive the institutional change needed to improve coordination and to meet their needs.

M. Saleth and A. Dinar (2004, 2005, 2008) also offer a positive analysis of the institutional dynamics of urban uses of water.[1] The aim of the authors is similar to that of this chapter: they proceed to characterize phenomena by avoiding the use of theoretical elements. They consider that institutional change is a process so complex that it cannot be explained by a single theory, so they offer the most generic analytical framework possible in order not to ban a priori the use of conceptual devices during the explanatory stage of change.

> However, a combination of relevant theories can be logically linked to capture the whole dynamics of the change process. The stage-based perspective of institutional change proposed by Saleth and Dinar (2004) can be a general framework for linking different theories to provide a simple but relatively more complete description of the change process. (Saleth and Dinar 2005: 6)

M. Saleth and A. Dinar address change by differentiating the institutional environment from the governance structure and perceiving institutional evolution as a succession of four phases (Saleth and Dinar 2004, 2005; Saleth 2006). The first phase consists of a change in the mindset, which creates the territory necessary for institutional evolution and leads on to the second phase, political articulation. This articulation of facts is a period of debate leading to a political agreement on the need for change. Concrete decision-making and reform procedures fall under the phase of institutional change. This includes implementing the reform agenda that

has been decided upon. Finally, the fourth phase is that of current impacts, during which an analysis evaluates the results of the measures taken. This sequence of the change process is accompanied by a detailed analysis of the channels used for bringing about the change. In addition, the authors propose econometric estimates of the links between the components of a system in relation to its performance (Dinar 2000; Saleth and Dinar 2008). The analyses proceed on a national level and provide the means of international comparison. Finally, they highlight the strong interdependence between the components.

The aim of this chapter is broadly similar to that of the research programme led by M. Saleth and A. Dinar; in other words, a characterization of the efficiency of a system following its evolution. However, our methodology is different, mainly because we seek to provide a theoretical explanation for the phenomena that have been observed in order to derive generalized and transferable knowledge of the coordination and institutional evolution engines. The comparison to this programme also allows us to specify the framing of the chapter by relying on already existing analytical categories and by highlighting the similarities and differences between our work. First of all, in the sequence of the change process, modernization belongs to phase 3, that of institutional change, and the objective of this chapter is to compare the result of phase 4—current impacts—with the objectives of phase 3. In this case, the objectives to be attained are those of sustainable development, as mentioned in the WFD; the rationalization of UWSEs appears to be a means to this end. Like M. Saleth and A. Dinar, we view this in terms of a polycentric, interconnected system with strong institutional content. However, due to the complex system axiom, we do not rank in a sequential perception of change. Indeed, each component of a UWS evolves as a reaction and feedback to others. We reinterpret this perception from the position of the temporality of change in the components of a UWS, which varies in such a way as to reaffirm the notion of institutional integration (Williamson 2000), rather than as a series of stages.[2]

Our methodology also differs from that Saleth and Dinar, who adopt a statistical approach based on an international sample largely made up of developing countries. As we are focusing on UWSEs, the scale and the territory of the analysis differ, something that does not allow us use the

same methodology. Moreover, the objective of this chapter lies in the formulation of the relationship between modernization and sustainability in a phenomenal form. M. Saleth and A. Dinar are looking at the issue from a different angle, which isolates the factors for change and economic performance:

> This methodology is applied to provide a quantitative analysis of institutional linkages and their performance implications in the generic context of the global water sector. (Saleth and Dinar 2008: 397)

By comparison, our analysis of the relationship between modernization and efficiency is therefore a positive one, and focuses on the effects rather than the causes of institutional reform, the subject of Chap. 6.

Three Areas of Observation of the Sustainability of UWSEs: The Patrimonial State, the Environmental State and the Action of Economic Instruments

UWSEs bring together water institutions and an urban water cycle, with that cycle's specific characteristics. The water institutions are made up of the institutional environment and institutional structures (political, legal and organizational). The general elements involved in the management of UWSEs themselves can be found in the institutional environment (Ménard and Saleth 2013). As part of the territorial component, the institutional environment of UWSEs is characterized by a dynamic of relatively centralized urban sprawl and a strong artificialization of land, particularly as a result of the urbanization process that is associated with a tight urban grid. There are three major characteristics of the governance of European countries, which form the socio-economic component of this environment. It is essentially based on formal regulations, with which the community bodies increasingly engage; it tends towards decentralization; and it adopts a liberal approach to the management of services. Variations of this environment, the institutional structures of UWSEs, navigate between three models (German, French and English), in order to operationalize the aforementioned governance. Finally, the urban water cycle of the UWSE has a network infrastructure that is of a good quality, but is ageing. This

deviation process is sufficient for moderate usage for developed countries and, although universal, the service is relatively expensive.

The links between the components of UWSEs are multiple, complex and contingent upon each other. In addition, to establish the stylized facts relating to the sustainability induced by the modernization of UWSEs, we decided to focus on an analysis of the urban water cycle. This choice was not only relevant but could also be justified for four reasons. Firstly, the objectives of the modernization of UWSEs focus on the results of the interaction between suppliers and users of those UWSEs. The sustainability of UWSEs is perceived as a balance within the deviation process between satisfaction of usage and their externalities on the resource. It is for this reason that the first article of the WFP is worded:

> promotes sustainable water use based on a long-term protection of available water resources' (Art.1 §b) and is 'the provision of the sufficient supply of good quality surface water and groundwater as needed for sustainable, balanced and equitable water use. (Art.1 §e)

Secondly, by virtue of the holographic principle, the urban water cycle can serve as indicative of all of the dynamics of a UWSE.[3] Thirdly, the appropriateness of this choice is also evident in the fact that the urban water cycle is the element that evolves the most quickly, compared to the others components of an UWS, and is therefore the most likely to illustrate any effects of modernization. However, the converse is not systematically verified, particularly because of the polycentrism of UWSEs and their dialogical dynamic. Therefore, it is necessary to approach the results of this analysis with caution, since they are not integrated in the general dynamic of UWSEs. Fourthly, the components of the urban water cycle are more concrete than the other components and thus more easily observable and able to be compared on an empirical level.

B. Barraqué (2006: 3) lists seven main causes of 'urban water conflicts':

1. quality/extension of drinking water services and their continuity
2. quality/extension of waste-water collection and treatment
3. urban hydrology problems (storm water control)
4. impact of large cities upon their environment, in particular water resources use and misuse

5. financing of investments issue
6. tariff setting and cost recovery
7. degrees of freedom left to urban dwellers vis-à-vis the services provided.

We can summarize this list by grouping its items into three areas for impact monitoring of the modernization and its effectiveness on UWSE: patrimonial assets, environmental conditions and the action of economic instruments on the urban water cycle. We have seen that the infrastructure of UWSEs is mature and therefore poses a question regarding its maintenance and renewal. The latter is a major objective for actors involved in the deviation process and—at both a local and supranational level—managers of UWSEs (Engelhardt et al. 2000; Bouleau and Guérin-Schneider 2011; Bolognesi 2014a; Chenoweth 2012). The environmental dimension is one of the reasons for the modernization of UWSEs, for it represents an area of observation that is essential to the effectiveness of reform, all the more so given that current and future climate change will intensify the risks involved (Albiac and Murua 2009). Finally, a discussion on the effectiveness of economic instruments seems to us to be essential at a time when the WFD is promoting the use of market instruments and pricing as effective policy tools, and when a government bill on progressive pricing is currently being debated in France.[4]

These different areas of observation reflect the multidimensionality of UWSEs, and in turn we will look at technical, technological, environmental, economic and demographic aspects and so on. They offer a discreet glimpse into the effectiveness of UWSEs, so we therefore need to integrate them into a more general observation of the sustainability of UWSEs. This enables us to identify the stylized facts that characterize the direction to be taken in order to achieve sustainability through the modernization of UWSEs.

Construction of the Analytical Framework: Definition of the Approach to Sustainability and a Breakdown of the Notion into Six Dimensions

Examining the ideal goal will allow the potential of the crisis of UWSEs to be evaluated. Sustainability is the ideal goal to be upheld (section "A

'Neutral Approach' Among Meanings of Sustainable Development"). The notion of sustainability is broken down so that it can be mapped alongside the organization of the UWS (section "Analytical Breakdown of Sustainability and the Definition of Six Dimensions").

A 'Neutral Approach' to Definitions of Sustainable Development

Since the beginning of the 1970s, an 'economy of sustainability' has been developing. This economy of sustainability is built around the common issue of development, taking into account the three spheres of the economy, environment and society. J. Pezzey and M. Toman offer a historical reading of the constitution of this field. It shows that 'there is no clear understanding of, let alone consensus around, what constitutes a sustainability objective or standard' (Pezzey and Toman 2002: 23).[5] From the basis of assumptions made on the links between growth and economic development on the one hand, and growth and environment on the other, a simple but clear dichotomy emerges within this profusion of approaches (Pezzey and Toman 2006; Vivien 2003, 2005). This dichotomy crystallizes within the dual structure of the field, which is composed of a 'weak' or 'strong' definition of sustainability. The 'weak' version is an extension of the neoclassical approach to environmental problems. It is characterized by the assumption that there is substitutability between different assets (including natural and economic), and the assumption that technical innovation could render substitutability between factors possible (Nordhaus 1973; 'Hartwick Rule' 1977). Conversely, the strong version rejects this assumption and looks instead to complementarity and co-evolution between the natural and social spheres (Norgaard 1984); this approach calls for the use of a precautionary principle to preserve a minimum natural capital stock, in order to avoid any harmful irreversibility induced by the trajectories of development (Daly 1996).

L. Illge and R. Schwarze (2009) show that this segmentation remains relevant. By questioning the various German economists, these authors clearly reidentify the two groups formed by neoclassical economists of the environment and ecological economists. However, beyond this duality, O. Godard (2005: 9) distinguishes a third strand

> that fits within the perspective of socioeconomics. [The strand] underlines the inscription of the report within the natural environment and its resources in institutions, cultures, and moral visions (Foster 1997) and social functioning that mediates the formation of individual choices (Kapp 1950; Bromley 1995) and their modes of coordination (Godard 1990).

M. Rijsberman and F. van de Ven (2000) transpose the terms of these epistemological readings into urban water systems. They cross two axes, the first relative to the human/environment link (moving from an anthropocentric vision to a different environmental-centric vision) and the second to the type of assessment (ranging from a qualitative approach (values) to a quantitative approach (standards). A typology can therefore be derived from this, the four quadrants of which can be used to distinguish an approach by means of ability, ratiocentrism, sociocentrism or ecocentrism. The first approach focuses on the land-carrying capacity of ecosystems and gives rise to two possibilities: a sustainable or degraded state (often with irreversible consequences). The ratiocentric approach is based on evaluations that are used to try to find, a priori, a solution that maximizes the attainment of objectives: for example, a multi-criteria approach. The sociocentric approach takes the form of an interactive process that places the interest and views of stakeholders at the heart of the approach. The ecocentric approach puts the environment at the heart of the approach and is designed primarily with its preservation in mind.

This presentation of the different approaches to sustainability in the economy allows us to specify the perspective of Chaps. 3 and 6, with both relating to the analysis, observation and explication, respectively, of the phenomena of modernization in terms of sustainability. As we have seen, the choice of a vision of sustainability relates to normative considerations. 'Sustainability is a normative notion about the way in which humans should act towards nature, and how they are responsible towards one another and future generations' (Baumgartner and Quass 2010: 445). This anchorage can also be ontological. In our case, our axioms of institutionalism and the complex system, based on the definition of a UWS, refer on the one hand to the idea of institutions acting as a medium between man and the environment, and on the other to a co-evolution of the socio-economic and ecosystemic aspects. Therefore, our general

approach is at the crossroads of the green economy and the socio-economics of the environment. However, it is noteworthy that our approach of sustainability was the most positive possible and that it focussed on the difference between the results achieved by management and the objectives expected by stakeholders in UWSEs. In this way, our approach has little influence on the analysis undertaken in this chapter. After having defined the analytic prism, this orientation, as well as the typology of M. Rijsberman and F. van de Ven, leads us to a specification of the method of observation.

Statistical indicators are among the most commonly used tools in the assessment of a system's sustainability. Three of their capabilities make them essential. They allow the system to be described, by facilitating the evaluation of management options and alerts in the event of a problem (McCool and Stankey 2004). In the case of water, there is a wide range of indicators according to the system's degree of complexity and integration (Buchs 2008; Palme and Tillman 2009). Most deal with uses of water, the system's impact on the resource and/or the capacity of the resource to allow usage (Molle and Mollinga 2003; Rijsberman 2006). Two main methodologies of the construction of indicators apply to water in cities. The first is based on indicators showing a very specific aspect of the system (Margat et al. 1996) which are then grouped within a larger indicator, the architecture of which is complex (Phillis and Andriantiatsaholiniaina 2001; Simonovic 2009). The second harvest of qualitative data then brings it together within a summary indicator (Bagheri and Hjorth 2007; Milman and Short 2008; Angueletou-Marteau 2009).

Statistical indicators were used to analyse the effectiveness of modernization. However, we have not used one that reflected the overall condition of a UWS. Indeed, our approach, particularly due to a lack of data, did not allow us to compare all UWSEs. We will therefore use statistical indicators on a discretionary basis. This choice is also motivated by the content of modernization itself. We have seen that in its organizational dimension, modernization implies a reform of the information on UWSEs, which leads to the emergence of common statistical indicators: performance indicators, indicators of good environmental status, and so on (Canneva and Guérin-Schneider 2011; Salvetti 2012; Renou 2015); this data will therefore be mobilized and made consistent thanks to the

the notion of sustainability, which breaks it down and orders the information that has been collected so that stylized facts can emerge.

Analytical Breakdown of Sustainability and the Definition of Six Dimensions

In order to characterize the states and the prospects for results identified within the UWSEs, we must distinguish the different dimensions of sustainability. In this way, the sparse data that has been collected can be pooled in a single analytical grid, allowing it to be shared and the phenomena to be separated from the Salient Facts. Sustainable development is the meeting point between three spheres: those of the environment, the economy and society. A goal is awarded to each sphere. The environmental integrity of the system is the goal of the environmental sphere. The economic sphere aspires to achieve effectiveness of that system and the social sphere aims for fairness. These objectives correspond to the issues below. Integrity questions the resilience of the ecosystem. For the UWSE, it is in particular about preserving and/or improving the quality of the resource. The issue of efficiency is expressed in terms of the profitability of the water sector. The ways in which the universality of access to water is ensured relate to the issue of fairness. A sustainable system meets all these objectives, as it is located at the crossroads of the three spheres.

This first breakdown of the notion of sustainability highlights the search for a compromise between generic notions and the above three spheres that form the basis of sustainable development, uncoupling one from the other. In order to rely on notions that are not connected with each other, it has proven necessary to use intermediate categories. In order to construct them, we rely on fractal approaches towards the notion of sustainability in its tripolar form, with each apex breaking down into an economy–environment–society triangle.[6] The Sustainability Impact Assessment (SIA) as initially proposed by P. Lamy and used by the European Commission since 2002, provides an initial example by attaching 'sub-topics' of sustainable development to each pillar (European Commission 2006).[7] A. Da Cunha et al. (2005) also proposes a fractal approach. He notes that reasoning only on the basis of the three pillars poses a risk of only being able to come to a conclusion of a lack of sustainability. He then suggests that 'the ability to

overcome this situation is to be found in our ability to explore the interfaces or areas of integration between the three areas or dimensions of sustainable development' (Da Cunha et al. 2005: 15).

However, if sustainability represents an ideal goal, we must identify the intermediate areas in order that we do not merely come to the conclusion that a UWS is unsustainable. To successfully complete this process, we will deal with the sustainability of a matrix whose horizontal and vertical vectors will each be one of the three pillars of sustainability. Thus, the concept is broken down into the different subsections, each representing a specific facet of the initial notion. These intermediate situations allow the strengths and weaknesses of a UWS to be precisely characterized. The intersection of each dimension of sustainability delineates these intermediate areas one by one. Six different facets of sustainability thereby emerge (Table 3.1): environmental integrity, efficiency,

Table 3.1 Crossroads of the dimensions of sustainable development

	Economical dimension	Social dimension	Environmental dimension
Economical dimension	Efficiency: Profitability of the water sector (Gonzalez-Gomez and Garcia-Rubio 2008)		
Social dimension	Effiquity: Redistribute, insert, integrate (Da Cunha et al. 2005) Equalization payments	Fairness: Universality of access to water (MDG)	
Environmental dimension	Viability: Eco-efficiency: revalue, recycle (Da Cunha et al. 2005) Steady state economy (Daly 1977, 1996) Maintain the resource as an input and absorber of output (Basiago 1999: 155)	Environmental justice: Quality of the living environment (Da Cunha et al. 2005) No social discrimination in respect of the environment (Laurent 2011)	Integrity: Ecological resilience (Holling 1973, 1986) Good environmental status of the resource (WFD 2000)

Source: Created by the author with reference to Da Cunha et al. (2005)

fairness, viability, environmental justice and effiquity (Da Cunha et al. 2005). Each responds to a specific objective within the framework of the UWS (Table 3.2).

Effiquity represents the interval common to both the economic and social dimensions. The effiquity of a UWS depends on its ability to maintain a profitable sector, providing a quality service to everyone. It makes use of different forms of redistribution and perequation. Viability questions the ability of the UWS to combine economic and environmental performance. It is therefore located at the intersection of the economic and environmental spheres. In relation to the water resource, it is about exploiting the water sector while maintaining the ecosystem properties of production inputs and the absorption of outputs (Basiago 1999). When taken to its extreme it correlates with the idea of a steady-state economy as proposed by H. Daly (1977). Eco-efficiency is a less restrictive alternative (Da Cunha et al. 2005). It also applies the same logic of a qualitative improvement of production resulting in a reduction of the intensity of its impact on the environment, while also setting a limit for the volume released and produced. Finally, environmental justice ensures the independence of the quality of the resource in relation to the social characteristics of urbanites (Laurent 2011; *Flux* special issue 2012). This is to avoid a sector of the urban population suffering excessively from the negative externalities of the UWS (flooding, pollution, and so on).

Table 3.2 Issues of the urban water system associated with the different subdivisions of sustainability

Concepts	Associated issues
Performance	How can the profitability of the water sector be maintained?
Equity	How can access to quality water be ensured for all citizens?
Integrity	How can the quality of water resources be preserved/improved?
Effiquity	How can redistribution be organized to guarantee fair access?
Viability	How can economic and environmental performance be linked?
Environmental justice	How can a minimum quality level be assured for the resource for all citizens in order to avoid increased social segregation?

This breakdown in terms of the organization of a UWS allows the outcome of the governance of UWSEs to be characterized in terms of sustainability and for problematic phenomena to be isolated. The approach only highlights the fact that modernization of UWSEs is the answer to each of the sustainability issues. Thus, by systematically replacing the analysis of the three areas of observation noted in section "Three Areas of Observation of the Sustainability of UWSEs: The Patrimonial State, the Environmental State and the Action of Economic Instruments"—patrimonial assets, the environmental condition and the action of the economic instruments of an urban water cycle—in the grid, we can develop a stylized fact pertaining to the link between sustainability and the modernization of UWSEs. In this way, we can define the nature of any possible dysfunction in the UWSEs in relation to their sustainability objectives.

Using this method, the following section applies to the instance of two major structural problems facing the UWSE, namely the renewal of infrastructure and the preservation of resources.

2 Modernization, Renewal of Networks and Environmental Conservation: Limits to Efficiency, Viability and the Integrity of UWSEs

The renewal of the network (section "The Renewal of Networks: A Major Structural Challenge for the UWSE") and environmental conservation (section "The Environmental Dimension: A Pessimistic Perspective") are two major challenges to the sustainability of UWSEs.

The Renewal of Networks: A Major Structural Challenge for the UWSE

The first subsection presents the condition of the infrastructure used in deviation processes in European cities (section "State of the Renewal of the Infrastructure of UWSEs"). In structural terms, it would appear that the renewal of European water infrastructure poses problems to both

efficiency (section "A Problem of Efficiency: The Lack of Investment in Urban Water Cycles") and viability (section "European Environmental Regulations: A Catalyst for Viability Issues").

State of the Renewal of the Infrastructure of UWSEs

It is possible to predict the characteristics of a typical life cycle of the infrastructures of a UWSE (Fig. 3.1). The main variables describing the physical condition of the infrastructure involved in the deviation process are sizing, operating life, failure rate and survival function (Herz 1996). Dimensioning takes into account the technical characteristics of the network on a given date (length, calibration, materials and age). The operating life varies between 40 and 80 years and is directly linked to the failure rate, since it depends on initial failures (construction or design

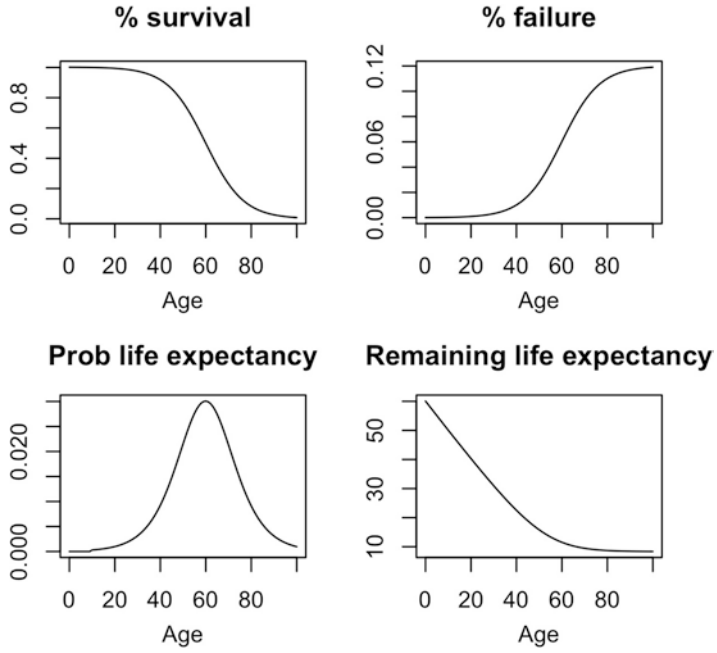


Fig. 3.1 Principal orders of magnitude for the life cycle of the assets of UWSEs
Key: With a = 400 per year, b = 0.12 per year, c = 10 years

defects) and failures as a result of aging. R. Herz (1996) provides the values for these characteristics observed in Stuttgart, which enables an estimate of these technical parameters according to the type of network components (Table 3.3). Finally, the survival function is constructed from the previous characteristics and has three phases. Firstly, from 0 to 30 years, the survival rate remains close to 100%, then from 40 to 80 years a rapid deterioration can be observed in the rate from 90% to 10%; finally, beyond 80 years, functionality slowly declines until you reach a survival rate of zero. This functionality can be written using the following generic form:

$$y(x) = \frac{a+1}{a+e^{b(x-c)}} \text{ with } x \geq c$$

Where:

y = proportion surviving
x = age
a, b, c = parameters of ageing:

Table 3.3 Parameters of ageing and life expectancy according to the material used in the water supply infrastructure in Stuttgart

	Parameters of ageing			Operating life (years)	
Materials	*a*	*b*	*c*	Average value	Standard deviation
Steel	2400	0.12	15	80	33
Cast iron	1200	0.12	10	69	32
Ductile iron without anti-corrosion protection (1965–1972)	600.	0.21	5	35	18
Ductile iron with weak anti-corrosion protection (1973–1979)	600	0.14	8	54	27
Ductile iron with good anti-corrosion protection (since 1979)	1200	0.11	15	79	35
New pipes (after 1990)	1200	0.11	15	79	35
Renovated pipes (after 1990)	400	0.30	10	30.	12

Source: Herz (1996: 31)

a – degradation factor
b – failure factor
c – resistance period

The renewal of infrastructure meets a need for maintenance of the quality of the UWS's supply and drainage network. This therefore comes down to an observable problem within the urban water cycle and one for which the question of financing proves crucial (Barraqué 2006). In 2011, the European drinking-water supply network measured approximately 3,500,000 km (Canalisateurs de France 2011). France is equipped with an extremely developed infrastructure, clearly evidenced by the fact that the French supply network accounts for a quarter of the European supply network (Fig. 3.2). Thus, 891,439 km of pipelines ensure the supply of drinking water and 391,305 km of pipes are used for the evacuation of waste water, resulting in a network with the total coverage of 1,282,744 km. By contrast, the English and German networks are much shorter. In England and Wales, the network extends over 645,331 km, of which 335,500 km is used for supply, and 309,831 km for drainage. In Germany, 530,000 km of pipelines transport drinking water and 540,646 km evacuate waste water giving a total infrastructure of 1,070,646 km.

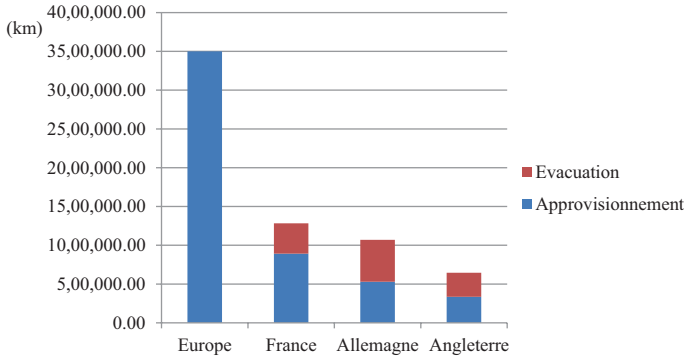


Fig. 3.2 Linear length (kilometres) of networks used for drinking water supply and wastewater evacuation in France, England/Wales and Germany in 2007–2008 (Source: Created by the author using the IFEN, Eider database; Canalisateurs de France (2011); Water UK (2008); Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2011))

These figures demonstrate the differences in the size and proportions of the infrastructure in the three countries. The discrepancy in terms of area partly explains the difference in the networks' size. The German network serves a territory half the size of France and about twice the size of England and Wales put together. The differences in the length of the supply networks seem to be proportionate to the differences in area of the three countries. This same proportionality is not found in the lengths of the drainage networks. The drainage system is longest in Germany, and those of England and France are relatively similar in size. Another difference in terms of the proportions can also be seen. In France, the supply network is twice as large as the drainage network, whereas the English and German networks have almost as many pipelines per linear metre (m)for supply as for drainage.

Salient Fact 25: *The total length of the infrastructure used in the deviation process is the largest in France, then in Germany and England respectively.*

Consistent and complete aggregated data on a national level, which would provide information on the calibration and age of the infrastructure used in the various deviation processes of UWSEs, is not available. This deficiency is explained by the contingency of such information and the large number of UWSEs. Nevertheless, reports provide information on the infrastructure's age. In France, pipelines were laid at a rate of 30.5% before 1965 and this same figure was 36.9% in 1998 (IFEN, data from Eider dataset). Looking at the results of surveys carried out in eight *départements*,[8] J.M. Cador (2002) put together the history of the installation of the networks in France by means of extrapolation. One of the findings was that in 2000, more than 40% of networks had been in place at least 30 years (Fig. 3.3). The age of the German network matched that of France, if one were to assume that the drainage infrastructure was laid at the same time as that of the supply network. Thirty-two percent of the infrastructure dated back at least 50 years (Fig. 3.4). Much of the infrastructure, therefore, had reached its age of maturity, and in England, an ageing infrastructure was also noted. Hilary Benn, Secretary of State for

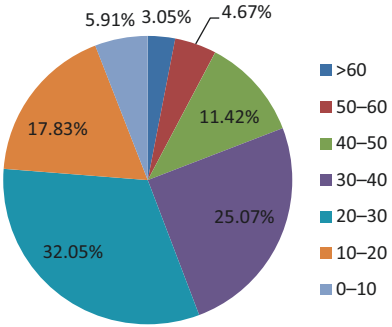


Fig. 3.3 Profile of the supply infrastructure of UWSs in France in % in 2000, grouped by age (Source: Bolognesi 2014a: 73)
Key: The estimate evaluates sections of the network according to the age of the network using the history proposed by J.M. Cador, with a reference date of 2000

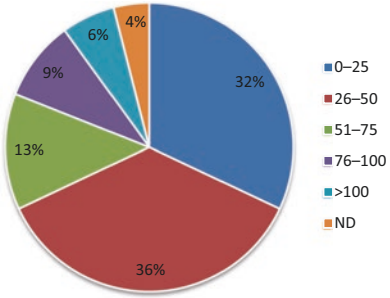


Fig. 3.4 Breakdown of the drainage infrastructure of UWS in Germany in % in 2009, grouped by age (Source: BDEW 2011)

Environmental, Food and Rural Affairs, statedin his introduction to Walter's UK's annual report that "We still have environmental water quality problems, an ageing infrastructure, and an unsustainable supply-demand balance in certain parts of the country" (Water UK 2008: 4).

Looking at the age characteristics of the French infrastructure provided by J.M. Cador (2002), it is possible to evaluate the evolution of the assets' condition. Working on the assumption of non-renewal, the theoretical values provided by R. Herz (1996) conclude that today, approximately 40% of infrastructure has reached a stage during which malfunctions start to appear as a result of ageing, since it has been in place at least 40 years.

Our estimates and projections of the life-cycle of the infrastructure, as described by J. M. Cador, confirm this hypothesis (Fig. 3.5). Indeed, the shape of the survival curve indicates that the infrastructure of French UWS has broadly entered a phase of deterioration, with a rate of survival of 0.86% in 2017, which it is estimated will be 0.68% in 2030. The projection of the failure rate confirms this condition and shows the currency and imminence of investments to be made in renewal. According to our calculations, the failure rate started to grow in 2010, and will accelerate sharply from 2030, going from 1% in 2010 to 6.1% in 2040. Of course, these estimates do not account for any renovation work or maintenance,

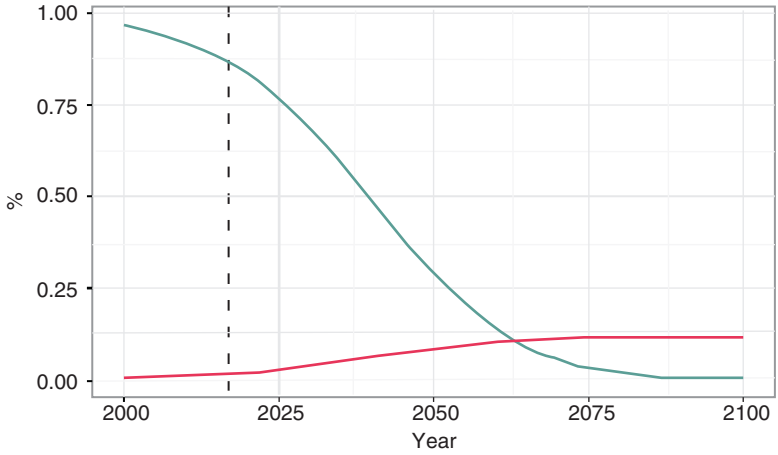


Fig. 3.5 Valuation and projection of the condition of the assets of the French UWS based on characteristics observed in 2000
Key: *Blue* line: survival rate, *red* line: failure rate
The calculations have been worked out using the following parameters: $a = 600$; $b = 0.12$; $c = 10$ and the year 2000 is used as the base year. These levels have been set according to those observed in Stuttgart. Only parameter a differs between the estimate and the theoretical values calculated above. In our estimation, it is 50% higher than the theoretical values. This fixation on the increase delays the phase during which a strong decrease in the survival function and a growth of the failure rate is seen. Compared to the theoretical values, therefore, we are underestimating the state of emergency surrounding the depreciation of the assets. The choice appears logical in the sense that an underestimation compensates for not taking into account maintenance work. In addition, compared to the realities observed in Stuttgart, R. Herz undervalues the theoretical parameters

but they do reflect a need for the renovation rate to accelerate in the coming years.

Salient Fact 26: *The assets of the UWSEs are entering a phase in the life cycle where the failure rate increases and the survival function decreases.*

Salient Fact 27: *In order to maintain the quality of the services provided, both the management of and investment into the infrastructure of assets of UWSEs must become a central objective for the next two decades.*

In France, the annual renovation rate of the supply network decreased from 0.72% in 1998 to 0.56% in 2008, and from 0.63% to 0.5% with regard to drainage networks (IFEN, data from Eider). The average level of renovation in French UWSEs has thereby averaged out at approximately 0.6%; at that rate, a complete renewal of infrastructure would last 166 years. There is therefore a gap between the investment needed for the sustainability of the infrastructure used for the deviation process and the investment that is actually made. In England, about 1% of the total network, 0.8% of which is used for supply purposes, has been renewed on an annual basis over the last decade, which means that the period of renewal will last in total 100 to 125 years (OFWAT 2009). Over the same period in Germany, the renewal rate varies due to local circumstances from between 0.4% and 1.2% per year; in other words, a total length of renewal period that would last from 83 up to 250 years (BDEW 2011). A comparison of this data with the theoretical values reveals the topicality of this issue of asset management in UWSEs.

Salient Fact 28: *The renewal rate in the infrastructure of the deviation process seems inadequate in the face of the estimated requirements, something that threatens the physical integrity of the networks in the medium term.*

The leakage rate is an indicator of the quality of the infrastructure used in the deviation process. This leakage rate varies greatly between the three countries (Fig. 3.6) and European countries in general (Fig. 3.7). Taking Germany as an example, it can be seen that the leakage rate was already low in 1998 (8%), yet fell to 6.5% in 2007. In France and England, the leakage rate is much higher, at around 20%. Between the period 1998 and 2007, France has reduced this rate by 10%, although losses in the English network have stagnated. This sharp reduction coincides with a replacement of the oldest pipes, which are predominantly carried out as they contain 'problematic materials'.[9]

Salient Fact 29: *The leakage rate is higher in more modernized countries.*

Salient Fact 30: *The leakage rate tends to decrease in UWSEs.*

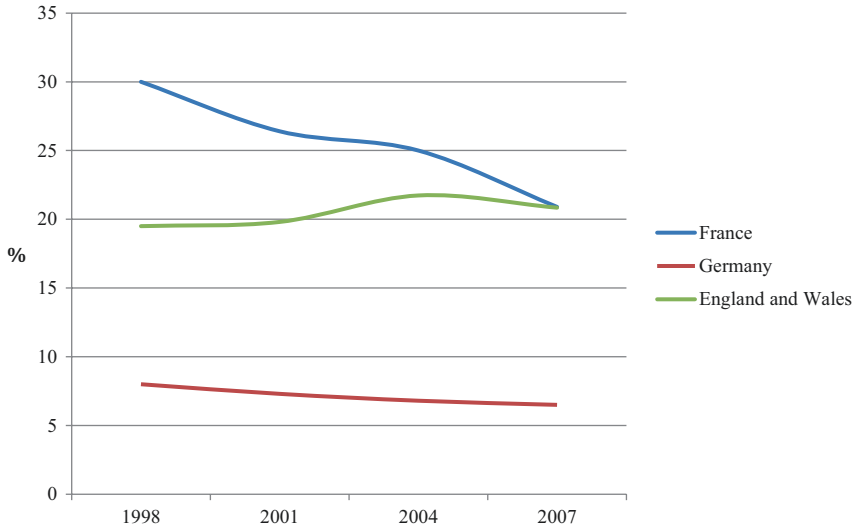


Fig. 3.6 Evolution of the leakage rate of the supply network from 1998 to 2008 (Source: Bolognesi 2014a: 74)

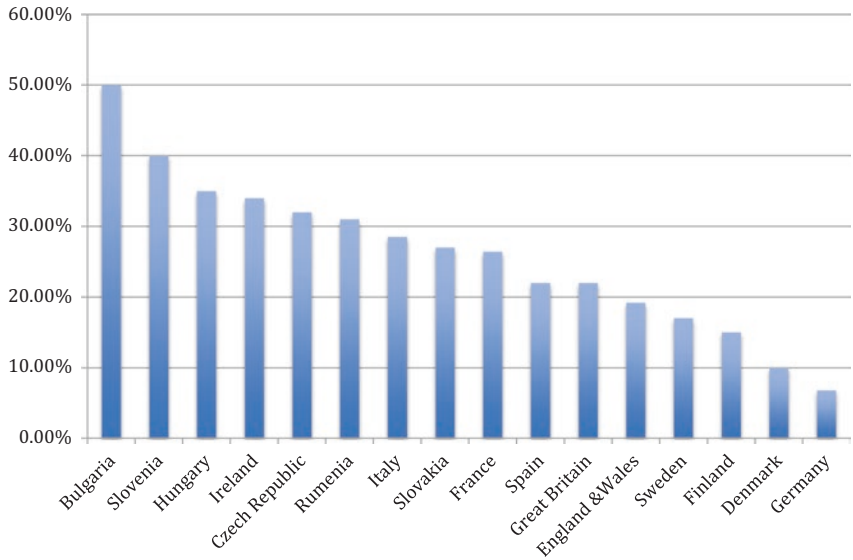


Fig. 3.7 Comparison of the leakage rate of supply networks of drinking water in the EU, in 2008 in % (Source: German Federal Agency 2011)

Salient Fact 31: *In Germany, there has been no major shock to the modernization of the quality of the (already good) infrastructure.*

A Problem of Efficiency: The Lack of Investment in Urban Water Cycles

In Germany, the infrastructure of the urban water cycle appears to be sustainable. Although the network's renewal rate is no higher than elsewhere, there are few losses. In France and across the channel, the situation shows a real need to improve the condition of the infrastructure. We can therefore assume that the key players in the German urban water cycle realize and finance the necessary investments, in contrast to those based in the other two countries. By extrapolating the comparison, it would appear there is a positive correlation between the degree of penetration of modernization and the difficulties encountered in encouraging and engaging the necessary investment in the infrastructure of the urban

water cycle. To this extent, renewal of the network is part of the issue of the effectiveness of sustainable development. It is about organizing a UWS that is capable of bringing together the necessary financing capacity for these investments. Intuitively, the German situation seems more efficient thanks to higher water prices. The same observation can be made in Denmark, which has the best performing infrastructure and where the price of water is the highest in Europe: approximately $\$8/m^3$ (cf. Chap. 2, section "The Urban Water System: A Uniting Representation of Municipal Water Management") (Keating 2008). In addition, the relatively large size of the *Stadtwerke* and their specific features allow them to negotiate preferential rates of interest. In this way, German operators are able to increase their cash flow and reduce investment costs. This mechanism illustrates the impact of the institutional structure on the urban water cycle. Looked at jointly with the description of prices in the UWSE, we can take note of the following (see Chap. 2, section "Organizational Structures: Multilevel Architecture Between Local Management and National Regulation"):

Salient Fact 32: *The political use of pricing facilitates the necessary level of investment in the UWSE being achieved.*

The data pertaining to the issue of the asset management of water is predominantly found at a local level. Collecting and compiling it to create an international comparative analysis proves both difficult and risky. Differing accounting methods result in a low comparability of data. For example in France, the system of M49 accounting, which has been used since 1992 for water, is quite unique (Act No. 92–3, 3 January 1992).[10] This informational problem explains how few macroeconomic studies there are on the subject. In France, the Ministry of Ecology has focused on this issue of assets and has tried to generate data in order to determine the extent of the issue (Cador 2002; Ernst & Young 2012). According to average estimates, the 2009 value of the French urban wastewater drainage system was €196,756 million and €170,231 million for the drinking water supply (Table 3.4). The average estimate of the annual depreciation of all the networks was valued at €7515 million.

Table 3.4 Monetary assessment of the assets of the French urban water cycle in 2009, in millions of euros

	Valuation			CFC (Consumption of fixed capital)		
Drainage	**Low**	**Average**	**High**	**Low**	**Average**	**High**
Collective wastewater treatment						
Rural lines	25,998	29,593.50	33,189	325	439	553
Urban lines	99,379	119,964.50	140,550	1242	1792	2342
Water treatment stations	23,466	24,874	26,282	782	1048	1314
Connections	18,603	22,324	26,045	465	666.50	868
Total	167,446	196,756	226,066	2814	3945.50	5077

	Valuation			CFC (Consumption of fixed capital)		
Supply	**Low**	**Average**	**High**	**Low**	**Average**	**High**
Production	9923	11,284	12,645	331	481.50	632
Reservoirs	2011	2377	2743	20	27	34
Rural lines	52,809	52,809	52,809	660	858	1056
Urban lines	84,961	84,961	84,961	1062	1380.50	1699
Connections	14,100	18,800	23,500	470	822.50	1175
Total	163,804	170,231	176,658	2543	3569.50	4596
Urban area						
Total infrastructure	252,443	284,584.50	316,726	4372	6218	8064
Depreciation coverage				2323	477	−1369
% Depreciation coverage				153.13	107.67	83.02
Rural + urban						
Total infrastructure	331,250	366,987	402,724	5357	7515	9673
Depreciation coverage				1338	−820	−2978
% Depreciation coverage				124.98	89.09	69.21

CAF 2009	3581
Subsidies for investments and capital contributions	1763
Debt	1351
Investment—2009	6695
% Self-financed	0.79

Source: Bolognesi (2014a: 77)

Key: *CFC* consumption of fixed capital, established on the basis of a replacement value of facilities, divided by their technical operating life (and not their financial life). It corresponds to the depreciation suffered by fixed capital during a period of normal wear and tear and foreseeable obsolescence

The calculations are worked out on the basis of the level of investment intended for the renewal of infrastructure in 2009, i.e. €6695 million

However, for the same year, investments from operators amounted to €6695 million, or 89.09% of the level of depreciation. According to an average estimate, and if we stick to the false assumption that the entire investment from operators is spent on renewal, the French network would depreciate at a rate of €820 million per year. If this were to be estimated pessimistically, net depreciation would amount to €2978 million euros per year. This data illustrates and confirms the importance of the need for investment in the renewal of the French network.

Salient Fact 33: *The level of investment in the urban water cycle of UWSEs is insufficient to ensure the physical sustainability of the network.*

In England, the same dynamic is at work. Nevertheless, even if there is still underinvestment compared to what is needed, the data issued by OFWAT does show an average increase in the annual level of investment (OFWAT 2010). This move towards five-year stages attests to the incentive effect of the price-capping system in England (Fig. 3.8). The rise in prices therefore translates into an increase in investment between the 2000–2005 and the 2005–2010 programmes. Only the gap between the cost of the renovations and expenditure commitments remains constant, indicating that, in terms of constant costs, businesses maintain their rate of profit rather than increasing investment with a view to avoiding excessive deterioration of the assets. When it comes to modernization, the preference is to focus on the here and now.

Salient Fact 34: *The governance principles of the modernization of UWSEs do not seem sufficient to be able to incite the actors of the urban water cycle to increase their willingness to invest, thus leading them to enter into conflict with the principles of corporate governance.*[11]

It should be noted that the current period of crisis only serves to amplify the problem. Uncertainty increases and forces up interest rates. This is why there is a preference for looking at the here and now, rather than an incentive to invest in the future. Moreover, as countries try to reduce their debt, the subsidies that are provided to increase the capacity

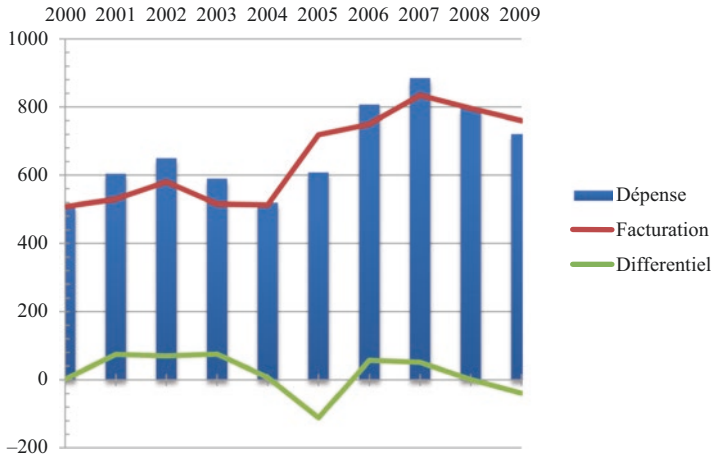


Fig. 3.8 Evolution of financial flows intended to be used on the renewal of infrastructure from 2000 to 2010, in millions of pounds sterling (Source: OFWAT 2010: 25)

of investments from operators could well diminish. In France, subsidies and endowments represent 37% of the financing capacity within the UWS (Ernst & Young 2007; Demoulière et al. 2012). This loss in terms of capital redistribution would be considerable. The economic crisis and budgetary rigour illustrate the potential impact of the institutional environment on the institutional structure and the way in which key players behave. This type of exogenous shock is a strong adjuvant of institutional change (Saleth and Dinar 2004) and, in our case, an inhibitor of the sustainability of UWSEs.

Salient Fact 35: *Macroeconomic difficulties reduce the ability of key players in UWSEs to ensure the level of investment necessary for the sustainability of the deviation process of the UWSEs.*

The institutional environment also influences infrastructure renewal in other ways. This is why urban sprawl, which increases the need for expansion, creates a crowding-out effect for renewal. In fact, between 1998 and 2008, the rate of expansion for the entire infrastructure was higher than the renovation and renewal rate in the French UWS (IFEN, Eider data).

In addition, as the density decreases, the length and the cost of the connection to each additional user increases. F. Maurel (2010) compared network connection costs on the basis of remoteness. For a fixed cost of €100 euros, variable costs totalled €700, €2000 and €3000 for respective distances of 7, 20 and 30 m. In more general terms, C. Speir and K. Stephenson (2002) illustrated that the supply costs could vary with the size of the plots by between 30% and 70%. In a cost–benefit study,[12] G. Pflieger and F. Ecoffey (2011: 861) showed that:

> The costs of transport and of pumping weigh heavily on the costs of distribution. Sprawl in the sense of urban dispersion and the increase in the distance between the new areas and the centres of production can thus be expensive. In contrast, a compact urban form or the location of production centres in a concentric manner can reduce the cost of transport.

In France, this mechanism can be activated as a result of network expansion rates exceeding those of renewal rates (IFEN, Eider data). The same trend can also be seen in Germany. It is therefore possible that the German capacity for infrastructure renewal will be undermined in the coming decade. This should be put into perspective and an emphasis placed on the fact that the compact form of European towns and the density of the urban network moderate the scale of the investment required.

Salient Fact 36: *The characteristics of urban growth in European cities increase the costs of management and operation of the deviation process of UWSEs.*

All of these elements confirm the difficulty there is in both modernizing and maintaining the economic viability of the sector. Arbitration between the short-term profitability of UWSEs and the maintenance of their technical integrity highlights the growing problem of sustainability faced by UWSEs, in particular on an economic basis. These difficulties in efficiency are clear when observing that a certain level of annual profit must be maintained, while the trajectory of investment turns out to be insufficient when faced with the needs.

Salient Fact 37: *Following the modernization of UWSEs, the key players are not able to respond to the economic objectives that allow the sustainability of the systems; the profitability of the sector therefore seems threatened in the long term.*

European Environmental Regulations: A Catalyst for Viability Issues

Apart from efficiency, the sustainability of UWSEs is also affected by their viability. This situation highlights the dilemma and tension that exists when meeting both economic and environmental needs (Bromley 1990; Bithas 2008). Looking at it in terms of volume of water consumption, the imperative for the renewal of infrastructure and its financing are at the heart of the issue of viability. All other things being equal, the increase in the volume of water consumption generates more revenue for the operator. As a result, financing capacity increases and/or the depreciation period diminishes. The prospect of stable or rising consumption thus incites investment. Conversely, environmental considerations are encouraging a reduction of pressure on the resource. From this perspective, the volume of consumption must decrease in order to reduce quantitative pressures (overexploitation and so on) and qualitative pressures (pollution, discharge and so on) on the resource. The principle of rationalization that forms part of the modernization procedure is therefore in favour of this trend, via the implementation of full-cost pricing and the user-pays principle (transposition of Pigouvian incentive principles onto the UWSE). Environmental and economic objectives therefore clash with each other, resulting in a deficit in the viability of UWSEs. Due to the condition of the infrastructure, as presented above, and the increase in environmental regulations, we can assume that this antagonism is growing.

Overall, usage of the urban water cycle is decreasing in major cities of Western Europe and have remained stable in the south of Europe since the early 1990s (Poquet and Maresca 2006; EEA 2010). M. Montginoul, L. Even and D. Verdon (2010) have been evaluating this trend for urban usage of the UWS in Nantes. They have measured an average decrease in consumption of 31% per subscriber and 14% per capita between 2003 and 2008. Over a longer period, J. Souriau has observed the same

dynamic in the Paris UWS. Consumption by Parisians has increased logarithmically since 1945.[13] In 1990, it joined its horizontal asymptote of 250 million m^3/year. The diagram traces a strong decline in water consumption by Parisians, which diminished by almost a quarter between 1990 and 2010. The year 1990 therefore appeared to be a pivotal one in the evolution of water consumption in Paris. This drop in consumption has been of benefit to the environment, but has threatened the financing capacity for infrastructure renewal.

Salient Fact 38: *Average water consumption has decreased in UWSEs since the 1990s.*

The reduction of consumption in major European cities is the result of technical progress, a decline in water use by of large consumers of water and empowerment of the users towards the environment and the resource (Poquet and Maresca 2006; Barraqué and Nercessian 2008). By way of illustrating the effects of technical progress, washing machines today use up to 90 litres of water less per wash than in 1983. This move towards eco-efficiency, as encouraged by the European Union, seems to be working (European Commission 2005). Residential consumption is also diminishing a little by virtue of the fact that there are such a large number of domestic users and they are therefore able to influence the average total. With large consumers being few in number, their contribution to the overall decline is explained by a significant fall in their unit consumption. Incitement by way of price is therefore exclusively effective for large-scale consumers. Thus, the source of the sustainability issue is that key players in the urban water cycle have decreased their UWSE usage. Regulations at the level of the institutional environment of UWSEs are relayed by the supporting institutional structures, but this dynamic began before the modernization period of UWSEs. In this sense, the phenomenon appears to be structural.

Salient Fact 39: *The impact of large consumer subscribers on the decline in water consumption is due to a sharp reduction in their consumption, while that of small-scale consumers is largely as a result of the large number of such consumers.*

Salient Fact 40: *The decline in consumption that has been taking place since the 1990s is not directly attributable to the modernization of UWSEs. Rather, it is about structural changes.*

The institutional environment of UWSEs can lead to a decline in urban consumption of water by means of another component. In most European countries, the prospects for population growth for the next few decades are zero, or even negative (BDEW 2011). If we assume that the number of users continues to fall and the individual volume of consumption does not increase, the network will have to produce, treat and transport less water. In this case, the operation rate would be reduced and the network would become over-calibrated. This dynamic increases the problem of financing investments in the deviation process, thereby threatening the effiquity and viability of UWSEs (Bolognesi 2014a). In addition, the reduction in consumption also threatens the sanitation of UWSEs. If the water network is underused, water can stagnate and this encourages the development of bacteria.[14] Water must therefore be fed into the network to rinse it out and avoid sanitation problems, a process which in turn increases operating costs: since the extra influx does not correspond to an increase in consumption, there is therefore no additional revenue.

Towns and cities in East Germany are already facing the adverse effects of water consumption dropping too greatly. By the time of reunification in 1990, the public authorities had already invested heavily in East German infrastructure in order that coverage and quality be the same throughout the country. As a result of this proactive policy, many local authorities became indebted at a time when East German cities were in decline. Clear evidence of this decline can be found in the significant drop in the resident population and the process of deindustrialization taking place at the time. In fact, this 'shrinking cities' phenomenon poses a very real problem for infrastructure (Bontje 2004; Naumann and Wissen 2007).[15] It has resulted in a decrease in consumption of 40% from the level recorded in 1990, and investment has been a heavy burden on local authority budgets.

Salient Fact 41: *A decline in consumption greatly complicates the financial balance of UWSEs and the financing of asset management, but does result in environmental objectives being met.*

Salient Fact 42: *The rationalization rules pertaining to the governance of UWSEs and to the environmental objectives included within the modernization process exacerbate tensions within the urban water cycle.*

Salient Fact 43: *The clash between the structural tendency to lower consumption and the growing need to invest in the deviation process crystallizes these tensions.*

Salient Fact 44: *The renewal of infrastructure creates a viability issue for UWSEs.*

We have seen how the issue of infrastructure renewal poses a threat to the sustainability of UWSEs The sticking points are found in the institutional environment (urbanization and macroeconomic difficulties), as well as in the urban water cycle (low consumption and high costs). They predominantly affect the viability and effectiveness of the system. We will now turn to the other structural issue regarding the sustainability of UWSEs, that of environmental conservation and preservation of the resource.

The Environmental Dimension: A Pessimistic Perspective

Environmental and water resources are deteriorating in Europe (section "The Environmental Condition of Urban Water Systems in Europe"). This trend threatens the integrity (section "A Question of Integrity:

Pollution and Overexploitation of Resources") and viability (section "The Costs of Preservation: A Factor Endangering the Viability of the System") of UWSEs.

The Environmental Condition of Urban Water Systems in Europe

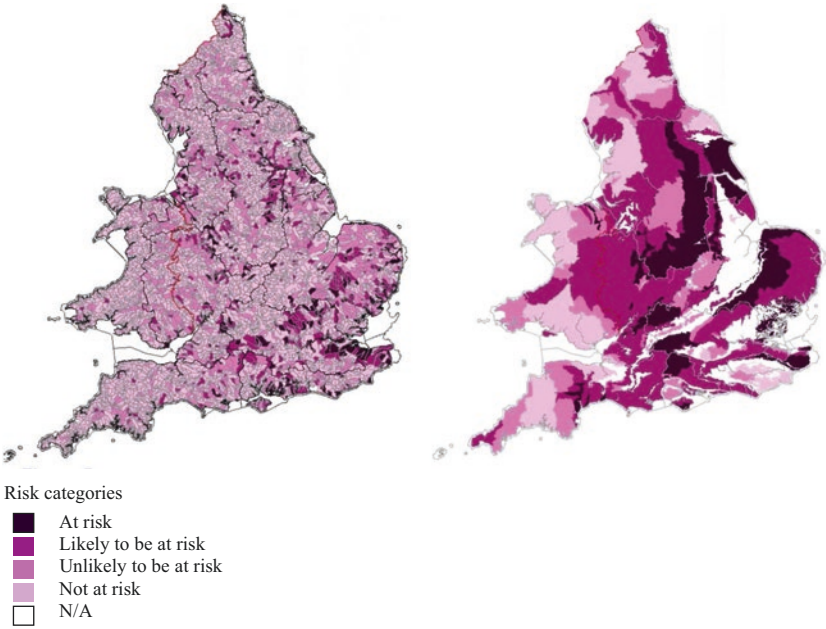
Conservation and restoration of the environment constitutes one of the priorities of European institutions. The WFD transposes this global objective to the water sector, placing it at the heart of the modernization of UWSEs (see Chap. 2, section "The Urban Water System: A Uniting Representation of Municipal Water Management").[16] It proposes an integrated approach to physical and socio-economic issues and an approach that is concerned with the quality of the resource; in other words, emission control, that is, control of above-ground emissions and protection of aquifers (Kallis and Butler 2001; Kaika 2003). In order to assess the condition of aquatic ecosystems and the resource, the WFD requires countries to report using a ratio of ecological quality.[17] This composite ratio is evidence of the good ecological, chemical and quantitative status of bodies of natural water and the good potential of highly modified bodies of water on the one hand, and artificial ones on the other. Article 2 of the WFD defines the different terms within the nomenclature and Annex V specifies the characteristics of the different statuses of bodies of water (WFD 2000). The ecological condition is divided into five classes (bad, poor, average, good, very good); the chemical status into two classes (bad, good); the quantitative status into two classes (good, mediocre); and the potential of modified and artificial water bodies into four classes (bad, poor, average, good). In order to represent the significance of the statuses, R. Sanchèz-Navarro and G. Schmidt (2012) proposed a conversion table between the statuses and the quality level of the resource. This table allows us to see a representation of what a high status, for example, actually means in terms of a reduction in quality or quantity of the mass of water in question. The turning points of quality level are 40% of hydrologic alteration and 60% of environmental flow decrease.

The construction method used for these ratios has only been partly discussed and the ratios' use has not been fully accepted by scientists and key players in the sector (Moss 2007, 2008; Dufour and Piegay 2009; Hering et al. 2010). Despite these weaknesses and critiques, it appears that the using these ratios allows analyses within Europe to be harmonized and, thanks to more than 1900 communications (reports and academic papers mainly), has led to a significant increase in knowledge about the quality of European waters.[18] Nevertheless, there remain differences with regard to the method used, and results are still only on a regional level. The fact that these results are not perfectly centralized limits the possibility and significance of an analysis on a large scale. Nevertheless, it should be noted that the quality of European water is not good. According to World Wide Fund for Nature (2006), the main obstacle to improving this quality lies in the pressure exerted by the economic development of the zone.

> River systems and wetlands are increasingly at risk. The quality of Europe's rivers, lakes and groundwater is being threatened by the discharge of sewage and industrial waste and by excessive application of pesticides and fertilizers. (WWF 2010: 11)

Although the condition of the resource has improved since the 1990s, the data that we have collected shows that, overall, the resource situation in Europe is average. England runs a significant risk of overexploitation and pollution as 20% of its rivers could not, according to these estimates, achieve a good environmental status by 2015. The same goes for 90% of English aquifers (EA 2008). Specifically, the east and the south-east of England are particularly affected by this and are under threat (Map 3.1). It is therefore the most urbanized areas of the country that attract the least satisfactory results. The load capacity of the water systems in the country fail to contain the pressures arising from human activity. Situated within the framework of a complex system, this observation shows the co-evolution between the social and ecological spheres of UWSEs.

Data on the quality of French waters show the reverse situation. The quality of subsurface waters excels that of surface waters. In 2009, less

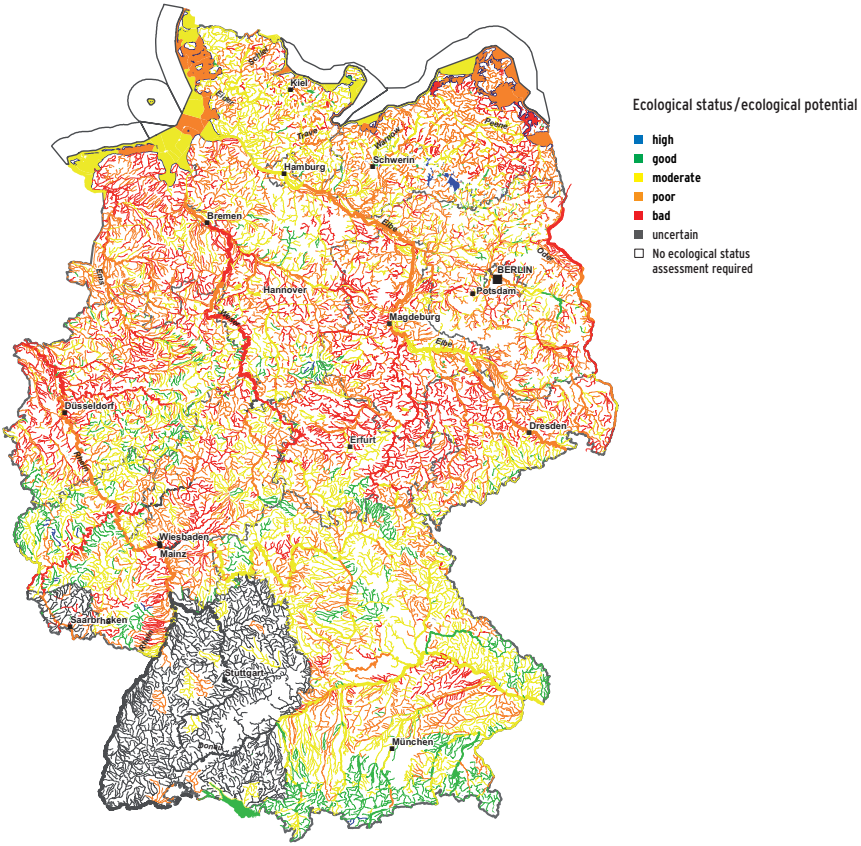


Map 3.1 Condition of water resources in England and Wales: rivers at risk of over-exploitation (*left*) and aquifers polluted by nitrates (*right*) (Source: EA 2008: 15)

than half of surface water was in a good condition or had environmental potential. Similarly, only 45% of natural surface water and 29% of heavily modified waters had been granted a good chemical status. On the other hand, French aquifers were generally well preserved; 89% retained a good quantitative status and 59% a good chemical status. Taking into account the quantitative constraints, this observation is an incentive to increase protection and decontamination measures. In addition, more emphasis has to be placed on improving knowledge of surface water. Indeed, irrespective of the indicator, nearly a quarter of surface waters are not classified; this lack of characterization even rises to 38% of surface waters when looking at their ecological status (Bolognesi 2014c).

It is not possible to make a direct comparison between French and German ecological water quality ratios. The German report only includes those water bodies listed in the distribution of ratios. With regard to those indicators that interest us the most, the rate of those natural watercourses

with no status has risen to 9.9% of the hydrographic complex, whereas the rate relating to aquifers is zero. Furthermore, the German data is broken down into smaller categories than the data reported by France.[19] The profile of the quality of German waters resembles that of France. The data illustrates a deterioration in fairly advanced water courses and the good status of aquifers. Only 14% of natural watercourses and 11% of modified watercourses achieve a good environmental status (Map 3.2). However, the chemical status remains good for 88% of natural watercourses. This ratio falls to 63% in the case of aquifers that do not suffer



Map 3.2 Map showing the ecological condition of German waters in 2010 (Source: Arle 2011: 57)

from overexploitation; 96% of subsurface water has a good quantitative status. The lakes have similar levels to those of watercourses, but with a higher estimated non-classification rate of 16.30%.

Salient Fact 45: *The waters of UWSEs retain an average ecological quality, although they have improved since the 1990s.*

Salient Fact 46*: Economic usage, as a result of the pollution it causes, appears to be one of the main factors contributing to the average ecological quality of UWSEs.*

The quality of European waters overall is average, or even poor. This fact calls into question the integrity and viability of UWSEs.

A Question of Integrity: Pollution and Overexploitation of Resources

The urban water cycle influences the integrity of UWSEs in two ways. On the one hand, the supply phase impacts upon the quantitative status of the resource because of the withdrawals being made, whereas on the other, the drainage phase alters the qualitative status of the resource due to the discharge of waste water and polluting substances. In the East of England, urban water cycles strongly reduce the integrity of the UWS. In fact, Map 4 highlights the slump in the quantitative status of watercourses within urbanized areas. We can infer from this that urban usage and methods of urbanization result in overexploitation. This is less of a problem for French and German UWSEs. The issue of pollution, however, represents a major challenge for all UWSEs. The artificialization of land is a factor in the increase of polluting emissions from UWSEs. When it rains, drainage results in urban pollution and if the contaminated water is not contained or treated, it pollutes the bodies of water into which it flows (Rose 2007; Tu et al. 2007).

***Salient Fact 47**: The artificialization of land is a factor influencing the reduced integrity of UWSEs.*

The environmental status of European waters is not satisfactory. The UWSE must therefore reduce emissions of polluting substances. The European Directive on Urban Waste Water (UWWD) provides legislation on this. It imposes a more rigorous collection and treatment of waste water. France has transposed the UWWD into national law, but barely complies with its obligations (Keller 2007, 2011). Senator F. Keller sees this difficulty as a symptom of the problems of water governance in France. Her report showed the difficulties encountered by the institutional structure of the UWS in driving water policy and implementing effective tools, particularly with regard to controls and checks. In a section entitled 'Improvements still to be made to water governance', the senator recalls various warnings from the Senate in 2006:

> make further improvements to the services provided by the State in terms of water policy, improve the budgetary framework for this policy, and better coordinate the actions of the State with those of local authorities. (Keller 2011: 44)

While noting some progress in this direction, F. Keller highlighted three main problems at her time of writing in 2011: the direction of the water policy remained imperfect, there was a perpetuation of complex factors that reduced the ability of key players in UWSEs to coordinate with each other and, finally, the tools with which to implement policies still remained fairly inefficient.

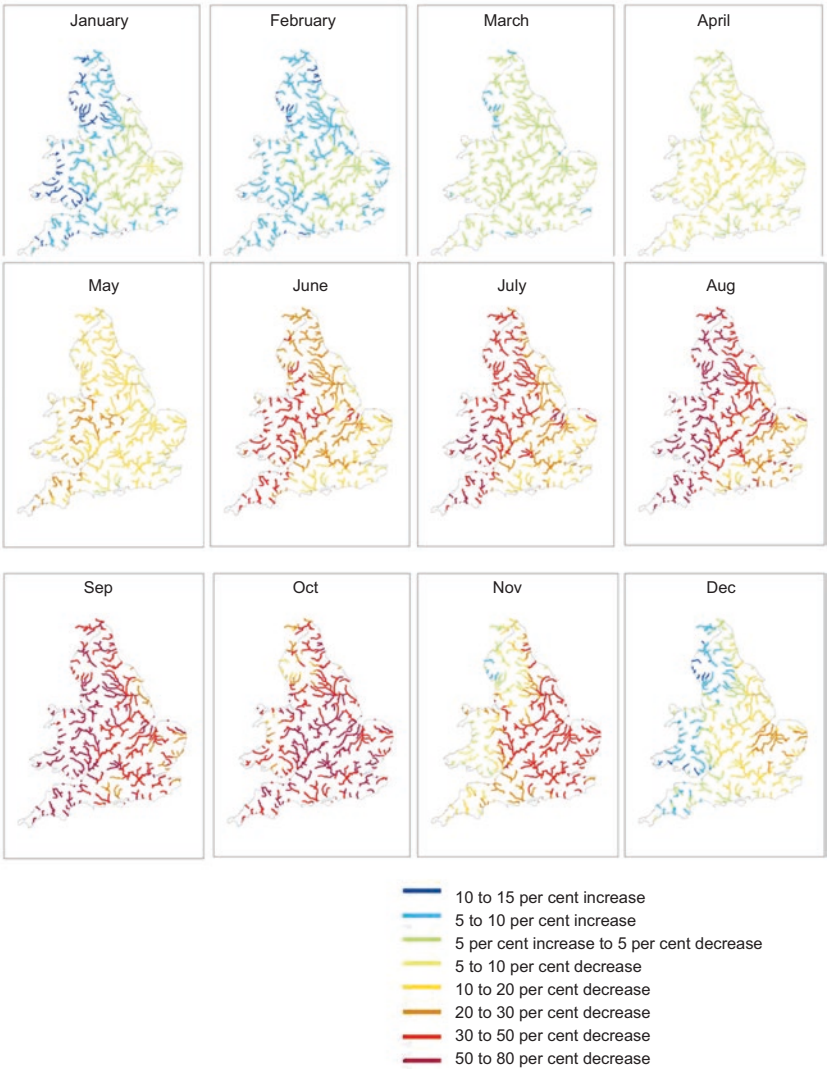
Having discussed the UWWD, a directive issued on a European level, it is important to return to the theme of the institutional environment of UWSEs. Both directives, the UWWD and the WFD, indicate that the institutional environment of UWSEs is a source of regulations for the preservation and protection of the resource. We have illustrated the general poor state of the resource, but it should be noted that these regulations have still contributed to the improvement of the ecological state of water resources. They reduce pressure on the integrity of UWSEs (Defra 2002).

The issue of the integrity of UWSEs is therefore taken into account on an institutional environment level, but the perpetuation of a non-satisfactory ecological condition indicates that the re-regulation proposed by modernization is not producing the expected results or has not been conducive enough to change (Kallis 2005).

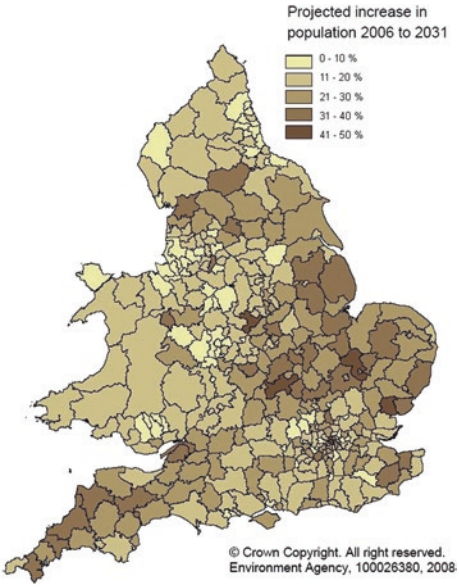
Salient Fact 48: *Regulations to maintain the ecological sustainability of UWSEs and the resource in general come into conflict with the preferences of key players in the urban water cycle and/or are not able to respect them.*

This result applies in general to UWSEs, but examples to the contrary do exist. Since the 1990s, Munich and a few other German cities have changed the way in which they manage their water resources, as nitrate water pollution levels have been deemed too high. In 1991, Munich municipal services put in place financial incentives for farmers in key water catchment areas (Pointereau 1999; Meiffren and Pointereau 2009; Krimmer 2010). As a result, 2250 farms, established in the protective perimeter for water catchment, will receive subsidies if they convert to organic farming. This shows how a city can improve the quality of its resources in the urban water cycle. Since this reform took place, people in Munich have been able to drink pure and untreated water directly from the tap. Savings made during the treatment phase are offset almost exclusively by the grants distributed to farmers. The programme costs the citizens of Munich €0.01 /m^3. By way of comparison, when it comes to the treatment of French water, denitrification only costs €0.28 /m^3. In this way, the juncture between the urban world and the rural world is proving to be a central aspect in the governance of UWSEs (Garin and Barraqué 2012).

Climate change is an additional obstacle to the sustainability of UWSEs.[20] The links between water, climate change and cities have not yet been clearly identified (Praskievicz and Chang 2009). The principal questions are focused around the variability of events (number and intensity) and changes induced in the catchment areas. However, there is a consensus that climate change will be expressed through a multiplication of extreme events rather than a homogeneous less extreme change in



Map 3.3 Average monthly changes in the flow of English water courses from now until 2050 and an overview of demographic changes between 2006 and 2031 (Source: Environmental Agency 2008: 20, 17)



Map 3.3 (Continued)

weather and geographical area. For the UWSEs, the main threat lies in the increased frequency and intensity of floods and droughts (Mailhot and Duchesne 2005). For example, the Intergovernmental Panel on Climate Change (IPCC) anticipates that France will see an increase in precipitation of 30% in the central region and a decrease of 10% to 20% along the Mediterranean (UNEP 2007, taken from IPCC data). Conversely, the level of water stress experienced in England should greatly increase (EA 2008). Projections indicate that the population of the east coast of England will increase by 20–40%, while the flow of the rivers will be reduced by 80% during the summer months (Map 3.3). Thus, climate change is a modification in the territorial dimension of the institutional environment of UWSEs, which is likely to profoundly alter the extent and quality of their integrity.

Salient Fact 49: *Climate change is likely to contribute to an alteration in the sustainability of UWSEs by increasing tension in terms of their integrity.*

The Costs of Preservation: A Factor Endangering the Viability of the System

Whether for consumption or environmental ends, the intention behind the modernization of UWSEs is the preservation of the resource. This goal gives rise to the promulgation of many rules that ultimately affect the viability of UWSEs, leading to additional costs in the urban water cycle. These difficulties and costs can be grouped in particular around three points. Firstly, the increase in the number of technical regulations involves service supply procedures that are increasingly more expensive and more complex. Secondly, compliance with the regulations in force calls for an investment in infrastructure and/or considerable efforts to be made. Thirdly, in the event of non-compliance, the countries and UWSEs may be fined by the European Commission. The work of B. Barraqué analyses this phenomenon of reduced viability of UWSEs, in particular as a result of the problems caused by EAU&3^{E}, and our work is inspired by it.[21] Furthermore, it should be noted that the scale of these costs is also due to the magnitude of the needs arising from the environmental status of European waters. For example, according to the Freshfield group (2003, cited by Jury and Vaux 2007: 16) the cost of cleaning up German resources would, it is estimated, cost between €200 and €500 billion.

Salient Fact 50: *European regulations lead to issues in viability for UWSEs, by incentivizing pro-environmental measures that represent a significant additional financial burden.*

With regard to the first point, the new standards render the technical procedures of the deviation process more complex, adding a substantial burden to budgets. This is why B. Barraqué (2005) considers the proliferation of drinking water parameters as a factor in the crisis. By way of illustration, there were six such parameters in the nineteenth century, but there are more than 10 times more than that today:

> the ever increasing number (83, and may soon be 110 in the United States) [of drinking water standards] can lead to fears of 'incompatible complexification':

> we would no longer be able to satisfy all parameters at once, except at an exorbitant price, and by using more and more chemical treatments that are contradictory to our deep love of nature and the natural world that has developed within our societies. (Barraqué 2005: 6)

Therefore, the author concludes that it is the UWSEs' performance that has brought about the crisis in sanitary engineering. A service model in which supply networks are pumping both faraway water and in situ drinking-water treatment plants or sanitization plants is no longer a viable solution. A new model of environmental engineering (Barraqué 2015), whereby the resource is protected upstream of the UWS in order to reduce technical operations within the urban water cycle, seems to better address the issue of sustainability. The Munich case illustrates this new logic.

Salient Fact 51: *An increase in the number of environmental standards can become counterproductive.*

On the second point, the French Department of Ecology (MEDDTL, 2012) estimated the cost of enacting the programme of measures intended to maintain or improve the quality of the resource would be 27 billion euros between 2010 and 2015. Approximately one quarter of this amount was explicitly dedicated to the requirements of the WFD. Eighty per cent of the cost of reducing one-off pollution corresponds to the improvement of collective wastewater treatment, which falls under the remit of the UWWD. Water agencies committed €31 million in 2010 for non-collective sanitation, a level that was equivalent to that of 2009 (Keller 2011). B. Barraqué (2005) isolates the potential impact of an individual standard in order to highlight the problem of viability that we consider to be a salient fact of the modernization of UWSEs.

> 'The Drinking Water Directive', revised in 1998, contains a clause that very much perturbed the French, as well any other countries that had lead mines at home or within their colonies: the standard regarding the amount of lead in water was lowered from 50 to 10 µg/l. This meant eliminating all lead pipes, including those in buildings. The cost could reach 20 billion euros for our country within 15 years, of which approximately a quarter relates to public networks and branches. This represents an additional

> effort that is barely compatible with the necessary investments to be made in sanitation. In addition, there have been no identified cases of lead poisoning as a result of tap water. (Barraqué 2005: 6)

The situation is the same in other European countries. For example, in Spain, J. Martin-Ortega et al. (2011) noted that, for the Guadalquivir basin, it was estimated that the programme of measures would cost € 465 million per year over the period 2009–2015.

Salient Fact 52: *Compliance with European health and sanitation rules comes at a considerable cost, which adds to the need for investment.*

In 2012, the French General Commission for Sustainable Development (CGDD) praised the effectiveness of the policy's implementation and the organization of financing. We do not share this view because, on the one hand, France is engaged in costly litigation with the European Union pursuant to the UWWD and, on the other hand, because the increase in the efficiency of water policies comes in part from recent authorizations for derogations from the WFD and the UWWD by Community bodies (Bolognesi 2012, 2014c). Improving the numbers does not therefore mean an improvement in the overall quality of water and the above problem is deferred rather than solved. This French example underscores the difficulties UWSEs face in ensuring compliance of the territories with Community rules and thereby puts into perspective the effectiveness of measures undertaken to modernize the sector.

On the third point, water, along with waste and biodiversity, is one of the areas in which breaches of European environmental law are found most frequently, and this is particularly the case in France. Thirty-four per cent of French litigation on European environmental law concerns water, while for the whole of the European Union in general, water is the initiating factor in only 20% of litigation (Keller 2011). On 24 March 2011, F. Keller (2011) identified four procedures under article 260 of the Treaty of the European Union (TFEU) and 11 procedures, three of which were considered by the European Court of Justice, on the basis of article 258 of the TFEU, and the court found France to be in breach of these articles. In order to consider the risks involved, it is important to know that the

sanctions pertaining to case C-280/02, which covers urban waste water, are estimated at several hundred million euros (Keller 2007). For their part, the United Kingdom (56 offences) and Germany (57 offences) have committed fewer offences than France (74 offences), while Belgium comes bottom of the class with 109 offences identified in December 2010.

Salient Fact 53: *The key players in UWSEs struggle to comply with the environmental rules regarding modernization and thus face fines, which only serves to emphasize the ongoing issue of viability.*

Thus, we observe that the institutional environment greatly constrains institutional structures and the urban water cycle of UWSEs. The Community's rules have quite an impact as they insist that institutional structures be adapted on a national scale, thereby causing, in the short term, additional costs for those involved in UWSEs. Moreover, as stated by K. Arrow et al. (1995) or the CGDD (2012), we can assume that the artificialization of land results in a loss of ecosystem services; the compensation for, and impact of this also increases the financial pressure on the UWSE.

We have now set out the two major structural problems facing the UWSE: the constraints on water (qualitity and quantity) and the cost of preserving it. These problems mainly affect the environmental and economic dimensions of the UWSE by reducing their efficiency, integrity and sustainability. The origin of these problems can be predominantly found in the institutional environment and the urban water cycle. Institutional structures may also be questioned as they struggle to incorporate the impact of the institutional environment and guide the behaviour of actors. The findings of B. Barraqué (2005: 3) therefore remain relevant:

> The growing gap today between economic rationalization and absolute health led to an adherence to inefficient standards, resulting in some perverse effects; some have led to inadequate investments, others are threatening to destroy the boundaries of the water and sanitation utility sectors, which were granted autonomy from other water policies in the Western world, thanks to two technological principles: treatment plants and drinking water networks are upstream of cities, while sewer systems and sewage treatment plants are downstream.

This set-up of institutional structures brings us back to the organizational aspect of UWSEs, which we will look at by re-examining the issue of governance and modernization tools. In particular, we will discuss issues of pricing and liberalization in the UWSE.

3 Modernization of UWSEs and Economic Instruments: Limits and Scope of Pricing, Liberalization and Privatization

Public policies aim to improve the efficiency, integrity and fairness of the UWSE. The main tools and policies currently advocated by the European Commission and mobilized by those managing it are pricing (section "Theoretical Usefulness and Empirical Limits of Rational Pricing"), and the liberalization and privatization of the sector (section "Liberalization and Privatization of the Deviation Process: A Choice Between Resilience and Resistance of the System").

Theoretical Usefulness and Empirical Limits of Rational Pricing

After setting out the expected effects of the use of pricing (section "Theoretical Principles: An Instrument of Efficient Allocation Based on the Price Elasticity of Demand"), we will see that its application is not always effective and does not always correspond to the suggested model (section "An Important Risk of Counterproductive Effects: Price Inelasticity of Demand and Differences Between Practice and Theory").

Theoretical Principles: An Instrument of Efficient Allocation Based on the Price Elasticity of Demand

When pricing is based on price incentives, it is a privileged instrument of governance promoted by modernization. J.M. Glachant and Y. Perez (2007) retrace the history of the use of these instruments and their underlying

theoretical developments. The 'theoretical route of rational pricing' emerged in France during the nineteenth century under the leadership of engineers working on bridges and railways, notably Jules Dupuit and Alfred Picard. Today, the works of J.J. Laffont and J. Tirole (1993, 2000) illustrate the latest refinements to this, in the form of third-generation critique. In the UWSE, the pricing and the elements relating to the price of water appear in each of the institutional structures (Saleth and Dinar 2004). The political structure decides the cost-recovery policy. The legal structure formalizes the adopted strategy by enacting regulatory terms and conditions.

The organizational structure implements a pricing system and a royalty collection system. Six different modes of pricing exist: a simple flat rate, a simple proportional rate ('flat'), a decreasing incremental rate, an increasing incremental rate (possibly with a first free element), a proportional rate with a fixed fee (with or without increments or decreases) and a two-part tariff (with or without increments or decreases) (Erhard-Cassegrain and Margat 1983) (Fig. 3.9). According to their 'philosophy', these different terms fall into three categories: linear pricing (where the

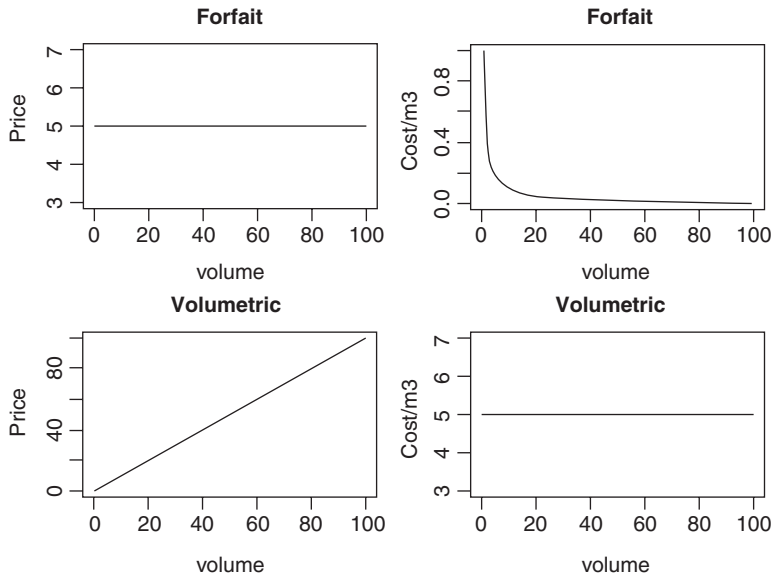


Fig. 3.9 Different methods of pricing

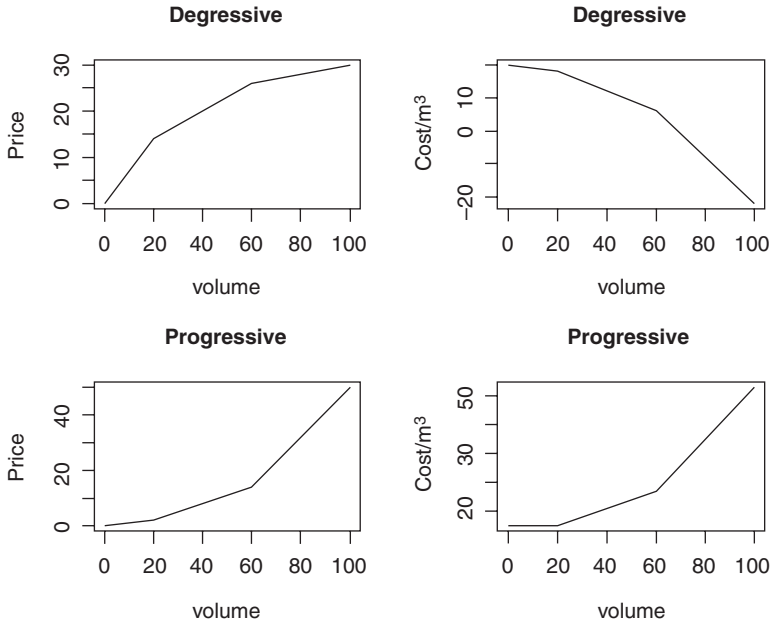


Fig 3.9 (Continued)

price is equal to the average cost or marginal cost), pricing that increases in increments and pricing that decreases in increments, in addition to being binomial or not.

Action that is taken with the intention of meeting environmental objectives helps reduce consumption, i.e. the pressure on the resource upstream and downstream of the urban water cycle. Conversely, a focus on economic efficiency tends to maximize revenues and the volume consumed. Fair pricing avoids excluding a section of users and promotes inter-user redistribution. M. Montginoul (2007) proposes the classification of pricing methods according to their assigned objectives (Fig. 3.10). This ranking clearly shows that, depending on the intended objectives, the share of the price varies in the formula, as it does in the variable portion. The goal of pricing inclusive of a large flat fee is therefore essentially one of covering costs, while a large variable share is indicative of looking for incentives such as pricing signals, while also aiming to shape the mode of consumption.

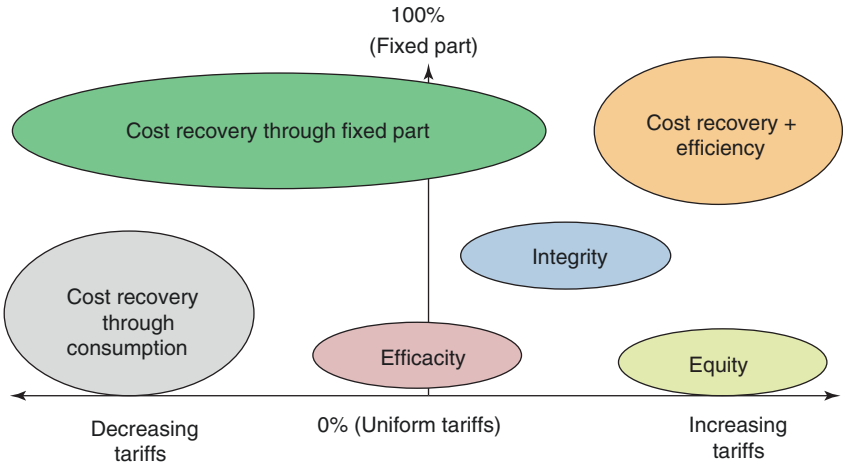


Fig. 3.10 The principles of allocation according to the modalities of the pricing structure (Source: Created by the author with reference to Montginoul 2007)

Considering the request as an inverse function of the price, the theoretical principle of elasticity confirms the three basic premises of the rational pricing of water. The first premise is that pricing that increases in steps can result in pro-environmental incentives (Azevedo and Baltar 2005; Garcia 2005; Martins and Fortunato 2007). The second premise is that pricing that decreases in increments benefits the economic dimension of the UWSE and the third premise is that marginal cost pricing benefits the social dimension (Nordin 1976; Shaw 2005; Hanemann 2006). J.A. Nordin (1976) adds that a criterion of differentiation according to household income increases the fairness of marginal cost pricing.

An Important Potential Cause of Counterproductive Effects: Price Inelasticity of Demand and Differences Between Practice and Theory

The present theoretical principles work if demand is sensitive to price and the incentive created increases in the same direction as the sensitivity (if the opposite occurs, the measure is counterproductive). Therefore, assessment of the price elasticity of demand is crucial in determining to what extent pricing is an effective tool with which to achieve the objectives of modernization.

The international comparison of price elasticities is risky because it can be influenced by many sociopolitical variables and the real impact of the price is barely identifiable (OECD 1999). It is therefore necessary to treat any interpretation of results with caution, before making generalizations. However, empirical studies come to a common conclusion on price inelasticity of demand (Arbués et al. 2003; Olmstead et al. 2007; Ruijs et al. 2008; Schleich and Hillenbrand 2009).[22] These studies focus predominantly on residential demand, as other pricing formulas are difficult to recognize.

Salient Fact 54: *In the UWSE, users have little or no awareness of price changes and, therefore, of the intended incentives.*

Specifically, pricing by means of increasing increments turns out to be more of an incentive than uniform pricing at a marginal price (Espey et al. 1997; Dalhuisen et al. 2003) and pricing by means of decreasing increments (Nieswiadomy and Cobb 1993). Similarly, pricing at the average price has a greater effect on behaviour than pricing at the marginal price (Ruijs et al. 2008). The first pricing block is of particular importance because it is the one most likely to encourage companies to invest; another great incentive is the fixed fee component of the price. Indeed, revenues become easier to estimate and, as a result, uncertainty decreases. Finally, a case study of South Carolina identified a positive correlation between a short-term marginal pricing structure and urban sprawl (Erie and Joassart-Marcelli 2000).[23]

Salient Fact 55: *Among the components of rational pricing, the fixed fee component and the first pricing block offer the most incentives.*

Four factors explain the low price elasticity of the demand for water (OECD 1999; Shaw 2005). Firstly, users react very little to price changes when the part of their budget allocated to water is low. Secondly, there are no direct substitutes for most of the uses of water. In addition, below a certain level, consumption cannot fall any more, meaning that users are therefore relatively captive. Thirdly, the complexity of the pricing system limits the rationality of users who can then become insensitive to

the incentives being implemented. Finally, a lack of knowledge of water-saving technology hinders the willingness of users to reduce their consumption. We consider that this fourth factor is of little significance to the UWSE. Indeed, thanks in particular to advances in home automation, we have identified the notable role played by eco-efficiency in reducing water consumption in water in Paris and in UWSEs in general. On the other hand, we consider that all UWSEs are affected by at least one of the three factors elucidated above, which would explain the price inelasticity of water demand in UWSEs. The OECD (2010) states that industrial applications are more sensitive to price than domestic applications. This result is consistent with a factorial analysis of the reduction of consumption in UWSEs, since we found that the price had a bigger impact on large-scale consumers than on smaller consumers.

The terms of pricing (increments, levels, taxes and so on) vary greatly according to the UWSE, both on an international and national level (cf. Chap. 2, Sect. 3). Nevertheless, degressive formulae are disappearing in favour of single or progressive tariff structures, which correspond to the theoretical formula that satisfies the objectives of modernization. In addition, the majority of countries have adopted a two-part tariff (OECD 1999, 2010; EauFrance). In 2004, Marielle Montginoul conducted a study on the pricing of water in France, partly confirming these results. The study is based on a survey conducted by the author. It shows that 94% of municipalities in the sample (429) have adopted a two-part tariff; 57% of the surveyed municipalities (71% of the population) use a single-tariff structure; 36% of municipalities (20% of the population) rely on decreasing increments; and only 1% of municipalities (5% of the population) use increasing increments. Large municipalities therefore have a greater tendency to adopt a progressive incremental rate than smaller ones. Furthermore, the larger the city is, the more the fixed share tends to decrease.

Salient Fact 56: *There is a gap between the pricing formulae that are best in theoretical terms and those formulae adopted in the UWSE.*

This data allows us to suggest a difference in objectives between the large and small cities. Small towns would rather consume water in order

to cover the cost of facilities, while larger cities would rather reduce the negative impact on the environment by encouraging moderate consumption. This choice is rational insofar as most of the costs of a UWSE are fixed, and the most obvious way for small municipalities to pay them off is to encourage an increase in individual consumption volumes, given that the number of users and potential new users is low. In terms of viability within the UWSE, this point once more illustrates the tensions that arise from the total-cost-recovery regulation.

The social objectives of the UWSEs have generally been achieved. Universality of access seems to have been acquired, and water accounts for only a small part of the household budget. Even though its share has quadrupled from 1960 to 2006, water still only accounts for a very low proportion of domestic spending in France. It represents about 0.8% of household income. By way of comparison, the proportion of the budget spent on electricity exceeds 4% (Smets 2008). On average in Europe, this ratio is 1.1% for households with a median income and 2.6% for poor households (first decile). In addition, European countries as a whole have introduced systems of redistribution that support disadvantaged households in order to ensure their access to water and to avoid there being insufficient funds. These are targeted systems in France (Housing Solidarity Fund) and England (through taxes) and non-targeted in Germany (Smets 2008).

Salient Fact 57: *Under current conditions, the levels of equity and universality of access to services are acceptable and are not one of the priority objectives of pricing structures.*

In light of the price inelasticity of demand, pricing of water does not seem to be a relevant tool for achieving environmental objectives through the reduction of consumption. In order for it to become so, the price increase would be such that the social dimension of the UWSE would have to degrade significantly. For example, in the west of the region of Hérault, it would take an increase of more than 20% of the variable price to generate a substantial decrease in consumption (Neverre et al. 2010). In contrast, the current state of UWSEs indicates a level of fairness in acceptable systems (Smets 2008). As a result, the social dimension cannot currently be deemed to be a major objective in pricing structures.

We are of the opinion that, given the current circumstances of UWSEs, pricing is a relevant incentive tool that is used essentially to achieve goals pertaining to effectiveness. In particular, it can reduce the uncertainty of the long term and can encourage the necessary investments in the renewal of infrastructure. As such, the fixed fee and the first price increment of the tariff structures are essential because they provide suppliers with a predictable income. However, tariff measures to improve the efficient operation of UWSEs must take into account the potential impact on household income. An increase in the fixed fee part or of the first increment diminishes the fairness of the system since all users are initially affected. In that event, a redistribution system or system for household differentiation seems necessary in order that the social sphere of the UWSE is not sacrificed in pursuit of an ever more efficient system. This risk is particularly evident in England and Wales. The share of expenditure on water in the budget of the poorest percentile was 10.5% in 2000. This figure encouraged the CEO of OFWAT to ensure that social security featured among its major concerns (Smets 2008).

Salient Fact 58: *Water pricing represents an effective tool with which to achieve the economic objectives of UWSEs, but its use should take into account the risk of making the system more inequitable.*

Finally, pricing policies must be enacted with caution. In UWSEs, uses are heterogeneous, meaning that the same incentive does not impact in the same way on different users. Seasonal pricing was, notably, developed for this reason, to take into account summer usage in second homes. A similar problem is that, in practice, there is one bill per household, which does not take into account the number of members of the household. It is not difficult to imagine the textbook case of progressive pricing, a priori pro-social, where a family on a low income, despite being a large family, subsidizes the consumption of a wealthier couple. Finally, it should be remembered that pricing policies include a cost that models do not, that of individual meters (installation, maintenance and use). The costs of the policy can sometimes surpass the expected gains of redistribution.

Liberalization and Privatization of the Deviation Process: A Choice Between Resilience and Resistance of the System

As a first step, we will discuss the intended effects of liberalization and deprivation (section "Generic Considerations Regarding Efficiency Expected as a Result of Liberalization and Privatization"), and then look at their real effects in terms of the problems we have identified (section "Implication of the Reforms in the Three Models of UWSE: Limits and Scope").

Generic Considerations Regarding Efficiency Expected as a Result of Liberalization and Privatization

The European Union chose recourse to the market as another tool with which to optimize the operation of network services. Since the 1980s, a wave of liberalization has been taking place in the electrical and telecommunications industry. Today, the water sector is the last service sector in the network involved in this process.[24] The WFD promotes the participation of the private sector and the use of market mechanisms to improve the management of water in Europe.[25]

> Water management in the perspective of sustainable development is a matter for all: governments, parliaments, local and regional authorities, representatives of business, science and technology, non-governmental organizations and the public. For this reason, co-operation must be encouraged between administrations and between the private sector and the public authorities, which should retain a leading role in water management (Velikov 2004: 1§6)

These mechanisms are part of the rationalization objective of public procurement and sector efficiency. Although they often go hand in hand, privatization and liberalization are components of different dynamics. Liberalization refers to a process of organizing competition-based relations between actors, while privatization identifies a reduction in the role of the state, or an increase in that of the private sphere within the sector being studied (Savas 1987; Ostrom et al. 1993).

In the literature, no agreement emerges on the impact of privatization on the quality of the service provided by the UWS. Empirical analyses defend the benefits of privatization (World Bank 2004, 2010; Cave 2009) but still more numerous are those that base their results on the type of property. The type of property, public or private, is no reliable indicator of the effectiveness of the service (Ménard and Saussier 2000; Pérard 2007; Gassner et al. 2007, 2009; Wallsten and Kosec 2008).

> There are significant differences in performance amongst UWS. But these differences do not express the absolute advantage of one mode of governance over the others. (Ménard and Saussier 2000: 402)

The degree of privatization varies within European UWSEs (cf. Chap. 2, section "Political Structures: Societal Guidance and UWSEs"). The private sphere occupies a principal role in French and English UWSs, while the German UWS is based predominantly on the public provision of services. Water institutions determine the degree of participation of the private sector, which is one element of the institutional framework that encourages the actors in the UWSE. The modalities governing this privatization (degree of centralization, type of integration and so on) and the extent of competition that actors undergo appear to be essential in determining the effectiveness of the organization.[26]

Salient Fact 59: *The success of privatization and the achievement of the intended effects depends on the framework provided by the institutional structures and the institutional environment.*

Let us look at the main features of the liberalization process. This is a process where re-regulation—which also includes de-integration (Demsetz 1989), i.e. the separation of production, transport and distribution activities—and the contestability of markets (Baumol et al. 1982) form the two foundations. There are three factors which explain why the water industry will liberalize in singular forms compared to other network industries. Firstly, in the case of water, opportunities for introducing competition are limited to winning a contract and benchmarking (yardstick regulation). To compensate for this characteristic, the separation

of infrastructure and service builds in a level of additional competition. Secondly, the absence of major technological innovations reduces the radical transformative potential of the sector. Finally, the consumer perception of water is resistant to total liberalization and makes complete privatization impossible, resulting in the risk of rejection and a strong political cost of such measures.

M. Finger et al. (2007) suggests a foresight exercise designed to portray the traits that could move the liberalization of the water sector forward. They compare six probable liberalization scenarios: a strongly regulated delegation contract, a delegation contract supported by strong competition, outsourcing, regulated monopoly, direct public management and the self-organization of communities. The authors estimate that the potential reduction in operating costs and the potential increase in productivity is highest in the case of a regulated monopoly, and lowest in the case of direct public management. The contract options are also potentially very interesting, but they are highly dependent on the (re)negotiation terms and conditions. As the opposite of a regulated monopoly and direct public management, a delegation of powers is the contract with the shortest duration, which frustrates any incentive to invest. Finally, the authors note that, in the delegation, the public part should properly define *ex ante* the terms of the contract in order to avoid any potential conflict between the autonomy of the operators and the objectives of the delegator.

England and Wales, Germany and France constitute the three models of liberalization that can currently be seen in Europe (Wackerbauer 2007; Ménard and Peeroo 2011; Bolognesi 2014a, b). In England and Wales, the institutional structure is organized around a totally privatized sector, controlled by a third-party regulatory agency. OFWAT regulates prices and maintains competition. Management is on a regional level and relies on the skills of professionals in the sector. The model appears to be relatively flexible and is a result of organizational innovation and adaptation (Lorrain 2000). In France, the public and private spheres cooperate under the auspice of public–private partnerships, where delegation is the form most commonly found. Liberalization remains limited, since there are more than three operators competing for each share of the market. These national sector champions share their skills with local communities. Due to its strong political aspect, the water sector has changed little. Management is organized mainly on the level of watersheds and municipalities. In Germany,

the degree of liberalization is very low and the local public authorities retain ownership of the sector. Operators are undertakings governed by private law that belong to the municipalities. As a result, there is marked fragmentation and autonomy within the sector. As in France, it is engineers and mayors who organize the sector. The management style is thus more pragmatic than in England, where it is primarily economic engineering that is the impetus behind the choice of management method (Lorrain 2005).

Salient Fact 60: *A priori, an increase in the degree of liberalization enhances the ability of the urban water cycle to reorganize in the short term.*

Implication of the Reforms in the Three Models of UWSE: Limits and Scope

The general framework of the liberalization of UWSEs has been touched on. We will now examine how this organizational framework is able to respond to the structural problems previously identified in the chapter. The impact of liberalization on the protection of the environment, i.e. the integrity of UWSEs, remains difficult to determine (Aubin and Varone 2007). The UWSE has numerous external effects on the environment. An assessment of those internalization measures that have been implemented, such as water withdrawal licences in France, remains an estimate because of a lack of data and our limited ability to isolate the explanatory factors. Moreover, the environmental character of these measures, rather than their ability to meet the needs of users, is not evident.

Salient Fact 61: *The impact of liberalization on the environment is difficult to determine and is not necessarily positive.*

In terms of efficiency, liberalization of the sector seems a powerful factor. The profitability rate in the sector has been increasing more in England than in Germany and France since the reforms were first initiated (Bakker 2003). However, this additional extraction of financial resources has not been converted into an improvement in the quality of

the service. Any improvement in efficiency is therefore more likely to be short term than the long term. Indeed, the operators only partly addressed the issue of renewal of the network, resulting in a shortage of the resource in 1995 in Yorkshire (Bakker 2000).

> […] the Yorkshire drought was neither simply a freak of nature, nor an isolated case of spectacular mismanagement of a water supply system, but rather what Neil Smith terms 'produced scarcity in nature' (Smith 1984, 60). The restructuring of YWS post-privatization entailed changing flows of information and reconfiguring of resource and quality management techniques, altering not only decision-making practices but also the sanctioned actors and information involved in decision making. (Bakker 2000: 22)

OFWAT established new, more stringent rules, forced lower prices and enacted a new regulation that defined excess profits. With deregulation failing, a re-regulation phase began in order to ensure the satisfaction of social and environmental needs. This regulatory shock took place in 1999 and ably illustrates the strength and the weakness of the English model. Its strength lies in the ability of the institutional structure of the UWS to react quickly when faced with a newly identified problem and in the fact that the actors of the urban water cycle can adapt as a result of this institutional change. There is a large capacity for innovation and adaptation of the system. However, if control over operators is relaxed, there is a growing tendency not to satisfy the social and environmental spheres of the UWS. The emergence of the theme of environmental justice in England is testament to this inclination (Laurent 2011).

In Germany, local authorities keep watch over the public interest and develop the quality of services provided by the UWS. However, because of the local nature and fragmentation of the sector, this structure is quite a burden on municipal budgets. This is why the *Stadwerke* are horizontally integrated, in order to compensate for losses experienced in some areas by achieving gains in others. The German method of organization confers a high level of inertia on the UWS. Any developments and modernization takes place in stages on the margins, without fundamentally changing the structure. The gradual liberalization of the sector is one of these developments. It aims to balance the financial management of local public services; in other words, to increase the efficiency of the UWS. The

property, however, remains public in order that environmental and social objectives can be successfully pursued, i.e. the goal of achieving integrity and fairness in the UWS. Although this model seems immutable, it does remain pragmatic and attempts to deliver innovative solutions to new problems (Reidenbach 1995). The situation in Munich illustrates this very point. It should be noted that because of strong local autonomy, the instigation of these reforms depends largely on the will of the mayor and local decision-makers.

In France, PPPs have been around for a long time. They combine the competency of major groups with the objectives of policy-makers. The PPP, and liberalization, thereby emerges as a result of the inability of local communities to manage their own water management challenges: budgetary constraints, technical dimensions and so on. The delegates of the service gain autonomy in order that they can put their expertise at the service of the public interest (Pezon 2008). Communities assess the outcome, but do not scrutinize the process. This process increases the level of attention that is paid to budgetary and financial constraints, thereby managing the effectiveness of the UWS. However, it does not lend itself to deregulation. Indeed, the state decentralizes its own power and its share, particularly through the water agencies, in order to support this liberalization movement. The water sector therefore remains strongly political in tone, an influence which, despite management pragmatism, weaves inertia into the evolution of the system (Lorrain 2005). This phenomenon could lead to the failure of the organization. For example, users fear corrupt behaviour and so hamper the privatization and liberalization of the sector. This organization is therefore trying to increase the effectiveness of the UWS, but may struggle to integrate any shocks that threaten the integrity and fairness of the system.

Salient Fact 62: *Modernization improves the adaptive capacity of UWSEs (innovation, organization and speed) but this gain is accompanied by greater uncertainty about the evolution of the UWS.*

These observations lead us to draw two conclusions about the characterization of the organization of UWSEs. The English model of UWS

seems resilient, while the German and French models appear to be relatively resistant. Indeed, in England and Wales, the operators of urban water cycles are quick to adapt and the organizational structure creates a high capacity for (rapid) innovation of the system. The system is able to integrate external shocks, but optimizes its sustainability only moderately. We have shown the latent risks to integrity and fairness with which the system is faced.[27] It is for this reason that the operators adapt quickly to change. However, their capacity for adaptation appears to reduce their ability to follow a sustainable path. Conversely, the French and German systems transform themselves very little; moreover, the basic principles of their organization are secular and better suited to optimize their sustainability. In this way they are resistant to small shocks, but a major shock can really jeopardize them, and force them to adopt a new institutional regime.

4 Conclusion

This chapter was designed to characterize the efficiency of the modernization of UWSEs in view of their central goal of sustainability (the third pillar). This exercise was conducted from a positive viewpoint since it was about observing the effects of the modernization of UWSEs. We have broken down the notion of sustainability into six different categories: efficiency, equity, integrity, effiquity, sustainability and environmental justice. We applied this to two of the main challenges faced by UWSEs (the renewal of infrastructure and environmental conservation) and then used it to evaluate the relevance of the three principles of governance at the heart of modernization (pricing incentives, liberalization and privatization). This approach made it possible to specify the issues of sustainability, to target sources and to avoid simply concluding that there is a global lack of sustainability in UWSEs (which is the main risk of this type of analysis).

By taking note of the 37 salient facts, this chapter has set out the five main features that characterize the modernization of UWSEs from the point of view of their sustainability. Firstly, the efficiency of UWSEs (economic sphere) is not optimized because of an ageing infrastructure, a reduction in consumption, a lack of investment and a difficulty in

incentivizing them with current coordination mechanisms. Secondly, viability (economic and environmental sphere) is decreasing due to the unwanted effects of environmental regulation (increase of costs and the complexity of the deviation process), and a development mode that creates negative external effects on the environment (artificialization and so on). Thirdly, we have shown that the integrity (environmental sphere) of UWSEs is still unsatisfactory and that climate change could even result in it worsening. Fourthly, equity (in the social sphere) and effiquity (in the social and environmental sphere) are satisfactory. Services are seldom inaccessible and, if necessary, redistribution mechanisms do exist and function. However, we must stress that the solutions to the aforementioned problems could have a negative impact on these two dimensions of the sustainability of UWSEs. Finally, fifthly, this chapter looks at the intrinsic efficiency of the mechanisms for coordinating the modernization process. Such mechanisms improve the ability to adapt in the face of new problems, but this advantage is accompanied by an increase in uncertainty about future trajectories. In addition, due to a low price elasticity, price incentive mechanisms are not the most relevant for dealing with the management of the resource and the social dimensions of sustainability.

This chapter constitutes the second observation phase of the modernization of UWSEs and, after dealing with the organizational dimension, we addressed the issue of sustainability. These analyses complement each other since they reflect aspects of both the structure and efficiency of the modernization process of UWSEs. By putting them together, we can complete our characterization phases by formulating stylized facts in the guise of empirical results.

Conclusion of the Section

The three stylized facts stated at the end of this section are the result of an observation of urban water systems in Europe (UWSE) and of their modernization, formalized periodically by the identification of Salient Facts. To simplify this third and final phase of observation, all of the Salient Facts (F_{sn}) have been collated below (Box 3.1). The methodology adopted

to highlight these facts is based on an institutional analysis by means of comparison of the models of German, French and English urban water systems (UWSs). Among the Salient Facts that have been identified, several really capture this approach. They distinguish a European model within the diversity found on a global scale (F_{s1}, F_{s2}), and specify the characterization of this model (F_{s3}, F_{s4}, F_{s5}, F_{s6}, F_{s9}, F_{s10}) and its national variations (F_{s7}, F_{s8}). The first stylized fact reflects the phenomenon of change within the structure of UWSEs, the second a phenomenon of the transformation of UWSE dynamics and the third a phenomenon whereupon the antagonisms between the objectives of UWSEs are exacerbated.

Box 3.1: A Reminder of the Salient Facts in Part I

Salient Fact 1: *The technical characteristics of the deviation process in developed countries contribute to the universal provision of services via a mature network infrastructure.*

Salient Fact 2: *The micro-economic features of the urban water cycle differentiate the European model of UWS; with relatively moderate consumption and relatively high prices, the water bill per average inhabitant is equivalent to 2/3 of that of the American model.*

Salient Fact 3: *The territorial structure of the institutional environment of UWSEs is unique in that it combines high levels of development, the artificialization of land and centralized cities.*

Salient Fact 4: *European cities are characterized by their compactness and have only recently developed in terms of structure under the impetus of urban sprawl.*

Salient Fact 5: *European countries enjoy a style of governance that is based on very formal regulatory systems.*

Salient Fact 6: *A strong polycentric and multilevel character shapes the organization of governance within European countries.*

Salient Fact 7: *In Europe, governance follows a liberal model, which gives rise to a variety of enforcement methods ranging from a tendency towards pure liberalism (Mediterranean and Anglo-Saxon systems) to moderate liberalism (German, French and Nordic systems).*

Salient Fact 8: *The modernization of UWSEs does not unfold in the same way in all countries, giving rise to three ideal organizational variants typical of the European model in Germany, France and England (in order of appropriateness in relation to the organizational principles of modernization).*

Salient Fact 9: *The withdrawal trend has followed that of consumption, decreasing since the 1990s.*

Salient Fact 10: *Modernization brings UWSEs into age of environmental engineering.*

Salient Fact 11: *Modernization tends to empower services through decentralization and the devolution of organizational processes.*

Salient Fact 12: *The integration of modernization in the political structure tends to be stronger when the UWSs agree to participate in the private sector.*

Salient Fact 13: *The modernization of UWSEs tends to reduce the number of operators within a national territory and, consequently, there is more of a focus on the 'big' operators who have reached a substantial critical mass.*

Salient Fact 14: *The principles of modernization diffuse better in structures that are derived from common law: they are more flexible and less bureaucratized.*

Salient Fact 15: *There is a connection between the degree of integration of modernization and the capacity of the legal structures to focus on the individual and favour the resolution of disputes rather than defending abstract and/or moral principles in the name of general interest.*

Salient Fact 16: *Modernization supports the notion of the public sector no longer managing the urban water cycle.*

Salient Fact 17: *Modernization has induced a shift in legal structures, allowing more freedom of contract.*

Salient Fact 18: *Modernization has induced evolution in institutions, encouraging a reduction in the duration of contracts and increasing competition in terms of the procurement of contracts and the deviation process.*

Salient Fact 19: *Modernization promotes the emergence of different state actors in the regulation process.*

Salient Fact 20: *Modernization increases the weighting of contractual relations within the institutional polycentrism of the UWSEs.*

Salient Fact 21: *Less modernized UWSEs continue to have a dependence on political or moral principles.*

Salient Fact 22: *In the German UWS, management is still largely in the hands of the public sphere, which monitors the supply of network services in the general interest.*

Salient Fact 23: *In French UWS, the increase in the number of Sapin procedures and the reduction in the duration of contracts have seen competition intensify.*

Salient Fact 24: *The organization of the English UWS formally allows operators to have more freedom and is based on the production, dissemination and control of information by autonomous regulatory agencies.*

Salient Fact 25: *The total length of the infrastructure used in the deviation process is the largest in France, then in Germany and England respectively.*

Salient Fact 26: *The assets of the UWSEs are entering a phase in the life cycle where the failure rate increases and the survival function decreases.*

Salient Fact 27: *In order to maintain the quality of the services provided, both the management of and investment into the infrastructure of assets of UWSEs must become a central objective for the next two decades.*

Salient Fact 28: *The renewal rate in the infrastructure of the deviation process seems inadequate in the face of the estimated requirements, something that threatens the physical integrity of the networks in the medium term.*

Salient Fact 29: *The leakage rate is higher in more modernized countries.*

Salient Fact 30: *The leakage rate tends to decrease in UWSEs.*

Salient Fact 31: *In Germany, there has been no major shock to the modernization of the quality of the (already good) infrastructure.*

Salient Fact 32: *The political use of price facilitates the necessary level of investment in the UWSE being achieved.*

Salient Fact 33: *The level of investment in the urban water cycle of UWSEs is insufficient to ensure the physical sustainability of the network.*

Salient Fact 34: *The governance principles of the modernization of UWSEs do not seem sufficient to be able to incite the actors of the urban water cycle to increase their willingness to invest, thus leading them to enter into conflict with the principles of corporate governance.*

Salient Fact 35: *Macroeconomic difficulties reduce the ability of key players in UWSEs to ensure the level of investment necessary for the sustainability of the deviation process of the UWSEs.*

Salient Fact 36: *The characteristics of urban growth in European cities increase the costs of management and operation of the deviation process of UWSEs.*

Salient Fact 37: *Following the modernization of UWSEs, the key players are not able to respond to the economic objectives that allow the sustainability of the systems; the profitability of the sector therefore seems threatened in the long term.*

Salient Fact 38: *Average water consumption has decreased in UWSEs since the 1990s.*

Salient Fact 39: *The impact of large consumer subscribers on the decline in water consumption is due to a sharp reduction in their consumption, while that of small-scale consumers is largely as a result of the large number of such consumers.*

Salient Fact 40: *The decline in consumption that has been taking place from the 1990s is not directly attributable to the modernization of UWSEs. Rather, it is about structural changes.*

Salient Fact 41: *A decline in consumption greatly complicates the financial balance of UWSEs and the financing of asset management, but does result in environmental objectives being met.*

Salient Fact 42: *The rationalization rules pertaining to the governance of UWSEs and to the environmental objectives included within the modernization process exacerbate tensions within the urban water cycle.*

Salient Fact 43: *The clash between the structural tendency to lower consumption and the growing need to invest in the deviation process crystallizes these tensions.*

Salient Fact 44: *The renewal of infrastructure creates a viability issue for UWSEs.*

Salient Fact 45: *The waters of UWSEs retain an average ecological quality, although they have improved since the 1990s.*

Salient Fact 46*: Economic usage, as a result of the pollution it causes, appears to be one of the main factors contributing to the average ecological quality of UWSEs.*

Salient Fact 47*: The artificialization of land is a factor influencing the reduced integrity of UWSEs.*

Salient Fact 48: *Regulations to maintain the ecological sustainability of UWSEs and the resource in general come into conflict with the preferences of key players in the urban water cycle and/or are not able to respect them.*

Salient Fact 49: *Climate change is likely to contribute to an alteration in the sustainability of UWSEs by increasing tension in terms of their integrity.*

Salient Fact 50: *European regulations lead to issues in viability for UWSEs, by incentivizing pro-environmental measures that represent a significant additional financial burden.*

Salient Fact 51: *An increase in the number of environmental standards can become counterproductive.*

Salient Fact 52: *Compliance with the European health and sanitation rules comes at a considerable cost, which adds to the need for investment.*

Salient Fact 53: *The key players in UWSEs struggle to comply with the environmental rules regarding modernization and thus face fines, which only serves to emphasize the ongoing issue of viability.*

Salient Fact 54: *In the UWSE, users have little or no awareness of price changes and, therefore, of the intended incentives.*

Salient Fact 55: *Among the components of rational pricing, the fixed fee component and the first pricing block offer the most incentives.*

Salient Fact 56: *There is a gap between the pricing formulae that are best in theoretical terms and those formulae adopted in the UWSE.*

Salient Fact 57: *Under current conditions, the levels of equity and universality of access to services are acceptable and are not one of the priority objectives of pricing structures.*

Salient Fact 58: *Water pricing represents an effective tool with which to achieve the economic objectives of UWSEs, but its use should take into account the risk of making the system more inequitable.*

Salient Fact 59: *The success of privatization and the achievement of the intended effects depends on the framework provided by the institutional structures and the institutional environment.*

Salient Fact 60: *A priori, an increase in the degree of liberalization enhances the ability of the urban water cycle to reorganize in the short term.*

Salient Fact 61: *The impact of liberalization on the environment is difficult to determine and is not necessarily positive.*

Salient Fact 62: *Modernization improves the adaptive capacity of UWSEs (innovation, organization and speed) but this gain is accompanied by greater uncertainty about the evolution of the system.*

First Stylized Fact: Modernization and Depoliticization of UWSEs

The first stylized fact relates to a transformation brought about by the modernization of the structure of the organization of UWSEs. It is based on the general finding of a reduction of the role of the state in the UWSE, a notion that is deduced from Salient Facts 5, 6, 7, 11, 12, 13, 16, 19, 20, 23 and 24. Indeed, within a polycentric and multilevel system, modernization implies a decline in the activity of the state as an actor in the two parts of a UWS: the water institutions and the urban water cycle (F_{s5}, F_{s6}, F_{s7}).

At the level of the water institutions, this means a reduction in the dependence of the actors and the coordination mechanisms on state powers of coercion and control (F_{s19}, F_{s20}, F_{s23}, F_{s24}). The increasing use of contractualization and the emergence of autonomous regulatory agencies highlight this trend more explicitly (F_{s20}, F_{s23}, F_{s24}). Confirming the result of this observation as part of an analysis of the evolution of governance following the signing of PPPs in Europe, D. Giauque (2009: 388) notes that due to the increase of information asymmetries:

> The complexity of governance that induces these new forms of coordination partnership is hardly of a nature to facilitate the task for the public authorities in their efforts to control regulation (Giauque 2009: 388)

At the level of the urban water cycle, the shrinking role of the state results in a greater autonomy and diversity of the actors in the deviation process (F_{s7}, F_{s11}). We have seen a gradual substitution of public actors with other private law actors, and, a priori, these are legal persons that are more independent of politics (F_{s12}, F_{s16}).

The first stylized fact takes into account the following phenomenon: *the modernization of UWSEs brings about the process of their depoliticization.* To clearly define the content of this statement, and therefore the explanatory perspective of Chap. 5, two clarifications are necessary. First, this phenomenon highlights a causal relationship between modernization and depoliticization. Then, by depoliticization of UWSEs' we mean a dynamic whereby the water institutions and/or the urban water cycle deviate little by little from the crux of the business of the state and from their conduct, i.e. they are no longer limited to the functional role of the state. In this way, the term does not refer to conflicting aspects and issues of power, such as might be considered from a realistic perspective.[28]

Second Stylized Fact: Modernization and Socio-institutional Resilience of UWSEs

The second stylized fact reflects a transformation of the organizing dynamics of the UWSEs related to their modernization. It is relative to the dynamic of the organization for the coordination of UWSEs and its formulation is based on salient facts 7, 11, 14, 15, 17, 18, 24, 60 and 62. We have found a correlation between the degree of penetration in water institutions of the principles of modernization and the ability of UWSEs to transform.

This ability stems from the multiplication of the potential sources of institutional innovation/development and the removal of obstacles to these alternatives. We have seen that the penetration of modernization is accompanied by the increased diversity of actors and the modalities of coordination (F_{s7}, F_{s17}, F_{s18}). It appears that, faced with socio-economic or geophysical shock, actors quickly reorganize by following new plans and schemes. When it comes to removing these obstacles, it is clear that modernization better penetrates water institutions when they facilitate flexibility in the choice of the form of governance (F_{s11}, F_{s14}, F_{s15}, $F_{s24,}$ $F_{s60,}$ F_{s62}).

The second stylized fact takes into account the phenomenon whereby *the degree of integration of the principles of modernization in a UWSE is positively correlated to a resilient socio-institutional dynamic rather than a resistant one.* We define socio-institutional resilience as the ability of the human system to change its coordination mechanisms in the face of a shock, and to do so quickly while continuing with basic duties (Gunderson and Holling 2002). This is directly correlated to the system's level of transformability and persistence. The analysis by C. Knill and D. Lehmkuhl (2002) confirms the statement of this phenomenon. By studying 'Europeanization' mechanisms, the authors note that, in the water sector, Germany and France demonstrate resistance to the penetration of Community principles in contrast to England. Similarly, G. Marcou (2012), citing the example of the Localism Act of 2011, points out that, in England, freedom of action and organization of key players is growing.

Third Stylized Fact: Modernization and Barriers to Sustainability

The third stylized fact takes into account the relative 'underperformance' of modernization in the face of its sustainability objectives. It is relative to the role of modernization in the evolution of the sustainability of UWSEs, and its formulation is based on the majority of the Salient Facts noted in this chapter (F_{s26} to F_{s60}). The number of mobilized facts is greater here than with the previous two stylized fact statements because this third stylized fact is articulated in two stages. Firstly, we see the inability of modernization to meet its requirements in terms of sustainability, followed by an intensification of difficulties at the interface with the economic dimension of sustainability.

On a general level, the condition of UWSEs is degrading or threatening to do so (F_{s26}, F_{s29}, F_{s45}) and structural trends such as the decrease in consumption, and climate change—which are external to the urban water cycle—are likely to accentuate this dynamic (F_{s36}, F_{s40}, F_{s49}). Moreover, the theoretical effectiveness of the principles and instruments of modernization to meet the challenges identified is not reflected in their application to UWSEs (F_{s54}, F_{s56}, F_{s59}, F_{s61}). Modernization is a stumbling block in

curbing these trends and fans new tensions in terms of efficiency (F_{s28}, F_{s34}, F_{s37}), viability (F_{s42}, F_{s43}, F_{s46}, F_{s48}, F_{s50}) and potentially effiquity (F_{s57}, F_{s58}).

The third stylized fact takes into account the phenomenon according to which *modernization not only fails to satisfy its own requirements in terms of sustainability, but also stirs up antagonism between the economic pillar and the other pillars.* We consider that this antagonism results in an accentuation of incompatibilities between the principles of governance of modernization and its objectives, i.e. between the expected and the actual functioning of coordination. This third phenomenon might seem tautological in light of the ontological principles of UWSEs, including those of dialogic, polycentric and multilevel organization. However this is not the case, insofar as it identifies a source and a demonstration area that benefits from the antagonisms cited.

The statement of these three stylized facts closes this observation of the modernization of UWSEs and sets out the phenomena to be explained in Part 2. A reflection of these phenomena will enable us to ultimately provide an explanation of the substance of modernization, contributing to knowledge on identifying the drivers of coordination and information on institutional development that can be generalized and applied to other sectors.

Notes

1. They also address the issue of agricultural practices, including irrigation (Ménard and Saleth 2013).
2. It should be noted that M. Saleth and A. Dinar partly accept this position: 'These stages progress as a circular process which is subject to constant subjective and objective feedbacks, learning, participation and adaptations' (Saleth 2006: 11).
3. The holographic principle posits that the component contains everything, and vice versa; analysing a component therefore allows an extrapolation of the entire structure.
4. In its 'Private Member's Bill aimed at preparing for the transition towards a clean energy system and the various provisions on pricing of water and wind turbines' of 11 March 2013, the National Assembly noted in article 28 that 'pursuant to article 72 of the constitution, an undertaking is made for an experiment to be held over five years from the date of

enactment of this Act to promote access to water and implement social pricing of water' and that 'the national water committee is responsible for the monitoring and evaluation of this experiment. Before the end of 2015, it will present to the government a report describing actions undertaken within the framework of this experiment, with an intermediary report to be presented before the end of 2016, and an evaluation report and proposal to be submitted before the end of 2017. These reports are to be sent to the local authorities that participated in the experiment for comments'.

5. Three periods mark their chronology: (1) from 1974 to 1986, the field is marked by the book *Limits to Growth* (Meadows et al. 1972); (2) from 1987 to 1996, a literature on sustainability emerges; and (3) since 1997, the field has been booming and expanding.
6. This is not to do with a fractal approach in geographical terms, which refers to the issue of the 'glocal' (Godard 1996; Boutaud and Brodhag 2006).
7. On 6 February 2003, P. Lamy gave a talk on the origin, vocation and usefulness of the SIA. The speech can be found at the following web address: http://europa.eu/rapid/press-release_SPEECH-03-61_en.htm?locale=FR, accessed 6 May 2013.
8. The eight départements looked at in the study were Allier, Aveyron, Doubs, Hérault, Indre-et-Loire, La Manche, Somme and the lower Rhine.
9. The identification of these 'problematic' materials is the result of an investigation undertaken by J. M. Cador (2002) and it corresponds to the parameters and variables adopted by R. Herz (1996) for Stuttgart. According to the survey, the materials in question are steel and cast iron, which are very brittle and were an essential component of pre-1970 pipelines—in other words, 45% of assets in 2000[2]. Old PVC piping with glued joints used during the 1970s account for 15% of assets while those made of asbestos-cement are estimated to be 2% of assets. It should be noted that J. M. Cador (2002: 174–180) has analysed three different renewal strategies and has illustrated a spike in investment between 2005 and 2025, and then after 2050.
10. The M49 chart of accounts is available on the web page of the French Ministry of the Economy: http://www.collectivites-locales.gouv.fr/files/files/finances_locales/m4/m49_pdc_dev_2014.pdf, accessed 31 October 2015.

11. This Salient Fact recalls the famous article in *The New York Times Magazines* by M. Friedman (1970), 'The Social Responsibility of Business Is to Increase its Profits', which marks the modern debate on corporate social responsibility and the links between personal and public interest in an economy based on private property. M. Friedman criticizes the assertion that pro-social behaviour systematically benefits the public interest.
12. Previous studies have only analysed investment costs; G. Pflieger and F. Ecoffey (2011) propose a method that also integrated the annual operating costs, as well as those costs relating to renewal and maintenance.
13. The analysis of universal distribution of water in Paris shows that this increase began in 1860 in the same format (Boquet et al. 2009).
14. In addition, should the water become warmer in the pipes as a result of the decline in flow, this also facilitates the formation and deposit of bacteria.
15. Dean Stansel (2011) examined this and produced an overview of the 'shrinking cities' process in the USA.
16. A directive on the ecological quality of surface waters had been previously proposed. Despite the growing interest in environmental issues, it never materialized. A withdrawal of socio-economic interests to the benefit of ecology would likely be the principal reason behind a deadlock in the negotiations (Hering et al. 2010).
17. The reports of all European countries are available on the following website: http://cdr.eionet.europa.eu/, accessed 31 October 2015.
18. The Water Information System for Europe (WISE) makes available a large number of maps and charts showing the condition and status of water in the European Union (http://water.europa.eu, accessed 31 August 2015).
19. Here, we have only brought together the most aggregated indicators in order to account for the general state of the resource in Germany. The report by the Federal Environmental Agency (Arle 2011, section 2) provides more detailed statistics.
20. Analysing the link between climate change and the management of water brings us back to foresight exercises and, on this point, differs from the objective of this book and this section. Nevertheless, there is a wealth of literature on this topic: Morel (2007), Pahl-Wostl (2007); McDonald et al. (2011), Gersonius et al. (2013). For more information on a scenario-based analysis, please see: Gallopin (2012).

21. A project that is part of the ANR sustainable cities programme—the EAU&3^{E} project—deals with the sustainability of water services in large cities, offering a multidisciplinary approach. The acronym 3^{E} refers to the three 'E's of the environment-economy-equity triptych, to which the notion of governance is also added.
22. F. Arbuès et al. (2003: 86–87) lists all of the price elasticities calculated in various academic works. A.C. Wothington and M. Hoffman (2008: 845–852) provide a complementary table. More recent work, using more specific econometric methods, does not refute the content of the main message: price elasticity has little or no effect on the UWSE.
23. Although they are interesting, these findings should be interpreted with caution since this study only notes the correlation and does not explain the logical relationship between the two variables (Hanemann 2006).
24. The *Aqualibrium* report drawn up by Shahrooz Mohajeri et al. (2003) presents at the end of each chapter the status quo of national debates on the liberalization and privatization of the water sector.
25. Elinor Ostrom (1990) sets out privatization, along with liberalization, as being one of the three main paradigms of the governance of water. Totally public management ('the Leviathan model') and self-organization ('alternative solution') are the basis for the other two.
26. If the reader is interested in the details of this issue, the latest developments pertaining to this can be found in recent special issues of the *Revue d'économie industrielle* and the *Journal of Economic Behavior & Organization*. Edition 140 of the *Revue d'économie industrielle* (2012) offers a qualitative diagnostic and empirical feedback on the French experience of PPPs. Edition 89 of the *Journal of Economic Behavior & Organization* (2013) brings together various communications on theoretical approaches and empirical developments on this theme. Iossa and Martimort (2015) present and discuss the microeconomic foundations of PPPs.
27. It is all about the risk of a change in status within the same regime (Perrings 1998; A. Rose 2007).
28. As such, the reader will recall that, following the definition of a UWS, we noted that the 'power' dimension would not be addressed here because of the strong contingency involved in its analysis. Indeed, we are dealing with cross-cutting and generalizable phenomena in order to increase the scope of the theoretical analysis undertaken in the second part of this work.

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Part 2

Institutional Hybridization and Inconsistencies: Theoretical Lessons for Institutional Dynamics and Its Sustainability

This second section has a dual purpose. Firstly, in order to complete the argumentative structure, an explanation of organizational phenomena and sustainability of the modernization of urban water systems in Europe (UWSE) is conducted over the following three chapters. It should be noted that this choice to employ theory after an empirical analysis is part of an empiric-formal approach. Secondly, the theoretical explanation must lend itself to generalization. In this way we can contribute to the development of generic knowledge on the dynamics of coordination and quality. If this second goal and the theoretical nature of the section call for a certain level of abstraction, we will ensure the report maintains a link to reality by making systematic reference to the salient facts that have been identified and formulated in the first section.[1]

Putting together the results of this explanatory phase incorporates the structuring features of the general methodology used during the observation of the modernization of UWSEs. In this way, a synchronic and diachronic comparison of the German, French and English models allows explanatory mechanisms to be identified and theoretical speculation to be tested. In addition, the stylized facts change status. In Part 1, they occupied the role of results (observational) while, in Part 2, they are treated like given phenomena, as starting points in the argument. In terms of their content, the stylized facts are of different natures. The first two report on the organizational aspects and modalities for coordination

of UWSEs, while the third pertains to the sustainability and quality of coordination in the UWSE. We have therefore justified an interest in mobilizing an explanatory model dedicated to each of these two characteristics, respectively that of new institutional economics (NIE) and the institutional resource regimes (IRR). In terms of relevance and consistency, this justification provides a basis for, and informs the direction taken by, the explanation proposed in this section. Next, each model is mobilized by formally separating its presentation from its application.

Using NIE to analyse the organizational stylized facts embraces three sections of the 'NIE domain' furthered by C. Ménard and M. Shirley (2005) and originally presented by D. North (1995), R. Coase (1991) and O. Williamson (2002). It addresses the general issue of the coordination process, taking into account the dynamics of institutional change, the industrial organization and transaction costs. More specifically, our problem can be found rooted within recent neo-institutionalist debates on the regulation of the network (Finger and Künneke 2011; Spiller 2013), on the specificity of the environment (Ménard 2011; Brousseau et al. 2012a, b) and on a systemic interpretation of institutional dynamics (Aoki 2011; Eggertsson 2013). The third field appears to be more generic than the other two, with a rather more somatic feel to it, and it shapes the structure of the argument. We are trying to articulate an analysis in terms of transaction costs into another focused on the institutional environment by means of reappropriating the institutional environment as a complex system. In this case, we have chosen to deal with informal institutions as a cross-cutting element of the institutional environment.

These two objectives will justify the mobilization of the IRR in order that the stylized fact of sustainability can be analysed. The first is pragmatic in approach. The IRR provide a conceptual framework that is specifically dedicated to an analysis of the formal coordination of uses of a natural resource, and an assessment of the quality of this coordination in reference to the potential for sustainability (Reynard et al. 2000; Kissling-Näf and Kuks 2004; Knoepfel and Nahrath 2005; Gerber et al. 2009). In semantical, theoretical and analytical terms, therefore, this research programme coincides with the need to explain the impact of modernization on the sustainability of UWSEs. The second objective engages with the process of a scientific dynamic. The framework of the IRR, as a recent research programme, has grown in relevance over the past years and has

been tested on different resources and in various areas (Knoepfel et al. 2001; Bréthaut 2012; Schweizer 2012). As an action born of its relevance, it seems appropriate to discuss some points of the theoretical construction in order to participate in the development of positive heuristics in the research programme. From this perspective, this research comes under the auspices of dialogue with institutional economics, which is the starting point for the IRR. In view of these favourable conditions and due to the need to explain this third stylized fact, we propose to deepen the exchange between the two research programmes.

Chapters 4 and 5 address the organizational dimension of UWSEs or, in other words, the explanation of the first two stylized facts by means of the NIE. Chapter 6 focuses on the impact of modernization on the sustainability of UWSEs by mobilizing the IRR and crossing them with the NIE.

Notes

1. These references do not refer to the statements of the salient facts and therefore are noted using the annotation Fs_n. By referring to the number of the fact cited, the reader can consult the list of salient facts set out in the conclusion of Chap. 3/Part 1, or can return to the heart of the observation found in the Part 1.

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4

The Micro-institutional Determinants of Depoliticization and Resilience in UWSEs

This chapter provides a micro-institutional analysis of the organizational stylized facts of the modernization of urban water systems in Europe (UWSE). The first stylized fact states that *the modernization of UWSEs brings about the process of their depoliticization.* The second stylized fact is witness to the phenomenon whereby *the degree of integration of the principles of modernization in a UWSE is positively correlated to a resilient socio-institutional dynamic rather than a resistant one.*

In this chapter, we will use new institutional economics (NIE) in order to highlight the micro-determinants of the impact of modernization on the modes of coordination of UWSEs in terms of depoliticization and resilience. To construct our argument, we take the classic dichotomy of the NIE between the theory of transaction costs (transaction cost economics, or TCE) on the one hand, and the analysis of the institutional environment on the other. This distinction allows us to isolate the micro-determinants of the depoliticization and the resilience of UWSEs; a study of the macro-determinants will be the subject of the next chapter.

Finally, we will argue that the modernization of UWSEs hybridizes their governance structure, favouring institutional arrangements that increasingly integrate the characteristics of the specialist market. Modernization

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was a regulatory shock that modified the structure of the transaction costs into a form whereby coordination by means of autonomy and the adaptability of key players was favoured.

In support of this guiding notion, the chapter articulates a transactional analysis of the modernization of UWSEs based around the triptych of behaviour–transaction–governance by first presenting a theoretical analysis and predictions (Sect. 1) before then comparing these to the empirical data to refine them (Sect. 2).

1 Explanatory Architecture of the Theory Behind Transaction Costs: The Triptych of Behaviour–Transaction–Governance

The TCE articulates four main steps in the construction of an institutional arrangement. Firstly, three behavioural principles establish mechanisms from which individuals make decisions (section "Behavioural Assumptions: From Limited Rationality and Expediency to Strategic Uncertainty"). Next, the transaction and its costs serve as a unit of analysis and formalize all the difficulties with which individuals deal (section "Characteristics of Transactions: Specificity, Frequency and Contextual Uncertainty"). Then, the governance reports on coordination options to minimize previously identified transaction costs (section "Institutionalization of Transactions: Contracts and Coordination"). Finally, starting from the basis of contracts and coordination needs, a mode of governance minimizing transaction costs provides a framework for the key players in the system (section "Modes of Governance: Contract Frameworks and Coordination Mechanisms").

Behavioural Assumptions: From Limited Rationality and Expediency to Strategic Uncertainty

According to the TCE, the key players evolve within a context of radical uncertainty. This uncertainty limits the optimality of choice and the transparency of behaviour. So that the actors can come together

with this contextual constraint, the TCE postulates three behavioural characteristics: *limited rationality*, the *pursuit of personal interest* and *future deployability* (Williamson 2000).[1] These three constituent attributes of the individual produce a central behavioural uncertainty for the progression of the theoretical sequence, for this is at the origin of transaction costs and the need for coordination (Williamson 1985).

The first behavioural hypothesis is that limited rationality stems directly from the contextual uncertainty in which choices are formed. The corollary is the inability of agents to systematically develop optimal choices. This axiom provides protection from an accusation of a lack of realism inherited from neoclassical theory due to the assumption of *homo oeconomicus* (Simon 1976).[2] The axiom of limited rationality then aims to increase the realism of the neo-institutionalist approach and is part of the development of the work of H. Simon, while eventually allowing a Williamsonian concept of rationality to develop (Dequech 2006). Indeed, O. Williamson replaces the notion of *satisfecit* [satisfaction],[3] created by H. Simon, with *economizing* behaviour. Rather than stop their choice as soon as they find a solution that seems to satisfy their expectation level, the individuals continue in their search for a lowering of transaction costs (Williamson 1996).

The economizing behaviour of the actors is a selection process that takes place in two successive phases. The alignment phase is one during which 'transactions, which differ in their attributes, are aligned with the governance structures, which differ in their costs and skills' (Williamson 2010: 681). Then, the second phase applies the remediability test, whereby 'the mode of organization that remains is one for which no form of superior feasible organization can be described or introduced to ensure net gains. It is deemed to be effective' (Williamson, 2010: 684). This sense of rationality assumes that players minimize transaction costs and is therefore closer than the notion of H. Simon to the hypothesis of rationality associated with the neoclassical theory of *homo oeconomicus*.

The authors identify three elements limiting rationality. The cost of collection and processing of information, as well as the complexity of the calculations to find an optimal solution, represent the limits of resources. Indeed, agents do not have all of the financial, physical and cognitive capabilities, and so on, to ensure an assessment of the optimal

choice. Thirdly, the uncertainty inherent in the economy, i.e. a dynamic perceived to be stochastic, is considered as a factor that reduces the rationality of agents. In addition, these agents can experience a change of preference over time; this second-rank behavioural uncertainty is called *innocent uncertainty* (Koopmans 1957; Williamson 1985).

According to the TCE, the second human characteristic—the pursuit of personal interest—links two characteristics of human beings: individuals combining *routine behaviours* with *opportunism* (Williamson 2007). Most of the time, people do what they say they will do; in addition, routine behaviours represent the mass of behaviours and pose few problems of coordination. Conversely, opportunism results in uncertainty, renders coordination more complex and relies on the notion of deception as the individual tries to take advantage of existing information asymmetries. Steps should be taken to distinguish two different periods of time during which opportunism can manifest. Firstly, *ex ante* opportunism signifies deception before the signing of the contract and corresponds to a problem of adverse selection. Secondly, *ex post* opportunism refers to a case in which deception is taking place once the contract has been signed; this time it is more a problem of moral hazard. The opportunistic nature of individuals is essential in the TCE as governance and institutional arrangements are designed largely to minimize the impact of the harmful effects of this behavioural characteristic.

Finally, the third attribute of human behaviour according to the TCE—deployability and anticipation—guides the choices. Individuals cannot solve *ex ante* their coordination problems, nor can they set up mechanisms to build effective coordination in a scalable way.[4] This capability complements the cognitive abilities of the framework of procedural rationality and testifies to the ability of individuals to imagine the extent of possible and achievable solutions.[5] It expresses itself primarily through the anticipation of potential disputes. In this way it integrates limited rationality and the opportunistic character of individuals by revealing any likely future disputes. Deployability and anticipation impact directly on the creation of transaction contracts with the result that they attenuate the hazard while providing effective coordination. From that point, it develops the ability to make credible commitments.

These three behavioural attributes contribute to produce a type of behavioural uncertainty that, because it is a matter of rational and calculated choice, is called *strategic*. Working on the basis of these axioms, O. Williamson (1985) compared the TCE to the main approaches in economics of organizations. He took the opportunity to clarify the guidance they provide on the approach of the coordination within the framework of the TCE (Williamson 1985: 46):

> Economization applied to limited rationality takes two forms. One addresses the decision-making process, and the other involves governance structures. The heuristic use of problem solving […] is a response to the decision. 'The economics of transaction costs is, however, mainly concerned with the consequences of the economization in terms of the assignment, in a discriminating way, of transactions within the governance structures.

The TCE seeks to understand 'what the most efficient structures of governance are and for what types of transactions'. In other words, it looks at how the triptych behaviour, transaction and governance structure is articulated to provide effective coordination. This approach will allow us to look at the 'governance' link in the UWSE between the actors in the urban water cycle, mainly those involved with the deviation process, and the institutional structures included among water institutions.

In addition to behaviours, the study of the transaction positions the other starting point for an analysis of transaction costs.

Characteristics of Transactions: Specificity, Frequency and Contextual Uncertainty

The transaction is the unit of analysis of the TCE. According to O. Williamson (1985: 1), it 'appears when a good or service is transferred through an interface that is technologically separable'. The conduct of the transaction necessitates three stages. Firstly, an initial negotiation between the different parties involved begins the transaction process. Then, the formulation of an exchange contract continues it. Finally, once

the exchange has taken place, the process is ended when the contract is resolved. Each transaction is unique and is characterized by its specificity, its uncertainty and its frequency. These characteristics, along with the behavioural attributes, thus define the different transaction costs that the contracts, organization and governance are trying to minimize.

The specificity of an asset makes reference to its degree of redeployability in the event of a breakdown of the transaction before completion (Williamson 1985). The more the specificity is increased, the harder it is to find uses or alternative users without experiencing a loss in value of the asset. It is therefore normally accompanied by a loss of opportunity and sunk costs. This concept must be understood in an intertemporal way; the specificity exists because a transaction is not instantaneous, but takes place over time. This intertemporality and the degree of specificity of an asset generates bilateral dependence between the parties; this dependence is the result of six factors (Chabaud et al. 2008):

1. The specificity of site, referring to the geographical features (proximity, etc.) of the production process;
2. The specificity of physical assets, which takes into account the degree of specialization of the different tools used during the production process;
3. The specificity of human assets, which consists of the skills of the workforce as relevant to each transaction being analyzed. The greater the number of skills, the more the specificity increases. It is witness to the effect that learning has;
4. The existence of investments in assets dedicated to a single customer;
5. The existence of a brand image;
6. Temporal specificity, which refers to the temporal coordination requirements in the production process.

The second feature of a transaction, uncertainty, stems primarily from a lack of information. This is due to limited rationality and information asymmetries that are exacerbated by the strategic dimension of interactions between key players. In addition, if the number of number of agents involved in the transaction is small, this tends to increase

uncertainty because the degree of substitutability in relation to the partners is dwindling.[6] Finally, a third feature is the frequency of a transaction, something that can be an important factor influencing the shape of the governance structure. Indeed, a large number of transactions produces repeated costs and, if assets are evidence of increased specificity, these costs can be high. In this instance, it becomes possible and economically advantageous to group costs together. Finally, the three features of the transaction set out above attach a set of costs to the exchange that become an inherent part of it.

R. Coase (1937, 1960) invented the concept of transaction costs, and believes in particular that they are positive; they are necessary to respond to the inability to understand and explain the organizational choices of firms solely through means of price. O. Williamson (1985, 2010) takes up this concept once more and clarifies it in order to avoid three pitfalls. Firstly, he points out that applying positive transaction costs is akin to opening Pandora's Box, since a less than rigorous observer might see them everywhere and bias analytical conclusions. Secondly, confirming the existence of transaction costs is not enough; you have to analyse their variations according to the modes of governance in order to understand the coordination choices. Finally, integrating transaction costs should not theoretically remove the theory's predictive ability, but strengthen it.[7] Because of these pitfalls, he notes that

> Transaction costs were frequently invoked in a tautological way, thereby to 'explain' any puzzling phenomenon whatsoever after the fact. (Williamson 2007: 16)

O. Williamson thereby concluded that transaction costs should be integrated in a broader analytical grid in order to deduct theoretical results that can be empirically tested.

Transaction costs emerge during each stage of the transaction process: the genesis of the agreement, the functioning of the process and the resolution of the transaction. In the end, as a result of the emergence of an agreement, O. Williamson (1996) distinguishes *ex ante* costs and *ex post* costs that the actors have to bear, then lists them (Table 4.1). He recalls the interdependence of these costs and consequently stresses the need for

Table 4.1 Different transaction costs in an analysis by O. Williamson

Ex ante costs	*Ex post* costs
1. Negotiation of an agreement 2. Drafting of an agreement 3. Guarantee of an agreement[a]	1. Poor adaptation to the contract 2. Haggling caused by divergence in the performance of the contract 3. Organization and functioning of structures of governance 4. Costs of establishing secure commitments

Source: Created by the author with reference to Williamson (1996)
[a]Indeed, rather than resort to going to court, the organization prefers to build internal arbitration mechanisms to resolve disputes

global rather than sequential awareness. With the measurement of transaction costs proving to be complex, the majority of analyses of the TCE evaluate them by comparing the different possibilities; the order of magnitude of the costs is therefore relative and not absolute. The goal is not to know how much is in itself a transaction, but to discriminate the modes of governance according to the level of their transaction costs. In the end, the decision-making of the agents is built around the assessment of these costs. The economizing behaviour pushes the agents to minimize them by comparing different alternatives of governance. Out of these processes of alignment and remediability, an institutional arrangement emerges.

The combination of behavioural and transactional characteristics leads to the identification of transaction costs. In order to increase the efficiency of the economy, and more particularly that of the system being studied, transactions must be accompanied by regulation and institutions minimizing the identified costs. This is the role played by contracts, and they belong to the governance dimension of the explanatory triptych of coordination according to the TCE.

Institutionalization of Transactions: Contracts and Coordination

The contract is the first step in the organization of transactions and governance. Each transaction is accompanied by a contract and the latter aims to reduce the uncertainty inherent in transactions. The contract therefore

has a central place in the TCE; it is the smallest building block of an institutional arrangement that is at the foundation of an institutional system.[8] With this definition of a contract we refer to L. Davis and D. North (1971: 6–7), who propose the definition of an institutional arrangement as, 'an arrangement between economic units that governs the way in which these units may cooperate and/or compete'. Only in order to facilitate a distinction of the elements in institutional integration, and subsequently that of UWSEs, we must add that the institutional arrangement is both specific and operating, i.e. it is the means of coordination chosen by the participants in the transaction.

When buyers and sellers engage in a transaction, they set out a contract that defines the terms of trade with relation to price and the specificity of the assets and guarantees; in advance, the parties have specified the quantities, the quality and the duration of the transactions (Williamson 1996). Furthermore, due to the behavioural and contextual uncertainty surrounding each transaction, contracts remain incomplete (Ménard 2010). E. Brousseau (2008) identifies two reasons behind the incompleteness of contracts. The first refers to the work of O. Williamson and assigns the cost and the imperfection of the contracts to the limited rationality of the actors and the insertion of the contract into an institutional framework that is itself imperfect. The second refers to the work of I. MacNeil (1974; Campbell 2001), according to which the relational dimension of contracts induces an inability to formally retranscribe everything. This in turn leads to an interest in informal institutions.

By way of summary, contracts:

> [a]re necessary for coordination, but not sufficient in guaranteeing its efficiency. A lot depends upon the mutual behaviour of the agents, upon the dynamics of their relationship, and upon the quality of the institutional environment. (Brousseau 2008: 47)

This incompleteness of the contracts causes a bilateral dependence between signatories; this dependence is much stronger than the assets, which are seldom redeployable. Because of this, one of the central points of contractualization lies in the notification of measures for its readjustment in the face of a change in the circumstances of the transaction (Williamson 1990). In the

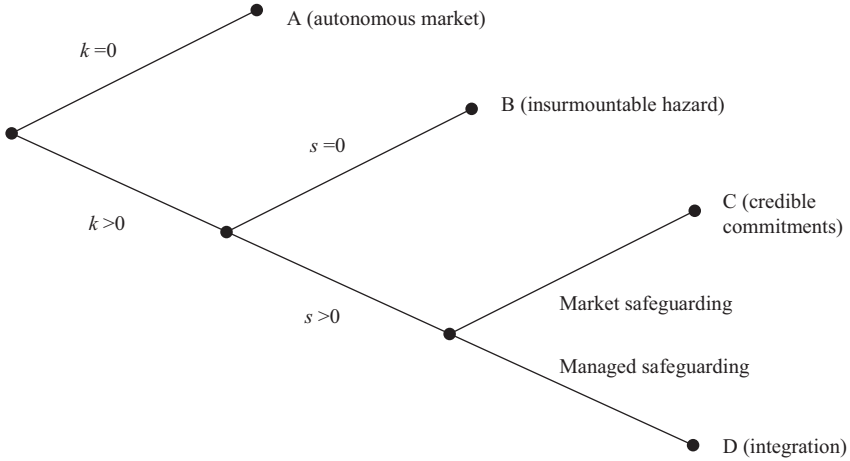

Fig. 4.1 Four generic contractual forms framing a transaction (Source: Williamson 2000: 604, 2007: 22)

end, the form of a contract depends on the features of the transactions and the means of implementation that embed them within the institutional environment.[9]

Depending on the degree of specificity of the assets (k) and the existence, or not, of safeguards in the contract (s), O. Williamson (2000, 2007) constructed a diagram illustrating four generic forms of contracts (Fig. 4.1).[10] When the assets are not specific (A), the transaction corresponds to an exchange under the auspices of a self-sustaining market subject to the laws of competition. In this case there is no dependency between buyers and sellers. If the assets contain a form of specificity, and therefore generate bilateral dependence, they can be exchanged in three different ways. In the first of these, the contract includes no safeguarding measures (B) and the transaction remains subject to various forms of hazard. The use of this contractual method remains rare since it neither reduces transaction costs nor uncertainty. It can therefore only rationally exist if transaction costs related to the implementation of the contract outweigh the opportunity costs and sunk costs induced by the specificity of the assets. The other two types of contracts contain backup mechanisms to overcome the incompleteness of the contracts

and to protect the contractors. These mechanisms create incentives for the continuity of the transaction. When the contract applies its safeguard measures on the market (C), it takes a hybrid form and establishes credible commitments. Finally, if safeguards are administered (D), the transaction is integrated.

O. Williamson (1985), by referring to the works of I. MacNeil (1978), distinguished three types of contractualization: *classical, neoclassical and evolutionary*. Classic contractualization corresponds to a type A contract: the contract is complete and the market effectively regulates the activity and economic exchange. It is only due to uncertainty that not all of the transactions form part of the contractual framework. Uncertainty, especially in the case of long-term contracts, makes it too expensive (if not impossible) to draft a full contract. Neoclassical contractualization responds to these limits and provides a framework to resolve disputes in the event of the transaction process not being in accordance with the process provided for in the initial drafting of the contract. Scalable contractualization goes further in taking into account the complexity and the duration of the contracts. It implements mechanisms for specific adjustments to be made to the transaction based on a strong relationship between the parties and administrative monitoring, for example.

In the condition in which they were presented, the contracts remain virtual. Contractualization takes place when a player decides, depending on their rationality and the characteristics of the assets, upon the form of organization of a specific transaction. This choice is in answer to the question 'make or have made'? Indeed, economic theory illustrates, especially with the help of opportunity costs, that each agent faces such questions (Mankiw 1998): is it better to produce what we need or buy it? Should we integrate production or outsource some of it? What is the most effective form of organization? In the TCE, the agents answer this question of vertical integration according to a logic of minimizing transaction costs. The difficulty of the organizational choice comes from the definition of a transaction itself. In fact, technological separability increases the variety of modes of organization of activity and thus the possible modalities of coordination. The chosen organization will be one that minimizes transaction costs and that will be formalized by a contract. The actors

identify the solution following selective alignment tests and remediability tests. As we have seen, it is predominantly the degree of uncertainty, the specificity of the assets and the costs of coordination which, in the end, guide the choice.

Depending on the frequency and the specificity of transactions, we can distinguish four different coordination mechanisms. They offer a first generic response to the question of the type of effective governance according to the specifics of the transaction (Williamson 1985). *Market governance* is theoretically the most effective when assets are not specific; it is based on classic contractualization and corresponds to the generic contract form A. *Trilateral governance* is possible when the frequency of transactions remains low and the assets contain specific components. Framed by neoclassical contractualization, this type of governance becomes less beneficial as the specificity increases. The third form, *bilateral governance*, seems most effective in coordinating recurring transactions that are also occasionally specific. This mode of governance, in the same way as the following one, is seen as scalable contractualization. Finally, *unified governance* regulates frequent transactions on specific assets. The advantage is that, as the specificity increases, little by little it is substituted with trilateral governance in the organization of an occasional transaction. It corresponds to a choice that favours vertical integration.

Contracts and coordination mechanisms respond to the problems of hazards and risks incurred during the time of a transaction. These mechanisms are the result of an interaction between actors and aim to reduce the uncertainty and transaction costs inherent in economic activity. A transactional analysis of contracts gives rise to an understanding of the different forms of organization of an urban water cycle, depending on requirements, as they relate to the provision of urban water services (deviation process and usage). The transactional analysis explains the variations between the different modes of coordination, including the degree of control and flexibility. It therefore offers a high-performance micro tool to explain the depoliticization and resilience of UWSEs following their modernization. Contracts establish a mode of contingency coordination and these specific institutional arrangements form part of a larger whole: the mode of governance.

Modes of Governance: Contract Frameworks and Coordination Mechanisms

Contracts are part of a mode of governance and the mode of governance turns out to be more generic than the contract. In addition, we wish to make a formal distinction between the *mode of governance* and *institutional arrangement*. As we have noted above, the institutional arrangement is a specific, chosen means of coordination; our use of mode of governance refers to a generic means of coordination that has not been selected. It offers a coordination solution among the alternatives present in the range of possible choices of actors. The mode of governance remains abstract: this is an individual's first benchmark level of an individual when forming their choice. An institutional arrangement is the result of this phase. More simply, we will speak of a mode of governance to refer to types of coordination that presents upstream of choice and institutional arrangements. A study of modes of governance thus enables the analysis of the coordination provided by the transactional analysis of contracts to be expanded. In particular, it facilitates the apprehension of coordination beyond the principal–agent relationship and, therefore, the highlighting of its multilateral and multilevel character (Brousseau 2008).

The four mechanisms of coordination presented at the end of the transactional analysis of contracts neither take into account the uncertainty nor the institutional environment. Both of these elements have an effect on the choice of mode of governance by weighting the risks against which individuals want to protect themselves, and by varying different transaction costs. The TCE finally retained three modes of governance (Williamson 1991; Ménard 2005): market governance, hybrid governance and hierarchy. Market governance and hierarchy are the two terminals of a *continuum* full of the diversity of hybrid governance structures.[11] In a system of organization by means of the market, prices ensure coordination between the various entities of the system. When organization is hierarchical, i.e. vertically integrated, the *fiat* serves as a mechanism of internal coordination. The term fiat refers to an act of authority and command within the structure. Hybrid forms combine these mechanisms of price and fiat, by weighting their importance in a variable way.

These three types of governance serve to break the logic of 'bad games' through the implementation of coordination mechanisms appropriate to the collective action problem that has been identified (Williamson 2007). In terms of the orientation of the TCE, different institutional arrangements provide, according to their advantages and disadvantages, effective organization that is specific to each variety of transaction. To do this, they incorporate characteristics or features that respond to potential problems emanating from the attributes of the transaction. Adaptability, management tools and the governing law of each mode of governance thus allow the efficiency and the coordination solutions provided by the institutional arrangement to be evaluated. C. Ménard, who is interested in the effectiveness of governance, highlights the interest of these 'devices intended to render effective the rules required by [the transaction]' (2003: 107). He called these devices micro-institutions and his analysis proceeded to include a multilevel perception of governance in the TCE (Ménard 2003, 2009; Ménard and Peeroo 2011).[12] The three following paragraphs detail the characteristics of the market, hierarchical and hybrid modes of governance.

Market governance organizes the system by using signals emitted by prices. The actors adapt independently and there is a classic contractualization system. These features highlight three specificities of this type of institutional arrangement. Firstly, given that competition regulates activity, transactions must offer the best possible value, in the absence of which they would not find a counterpart to the exchange. Secondly, adaptation occurs unilaterally. It requires no interpersonal relationships and involves generally low trading costs. Thirdly, the structure of the contracts takes a relatively simple form. The transaction attributes are standard, and the courts will decide the potential conflicts. Therefore, the contract requires little in the way of specifics.

In contrast, in a hierarchical structure, the coordination mechanism is based on command and authority; in addition there is a strong interdependence that connects the different actors. As a result, adaptation cannot be autonomous, as it is under market governance, but is carried out collectively and consciously. The modalities of the transaction are explained, the transaction follows an order issued by a chain of command and the adaptation of the institutional arrangement almost always requires negotiation. To

ensure coordination, contractualization is based on the principle of forbearance, meaning that the structure builds its own mechanisms for arbitration on an ad hoc basis. The transaction and all phases of the process are internal to the production structure.

Between these two modes, hybrid governance structures are based on a market structure, the gaps in which, with regard to the management of uncertainty, are filled by managed coordination mechanisms. The hybrid institutional arrangements juggle the governance costs of the hierarchical structure and the incompleteness of the market structure. In this context, transactions are long term and are based on neoclassical or progressive contractualization. This third mode of governance offers an organizational combination of mechanisms specific to the market and to the hierarchy. It allows a pragmatic institutional arrangement to be developed and includes the singularities of each transaction (Ménard 2004, 2005, 2011). It gives the actors a certain flexibility. This realism makes the hybrid mode of governance the most frequently implemented, but, far from being the standard option, hybrid arrangements show a variable inclination toward the two poles of governance, ranging from a coordination based on a strategic centre, to an organization based on information networks (Ménard 2011). In the end, arbitration between the modes of governance exists to balance the double costs of governance and specificity of the assets in such a way as to minimize the transaction costs (Williamson 1991, 1996).

The mode selection of governance takes place in a rational way. The emerging institutional arrangement is one whereby transaction costs are minimized (Fig. 4.2). Since the technological separability leads to a variety of potential organizations, the actors, in order to specify their choice, proceed by comparing the possible alternatives. Firstly, they *align* the different possibilities. Then, the *remediability* test discriminates between the alternatives. The idea is to weigh up the options, and in particular the test allows them the opportunity to examine how each possibility avoids the failures of the others. The chosen solution will be the one compared to which no other alternative would provide a net gain (Williamson 1996). These principles of alignment and remediability proceed from economization logic of the actors and, from an analytical point of view, from their procedural rationality.[13] Economizing behaviour induces a perpetual adjustment of institutional arrangements.

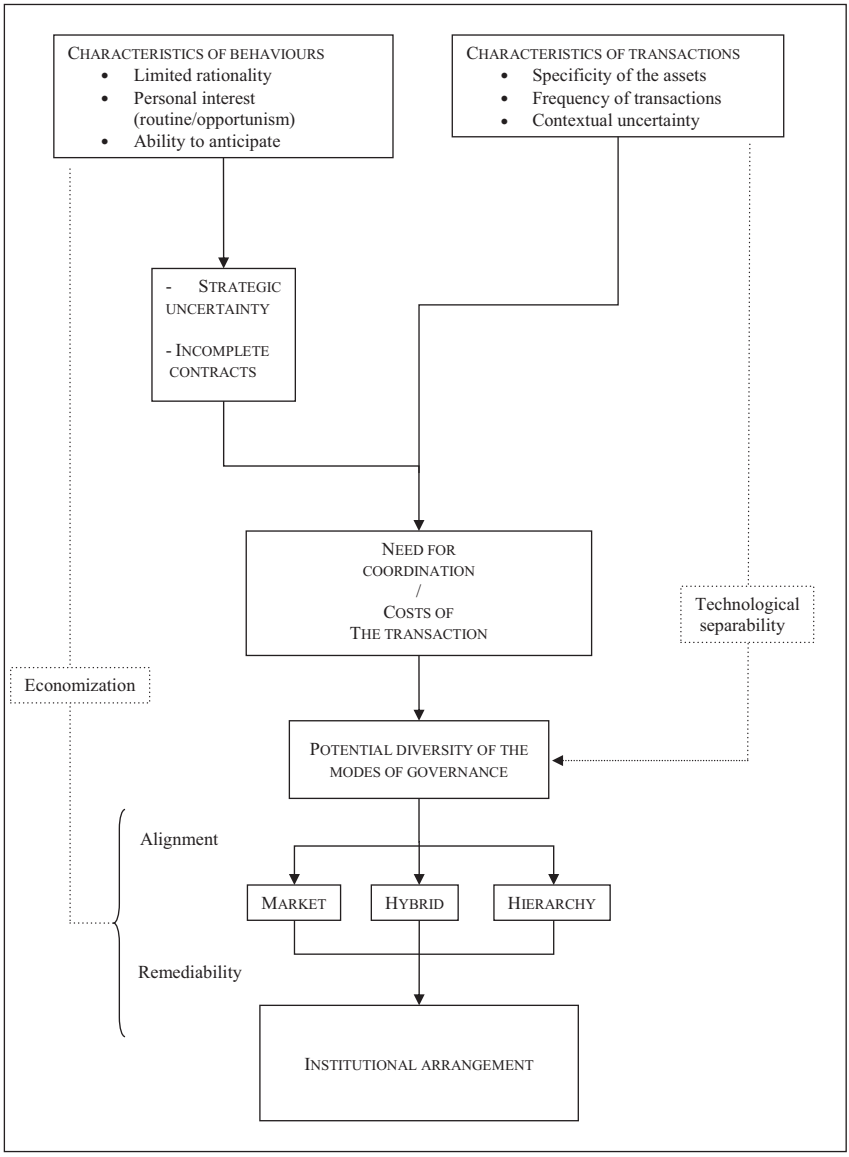

Fig. 4.2 Selection process for an institutional arrangement by individuals

> An existing organizational mode can be questioned as soon as an alternative form can be implemented with achievable net gains. (Chabaud et al. 2008: 119)

In this sense, institutional evolution is perceived in a functionalist manner; only the arrangements minimizing transaction costs persist.

Figure 4.2 includes the triptych of behaviour, transaction and structure of governance of the TCE, and summarizes the causal sequence leading to the emergence of an institutional arrangement as a coordination solution chosen by individuals. Before we present the structure of the TCE, note the two reductions voluntarily operating in this schema: the monocausal representation of links between elements and the fact that the institutional environment is not taken into account in the process. This simplification is the result of formal considerations rather than shortcomings in the theoretical model. Firstly, the pattern suggests monocausality, starting from the individual and leading to an institutional arrangement. This choice of monocausality lightens the graphic representation and does not intend to signify the absence of interactions, but to improve readability. Secondly, the institutional environment is obscured because its analysis is the subject of the second part of this chapter.

We do acknowledge, however, that the reality takes a more complex form than is suggested by this representation. This pause in the presentation of the TCE is an opportunity to expose the first integration elements of the complex system within the NIE. Figure 4.2, as well as the presentation of the TCE, leaves little place for feedback and the institutions seem to be exogenous to the systems; however, from an ontological viewpoint, and in reference to current literature, these interrelationships do exist (Aoki 2007; North et al. 2010; Brousseau et al. 2011). The concept of the complex system offers a way to highlight these multiple interactions between actors and institutions. A complex system is a back-and-forth process between its various constituent elements, which go through scenarios of organization, disorganization and reorganization and so on (Morin 2005, 2011).[14] Two principles here refine the understanding: the organizing recursive loop and the holographic principle.

The use of the recursive loop facilitates an analysis of the dynamics of the trade-offs: the passage of a mode of governance by means of alignment and remediability criteria leads to the choice of an institutional arrangement in a given transaction-cost structure. But this structure is perpetually changing as a result of the uncertainty due to the actors (strategic, innocent) and as a result of the context. In addition, the choices also modify the structure; coordination generates learning effects and creates confidence, reducing transaction costs. Therefore, remediable alternatives emerge and readjustment requirements appear where, in particular, there is a use of evolutionary contractualization during costly and long-term transactions. The holographic principle illustrates that institutions are in the image of the actors and vice versa. The incompleteness and the imperfection of the contracts depends directly on the limits to the rationality of the actors, and at the same time, these institutional characteristics partly define access to information and its processing for the actors.

The diagram shows that transaction costs and the need for coordination are both results of behavioural characteristics and of transactions. From this need for coordination emerges the identification of diverse modes of governance that are able to reduce transaction costs. According to their procedural rationality and characterized by the principle of economization, individuals thus choose the alternative that minimizes transaction costs. Once implemented, the alternative becomes the institutional arrangement of the system. This explanatory model focuses on the behaviour–transaction–governance triptych of the TCE. In the explanation of the phenomena of the modernization of UWSEs, it showcases the actors and the technical and economic characteristics of UWSEs as the micro-determinants of the terms of governance. This provision leads to the identification of two key aspects in the microeconomic explanation of the stylized facts:

- include these micro-determinants and their evolution in the process of modernization;
- explain why they lead to coordination solutions that cause depoliticization and go hand in hand with the growth in resilience of UWSEs.

The aim of this section is to present the theoretical background of the TCE and the guidance it gives to the explanation of stylized facts

1 and 2. The following subsection provides a transactional analysis of the modernization of UWSEs to explain the micro-determinants of the depoliticization and the increase in resilience of UWSEs following their modernization.

2 The Hybridization of Structures of Governance: Explanatory Factor for the Depoliticization and the Degree of Resilience of UWSEs

This subsection is organized into five steps. An analysis of the characteristics of transactions and behaviours (section "The Characteristics of Transactions and Behaviour: The UWSEs as Natural Public Monopolies") allows us to theoretically deduce the optimal governance structures for UWSEs (section "The Ambiguity of a Theoretically Optimized Organization: The Premise of Empirical Diversity Between Hierarchy and Hybrids"). We then put forward the peculiarities that theoretically would imply the modernization on the basis of these structures (section "Generic Analysis of the Dynamic Impact of Modernization: Decentralization and Depoliticization of Institutional Arrangements"). Based on these interim results, we are able to explain the microeconomic fundaments of the causal relationship between the modernization and depoliticization of UWSEs (section "Synchronic Test of the Causal Link Between Modernization and Depoliticization: Comparison of the Three European Models"), followed by the positive correlation between modernization and the socio-institutional resilience of UWSEs (section "From a Resistant Mode of Governance to a Resilient One: A Growing Preference for Flexibility and Autonomy").

The Characteristics of Transactions and Behaviour: The UWSEs as Natural Public Monopolies

Following the logic of the TCE and Fig. 4.2, our analysis of the characteristics of transactions and behaviours introduces an explanation of the effects of modernization on the organization of UWSEs. With regard to behaviours, we posed the axiom that these proceed according to the

same rationality that as in other economic sectors and between the different UWSEs; in other words, economizing behaviour is the product of procedural rationality. If individuals do not change, transactions within a UWSE seem to us to be slightly different than in the other sectors, which leads us to narrowly refine the definition of a transaction as provided by O. Williamson. In this case, the taking into account of two supplementary dimensions characteristic of UWSEs appears fruitful: the concept of public service and anchorage to a natural resource. The notion of public service refers to a transfer of responsibility and depends on the quality of goods and services traded; for water, we especially have to look at accessibility and the technical procedures for delivery. Then, anchorage to a natural resource implies taking into account the physical realities (quantity, quality and so on) that are not necessarily shown through pricing. These additions lead to increased uncertainty in the theoretical model.[15] Consequently, we will define a transaction in a UWSE as the exchange of access to the water resource or services mobilizing it in accordance with the given technical procedures.

To determine the specificity, frequency and the level of uncertainty inherent in the provision of the services of water supply and waste-water evacuation, we must remember the singularities of water as a private consumer good. Water is different from other consumer goods because of the place it occupies in the attitudes of individuals and its economic characteristics (Glennon 2004; Hanemann 2006). Here, we have no interest in economic characteristics; the mobility, variability and heterogeneity of water, as well as the industry's cost structure, strongly impact on the provision of services within the urban water cycle. During the analysis, attitudes to the interactions between the institutional environment and the governance structure will be addressed.

Water is a very fluid and therefore transportable asset. This is evidenced by the length of the connection channels between a city and its catchment areas. For example, Eaux de Paris brings water through a network of aqueducts measuring 470 km in length (Eau de Paris, accessed 26 March 2012). This mobile attribute of the resource allows multiple uses of the same molecule during the water cycle: for hydroelectricity, cooling, household uses, decorative uses and so on. However, the successive uses of the resource are not completely equivalent, since at every stage the

quality of the resource changes. Indeed, by polluting or warming it, most of the utilities degrade the resource and influence its possible usage.

This change in quality leads us to the second characteristic of water: its variability. Supply and water availability vary in space, time and quality, as we have just seen. The distribution of the resource on the planet is not homogeneous, neither, any longer, is its intensity of usage, which makes a geographical gap possible between the physical availability of the resource and socio-economic needs. This spatial variability affects UWSEs, for example on the south-east English coast where there is a high concentration of population, but little water (rivers and aquifers of medium sizes) (Environment Agency 2008). The seasonality of precipitation adds temporal variability and, in the UWSE, this phenomenon makes water more abundant in spring than in summer. These variations render the balance between supply and demand for water ever more complex. In order to maintain this balance, the technical classical solutions to reduce the impact of such changes on usage are storage and transfers of water between watersheds. Its geographic, temporal and qualitative characteristics lead to water being considered as a heterogeneous economic good.

The structure of the costs of providing supply and sanitation services also singles water out compared to other economic goods. The deviation process of UWSEs is based on an extended infrastructure that is costly and long-lasting. The development, maintenance and renewal of the infrastructure generates numerous fixed investments which, due to their high amounts, are amortized over the long-term. Moreover, although mobile, water remains technically difficult and expensive to transport (by means of aqueducts, and so on),[16] while its storage is relatively inexpensive.[17] The water industry is therefore distinguished by its high capital intensity and it involves significant fixed costs. For example, in France, the network respectively represents 70% and 60% of the value of the assets of drinking water and collective waste-water treatment services (Burtin et al. 2011). Furthermore, considerable opportunities for economies of scale are present in the storage, treatment and transport of waste water and drinking water (Hanemann 2006).[18] These economic characteristics are realized in production by a strong difference between a marginal cost in the short term and long term, reflecting the magnitude of increasing returns.

Table 4.2 The impact of the characteristics of water resources on the specificity of the assets of the UWSE's deviation process

	Characteristics of water resources				
Type of specificity	Mobility	Geographic variability	Temporal variability	Qualitative variability	The cost structure of the infrastructure
Site	–	++		+	++
Physical assets				++	++
Human assets				++	
Dedicated assets	++	++		+	++
Brand image					
Temporal specificity			++		–

These characteristics of water, as a singular economic good, shape the specificity of transactions within UWSEs (Table 4.2). The water industry is organized around assets that are specific to five characteristics. The first two characteristics, geographic variability and the high cost of transporting the resource, induce a strong specificity of site. In fact, operators are interested in minimizing the distance between the various operations of the deviation process, thereby reducing the scale of the infrastructure. This cost/quality argument during the beginning of the twentieth century justified a change in the governance of water in major European cities. B. Barraqué (2015), in showing the transition from a period of civil engineering to a period of sanitary engineering, recalls actors' concern with searching the nearest supply sources to the cities and treating these to make them drinkable. The opening of the doors of the new water treatment plant in Ivry in 1902, under the leadership of P. Brouse, was part of this transition in the Parisian UWS. Thirdly, the seasonality of the resource, as evidenced by precipitation, for example, establishes the temporal specificity of the procurement phase. It shows the need of coordination mechanisms to ensure the provision of a quality service throughout the year. The propensity for storage and similar activities to generate economies of scale also compensates the costs of this specificity. We have seen that the UWSs of the East of England are particularly subject to this type of specificity due to the strong seasonal

variability of available volumes of water. Fourthly, because of ever more demanding criteria relating to the standards of drinking water and the technical complexity of the sewerage process, the specialization of physical and human assets increases. Finally, the strong individual character of access to water in the UWSE dedicates a part of the infrastructure to a single customer and thus increases the specificity of the assets.

These five main specificities of the assets, necessary for the provision of drinking water and for waste-water evacuation, reduce investment in the diversion process and the extent to which the infrastructure can be redeployed. This low redeployability of investment pushes operators to assume significant sunk costs and opportunity costs in order to maintain their business activity. We have seen that the investments made are largely fixed, considerable and amortized over the long term. Therefore, it is not just that the urban water services industry involves sunk costs and opportunity costs but, in addition, that these costs are financially high. Concretely, the non-recoverable nature of the costs is easily noticeable since investments are fixed, durable over time and tangible; on the other hand, the opportunity costs are more abstract. Arbitration between the expansion of the network and its renewal illustrates this second type of cost. The maintenance of the network reduces the resources that can be mobilized to extend it. The potential number of clients served therefore increases more slowly, as does the volume of achievable revenue. On the other hand, abandoning renewal in favour of extension generates a risk of making existing customers dissatisfied, therefore losing the market. These costs and the specificity of the assets form a bilateral dependence between the actors of the transactions of the UWSEs, forcing them to establish long-term contracts.

Bilateral dependence and the duration of contracts increases the uncertainty of transactions. On the one hand, as a relation of dependence is born, each player submits to the opportunism of others. This dependence increases the impact of strategic uncertainty. The implementation of a strategy maximizing financial profitability at the expense of renewed investment, which leads to a degradation of the quality of services for users, illustrates a possible moral hazard. On the other hand, as a result of commitment in the long term, uncertainty over the transactions increases. This is how demographic changes, which are also independent

of the provision of services, threaten the long-term profitability of the investments made in the UWSE ($F_{s39,}$ $F_{s40,}$ F_{s41}). The *shrinking cities* process that is happening in East Germany represents a case of this type of hazard. Similarly, advances in home automation reduce domestic water consumption and disrupt the amortization plans of operators, who have to deal with a decline in domestic demand.

Transaction costs are high in the UWSE. These costs are a result of uncertainty and the specificity of assets caused by the transaction's characteristics and the associated consumer behaviours. In particular, because of the duration of the contracts, *ex post* costs increase. Indeed, the risk of poor adaptation of the contract, and therefore a need for renegotiation, is great. Coordination becomes necessary to minimize the total of these transaction costs. Theoretically, this suggests that hierarchical governance, materialized in public monopolies, would be the most effective form.

The Ambiguity of a Theoretically Optimized Organization: The Premise of Empirical Diversity Between Hierarchy and Hybrids

Contracts organize the coordination of actors and the terms of each transaction. They are direct responses to the transaction costs and coordination issues identified by stakeholders. Depending on the specificity of the assets and the type of safeguards included in the contracts, we have already isolated four generic contractual forms that can provide a framework for a transaction (Fig. 4.1). Therefore, by referring to the characteristics of the transactions we have noted, and by a process of elimination, it is possible to deduce the generic contractual form that is theoretically compatible with the UWSE. Once this form has been determined, we reveal the mode of governance that *a priori* proves the most powerful in coordinating the UWSE.

Contract type A corresponds to transactions involving non-specific assets. However, as we have just seen, the exchanges taking place in the UWSE rely on specific assets (water treatment, distribution networks and so on). This contract mode does not therefore provide a relevant solution for urban-water-cycle actors. A self-sustaining market cannot organize

the UWSE and the sole usage of competition rules leads to the inefficient coordination of actors in the system. The dependency between the actors and the transaction costs related to uncertainty are too high. Besides, the reality provides no example of the organization of the supply of drinking water and waste-water disposal that is based solely on competition and a comparison of quality/price ratios. This theoretical conclusion, confirmed by empirical data, leads to a rejection of contract form A, which is a simple contract in a self-sustaining market, used to provide an effective coordination solution for UWSEs.

The contractual forms B, C and D manage specific assets and put different safeguarding modalities at the disposal of the key players. Type B contracts do not involve transactions including safeguard mechanisms. The transaction is not protected and key players, bilaterally dependent, find themselves subject to the strategic and contextual vagaries that can disrupt the proper conduct of the transaction. This form of contract is risky because it only provides for *ex ante* coordination measures, so all the unforeseen developments cannot be taken into account. However, the choice of this contract mode is rational when the costs of implementing the governance of transactions outweighs the potential losses of assets caused by a poor resolution of the exchange. However, the large amounts of investment made by operators for the provision of urban water services make it unlikely that the non-implementation of safeguard mechanisms is of interest; i.e. they outperform the costs of governance. In addition, since most costs are fixed, operators retain little leeway in readjusting their strategy in the face of the failure of counterparts. As a result, contractual form B is rarely adopted in the economic exchange and it does not represent a satisfactory coordination modality for the actors of UWSEs.

Contractual forms C and D insert safeguards into the negotiated agreement. These safeguard measures are intended to mitigate the potential incompleteness of the initial terms of exchange in the face of an unanticipated future event. In the case of a long-term relationship over time, these measures reduce the risks and *ex post* transaction costs upon the signing of the contract. Also, thanks to the coordination solutions they offer, forms C and D prove to be superior to forms A and B for providing a framework for UWSE transactions. They encourage the continuity of

the transaction, which is essential for the deviation process because the amortization of investment extends over the long-term. C and D contracts respectively support their safeguarding mechanisms on the market or in an administrative structure.

The safeguarding methods of contractual mode C coexist with a market structure, and organization takes place between different firms. The safeguarding takes the form of agreements on the terms of renegotiation of the contract, such as the integration of the adjustment periodicity, or an inclusion of methods used to assess the necessary changes, for example. These contracts support the transaction over time and the difficulty in their formulation is found in the development of credible commitments.

> To overcome these hazards, agents have to make their promises credible. Commitments may become credible if, at the last resort, the cost of not fulfilling their obligation is higher than the cost of fulfilling it. (Brousseau 2008: 38)

The safeguard clauses must eradicate any incentive for opportunism and must take into account the changing economic environment. This type of contract is relevant in the UWSE when the conditions of formulating a commitment are met. Credible commitment ensures, for example, that the quality of services and the management of the price of water is maintained. The transaction involves several key players belonging to different entities and the contract shares responsibilities between them. Within this framework, the intervention of a third-party regulatory agency is used to establish trust. The Office of Water Services (OFWAT) plays this role in the English UWS, and it contributes to transparency and limits abuse.

Finally, contractual mode D relies on managed safeguard mechanisms. This form comes into play when the incompleteness of inter-firm contracts is proven; no safeguarding mechanism allows a credible commitment to be formulated. The actor considers the degree of strategic uncertainty to be too great and prefers to internalize production. By way of overview, if the quality or accessibility of the services is the priority, then the operator may prefer to remove the sources of risk posed by a potential partner that does not share the same values. Thus, the operator,

a regie, for example, ensures the continuity of the transaction and its resolution through vertical integration. Market mechanisms are not involved in the production process. This type of contract creates high costs of governance but practically cancels out any uncertainty and its negative consequences. Paris therefore moved to a regie option in 2009, and the new operator was called Régie Eau de Paris, with the city of Paris functioning as an organizing authority for the board (Bauby and Similie 2013). In the same way as contract C, it constituted an effective coordination option for the UWSE. In the end, the theory leads us to conclude that operators will choose between a C or D contract type.

The alignment of the characteristics of UWSE transactions with the coordination terms of each contractual form leads us to reject forms A and B, given that they do not include safeguard measures. A transactional analysis of contracts therefore suggests that the degree of risk aversion and the level of the costs of governance will be the main remediability criteria in discriminating between the forms of contract C and D. Next, we must expand the level of analysis in order to determine the a priori optimal governance structure for the UWSE. The forms of contracts selected refer to three of the possible coordination mechanisms: bilateral, trilateral and unified governance (Table 4.3). As a high degree of specificity characterizes the assets of UWSEs, the option of bilateral governance is ruled out. What remains is trilateral governance and unified governance, each respectively corresponding to hierarchical and hybrid institutional arrangements. Theoretically, the advantage of the hierarchy over the hybrid structure is strengthened to the extent that the frequency of the disturbance increases on the one hand, and the specificity of the assets increases on the other. As a result, and with respect to clarifications in the definition of the transaction, it should be noted that the accepted level of uncertainty constitutes a decisive micro-determinant in the choice of one of the two forms.

In order to develop the explanatory model of the TCE, we have posited the invariance of the rationality of a UWSE over another as a starting hypothesis. Moreover, by integrating the principle of organizational recursivity in the TCE, we want to better understand the interactions between actors and institutions. The result of the variety of possible choices to which this can lead can then be explained, not by the top-down causation

Table 4.3 Presentation of the main governance structures of UWSEs

	Name	Nature of the operator	Responsibility and risk
Direct management	Simple regie	Public operator integrated in the services of the municipality	Budget integrated into the general budget No autonomy of management
	Autonomous regie (financial autonomy)	Public administrative operator, distinct from a municipality	Budget annexed to the general budget Limited autonomy of management
	Regie with financial independence and legal personality	Public administrative operator, distinct from a municipality	Total financial autonomy in an industrial and commercial establishment
Government procurement	Provision of service	Private undertaking	Partial management Flat-rate remuneration paid by society
	Management	Private undertaking	Partial or full management Flat-rate remuneration paid by society
	Third-party management	Private undertaking	Partial or full management Flat-rate remuneration paid by society, with an award limited to results (or delegation)
Delegation	Concession and lease	Private undertaking	Overall management of the service, possible capital finance (concession clauses) Direct compensation by the users

Source: Guerin-Schneider et al. (2002: 11)

between water institutions and actors of the urban water cycle, but by the upward link between institutions and actors of that cycle. In the UWSE ontology presented in the first chapter, it is the preferences of the actors that form this link. Therefore, we put forward the conjecture that, within

the UWSE, the choice of a structure of hierarchical governance reveals a radical aversion to risk, or a preference for control. The corollary to this stipulates that two factors reinforce the attraction of hybrid governance towards a specialist market: activation of a preference for flexibility and a low fear of the risk of opportunism. These two competing options illustrate a compromise between 'security' and 'flexibility' in the choice of coordination (Brousseau and Nicita 2010).

This hypothesis implies the following changes in the UWSE following its modernization. With regard to the first stylized fact, since vertical integration can only be public in the UWSE, the preference for control equates to strong state intervention, which is exercised within a hierarchical regie. Modernization leads to the activation of an alternative preference to that of control. Therefore, the preference for flexibility and for low risk aversion results in the frequency of disturbances having very little influence when choosing a governance structure which moves away from the benefits of hierarchical structures. The result is a hybrid remedial solution that limits state intervention and leads to a depoliticization of UWSEs, such as a concession or a lease. With regard to the second stylized fact, hybridization strengthens the capability for autonomous adaptability, which improves the socio-institutional resilience of modernized UWSEs.

This change of preference, activated or accompanied by the modernization of UWSEs, means that the preference for public service no longer justifies a public monopoly. The actors consider that the benefits of widening participation and the use of coordination mechanisms are down to economic rationality (quality–price ratio) rather than other principles. Thus, the public actor cooperates and coordinates with other operators and regulators to take advantage of their skills.[19] The fiat and direct control are no longer the only mechanisms of coordination; there are also information and competition, for example. The model of yardstick competition developed by Shleifer (1985) therefore inspires the development of performance indicators for comparing different services (Renou 2015). Financial pressure accentuates this streamlining of the governance. This mechanism for changing the structure of the transaction costs explains one of the channels through which the modernization of UWSEs causes their depoliticization.

This arbitration allows an understanding of the differences in management between large and small cities, and underlines the decisive importance of the specificity of the assets. At the level of quality of service, small towns more often opt for a public–private partnership. They do not have the means to bear the costs of integrated governance and therefore prefer to pass them on to another specialized actor in the sector (Bouba-Olga et al. 2008). Conversely, the UWSs of major French cities have seen a wave of re-publicization. The desire to internalize the drinking water supply gives rise to a preference for public service and risk aversion. This commitment can be seen more clearly in big cities because they have the means to finance hierarchical governance and employ qualified personnel. So, in small towns, *ex post* transaction costs seem lower than the costs of governance, while the cities are in the opposite situation. The waste-water evacuation phase is less subject to this trend. This observation of the French UWS demonstrates the effects of preferences, but does not allow their origins to be identified. The macroeconomic analysis in Sect. 2 will help to capture these origins and explain them further.

In summary, the theoretical arguments supporting the coordination of the two phases of the deviation process of UWSEs tend naturally to hierarchical governance. The origin of this vertical integration stems from two sources. On the one hand, the specificity of the assets recommends the use of strong safeguarding clauses and control mechanisms. On the other hand, the objective of public interest, as inscribed in the public-service dimension of UWSEs, generates an aversion to disruptions and asymmetries of information. The theoretical sequence demonstrates the superiority of modes of governance that include safeguards, but leads to uncertainty with regard to support of these mechanisms. However, we have seen that modernization encourages the adoption of market mechanisms. Therefore, in addition to hierarchy, the hybrid institutional arrangements appear rational in the case of UWSEs. As the theory therefore shows, there is no universally optimal solution, but rather a diversity of possibilities. This result coincides with the empiricism and the identification of a variety of models of UWS in Europe in response to the modernization of the sector.

Generic Analysis of the Dynamic Impact of Modernization: Decentralization and Depoliticization of Institutional Arrangements

The organizational dimension of modernization is based largely on the liberalization and privatization sector, as well as a rationalization of public procurement, a process that is already at work in other European network industries (electricity, telecommunications and so on) (Finger and Künneke 2011).[20]

The water industry is a natural monopoly. The liberalization of the sector aims to implement monopolistic competition. There will be no atomicity of the agents, but the possibility of replacing the holder of the monopoly with another agent creates a form of competition. The removal of all barriers to entry is the *sine qua non* for the existence of this form of competition. Furthermore, the differentiation between products allows fringes of competition thanks to the substitutability of goods. In the UWSE, this second source of competition is excluded, because only the network provides services.[21] Note that this assertion is not universal. Indeed, it is possible for various forms of drinking water supplies to coexist and compete in developing counties, in the image of small private operators (Angueletou-Marteau 2009, 2010). These services differ in the quality of the water they provide, the access mode they offer and so on.

Therefore, the onset of liberalization can only be achieved according to two different procedures in the UWSE: competition for and in the market.[22]

> This competition for access to the contract is real, because each operation is unique and an offer that is well prepared by an 'average' actor can eclipse that of a leader. […] There is also a second-tier competition, because policy makers are not particularly keen to entrust a single cycle of water to a private firm; far from it. The operator can remain public, industrial cycles can be autonomized, and in this case, intervention by firms is carried out on different links in the cycle. (Lorrain 2003: 81)

On the one hand, the state enacts rules of monopolistic competition that threaten the position of the service provider (reduction of the duration

of the contracts, Sapin procedures and so on). On the other, thanks to the technological separability of transactions, the phases of the deviation process are uncoupled from each other and the provision of the service no longer proceeds from a single monopoly, but from several that are coordinated with one another, as well as subcontracted tasks. These two possibilities refer to the two theories used by the European Union to justify the relevance of modernizing network industries and regulation via competition rules; the theory of contestable markets (Baumol et al. 1982) and that of deintegration (Demsetz 1989).

The first and main form of competition refers to competition *for* the market. The unit of the service production cycle is maintained, and the owner of the infrastructure—in general the municipalities or community of municipalities—makes a tender offer for the acquisition of the market. After responding to the call for tenders and the completion of the selection process, an agent is assigned to operate the service for a specified period of time. The European Union has recently modernized the public procurement regulation, replacing the 'Utilities' Directive of 2004 (DIR 2004/17/EC) with Directive 2014/25/EU on Procurement by Entities Operating in the Water, Energy, Transport and Postal Services Sectors. In this case, there is really only competition during the selection process of the operator. The terms of the contract prevent the practice of a private monopolistic price and instead guarantee enforcement of the public interest, particularly through a *public service obligation*. If the operator does not respect these safeguard clauses, the delegator can legitimately dissolve the contract and change the service provider. This type of organization involves a transfer of responsibility from the state to the operators. The mechanisms governing the activity of the delegate (monitoring, control, guidance and so on) play a vital role in reducing the transaction costs of this type of governance and in reducing the risk. The British regulator, OFWAT, typically plays this role by sharing information and sending clear incentive signals by means of price-capping.

The second form of competition refers to competition *in* the market. The operator retains responsibility for the management, but then outsources the phases of the deviation process by making them independent of each other. In this way, the provision of water services is no longer a sector organized around two publicly controlled natural monopolies,

but a *continuum* of operators providing precise and specialized expertise as part of one of the stages of the service provision. This form of organization breaks the original vertical integration. There is therefore a deintegration of production and there is competition for subcontracts. This competition can be described as second tier, and is only rarely implemented (Lorrain 2003).

Through these procedures, the UWSE can be partially liberalized and privatized. However, these competitive opportunities remain limited with the urban water sector (Gee 2004; Allouche et al. 2007).[23] Indeed, the liberalization of the water sector does not function using the same modus operandi as other network industries. Classically, the liberalization of a network industry occurs by means of granting authorization to a third party to access the infrastructure (Spiller 2011). However, in the case of water, this provision does not exist and seems technically difficult to implement in view of the characteristics of the resource and the sector (Allouche et al. 2007). To do this, European officials prefer to talk about modernizing the sector, rather than liberalization in the strictest sense of the word (Gee 2004).[24] This modernization of UWSEs according to a particular process of liberalization, is the equivalent to a transfer of responsibilities and, more generally, to a decentralization of the management of UWSEs (Fig. 4.3), which only underscores the relevance of thinking of UWSEs and their modernization with reference to a multilevel plan.

Notably because of technological inseparabilities in transactions, which prevent full deintegration of the sector, a market-type governance structure is not deemed to be a possible format for UWSEs. However, following the modernization of the European water sector, the governance of UWSEs is becoming more hybridized and is focusing on a specialist market. The key players break down the deviation process of the UWSE into different, distinct phases, and the market mechanisms support the other constituents in coordinating the entire urban water cycle. The number of stakeholders in the urban water cycle multiplies and they share the responsibility brought about by the transaction. Thus, a delegate (under a BOT contract) can, for example, occasionally put out a call for tender for service providers (contracted services). This therefore promotes an increase in the number of actors involved in

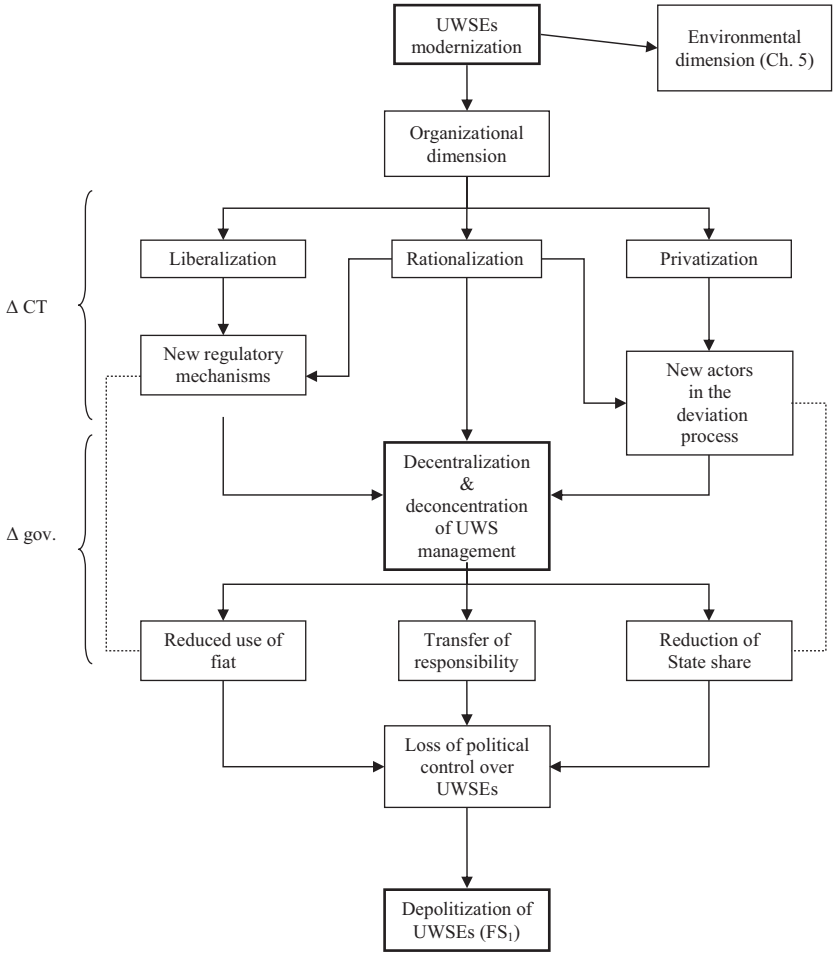

Fig. 4.3 Overview of the causal process linking the modernization of UWSEs to their depoliticization (FS_1) (Source: Bolognesi 2014: 318)
Key: Δ CT: changes in the structure of the transaction costs
Δ gov.: changes in the governance structure

the provision of the public service, as well as an increase in contractual entanglement. The parties seek to make credible commitments in order to ensure compliance with the terms of the transaction. Governance can then become trilateral, based on a mode of neoclassical contractualization, and prices, like incentives, become ever more important as a way of regulating the sector, unlike the fiat originally used by public authorities.

The organizational evolution of UWSEs that is induced by their modernization contributes to their depoliticization in two ways. Firstly, because of the decentralization of the provision of services, public authorities no longer have control over the whole process of deviation, while the participation rate of the private sector has continued to increase in recent decades ($F_{s11,}$ $F_{s12,}$ F_{s16}). Then, given that their method of organization is not hierarchical, control mechanisms other than the fiat appear, in particular those based on information-sharing and incitement ($F_{s19,}$ F_{s20}). Therefore, the state no longer holds a monopoly over control and micro-institutions emerge to coordinate the UWSE, using performance indicators and autonomous regulatory agencies. Modernization translates into a decentralization of transactions, which implies a transfer of responsibility from the state to the operators. To organize this transfer, the number of micro-institutions increases and they become a partial substitute for the state. In the end, the modernization of UWSEs leads to their depoliticization, in the sense that the direct control of the state diminishes. Depoliticization is explained by three interconnected factors:

1. a reduction in the use of the fiat, to the benefit of price incentives, performance indicators, sunshine regulation and so on;
2. a transfer of responsibility with the emergence of regulatory agencies and an increase in participation;
3. Diminishing role of the state because of privatization and participation.

Liberalization and privatization are conducive to flexibility, as well as a low level of risk aversion. Supported by a rationalization of public procurement, these reforms contribute to reducing the *ex post* transaction costs of those involved in the deviation process. The direct consequence is less weighting on the frequency of the disruptions and less uncertainty in

general when determining the choice of coordination. The actors then focus on the reduction of the costs of governance; hybrid governance structures become increasingly irremediable. This hybridization occurs with the appearance of new regulatory mechanisms and new actors becoming involved in the deviation process, so that a movement towards decentralization and de-concentration characterizes the modernization of the management of UWSEs. C. Ménard (2004) stresses that uncertainty pushes towards centralization, yet modernization pushes toward decentralization. It is therefore accompanied by a major push to improve the information and checking of operators by means of benchmarking. As illustrated (Table 4.3), this decentralization promotes forms of trilateral governance, including the third-party regulators that are associated with neoclassical contractualization. Mechanisms and modalities of coordination therefore change: the use of incentives increases, a number of transfers of responsibility take place and the role of the state decreases because of multiple contracts and deintegration. This sequence connects components of the triptych of the TCE and illustrates the factors and causal mechanisms of the depoliticization of UWSEs following their modernization (stylized fact 1).

The modernization of UWSEs is based on increased competition in the sector. Competition occurs through obtaining public monopolies or contracts for subcontracted services and this translates into a hybridization of the governance structure of UWSEs, generating a depoliticization of the business activity. The UWSEs implement EU liberalization rules differently, and the degree of participation of the private sector in the process of deviation varies; by taking another look at the three models of UWSE, we can refine this explanation.

Synchronic Test of the Causal Link Between Modernization and Depoliticization: Comparison of the Three European Models

The comparative analysis of UWSEs strengthens the demonstration of causality between modernization and their depoliticization, because the diversity of institutional arrangements allows the current mechanisms to

be tested in a synchronic way. Among the three modes of governance identified by the TCE, the market form seems theoretically and empirically inefficient for the UWSE. However, this mode of governance is the ideal type for advocates of modernization. So, by combining normative goals and positive constraints, the governance of UWSEs hybridizes, seeking a compromise between the flexibility of the market and the safety of the hierarchy. The hybrid governance structures refer to the development of public–private partnerships (PPPs), while the hierarchy corresponds to the UWSE deviation process that is only provided by the public authority. From this continuum of possible institutional arrangements, it is possible to classify institutional arrangements according to the extent to which they agree with the principles of the modernization of UWSEs.

English UWSs are going even further in the process of liberalization and privatization of the deviation process and, as such, are the most engaged in modernization. The institutional arrangements put in place entrust responsibility for the provision of water-supply services and water drainage to private companies, which are in effect infrastructure managers. The safeguard mechanisms are based largely on the market: autonomous regulatory agencies control the service providers; the dissemination of information plays a central role; price incentives readjust behaviours and so on. In contrast, the German UWSs are less enamoured with the modernization of the sector, meaning that institutional arrangements remain hierarchical (F_{s22}). These are public companies that provide urban water services and, increasingly, they are coming under the remit of private law. If the senior level of management in England is regional, in Germany, it is communal, which increases the power the mayor has over the deviation process. Situated between these two models, the French UWS illustrate the diversity of possible hybrid institutional arrangements. These can take the form of delegation contracts, leasing or even regies on French soil. Thus, from the most to the least modernized in Europe, we find the English, French and then German UWSs, as illustrated in the first section (F_{s8}).

To strengthen the notion of hybrid forms, four types of PPPs coexist. They differ according to the degree of responsibility of the private partners in their management and the extent of their shareholding

(Table 4.3). We describe this organizational mix using the closest structure to that of market governance, i.e. total privatization, until it becomes more akin to hierarchical governance, i.e. vertically integrated public management. By means of the concession contract, the public authority delegates a private operator to take care of all tasks relating to maintenance and investment in the infrastructure (renewal, extension and so on), as well as the management of the service. In this context, the operator is paid from profits and faces more risks than in the other PPPs. The leasing contract leaves the responsibility of heavy investments to the public sector, and the private operator is responsible for maintenance and service management; a negotiated proportion of the profit is used to pay them. The management contract with private operators only includes the administration of services, and there is no temporary transfer of ownership of the physical assets. Because of this, the risk is not shared and it is only the public assigner who is at risk. The assigner pays the private operator directly. A service contract establishes the same terms as a management contract, but the private operator's stake in the management of the service diminishes by contrast. In the latter case, the service rendered to the public supplier is more specific and punctual, for example pipe repairs or similar.

Under a mode of hierarchical governance, public management of urban water services comes in two forms: public administration and the public company. Overall in Europe, public governance is moving from administration management towards management by public companies. Two factors explain this change. On the one hand, budgetary constraints push local governments to autonomize water management. On the other hand, the growing complexity of the provision of urban water services, due to the strengthening of health and environmental standards, leads to greater involvement of specialists to ensure the urban public service. Thus, more and more local public enterprises are managing urban water services. The German *Stadtwerke* are a case in point. It should be remembered that these are the same constraints that can lead to an increase in private sector participation.

The ongoing modernization in UWSEs advocates competition from providers and participation of the private sector in the deviation process, which leads to a hybridization of the institutional arrangements. The

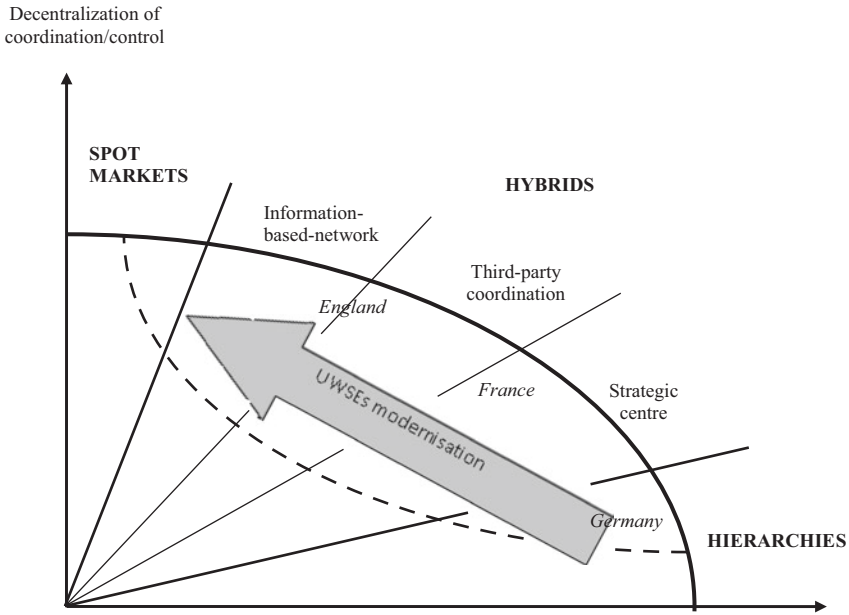

Fig. 4.4 Representation of the process of organizational modernization of UWSEs among the variety of modes of governance (Source: Bolognesi 2014: 380)

2014 European directives 'Public Contract' and 'Concession' are directly involved in this hybridization. C. Ménard offers a typology of hybrids according to their terms of regulation (Fig. 4.4). It shows a variation of the regulatory mechanisms depending on the position of the arrangement on the hierarchy–hybrid continuum. These mechanisms take the form of a specialist market, regulation by a third party and finally, of networks based on information for arrangements that are closest to the market. Replacing the three ideal UWSE categories in this typology highlights the transition from the modalities of regulation, as driven by modernization. The typology created by C. Ménard shows that the regulatory source is becoming increasingly detached from a centre that has a monopoly of control and order, so that it can become virtually autonomous. Thus, we find the theoretical trend of decentralization and devolution of governance following modernization (Fig. 4.3). The synchronic test of our theoretical explanation confirms that modernization leads to

a hybridization of the institutional arrangements tending towards a specialist market, which tends to empower regulation; we can observe that the result is a depoliticization of UWSEs.

It appears that the more modernized UWSs are those that are also the most decentralized and devolved in terms of coordination, control and industrial organization. Returning to the public service dimension from our definition of the transaction, this hybridization increases the transfer of responsibility from the state to others in the deviation process. The organization of the English and German UWSs confirms this conclusion because, in the former, the responsibility for production rests with private companies, and responsibility for control lies with independent agencies. In the latter, however, the public authorities retain those responsibilities. Thus, a comparison of the institutional arrangements of UWSEs confirms that the modernization of UWSEs assists in their depoliticization.

Depoliticization poses new problems of coordination since it increases information asymmetry, the possibilities of opportunism and therefore *ex post* risk (Ménard 2004; Massarutto 2007; Brousseau 2008). To meet these new transaction costs, an emergence of micro-institutions can be seen to emerge; these are aimed at making commitments credible and encouraging the sustainability of transactions. By way of illustration, in France, services have been created to help meet the performance indicators in the SISPEA database (Canneva and Guerin-Schneider 2011; Brochet et al. 2016; Bolognesi et al. 2016). Similarly, an inter-service water mission (MISE) aims to facilitate coordination between the main decentralized services and local public institutions. MISE helps to strengthen the coherence of water policy in France. In addition, it appears that the recent development of these micro-institutions focuses on the dissemination of information (the hybrid coordination mode closest to that of the market). Indeed, in England each of the supply and evacuation companies must provide an annual information report on its effectiveness (economic, social and environmental). Similarly, L. Guerin-Schneider and M. Nakhla (2003) demonstrate that, in France, the performance indicators also play an increasingly important role. Thus, reformers of the sector want market mechanisms to ensure coordination between the various actors of the urban water cycle. The price/quality ratio becomes one of the main variables for allocation; price incentives and perfor-

mance indicators are multiplying. They guide the activity and allow benchmarking, which is useful for streamlining the sector. These developments ensure that the modernization of UWSEs is practical, and can contribute to the erection of a depoliticized governance structure.

Market governance is a typical ideal of the modernization of UWSEs; however, because of the specificities of the transactions within the urban water cycle, market governance in the strictest sense is impossible. The governance has, nevertheless, hybridized to incorporate market governance features. These hybrid institutional arrangements support their safeguarding mechanisms on the market. Thus, the following emerges within the UWSE: an independent regulator, i.e. governance is trilateral; performance indicators, i.e. the mode of contracting is neoclassical; prices to guide behaviour, i.e. the instruments of governance are incentives. To help it function, this type of governance is based on evolving agreements that formalize credible commitments. The credible nature of commitments is essential because it allows opportunism to be limited (Brousseau 2008). This type of contractualization leads to the development of impersonal rules because they are the most universal possible, and can maximize the adaptability of the contracts. This contractualization regulates generic transactions and reduces the role of public control in governance.

Modernization alters the nature of the actors in the UWSE and has an effect on their behaviour. In addition, it helps to change the governance structure, the third element of the TCE triptych, in a bottom-up way, because the needs of the actors evolve in a top-down fashion, through laws and so on. In the end, there is a reduction in the areas of control and order of public authority. The regulation and backup mechanisms resulting from the market replace the fiat found in hierarchical governance structures. As a result, public authorities lose their ability to control the UWSE and impersonal modes of regulation come about via hybridization of governance. The first stylized fact reveals a general dynamic, but, as shown in the diversity of PPPs, there is a plurality of hybrid arrangements. The theoretical explanation allows us to specify the following: UWSEs increasingly depoliticize as the emerging hybrid arrangements move closer to market governance, basing their safeguarding mechanism on information networks.

The first stylized fact takes into account the phenomenon whereby the modernizing dynamic brings about the depoliticization of UWSEs. The tools and mechanisms of the TCE provide an explanation of this observation. Modernization is a shock to the structure of transaction costs, in the form of a reduction of *ex post* transaction costs levied by the key players. It follows the search for remediability, which is primarily focused on the costs of governance; they tend to lead to institutional arrangements in the advantage zone for hybrid governance structures. Therefore, coordination modes evolve. In particular, incentives and the devolution of control replace the fiat previously owned by the public authority. This general mechanism is realized in the form of a depoliticization of UWSEs. In this sequence, the rules of modernization are exogenous to the explanation. The TCE allows us to explain the trend that is seen during the alignment and remediability phrases, but does not explain why and how they constrain the structures of governance. We will have to expand the explanatory model to include macroeconomic elements.

The second stylized fact states that resilience and resistance of the system varies according to the degree of modernization. By putting together the diversity of UWSEs with the tools of the TCE, we are able to explain the mechanisms leading to this observation.

From a Resistant Mode of Governance to a Resilient One: A Growing Preference for Flexibility and Autonomy

Resilience is a concept used for the analysis of a system that is facing obstructions. It first took form in the field of economic sciences at the end of the 1990s (Farber 1995; Levin et al. 1998; Perrings 1998).[25] According to the perception of the link between the system and its disturbances, two definitions of resilience can be derived. The first identifies the ability of a system to maintain its most important mechanisms and features when it is subjected to a disturbance (Ludwig et al. 1997). The second focuses on the ability of the system to regain its equilibrium after a disruption (De Bruijn 2004; Ostrom and Janssen 2004). We have used this last definition since it distinguishes between

resilience and resistance. Thus, theoretically, we define resilience as the ability of a system to reorganize following a shock, and to keep to a given development plan. The resistance of a system therefore refers to its ability to absorb shock, without moving from its point of equilibrium. These concepts are not normative, therefore the presence or absence of the resilience of a system is without prejudice to its intrinsic quality. A system producing results that are judged to be poor can be both resilient and maintained.[26] The stylized facts, and therefore the theoretical explanation, only address these notions in their socio-institutional dimension.

The resilience of a system is based on that of its components. Self-organization via a spontaneous change in behaviours is at the heart of such resilience. The feedback mechanisms, the stimuli–response coupling and the diversity of resources and possible strategies therefore all contribute to a system's resilience (Levin et al. 1998; Rose 2007). This dynamic concept refers to the architecture of the UWS in terms of complex systems. It puts forward the principle of organizational recursion, with socio-institutional resilience being the result of the speed of this recursive process between actors and institutions. From the multi-scale and polycentric architecture of the UWS, it follows that the urban water cycle constitutes the component that evolves the most in the short term. The components do not evolve in the same time frame and the urban water cycle, which corresponds to the fourth institutional level of the NIE, is permanently evolving. Moreover, the frequency of change to the governance structure is observed over a period of 1–10 years and, for the institutional environment, from 10 to 100 years, or 1000 years in the case of some informal institutions. Therefore, the adaptability of urban water cycle actors is the main factor in UWSE resilience.

To explain the potential of socio-institutional resilience of UWSEs, we concentrate here on the actors present in the urban water cycle and their coordination. Focusing therefore on the urban water cycle does not mean that resilience or the resistance of UWSEs are alien concepts to the other components. As a result of the integration of institutional levels and the interactions between these, each element has a greater, or lesser, impact on the dynamic behaviour of the system (Williamson 2000; Gunderson and Holling 2002). Here, we consider that the reaction of the players when faced with a shock, and their ability to review strategies and behaviours,

is the foundation of the resilience of UWSEs. Conversely, when the reorganization of the urban water cycle slows or even stops when confronted with a shock, we can see that as proof of resistance. Shocks can take different forms: ecological, institutional, economic, demographic and so on. Similarly, their temporality can vary. By way of illustration, in their proposal of a typology of water crises, J. Patinet and M. Rama (2011) distinguish between crises with a quick, slow or long-lasting dynamic.

The second stylized fact states that the degree of integration of the principles of modernization in a UWSE is positively correlated to an increase in socio-institutional resilience. Specifically, political control stabilizes the shape of UWSEs, while modernization tends to make them heteromorphic. This observation is equivalent to the following theoretical proposal: the hybridization of the structures of governance towards a specialist market increases the adaptability and flexibility of the actors in the system, while hierarchical governance limits the ability of the players to individually and spontaneously change their behaviour. The modes of governance are based on coordination methods that result in different potentials of behavioural innovation, and control over the direction of the system. Modernization therefore promotes the quicker adoption of institutional arrangements to allow socio-institutional resilience of the system. An analysis of contractual evolution and the change in transaction costs helps to theoretically build this conclusion.

The first chapter put forward the fact that modernization led to a liberalization and privatization of UWSEs, while supporting the rationalization of public procurement. Logically, these reforms change the structure of the transaction costs in the UWSE. Moreover, we know that the specificity of the assets of UWSEs implies a high level of *ex post* costs (Table 4.2) and makes contractual forms C and D the most rational choice to ensure coordination. Modernization favours form C in order that the costs of governance can be minimized and public procurement can be streamlined. Therefore, the fiat participates less and less in the coordination of actors, in contrast to the safeguarding mechanisms inherent in the market. Contracts must then offer terms allowing the actors to accommodate the long-term rigidities imposed by the UWSE transactions (investments, specific features of the assets, governance costs and so on). In type C contracts, the solution is the integration of flexibility,

allowing the evolution of contract terms according to external constraints that arise during the course of the transaction. It follows a preference for organizational flexibility, which in our case becomes a regulatory mechanism in the form of a depoliticization of UWSEs. Therefore, modernized UWSEs develop socio-institutional resilience within the system, without which, under these conditions and under the strain of modernization, governance would not solve the coordination issues.

The closer the hybrid arrangements come to market governance, the more neoclassical or progressive contractualization incentives become a part of regulating the activity of the urban water cycle. In this case, the safeguard mechanisms are those of the market, rather than the centralized fiat ($F_{s20,}$ $F_{s23,}$ F_{s24}). So, for example, the 'Public Market' European directive, in article 72, provides a framework for, and makes more flexible, the possibility of modifying current contracts. In addition, it should be considered that agents tend to respond to market signals. For illustration purposes, OFWAT directed service suppliers involved in the English urban water cycle by means of a system of price-capping, while performance indicators provide information to users on the quality of the services. It is this price-cap system that enabled the mode of governance in English and Welsh UWSs to be resilient and not disappear in the early 2000s (Bakker 2000, 2003). In addition, contracts formalize credible commitments and provide measures facilitating the adaptation of contractual relations (Ménard 2004, 2005). To contractually arrange the adaptation of the transaction terms in the UWSE, the duration of contracts must diminish and they must include *ex ante* the characteristics of the adjustment process, such as in article 72 of the 'Public Market' directive (Saussier et al. 2004; Beuve et al. 2015).

These safeguarding and incentive mechanisms allow the actors to change their strategies and behaviours as a result of a hazard. Furthermore, since the rule here tends towards impersonalization, the adaptation of the actors of the urban water cycle is both autonomous and unilateral, as shown in the comparison of the theoretical benefits of different modes of governance (Williamson 2005). These features expand the range of possible behaviours and increase the responsiveness of the actors in comparison with governance, as administered by the fiat and inspection processes. The theory shows that when transaction costs are high as a result

of uncertainty, then scalable governance is effective (Williamson 1996). At the same time, the hybridization of specialist market governance increases the adaptability and flexibility of key players and, following this process, the modernization of the water sector goes hand in hand with the socio-institutional resilience of UWSEs. However, the frequency of early disruptions may encourage a choice in favour of hierarchical governance, which relates back to conjecture on the preferences of key players.

On the other hand, the intrinsic risks of contractualization persist and threaten the quality of the results of coordination. The incompleteness of contracts does not crowd out opportunism; on the contrary, we have seen that the decentralization of coordination resulting from the depoliticization of UWSEs increases the possibility of opportunistic behaviour. Thus, market-oriented hybrid governance structures, which are based on the information and decentralization of controls, facilitate adaptation to change (this organization is resilient). However, there is no indication that they coordinate key players in such a way as to action a satisfactory balance in terms of the quality of public service. In this sense, K. Bakker (2000) clearly shows that operators have benefited from price-capping by raising prices and maximizing their profits, without similarly improving the quality of service. They are then not able to immediately deal with external shocks, such as the drought in 1995, which prevented part of the population from accessing water supplies. Our comparison of the evolution of the levels of investments and profits in English UWSs confirms this analysis. Only after a change in the tariff ceilings and the introduction of new regulations to define and prohibit excessive profits, did adaptation take place.

While barely engaged in the process of modernization, hierarchical governance structures (regies), or similar (public companies under private law), do not offer the same ability to challenge resilience as do hybrid structures on the market. Their coordination modalities differ from the situations that we have presented and they reinforce the socio-institutional resistance of UWSEs. Instead of incentivization by market mechanisms, the fiat ensures coordination. The command directs the behaviours, and control over the evolution of the system is strengthened by limiting behavioural uncertainty. In this mode of governance, the system is consciously adapted and may require a negotiation between the

parties (Chabaud et al. 2008). The reorganization of the urban water cycle in the city of Munich illustrates this process of negotiation (Krimmer 2010). In order to reform the water supply, municipal authorities had to interact with (and compensate) farmers located in the pumping zones so that these farmers could farm organically. On the other hand, the same powers were in conversation with residents to persuade them to accept the price increase that was necessary for the financing of agricultural subsidies.

In a more general way, B. Barraqué and C. Viavattene (2009) demonstrate that the evolution of urban water governance in Germany has been achieved through dialogue between stakeholders and the establishment of partnerships between them. Coordinating through the administration and the fiat reduces the responsiveness of the actors of the urban water cycle when faced with shocks; or rather, the minimum scale of the shock leading to a reaction from the actors is higher in this mode of governance than in specialist market-oriented hybrids. This adaptation mechanism builds the socio-institutional resistance of UWSEs.

The English UWSs are organized according to the modalities that are closest to market governance; the German UWSs are precisely the opposite. Thus, if the first data empirically confirms the positive relationship between modernization and the socio-institutional resilience of systems, the latter provides evidence of the causal link between hierarchical governance and the socio-institutional resistance of the system. Indeed, in Germany, the provision of urban water services is a major local political issue and the governance model of the German UWS has barely changed in more than a century (Barraqué 1995; Isnard and Barraqué 2010). These modes of coordination minimize transaction costs in different ways. Hybrid structures therefore tend towards a market that reduces the *ex post* transaction costs relating to a poor adaptation to the contract, or poor organization or functioning of the governance structures,[27] thanks to the autonomous adaptation of key players and the effectiveness of incentives. In addition, the impersonal nature of the regulations reduces the *ex ante* costs of negotiation and of the drafting of an agreement. On the other hand, the costs incurred by the likelihood of a dispute are high; *ex ante* because of the creation of a guarantee and *ex post* because of the haggling caused by divergences from the expected performance of

a contract, the costs of establishing safe commitments or other factors. The hierarchical structure minimizes this type of cost, which is due to uncertainty, but imposes high governance costs.

The depoliticization of UWSEs develops their socio-institutional resilience based on the greater capability of the actors of the urban water cycle to autonomously adapt. Those UWSEs that are not deeply involved in the process of water sector modernization do not follow this trajectory and rather highlight socio-institutional resistance when faced with external shocks. Presented in this way, resilience and resistance appear to be two opposing characteristics, since we find that there is a trade-off between flexibility and security for each institutional arrangement. However, we shall consider them to be complementary. The strengths of the hierarchy are the weaknesses of market structures, and vice versa. In addition, prudent governance of UWSEs can lead to a mixing and bringing together of these different devices of coordination (Williamson 2005, 2010). Moreover, the diversity of hybrid institutional arrangements suggests that the mechanisms leading to autonomous adaptation and those organizing conscious adaptation can coexist, but in varying proportions. This is the meaning in particular of the notion of micro-institution as proposed by C. Ménard and the reason for the diversity in the models of the UWSE.

The positive correlation between the degree of modernization and the resilience of the UWSE comes from the benefits provided by the mode of governance favoured by modernization. We know that the transactions of UWSEs are carried out under the framework of contracts C or D and, to explain the causal relationship between modernization and depoliticization, we have shown that modernization promotes the formulation of contracts of type C. These contracts represent a hybrid governance allowing autonomous adaptation, while hierarchical governance (contract D) only allows for conscious adaptation. Autonomous adaptation is carried out, among other things, by means of unilateral organizational change. On average, this type of change is faster and simpler to perform than the concerted change induced by conscious adaptation. In these circumstances, change is theoretically likely to be more frequent because, on the one hand, the number of sources is multiplied and, on the other, no

external consent is required and the need for such consent cannot hinder it. What follows is socio-institutional resilience.

This hypothetical case takes account of the activity of the key players in their preference for flexibility.[28] The resilience that has been created offers actors the ability to adapt to the constraints engendered by the specificities of the transaction and the context with which they engage in the long term, in order to improve their performance. Fundamentally, coordination does not change as it continues to be based on incentives, information and so on, but the specific organizational arrangements are evolving. Note, however, that to aid exploitation, this increase in resilience places few rigidities on the contractual drafting procedures, and this promotes the creation of impersonal rules as part of a specialist market-oriented hybrid governance structure. This articulation of the behaviour–transaction–governance triptych explains the microeconomic determinants of the between modernization and resilience of UWSEs.

3 Conclusion

Using the TCE, this chapter has therefore set out a theoretical interpretation of stylized facts 1 and 2. We have highlighted the institutional mechanisms according to which the modernization process depoliticizes the UWSE on the one hand, and have exposed the reasons for the common evolution of levels of modernization and resilience in the UWSE on the other. The mechanisms examined refer to the triptych of transaction, behaviour and governance of the TCE, and are of a microeconomic nature: transaction costs, methods of contracting, types of institutional arrangements and so on. The definition of a transaction has been clarified to integrate the singularities of UWSEs, such as public service and the use of the natural resource as the anchor. On this basis, we explain that modernization has produced a decentralization/deconcentration of governance, and hybridizes the institutional arrangements in the direction of a specialist market. This decentralization/deconcentration causes a loss of state control over the UWSE and a reduction of the state's participation in the provision of services which, in the end, depoliticizes the UWSE. At the same time, modernization empowers stakeholders and increases the

possibility of organizational change, which helps increase the resilience of UWSEs.

These two theoretical interpretations of the phenomena of modernization rely, in part, on conjecture that modernization reveals the preference of stakeholders for flexibility and for low levels of fear of the risk of opportunism. The analysis of the macro-determinants of the stylized facts supports this hypothesis (Chap. 5). In addition, the macro analysis completes the micro analysis. Indeed, with the TCE, we have just seen how actors react rationally to a shock regarding the structure of the transaction costs. The analysis of the macro-institutional elements explains how this shock poses a problem of alignment and remediability of actors. It also enables the bonds of the complex system that is the institutional integration of UWSEs to continue to be forged.

Notes

1. For a wider discussion on the different methods with which the NIE analyses behaviours within a context of uncertainty, see D. Dequech (2006). The author presents the conception of the rationality of the key players of the NIE: E. Furubotn, X. Greif, D. North, R. Richter, O. Williamson and so and he suggests that, 'the dominant views of rationality in NIE are standard neoclassical maximization and bounded rationality, but alternative notions have also been defended' (Dequech 2006: 109).
2. As such, R. Coase, referring to the definition of the economy provided by J. Robbins (1935), underlines that this disdain for an analysis of this behaviour as inter-individual relationships shows that, 'the success of mainstream economics in spite of its defects is a tribute to the staying power of a theoretical underpinning, since mainstream economics is certainly strong on theory if weak on facts' (1998: 72).
3. H. Simon sets out 'the expression "satisficing", because there did not seem to exist in English another word for characterizing decision-making methods aimed at generating solutions that are considered good or satisfactory, but not optimal' (Simon 1969, [Trans. 2004]: 215).
4. By doing so, the TCE stands out from the theory of incentives and the theory of incomplete contracts set out in the work of O. Hart, who postulated that mechanisms can be created to resolve coordination problems

ex ante. For a detailed presentation of these theories concerning contracts, the reader can consult Brousseau and Glachant (2002); Glachant and Perez (2007).

5. Procedural uncertainty opposes substantial uncertainty. Substantial uncertainty refers to a limitation of the rationality of individuals by the sole informational deficiency, while procedural uncertainty refers to the impossibility of finding an optimal and universal solution. Formally, it is the fact that 'in a general resolution system, one is not able, or cannot know ex ante which or how many algorithms can be generated, or if they can be generated' (Dosi and Egidi 1991: 161).
6. Uncertainty seems essential to us in the case of UWSEs, particularly because of the concept of public service that guides the transaction in the direction of results, which are defined in terms of quality. The desire to ensure a minimum level of public service can increase an aversion to uncertainty.
7. On this point, it should be remembered that I. Lakatos (1994) considers the predictive ability of a research programme to be proof of its fertility. O. Williamson's proposal in the face of this third pitfall is to include transaction costs in the positive heuristics of the research programme. This is not to falsify the economics of organizations, but to avoid their sterility by integrating new testable work hypotheses through methodological falsification. This idea takes us back to the analytical orientation of the TCE, moving from behaviours to the modes of governance, as highlighted in the previous subsection.
8. However, in the introduction to *The Firm as a Nexus of Treaties*, O. Williamson warns against the tendency towards 'legal centralism'. When an analysis focuses only on the contract and its technical aspects, 'the fact is that the contract term often develops unwanted legal meanings. A legalistic vision of the contract can hinder rather than facilitate understanding of a complex economic organization' (Williamson 1990: 3). This is why he puts forward the concept of *treaty*, as a much wider concept than that of *contract* insofar as it encompasses the implications of the contract and the diversity of contexts: 'The limits of legal centralism become so transparent in treaties, because parties may refuse a forum of law and/or ignore legal sanctions, it appears from the outset that there is a clear need to build specialized governance structures within which a treaty can be integrated' (Williamson 1990: 4). It should be noted that, later on in his work, O. Williamson retains the contract as a unit of analysis and no longer talks about the treaty.

9. This forms the focus of the second section of this chapter by means of exploring the link between governance structure and the institutional environment.
10. A slight difference exists between the outline proposed in the 2000 article and that set out in 2007. Indeed, the 2000 diagram refers, by means of the parameter *h*, to contractual uncertainty. However, in 2007, the specificity of the assets, noted as *k*, overrides this measure of uncertainty. This divergence does not appear contradictory to us since contractual uncertainty depends directly on the specificity of the assets, in addition to the limits of rationality and opportunism. Thus, *h* is more encompassing than *k*. Here, we will preserve the second parameter, which seems to us to be more accurate and more consistent with the rest of the heuristic schemes that synthesize the logical mechanisms of the TCE.
11. The structure of governance is understood as a variation of a mode of governance.
12. E. Brousseau considers the different levels of governance on a centralization–decentralization axis; the concept of micro-institutions, as presented by C. Ménard, allows us to realize the link between these levels as well as to assess the consistency of the process of decentralization of governance.
13. Because of the conservation of the notion of neoclassical maximization, S. Saussier and A. Yvrande-Billon (2007: 13) note that 'Williamson only retains a weak version of limited rationality as defined by Simon'. In his doctoral thesis, S. Rossiaud (2012) discusses the impacts of this weak vision of rationality on the understanding of institutional dynamics.
14. 'Often, in the encounter between a flow and an obstacle, it creates an eddy, which is a constant organized form that constantly rebuilds itself; the union of the flow and the contra-flow produces this organized form that will last indefinitely, at least as long as the arch of the bridge is there. That is, an organizational order (eddy) can result from a process that produces disorder (turbulence)' (Morin 2005: 83).
15. Note that R. Künneke, J. Groenewegen and C. Ménard also highlight this need for a singular taking-into-account of the network industries. They speak of *criticality*, but this concept refers to the technical dimension of the transaction rather than the aspects that we mention. However, in the end, we can all agree on the desire to increase the role of the risk in the analysis and specify the technical quality of the supply.

> Often the term 'critical' is used to qualify things or circumstances considered significant or fundamental […] Expectations with respect to the technical functioning of infrastructures include reliability, safety, and security of supply. […] the criticality of the operation and management of infrastructures is very much determined by the strong degree of technical system complementarities. (Kunneke et al. 2010: 496)

16. By way of illustration, compare the share of the costs of transporting water, electricity and gas in the final cost of production. With a transport distance of 100 km of supplied goods, transport costs represent 50% of the final cost of water, 5% of the final cost of electricity, and 2.5% of the final cost of gas (Gee 2004: 38).
17. Note that this characteristic sets the water sector apart from other network industries such as electricity or telecommunications, transportation of which is less problematic than storage.
18. These economies of scale in transport must be understood in terms of volume capacity and not in terms of distance; with the latter, it is the installation of the infrastructure rather than its calibration that is expensive.
19. The notions of new public management corroborate this choice and serve as evidence for policy-makers seeking to modernize UWSEs of this kind (Ventriss 2000; Page 2005; Dreyfus 2010).
20. If the reader is interested in those other areas, the Florence School of Regulation provides a number of very interesting analyses: http://www.florence-school.eu/portal/page/portal/FSR_HOME/School_overview, accessed 16 October 2012.
21. Bottled water can be considered as a partial substitute for uses allowed by the drinking water system; however, because of the marginality of this competition, we will not take it into account. Besides, there is no evidence that bottled water and tap water belong in the same competition market.
22. Lorrain (2003) also refers to two other forms of competition: competition over prerequisites and competition for the sale of bottles. We do not take them into account because they are directly taken from the *sensu stricto* framework of the deviation process of UWSEs.
23. Gee (2004), however, separates industrial uses from domestic uses. According to him, the potential to insert competition is stronger in services for industrial users than services intended for households. Because

of the large volumes consumed, the connection to the network is amortized more quickly in the case of large-scale consumers of water, which reduces uncertainty and risk, thereby promoting flexibility.

24. It should also be noted that the fear of a storm of protest from civil society is likely a motivating factor behind this semantic choice.
25. For a history of the development of the term with regard to its conceptualization and its diversity, the reader can refer respectively to C. Folke et al. (2010) and C. Folke (2006). Also of interest is the panorama of definitions set out in the note by M. Schoon (2005).
26. Note that this definition may, indirectly, lead to a relaxation of the postulate of institutional functionalism.
27. In this instance, it is one of the main reasons upon which the idea of modernizing the sector relies in order to justify the use of public–private partnership and liberalization.
28. Actors arbitrate between the safeguard mechanisms from the market or hierarchy, following the process of alignment and remediability of institutional arrangements. They therefore show their preference for control in the case of hierarchy, or for flexibility in the case of hybrids closed to market. This choice justifies the conjecture noted above.

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5

The Macro-institutional Determinants of Depoliticization and Resilience in UWSEs

This chapter completes the analysis of the organizational stylized facts that was begun in Chap. 4. Chapter 4 has shown that transaction cost economics (TCE) tools can allow an optimal coordination solution to be found for all urban water systems in Europe (UWSEs), as well as highlighting the role of the key players' preference, which is linked to those players' limited rationality. In order to grasp this ambiguity, we will make use of an analysis of the institutional environment of UWSEs.

Indeed, by virtue of the institutional embeddedness and polycentrism diffused by the modernization of UWSEs, analyzing only the micro-determinants turns out to be partial. The construction of alternative governance modes from which the key players choose a form of institutional arrangement is based on the macroeconomic notions and concepts used in new institutional economics (NIE) when analysing the institutional environment. Neo-institutionalists explain how the public determines the specific details and coordinates actors in order to organize the allocation of resources. The use of this analytical grid, which complements that of the TCE, helps refine the theoretical explanation of stylized facts 1 and 2. In addition, this chapter concentrates on the macro-determinants that frame modernization and will study their impact on the

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micro-determinants. We continue the synchronic and diachronic analysis started in Chap. 4 by now looking at the main elements of the institutional environment of UWSEs, namely property rights, the institutional matrix and informal institutions (beliefs, etc.). It appears that modernization renders the structure of property rights within the UWSEs more complex (attenuation), expanding the distribution of associated rights of control. This mechanism is central to the depoliticization process. At the same time, we highlight the essential role of institutional complementarities. Thus, in order that modernization can be fully practised in UWSEs, there is a need for institutional matrices and informal institutions to be credible and support the reform; otherwise these will represent a form of resistance to modernization. The diversity of capitalism allows these elements and their dynamics to be observed, while explaining the variety of ideal-types of UWSEs.

As previously, the chapter provides a theoretical framework (Sect. 1) to use as an approach to this, and then refines it with the empirical data set out in Part 1 of the book (Sect. 2). It should be noted that this chapter focuses on institutional dynamics and contributes to a systemic approach to institutions.

1 Institutional Embeddedness as a Complex System: The Link Between Property Rights, Institutional Matrices and Beliefs

The institutional environment impacts on the structure of governance through three components: property rights, the institutional matrix and beliefs. Property rights limit the feasibility of institutional arrangements and guide the allocation of resources by creating an incentive structure (section "Property Rights: Definition of the Feasibility of Institutional Arrangements and Credibility of Commitments"). The institutional matrix serves as a base to which the property rights can be related, and it forms part of the composition of transaction costs (section "The Institutional Matrix: Macroeconomic Support to Stabilize

Property Rights"). Finally, the beliefs of individuals influence all formal rules (section "Beliefs: Do Informal Rules Have a Place at the Peak of Institutional Embeddedness?").

Property Rights: Definition of the Feasibility of Institutional Arrangements and Credibility of Commitments

In the NIE, the theory of property rights (TPR) corroborates the TCE and provides the tools necessary for an analysis of the institutional environment (North 1990; Williamson 2000).[1] A. Alchian (1965 [1977]: 129–130) defines property rights, in the broadest sense, as follows:

> The rights of individuals to the use of resources (i.e., property rights) in any society are to be construed as supported by the force of etiquette, social custom, ostracism, and formal legally enacted laws supported by the state's power of violence or punishment.

Property rights are institutions that provide incentives for stakeholders to organize the allocation of scarce resources. In particular, in the NIE model, they define the *feasibility* of institutional arrangements and are found upstream of contracts, on level 2 of institutional integration (Williamson 2000).

> Thus, the field of possible actors and forms of organization they set out in specific contracts will be derived from the structure of property rights. (North 1990: 52)

A non-mitigated property right brings together three attributes from Roman law: the *abusus*, the *usus* and *fructus* (Alchian 1965; Furubotn and Pejovich 1972; Foss 2010). This complete property right allows the holder:

- use (*usus*);
- transfer, change of form, access (*abusus*);
- compensation (*fructus*) from an asset.

However, the reality of this makes the mitigation of property rights possible, i.e. the owner does not hold the three attributes of a property right. Several owners can share full ownership of an asset and the ability of the holder of a right to edit and transfer an asset is thereby restricted. The attenuation of property rights is based on an essential characteristic: *fragmentation*.[2] The notion of fragmentation is intended to determine the specific decomposition of a property right and therefore the incentives that play key roles. Fragmentation reveals the incompleteness of property rights, something that theoretical notions address by proposing to analyse packages of rights that represent a non-mitigated property right[3]:

> The bundle of rights associated with a particular resource determines the consequences that the owners bear, affecting their choices and the use of the resource. (De Alessi 1990a: 47)

After having made the distinction between the different parts of a right, it is necessary to know its owners. Alongside fragmentation, the *identity* of the owners is the other essential element of a package of property rights (Alchian and Demsetz 1973). Four major property systems determine the identity of the owners: public, private, shared and free access. An analysis of these forms of ownership is intended to characterize the conditions of access to the property and the effectiveness of fragmentation in the coordination process. Thus, the confrontation between the benefits of a private system compared with a public system is the focus of the majority of debates on TPR. The study of common property, i.e. a group of owners who define the rules of use and maintenance of the asset or resource, has mainly been developed by E. Ostrom (2010).[4] Finally, there is very little research in secondary literature on the open-access system (Hadfield 2005).

Authors citing the TPR all believe in this set of notions and concepts, but do not necessarily engage with them in the same way. This analytical diversity manifests itself through the existence of three generations of the TPR. N. Foss (2010) makes a distinction between the classical theory of the first generation, that of the second generation and the modern theory of property rights. The first generation of the TPR[5] seeks to extend the neoclassical paradigm by raising the strong, and somewhat unrealistic,

assumption of zero transaction costs. It also sets out the theoretical and methodological groundwork of the TPR (Demsetz 1964; Furubotn and Pejovich 1972; Alchian and Demsetz 1973). The starting point is to consider that neoclassical theory perceives the interactions between actors as being without friction due to the assumption of zero transaction costs. However, this assumption reduces the realism of the approach and it must be surveyed in order to improve the comprehensive and explanatory character of the theory. The TPR then postulates the existence of positive transaction costs, generating an incompleteness of contracts and property rights.[6] Therefore, and in contrast to the spontaneous emergence of a Pareto-optimal balance assumed by neoclassical theory, the key players choose a mode of coordination from among several alternative ownership structures.[7] The approach is positive and seeks to understand the determinants of a contractual choice, as well as its implications for the allocation of resources from the structure of property rights.

The second generation further enlarges the TPR's spectrum of analysis, taking into account the institutional context.[8] Indeed, the first generation, by focusing on the relationship between contracts and property rights, neglects the role of more macroeconomic institutions such as laws, customs and so on (North 1990). However, the structure of property rights is part of an institutional matrix (North 1991) and the analysis of the institutional context of property rights is essential to understanding the emergence of arrangements and their effectiveness (De Alessi 1990b). 'The rules descend political regimes towards property rights to the point of specific contracts' (North 1990: 52). The institutional context contributes in particular to a definition and protection of property rights and therefore the credibility of the commitments. As such, many studies compare the ability of different legal systems to structure perennial property rights (Levine 2005).

Finally, the modern approach of the TPR, or GHM model,[9] focuses once more on commercial activity and is more prescriptive than previous approaches. The goal of the analysis is to determine who should own the assets and property rights in order to improve the effectiveness of institutional arrangements (Grossman and Hart 1986; Hart and Moore 1990). The modern approach differs from the traditional one in two ways; the first of these is methodological, the second conceptual. Firstly, adopting

the canons of modern economic science, the modern approach systematizes the use of econometric modelling. Secondly, the property no longer corresponds to a residual right to the income of an asset, but a residual right of control over an asset. O. Hart (1995) justifies this change by making reference to the technical requirements of simulation. In this case, the residual right of control is indivisible and can be simulated, the opposite of the concept of residual duty income.

Classical theorists have addressed two main criticisms of this modern approach to the TPR. H. Demsetz (1998) reproaches the ambiguous design of the property. He notes that the precise definition of residual rights remains difficult and remarks that a group of property rights does not bring together residual rights. So, for these two reasons, some of the property rights may escape the design of the property as proposed by the modern approach. The second criticism, by N. Foss and K. Foss (1999) notes a logical contradiction in that approach. It comes from the mismatch between the assumption of full ownership through the courts, and the assumption of an incomplete contract. J. Kim and J. Mahoney (2005) group together these criticisms by pointing out the reductionism of the modern approach due to its one-dimensional property definitions, which is however necessary for simulation. Moreover, they remind us that S. Grossman and O. Hart (1986) were aware of the same flaw, and that this methodology cannot account for the full complexity of the reality. The authors look at this template and discuss the limitations of the approach in presenting the hypotheses of the model (pp. 598–600):

> We model the relationship as a 'once and for all' event. To the extent that the relationship is repeated, the incentives for vertical integration may be different from those we give here. (Grossman and Hart 1986: 595–596)

The theoretical explanation of stylized facts 1 and 2 is above all positive; in addition, our use of the TPR is inspired predominantly by classic approaches to that theory. Each approach will be mobilized at different levels of institutional embeddedness. In particular, the first generation allows a description of the structures of property rights present in UWSEs and links it directly with forms of contractualization. This approach allows a deduction of the feasibility of the institutional arrangements with which

the actors constitute the UWSEs. The concept of feasibility offers a way to explain the role of the law regarding the decision of the players in terms of transaction costs; it defines the range of alternatives with which the actors can align. The notion of residual right of control will also be useful. We make use of the second generation of the TPR to identify the link between the structure of property rights and the institutional matrix. The analysis then focuses on the capacity of the water institutions to give credibility to the commitments made by the actors of the urban water cycle.

The Institutional Matrix: Macroeconomic Support to Stabilize Property Rights

A good definition of property rights, along with their security and enforcement, are the first conditions for the efficient allocation of resources through incentives created by those rights. However, these processes of definition, security and performance are based on institutions that are third parties to contracts and property rights. An analysis of the institutional matrix makes it possible to deal with the conditions under which questions of property rights might arise, and the quality of the processes that stabilize them. This matrix brings together and 'include[s] the executive, legislative, judicial, and bureaucratic functions of government as well as the distribution of powers across different levels of government' (Williamson 2000: 598). Thus, economic conditions and policies provided by the institutional matrix have an effect on the structure of the transaction costs. Because of this, O. Williamson points out that, for the actors, the constitution of an institutional matrix providing an environment conducive to the success of transactions constitutes 'first-order economization' (2000: 597).

To inform this first-rank economization, the characteristics of an institutional matrix conducive to the stabilization of property rights are evaluated. E. Brousseau and A. Nicita (2010: 91) point out that:

> Since property rights systems are inherently incomplete, the institutions in charge of the definition and enforcement of property rights perform a role in 'completing' property rights over time, to reduce transaction costs.

Therefore, referring to the problem of measurement as proposed by Y. Barzel, C. Ménard notes that 'public rules and institutions introducing [to an extent specialized agents] may be adopted in order to homogenize the measures and reduce the cost of the evaluation' (Ménard 2005: 306).[10] The studies that follow this line of research have a normative aim and postulate the superiority of coordination based on private property rights.

The majority of studies dealing with the link between the institutional matrix and property rights look at the legal system. Therefore, they look at how different legal systems minimize the transaction costs inherent in the use of private property rights—haggling, or the production of information rights, for example—and they confirm the commitments in general (Hadfield 2005; Katz 2008; La Porta et al. 2008; Brousseau and Nicita 2010). In general, it is about how the institutional matrix can compensate for the incompleteness of the structure of property rights. One speaks of the *quality of institutions,* and an arbitration must be made between the *ex ante* costs and *ex post* costs of governance (Brousseau 2008; Dixit 2008; Libecap 2008; Brousseau and Nicita 2010).[11] Indeed, just as with the course of a transaction, the constitution of an institutional matrix engenders costs. This arbitration helps to define the control over the evolution of the system and the scope for adaptation.

The legal system articulates a particular statutory regime, such as common law or Roman law, for example, where the administration ensures the rules are adhered to. D. North (1991) extends this articulation to the whole of the institutional matrix and highlights the importance of analysing the interactions between the institutional framework, the organizations that are emerging to support it and the resulting institutional change. Together with J. Wallis and B. Weingast (2010: 38), he makes the distinction between organizations of institutions, in that they 'constitute specific groups of individuals pursuing collective objectives, as well as individuals through partially coordinated behaviour'. More specifically, *the member organizations* are self-coordinated, while *contractual organizations* resort to third parties. A. Dixit (2008, 2009) analyses these interactions by talking about economic governance and adds a normative dimension by posing the question of the form of good governance for the market. In practice, this line of research leads to an analysis of the degree

of decentralization—with the relevant participants—in an economy, and the degree of consistency between the action and the powers of the different elements of the institutional matrix.

An institutional matrix is not *ex nihilo.* Past experience influences the shape of existing structures by creating opportunities or barriers. This phenomenon of *path dependence* occupies a central place in the Northian analysis (1990, 2005).[12] The decisions taken in the short term direct a change of the economy in the long term. F. Gagliardi discussed this notion and its different approaches. Based on the work of H. Schwartz (2003), F. Gagliardi (2008: 422–423) looks at three elements that logically link together and creates the basis of path dependence:

> Firstly, small contingent causes at the beginning of a path can have long-lasting effects; secondly, increasing returns to institutions are a mechanism for institutional reproduction and allow to explain why agents often refrain from modifying the existing institutions; finally, there exists an analogy between path dependence's 'critical junctures' and the evolutionary concept of punctuated equilibrium.

Therefore, and since transaction costs exist, path dependence means a constant readjustment actors' behaviour in the face of the new institutional conditions. Thus, institutional change is a process that is not only permanent, but partially incremental, and is not ergodic. Consequently, to understand an institutional matrix involves knowing its origins, and, as explained by D. North, an integration of the economic history into the institutional analysis.[13] It turns out to be crucial to locate behaviours within their environment. In order to analyse the institutional matrix of UWSEs, in addition to neo-institutionalist analysis, we make reference to the literature on the diversity of capitalism in general (Amable 2003, 2009) and that which is specific to cities (Lorrain 2005) in the European area.

These two approaches are complementary. The work of D. North fits into the NIE and allows inferences that are related to other concepts and neo-institutionalist notions. Nevertheless, it offers a global vision of the NIE,[14] relying on an historical analysis, and even political economy.[15] D. North thus fits well into a positive approach and demonstrates

scientific pragmatism.[16] With his work as a starting point, we will make use of authors who analyse the diversity of capitalism, as they will allow us to specify the regularities and differences within the institutional matrices of UWSEs and, ultimately, to explain our stylized facts.

Beliefs: Do Informal Rules Have a Place at the Peak of Institutional Embeddedness?

The third component of the model of analysis of the institutional environment, *beliefs*,[17] appear at the highest level of institutional embeddedness and manifest themselves through informal rules (traditions, customs, conventions, codes of conduct, etc.) (Williamson 2000; North 2005). The concept of belief is quite a soft one, and has many meanings. Mainly inspired by the work of D. North (1990, 2005; North et al. 2010), we have defined beliefs as a set of intangible cultural elements that provide actors with a subjective understanding of events (past, present and future). They shape the keys of interpretation that allow us to go beyond the indeterminacy of the choices in the face of uncertainty, and to participate for this reason in economic dynamics. For D. North (2005: 14):

> Economic change is essentially a deliberate process that is shaped by the perceptions that actors have of the consequences of their actions. These perceptions come from the beliefs of actors—their theories about the consequences of their actions—generally mixed with their preferences.

Therefore, beliefs play an essential role in the effectiveness of governance, *a fortiori* an institutional arrangement, by having an effect on the radical uncertainty that confronts individuals. Because of an informational deficit from the assumption of limited rationality and transaction costs, the signals emitted by formal institutions are not sufficient grounds for formulating a decision. However, individuals looking to make optimal choices—deciding between several alternatives, and carrying out the logic of economization—mobilize their beliefs. These allow an interpretation of the formal elements proposed by the governance structure and for the grey areas of available information to

be filled in (Vandenberg 2002; North 1990; North et al. 2010). They are a 'group of embedded institutions that allows us to not have to think about the problems or [how] to make choice[s]' (North 1990: 22). This mechanism is a structuring element of the postulated procedural rationality, because it suggests that individuals are intentional and, moreover, it reduces transaction costs.

Beliefs, and more widely informal standards, form part of institutional dynamics and the shaping of transaction costs in the governance structures. Despite this central role, their links with elements of institutional embeddedness are seldom the focus of studies. Two reasons are commonly invoked for this. Firstly, informal institutions are difficult to quantify and evolve over the long term. Therefore, there are epistemological difficulties (hypothesis testing, etc.) that justify the lack of research. Secondly, recourse to the concept of path dependency reduces the urgency of understanding the mechanisms related to beliefs from a theoretical standpoint. With regard to informal institutions, T. Eggertsson (2013: 2) talks about the link and the concepts that are the weakest and most often ignored. In his words:

> NIE, while recognizing the importance of informal institutions, has not developed a powerful theory for explaining the life cycle of social norms, in part because economists have a history of not attempting to analyze the formation of tastes and preferences in psychological terms

As such, identifying generic relationships between beliefs and other components of a system is a major challenge. The understanding of institutional dynamics, in our case the organizational phenomena of modernization, would be increased by this. The potential links are multiple and we will focus on those between actors and beliefs for two reasons. First of all, this dynamic articulation between beliefs and individuals refers to one of the basic axioms of the NIE: procedural rationality. A better understanding of this link helps to explain the formation and evolution of choices, which are not simply made by minimizing the evaluable transaction costs.[18] At this stage, it is about explaining and verifying our hypothesis for activating specific preferences that allow the principles of the modernization of UWSEs to impregnate the institutional arrangements.

Secondly, working on this link provides an opportunity to more deeply integrate the concepts of a complex system and institutional embeddedness (the objective set out in Chap. 4). Finally, it should be noted that our initiative is not unique (Chavance 2008; special issue of the *Journal of Institutional Economics* 2001). Thus, M. Aoki (2007, 2011) or A. Greif (2006; Greif and Tabellini 2010), among others, have placed at the heart of their research programme an analysis of the link between beliefs and individuals.

To better understand the concept of belief and its role in institutional embeddedness, we can break down beliefs into two categories: *mental models* and *ideologies*.[19] We'll talk about the mental model at the individual level and at the level of a group, with ideology being a shared belief, including *artefacts* (language, etc.). Beliefs are acquired through *learning*. This process articulates *education* on the one hand, and *individual experience* on the other (North et al. 2010). These two elements, sources of human learning, complement one another. Education transmits knowledge to each person in a formal manner—through school, for example—and in an informal way, through oral traditions or the family structure, for example. It concerns a source of development of beliefs external to the individual and, therefore, the integration of ideologies. Individual experience is built within individuals by comparing the effects anticipated by beliefs with the observation of behaviours and actual events. It confirms or breaks down the mental models of each person. Thus, experience adjusts ideologies and mental models acquired through education or experience, and relies largely on *social interaction*. This second constituent element of beliefs is unique to the individual. Perceived as an articulation between education and experience, beliefs appear to be individual; however, society tends to result in a convergence of mental models.

> The learning process is unique to each individual, but a common institutional/educational structure will result in partially shared beliefs. A common cultural heritage therefore provides a way to reduce the differences in mental models among members of a society and is necessary for the transmission of unifying perceptions from one generation to another. (North 2005: 49)

Beliefs are involved in the decision-making process. They therefore impact upon the transaction costs of the modes of governance structure, because they provide perceptions of transaction costs, which is all the more important as the measurement problem is obvious. In this way, interactions bind together beliefs and formal rules. The main interaction of this type dealt with by the NIE is the ability of beliefs to make commitments credible, i.e. how beliefs establish confidence in governance, where formal rules do not (Williamson 1998). Empirical studies show that, when individuals share pro-cooperative ideologies, making commitments credible is found to be easier and there are reduced application costs of coordination (Keefer and Knack 2005; Kocher et al. 2012). In addition, the leeway of individuals in the course of the transaction increases: contracts are less specific, because beliefs aid credibility. This type of organization leaves more room for innovation.

D. North (2005: 58–59) provides the key to understanding the role of beliefs in institutional dynamics:

> In essence, the richer the artefactual structure, the more important the reduction of uncertainty when making choices at a certain point in time. Over a long period, the richer the cultural context in terms of multiple experiments and creative competition, the more the company has a chance of surviving and succeeding. […] The richer the artefactual structure, the wider the range of possible routine decisions.[20]

Figure 5.1 offers a synthetic view of the relationship between people and beliefs. The classic impact of beliefs on the individual is detailed, as well as two mechanisms of feedback (strengthening and modification). In order to overcome the limits of their rationality, individuals build mental models to facilitate the decision-making process. These choices are part of inter-individual interactions that lead to a sharing of mental models, thus forming ideologies. Ideologies also come from communal learning organizations. They convey causal diagrams linking individual behaviour, institutions and social interactions. There, they build routines, and by means of experimental feedback, their routines reinforce ideologies. Behaviours that do not validate these ideologies pass for opportunism and modify the mental models. Thus, preferences, beliefs and behaviours

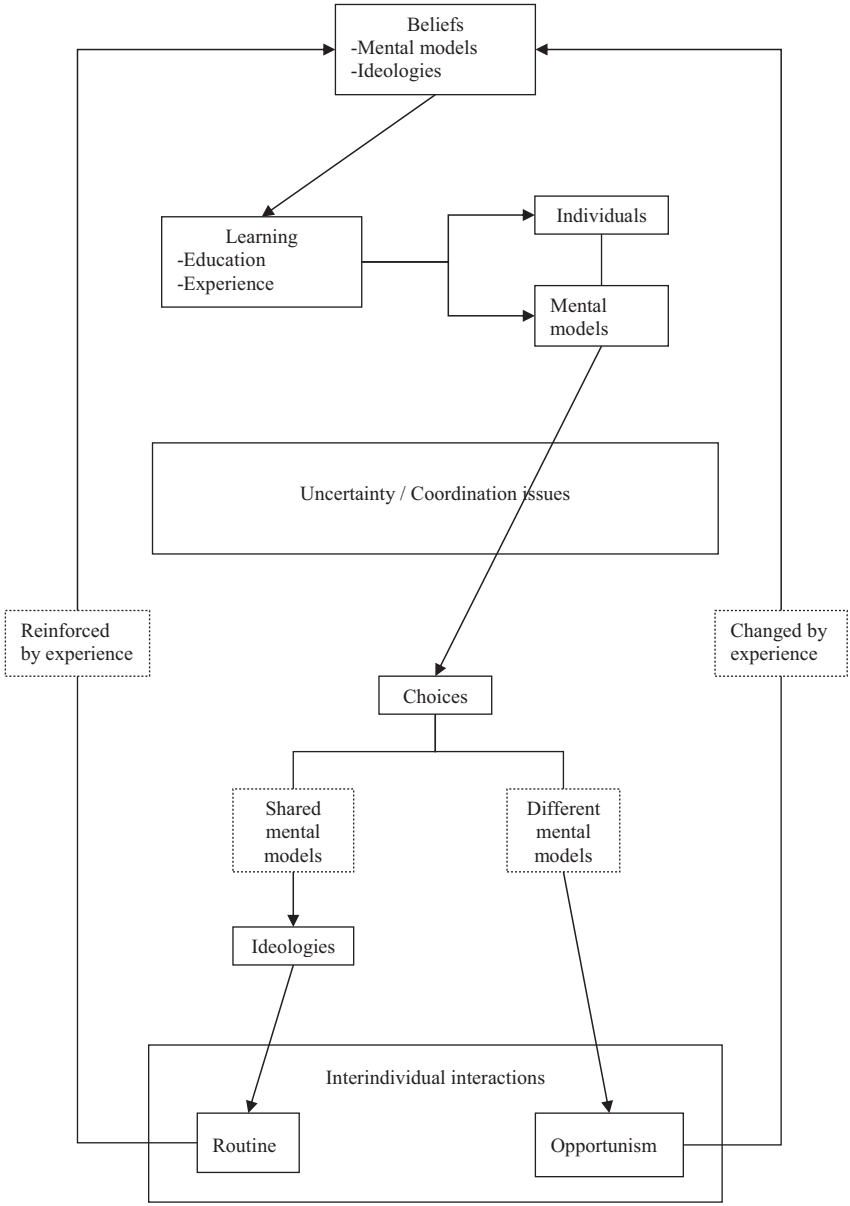

Fig. 5.1 The circular mechanic of beliefs: institutional embeddedness as a complex system

link together in a circular manner (Chabaud et al. 2005). P. Vandenberg (2002) interprets D. North's theory on beliefs. He highlights the double influence of beliefs about behaviours; positive ones provide a means to overcome cognitive constraints; normative beliefs teach what would be a 'good' choice.

> As we make those choices which are incrementally altering policy, we are changing reality. And in changing reality, we are changing in turn the belief system we have. (North 1999: 15)

At this point, it should be recalled that this process fits into a dynamic of path dependency and therefore plays on the institutional matrix.

This circular mechanism seems to us to be extremely powerful, as it articulates all concepts of neo-institutionalist theory. It creates interactions between the main elements of institutional embeddedness: individuals, behaviour, institutions and path dependence. This mechanism allows a real complex institutional system to be designed. Experience allows feedback, which forms part of organizational recursion and the dialogical system (principles 1 and 2 of a complex system). Indeed, experience has an effect on mental models, ideologies and behaviours. It highlights their antagonisms, complementarities and compatibilities in order that they can readjust beliefs and preferences. Therefore, the enactment of a preference and the choices form an institutional arrangement that falls under the holographic principle. Indeed, on the one hand, beliefs that are mobilized by the individual depend on the system as a whole; as well as being individual, they reflect the entire system. On the other hand, organizational recursion caused by experience posits ideologies and the whole system as a reflection of beliefs and individual choices. Thus, the part and the whole integrate with one another.

However, despite its apparent coherence, manipulating this circular mechanism should be done with caution. As we have seen, neo-institutionalist developments regarding the relationship between formal and informal standards are mainly confined to empirical studies and this line of research remains under-explored (North 2005). The theory poorly explains the mutual influence of the formal and informal rules. Thus, there are still few theoretical principles concerning beliefs

that we can build on in order to confirm or deny a proposal. In addition, it is empirically difficult to test theoretical hypotheses. We note that the concepts of the mental model and ideology are formally and conceptually distinct but, equally, they are built together and merge. Since they play a role in the dynamic at different times, a risk emerges that they may fail to isolate and distinguish the links of causalities in the analysis. With regard to beliefs more generally, D. Chabaud et al. (2005: 693) cite three main problems in using the concept:

1. the assessment of the cost of implementing a belief;
2. the extent of the effects of a belief; and
3. the identification of the origin of beliefs.

Figure 5.2 summarizes all of the interactions of the institutional environment, both internally and with the methods of governance and stakeholders. It shows that beliefs have a direct influence: on the institutional matrix, with the path-dependence phenomenon; on property rights, by acting on the confidence level; and on individuals, through education and learning. The institutional matrix then orients the structure of the property rights in determining their application, and then once more by means of path dependence. Finally, the last item in the institutional environment: property rights limit the range of possible modes of governance in determining their feasibility. Property rights will also help determine the residual rights to income and control. They thus contribute to a definition of the incentive structure. The rules, both formal and informal, guide the behaviour of individuals, but these individuals react and affect these rules. Indeed, the strategic uncertainty characteristic of individuals leads to an incessant movement of transaction costs, thus changing the structure of property rights.

The experience of the stakeholders also allows beliefs to evolve and thereby change the construction of future choices, either by taking part in a profound change of preferences, or by changing the level of confidence. These interactions suggest that the preference of stakeholders represents a key element in the selection process for an institutional arrangement and that it can change its shape. There is therefore a feedback process in the evolution of institutional embeddedness that renders a major part of

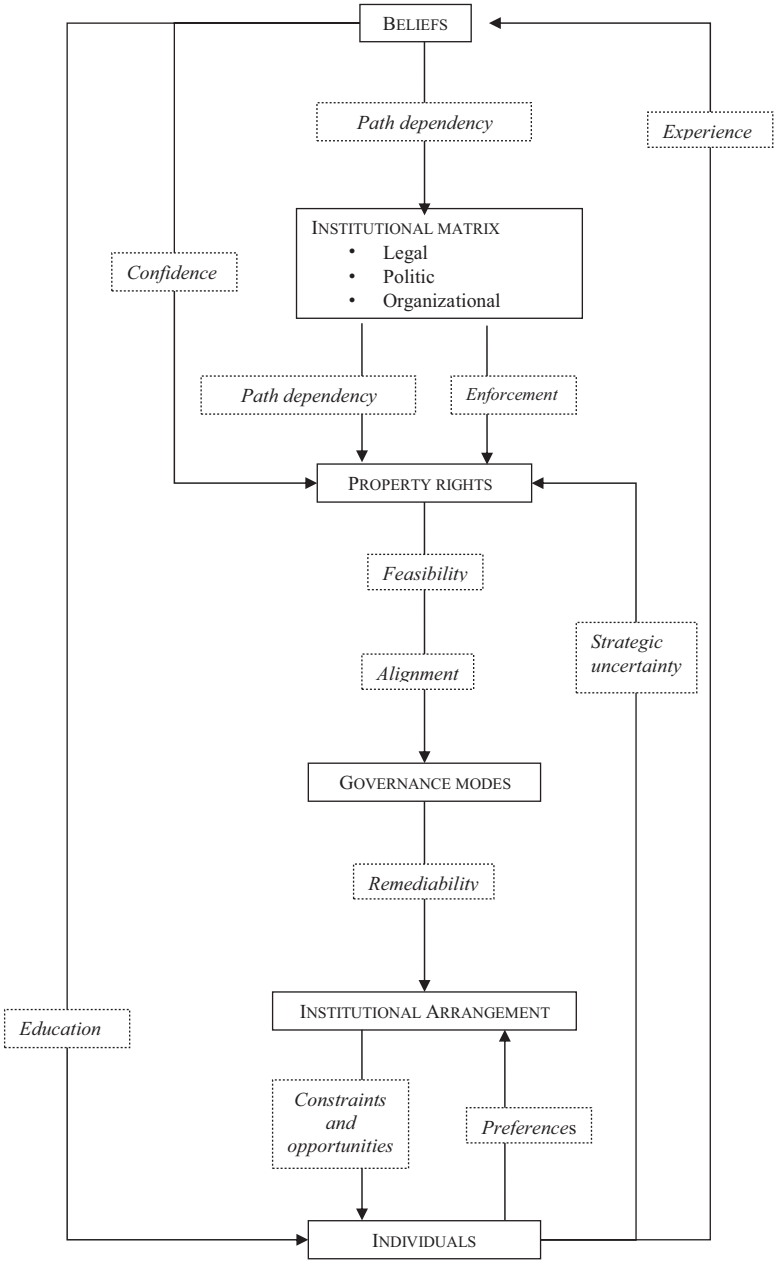

Fig. 5.2 Links within institutional embeddedness (Source: Bolognesi 2014: 374)

institutional change incremental, and reflects the systemic character of institutional embeddedness. Thus, beliefs are one of the cornerstones of our neo-institutionalist interpretation of UWSEs as a complex system, as put forward by E. Morin (2005). They affect the behaviour of the actors and the shape of the institutional matrix, but at the same time are changing as a result of the interaction between the behaviour of the actors, the governance structure and the institutional environment. Finally, links between beliefs, individuals and formal institutions form recursive loops within institutional embeddedness and crystallize a dialogical dynamic and holographic organization. These links involving beliefs help mould the institutional embeddedness as a complex system. As a result, their analysis helps us to understand the institutional dynamic and the modernization of UWSEs.

We have just demonstrated the essential role of beliefs, but their role should not be overestimated. The centrality of the beliefs in the previous presentation is the result of a choice that is made in advance and should not be interpreted as a supremacy of this element in institutional dynamics. Quite the contrary, the rest of this chapter highlights the impact of the other institutional components, and beliefs are used to refine the identification of links between them. Looking at the theoretical elements put forward, we can apply the grid analysis of the institutional macro-determinants in the case of the modernization of UWSEs to explain the organizational stylized facts.

2 Conditions that Make Hybridization Credible, and Evolutionary Multi-stakeholder Institutional Arrangements

The analysis of the relationship between the structure of governance of UWSEs and their institutional environment continues our project of analysing the closest elements to UWSEs, before addressing the more intangible institutions. An analysis of property rights allows the feasibility modes of governance to be determined (section "Apportionment of Property Rights and Feasibility of Modes of Governance: Modernization

as an Attenuation Process"). We will then see to what extent institutional matrices are present and we will determine the structure of the property rights of UWSEs (section "Modernization, Depoliticization and Resilience: The Diversity of Institutional Matrices and the Evolution from a Member Organization to a Contractual One"). Finally, understanding the beliefs of German, English and French companies shows the importance of informal rules in the constitution of formal institutions, and emphasizes the sovereignty of key players through their preferences (section "Depoliticization and Resilience of UWSEs: The Result of Pro-Cooperative Beliefs that Encourage Creative Competition").

Apportionment of Property Rights and Feasibility of Modes of Governance: Modernization as an Attenuation Process

In UWSEs, the state retains physical ownership of water resources; in other words, it holds *abusus*. Therefore, a full property right over water resources can only exist in the form of a public property system that corresponds to a mode of hierarchical governance. Thus, in UWSEs, the regie represents the only contractual form based on the full property rights of the urban water cycle operator. In this case, the state owns all of the assets included in the delivery of urban water uses, and therefore completely controls the water supply and/or waste-water and rainwater evacuation. If the regie turns into a public company under private law, fragmentation of property rights takes place. The state and the company share the *usus*, mitigating the structure of the property right. However, this attenuation is minor because, in the end, the state holds and continues to control the assets, since the company providing urban water services belongs to them. Such an institutional arrangement is found in some French UWS and in the majority of the German UWSs, notably in the form of the *Stadtwerke*.

In other forms of institutional arrangements, property rights are diminished and governance is hybrid. There is fragmentation of property rights and modes of governance offer packages of rights with varying incentive structures. J. Groenewegen (2011) offers a synthesis of the

impact of rights fragmentation according to the governance on ownership structures and the residual rights of control. To understand this evolution of the structure of rights of property, let us look at the example that is opposed to the regie in the UWSE. Private management is the coordination method chosen in the English UWS, and we have seen that it was the closest institutional arrangement to that of a market structure. Constitutionally, the state of the UK owns the *abusus*, but the *usus* and the *fructus* belong to private actors, the water companies. Legally, if the service provider is vertically integrated, this situation is a dismemberment of ownership rights, i.e. two actors share complete ownership, one (bare ownership) has the *abusus*, and the other (the *usufructuary*) brings together the *usus* and the *fructus*.[21] Water companies are the usufructuaries.[22] In the UWSE, this mode of governance is one in which the state controls less of the urban water cycle, since by ceding the *usus* and *fructus*, it confers a great deal of the rights of control to a private autonomous entity. This fragmentation is part of the depoliticization of UWSEs.

J. Groenewegen (2011) shows that in public–private partnerships, and in modes of hybrid governance in general, the distribution of packages of rights is more complex. We will present them on the basis of the closest form of governance to the English way of management. In the service contract and management contract, private operators have no ownership over the assets of UWSEs. They are paid by the state and thus indirectly access a proportion of the *fructus*. This proportion varies according to the negotiation of the contract and is greater in a management contract than a service contract, where the intervention of the private firm is occasional. In these two types of contract, the incentive provided by property rights pushes operators to offer the best value for money, but only with regard to the operation in question so that they can obtain the public contract. Private operators have no interest in management methods for urban water services.

In farming, the private operator shares the *usus* and the *fructus* with the state. The state takes charge of heavy investments and imposes public service obligations on the operator. Next, the rights of property holders are remunerated based on the profits generated by the activity; the share assigned to each one is specific to each contract. In this case, it is in the interest of the private operator to maximize the benefit of the activities of

the deviation process, and its risks are reduced because it does not make heavy investments. Margins come from management activities, while maintenance is costly, although the latter ensures the quality of the service necessary for obtaining and renewing the contract.

Here, we can see the emergence of an arbitration of a potentially problematic delegate for the proper conduct of the transaction in the UWSE. What is the most profitable solution? Invest and maintain the contract and the transaction as specified *ex ante* or *go for a free ride*, and accept the risk of losing the contract? This arbitration shows the possibility of opportunism, which strongly increases the transaction costs in the UWSE. C. Ménard and A. Peeroo (2011: 322) conclude that with the:

> PPPs, we are immediately confronted with standard problems of tariff increases, under-investment, especially towards the ending period of contracts, risk-averse strategies of operators so that public authorities tend to bear most of the uncertainties, and the very high rate of renegotiations.

Sharing property rights reduces the power of the state and micro-institutions appear necessary to limit the asymmetries of information, as well as to limit opportunistic behaviour. This need increases as the structure for the distribution of property rights is similar to that of governance by the market.

In a concession contract, the state yields a greater share of its initial property rights. The operator holds the *fructus* and a greater share of the *usus* since, compared with the previous situation, it is also in charge of heavy investments. In these last two forms of institutional arrangement, the structure of the property rights encourages the private operator to increase the profitability of the urban water cycle. In comparison to a regie-style organization, the fragmentation of property rights decreases, for each actor, the magnitude of residual income rights on the one hand, and residual control rights on the other. This puts forward the idea of a transfer of responsibility, referred to in our definition of the transaction within a UWSE, and underlying the depoliticization process that is driven forward by modernization. In addition, we see that the risk of opportunism also affects the quality of the service provided, which is another feature of the transactions being analysed.

The first section of the chapter showed that modernization has encouraged UWSEs to evolve within a public hierarchical mode of governance into a hybrid mode that tends towards a specialized market. Following an analysis of transaction costs, we believe it is impossible for there to be market governance within the UWSE. In terms of property rights, an analysis confirms this intermediate conclusion. Indeed, constitutionally, no other agent than the state can possess the *abusus*. Therefore, any intervention by another actor in the urban water cycle signifies an attenuation of property rights, and the structure of the property rights makes it infeasible to have market governance.

Modernization hybridizes institutional arrangements in order to implement incentives that are similar to those issued by a market. In doing so, the structure of property rights improves and fragmentation tends to increase the share of private actors in the package of property rights in the deviation process. Thus, the state cedes a part of their right to residual control in the provision of urban water services; private operators first of all have access to the *fructus* and then to the *usus*. As is the case in England and Wales, this fragmentation can go as far as dismemberment, where the state takes on bare ownership and a role as the usufructuary operator. In the end, the analysis of the governance of transactions of UWSEs in terms of property rights illustrates two dynamics. Firstly, modernization leads to an attenuation of the property rights in the UWSEs, and in particular to a transfer of public property rights over the urban water cycle. Secondly, modernization causes a dispersion of residual control rights and calls for the implementation of safeguarding mechanisms other than that of the fiat. There is a transfer of responsibility. Related to the elements found at the bottom of the institutional embeddedness, this mitigation and dismemberment involves bilateral or multilateral contracts. By highlighting these two mechanisms, we are able to refine the explanation of stylized facts 1 and 2.

With regard to the first stylized fact, the evolution of the structure of property rights as a consequence of modernization depoliticizes the UWSEs in two ways. The first is a depoliticization due to the fragmentation of rights. The attenuation of the property rights of a public power over UWSEs erodes public control over the deviation process. Control is split between the key players. Thus, mechanisms other than

the public fiat ensure transactions are smooth, such as autonomous regulatory agencies like OFWAT (The Office of Water Services) in England ($F_{s11,}$ F_{s18}). The second source of depoliticization comes from a change in identity of the actors involved in the packages of rights of UWSEs. Modernization leads to an integration of private actors in the urban water cycle (F_{s16}). This partial change in the ownership system is, in essence, a depoliticization of UWSEs. However, by keeping the *abusus* and part of the *usus*, the state can still oversee the strategies and behaviours of private operators.

Turning to the second stylized fact, depoliticization corresponds to the increase in the resilience of UWSEs; there are four main reasons for this. Firstly, fragmentation reflects an incompleteness in the property rights, where contracts cannot cover all the possible procedures for the transaction, which leaves room for innovation in the coordination. Secondly, depoliticization leads to an increase in the number of players and thereby diffuses the right of control over the UWSE. Coordination mechanisms are then based less on orders than on incentives, which allows the actors greater autonomy, which in turn increases the resilience of the system (F_{s20}). Thirdly, the fragmentation of property rights and the change of their holders' identity, linked to coordination mechanisms by means of the market, increases the ability to alter the structure of property rights (F_{s19}). The flexibility of the actors is greater and competition confers more of an advantage. The system can therefore evolve more rapidly (F_{s18}). For example, there is a decrease in the average duration of contracts and greater ease in carrying out procedures for renegotiation, particularly through the EU 'Public Procurement' and 'Concessions' Directives of 2014 (Beuve et al. 2015; BIPE 2015). The fourth reason is broader, and relies on the systemic dimension of UWSEs and institutional embeddedness via the influence of the structure of property rights on transaction costs. Fragmentation increases the number of possibilities for changing the structure, either by bringing together/dispersing rights, or by changing the identity of those who hold them. These changes affect the structure of the transaction costs and, by extension, the behaviour of agents (Williamson 2000). Conversely, when the state retains ownership, there are fewer interactions and so the system is less flexible and less scalable.

Modernization, Depoliticization and Resilience: The Diversity of Institutional Matrices and the Evolution from a Member Organization to a Contractual One

The structure of property rights is based on the institutional matrix of UWSEs. This structure allows an understanding in particular of the degree of fragmentation of property rights. Indeed, the more that rights and, by extension, incomplete contracts, are diminished, the more importance is placed on the matrix to ensure credible commitments. The legal models belonging to this matrix are an essential mechanism for the stabilization of property rights. Arbitration within the construction of a legal model balances the certainty provided by the precision of the law with the flexibility given to key players. Precision limits problems of interpretation, and so on, and flexibility facilitates adaptation in the face of unforeseen events (Brousseau 2008; Ebbesson 2010). In the UWSE, these elements appear within the legal component of the institutional structure. We shall now compare the German, French and English legal models.

Studies on the legal systems predominantly focus on an analysis of the link between the legal origin and growth, or the legal origin and the development of finance (La Porta et al. 1997, 1998, 2008; Levine 2005). German and French rights are forms of civil law and are derived from Roman law, while the foundations of English law are common law (La Porta et al. 2008). German law is more liberal than French law. Indeed, French law is heavily based on formalism, which tends to make it rigid. As for Germany, the legal model shares various procedures with the French model, but allows more judicial procedures, which renders it more flexible. In England, case law represents the essential element of the legal model. Formalism is relatively unimportant, and the decisions of judges guides and changes the law. Thus, civil law systems offer a legal model that is more formal and less judicial than Anglo-Saxon systems ($F_{s14,}$ F_{s15}).

Anglo-Saxon law and the reliance on case law facilitate the stabilization of property rights (Levine 2005). The work of R. La Porta et al. (1997, 1998, 2008) provides an estimation of this link. They show that the level of case law acts positively for securing property rights (coef. 0.55),

while formalism reduces the ability of application and the enforcement of contracts (coef. −0.51). Although they confirm our hypothesis, these statistical observations must be treated with caution for two reasons. Firstly, the correlations are measured using a sample of countries that are distinguished from each other according to their legal origin. However, the same legal origin does not equate to an equivalency of legal models and, indeed, does not say anything about the rest of the institutional matrix (which also affects the degree of credibility of contracts). Then, the heterogeneity of development levels may be important within the sample, and have a non-neutralized impact in the correlations.

However, the trend of the results is enlightening and is explained by the fact that the Anglo-Saxon models, by placing more importance on case law, for example, give more powers of interpretation and adaptation to the judges. These two qualities add credibility to commitments and represent two major assets in the reduction of *ex post* transaction costs. This legal support encourages a development of private ownership systems, and therefore the fragmentation of property rights in the English UWS. It explains the tendency to integrate private operators in the deviation process. Conversely, in civil law, the weight of politics is more important (term of office of the judges, formalism, etc.) and is reluctant to encourage the formulation of private property rights.

Anglo-Saxon law adds credibility to commitments and encourages the formation of private property rights. In light of the first stylized fact, this partly explains why the English UWS engages in modernization more than the German and French UWS. In addition, as defended by La Porta et al. (1997, 1998, 2008), the increased ability of judges to adapt and innovate in common law is important for the resilience of the UWS ($F_{s14,}$ $F_{s15,}$ F_{s17}). The incompleteness of the contracts will little alter the evolution of institutional arrangements in order to maintain coordination that is coherent with the changing economic environment. In this case, it promotes flexibility. The institutional matrix compensates for and completes the contractual imperfections in a way to ensure the correct definition, security and execution of the transactions through third-party micro-institutions and property rights. In this way, support for the modernization of UWSEs enables a depoliticization of the sector (stylized fact 1) and increases the resilience of UWSEs (stylized fact 2). However,

the authors of mobilized econometric studies are wary of their results and insist on the fact that the legal origin is not enough to determine the level of incentives in favour of the implementation of private property rights (Levine 2005; Hadfield 2005, 2008). It is therefore necessary to analyse the other elements of the institutional matrix.

These legal models form part of the diversity of capitalism, as presented by B. Amable (2003). The author distinguishes five forms of capitalism (Anglo-Saxon, social-democratic, Asian and those of Continental Europe and Southern Europe), on the basis of five criteria:

- the type of competition in the goods market;
- the level of deregulation in the labour market;
- the characteristics of the financial markets;
- the degree of social protection;
- the education system.

Germany and France belong to the Continental Europe category, and England to the Anglo-Saxon category. Germany and France have *social systems of innovation and production* based on strong public intervention at the level of central government or the local authorities. This method of organization strongly links the public infrastructure with the industry. The formation of national champions such as Veolia or Suez illustrates this dynamic in the French UWS. In England, the social systems of innovation and production rely on the market. Public intervention is limited and confined to the existence of monitoring institutions, such as OFWAT in the case of the English UWS.

D. Lorrain (2005) resumes work undertaken on the diversity of capitalism (Albert 1991; Crouch and Streek 1996) and specifies it within an analysis of European cities.

> The arguments that underlie this article are that (1) beyond any first-level complexity actually noted in the organization of each urban service in a given country, European countries basically follow three major models; (2) these simplified forms, or models, represent three ways of combining public policy principles with a market economy: they may be read as versions of urban capitalism. (Lorrain 2005: 231)

He distinguishes three *urban capitalisms* which emerged during the nineteenth century; the German, French and English models. The German model is characterized by a strong local public sector, the French model by the important role of policy and delegation, while the English model is characterized by the search for optimum functionality. We believe the analytical grid to be relevant because the characteristics of urban capitalism are actually found in the UWSE. In Germany, the management of water remains public and it is local authorities who take charge of it through the *Stadtwerke*. In France, the public authorities use private operators, including national champions for the sector. A decentralization of the powers of the central state, especially through management of the catchment area and the water agencies, is designed so as to provide optimum control of the private providers. In England, the provision of urban water services was privatized and it is independent regulatory agencies that oversee the functioning of the sector. Thus, the organization of UWSEs is decentralized; so as to maintain public control in Germany and France, and to empower operators in England.

C. Ménard and A. Peeroo (2011) studied the impact of the liberalization of UWSEs and identified similar models. With regard to England, they speak of 'full privatization, but close monitoring' (p. 316); for France, of 'more competitive pressure in PPPs, but limited risk-taking' (p. 318); in the case of Germany, they question whether 'corporatization is a step towards liberalization?' (p. 319). The authors explain this organizational diversity and these developments in the sector by interweaving specific institutions (those of UWSEs) with common national institutions. The range of micro-institutions presented contributes to the good implementation of modernization (Ménard 2009). For example, to facilitate coordination after the reorganization of UWSEs in France, inter-service water missions (MISE) were created to improve the articulation between actors in the face of the deconcentration and decentralization process (Keller 2011).[23]

C. Ménard and A. Peeroo (2011) show that the specificities of the sector mean that citizens are opposed to the transfer of property rights, fearing a loss of control of the sector. Overall, the key players therefore believe that the institutional matrix is not able to aid institutional arrangements that are solely based on safeguarding mechanisms in the market. This aversion constructs the resistance of systems. Brochet et al. (2016)

have evaluated the impact of this resistance in the urban area of Grenoble (France). According to their studies, key players demonstrate significant resistance to achieving performance indicators. For example, for the majority of the services analysed, 70% of the performance indicators are subject to resistance, which biases the assessment of performance. Those UWSEs that are most integrated in the modernization process are those who have micro-institutions that ensure safeguarding mechanisms and so on in the market, thereby reducing the aversion of the actors and, ultimately, increasing the resilience of the system.

The characteristics of German, French and English forms of capitalism have an impact on the UWSE, notably through path dependence, which can better explain the various degrees of modernization of UWSEs. The German and French interventionist tradition has resulted in a preference for control of public services. Therefore, the UWS of these countries will slow the dynamics of modernization in the sector, notably those decided at European level. France incorporates modernization to a greater extent than Germany because the coordination mode offered by the PPPs both suits and corresponds to the way in which the country is developing in the long run. Indeed, in France, the state has supported companies in strategic areas in order for them to become world leaders, such as the Compagnie Générale des Eaux, which became Suez Environnement (Jacquot 2002). The water sector is no exception to this development strategy, and local authorities regularly delegate part of the deviation process to these national champions. The English UWSs do not impede the process of modernization because it promotes similar values to those of their institutional matrix: use of the private sector, market coordination, control via autonomous regulatory agencies and so on. The rules of governance of the sector seem to be in agreement with the English model of UWS, while inconsistencies may appear when they are applied in the German and French UWSs. In addition, with the emergence of new micro-institutions and a change in the relationships between actors in the UWSE, modernization incites a transformation of member organizations (municipal coordination, etc.) into contractual organizations (OFWAT, etc.).

In the end, the explanation of the stylized facts and the observation of UWSEs confirm the theoretical model. The institutional matrix helps to build an institutional environment that defines the feasibility of governance structures, delineates the range of the alignment process and acts on the remedial character of those structures. This is a first-rank economization in which the actors are economized. Within the framework of our analysis, this first-ranking economization takes place via the diversity of capitalism and the politico-administrative arrangements specific to each UWSE. As a result, the terrain is more or less favourable to absorbing the principles of modernization in the UWSE, which itself is more or less conducive to depoliticization and organizational resilience.

Depoliticization and Resilience of UWSEs: The Result of Pro-Cooperative Beliefs that Encourage Creative Competition

The structure of the institutional matrices concretizes development strategies by linking water institutions and the urban water cycle. Therefore, in order to understand this structure, beliefs should be integrated into the explanatory model. In his analysis of urban capitalism, D. Lorrain (2005) goes back to look at beliefs and notes that they provide direction to formal institutions. The analysis presents the basic cultural characteristics of German, French and English models and these are the same features that form the basis and enable an understanding of the form these models take. To identify these features, D. Lorrain observed these countries over a long period of time and pays much attention to the crises and shocks affecting their systems. These periods and events, which D. North called the turning points in the institutional dynamic, catalyse the emergence of new beliefs and, coupled with an historical analysis of path dependence, enable the identification of prominent informal rules in each of the models.

In Germany, the conception of the state is that of a strong public power, which is interventionist and takes the role of an organizer. This, coupled with a long tradition of local democracy, shows how the role of cities is fundamental in the provision of local public services. The

development of the *Stadtwerke* arises from these two ideas and a desire for pragmatism in business management. Working from this ideological base, D. Lorrain enumerated three cultural elements that determine the provision of urban services in Germany (to which the deviation process of the UWSEs belongs):

- concept of change based on pragmatism (gradualism);
- consensus culture, co-production;
- lower importance placed on industrial production factors than on 'institutional design' (Lorrain 2005: 240).

During the nineteenth century, England shared this idea of free administration of local affairs. This very idea was called into question by the emergence of two other beliefs in the 1980s: a rationalization of public action and the pluralist conception of the state. The desire for rationalization led to an increase in the effectiveness of the services in terms of the quality/price ratio and encouraged adequate conditions of competition in the sectors. Then, the pluralist conception of the state led to an acceptance of the delegation of activities to actors other than those who were a part of the public authority, whereupon the issue then became the control of delegates. Three cultural features characterize the English model of urban capitalism (Lorrain 2005):

- conflicts and disputes, and the control culture;
- confidence in the market, belief in competition; and
- belief in the importance of institutions, an ongoing reform process.

In France, the idea of the state is both liberal and interventionist. This paradox comes from the existence of a strong central state at the heart of the country, and a relatively weak periphery. Since the central state cannot compensate for this territorial heterogeneity, recourse to delegation to private companies, which the state controls, is developing. Thus, in France, the provision of public services turns out to be politically connoted, but the idea of making this happen is also present in beliefs. There, the basics of a 'grammar of public action by delegation' dates back as far as the seventeenth century (Lorrain 2005: 250).

Four cultural traits can be found at the foundation of the French model (Lorrain 2005):

- a strong state and weak local power: guardianship and delegated management;
- development of national champions in monopolistic or oligopolistic structures, freedom of action for firms, important role of engineers;
- alliance of industrial and state elites, regulation by system of checks and balances; and
- gradual change, concrete modernization rather than change within the institutional framework.

Thus, the concept of the state in Germany and France pushes for strong interventionism, which gives an important political dimension to the provision of public services. By way of illustration—although, because of the lack of data, it is difficult to have an objective and definitive opinion—one can consider that the recent re-municipalizations of the management of waters in France are more praised for their political success rather than justified by a quest for efficiency. In these countries there is therefore a tradition of public control over local affairs, hence the maintenance of local public companies in Germany to manage urban water services. This preference for interventionism does not exclude the participation of the private sector in France. Indeed, it is believed that the state cannot take on everything and that, by affiliating itself with nationwide companies, the quality of benefits will increase. This belief justifies the signing of PPPs, a frequently used regulatory method in the French UWS. The British state is rather more sovereign, and reduces obstacles to entrepreneurial freedom. A faith in market mechanisms shapes the organization of public services and the state remedies vulnerabilities by establishing independent regulatory agencies.

The beliefs help to explain that, in an indirect way, causation links the modernization of UWSEs to their depoliticization (FS_1). Ideologies facilitate the construction of institutional matrices and arbitration aimed at modernization (F_{s21}). Thus, the European population survey undertaken for the EU (Eurobarometer 2012) shows that, on average, and in every country, economic instruments are seen as more effective than legislation in dealing with issues related to water. This notion is particularly

well supported in the UK. So, 70% of British respondents, compared to 60% and 57% in Germany and France, push forward polluter-pays tools; regarding financial incentives, the pro shares are 72% in England, 65% in Germany and 60% in France.

As well as beliefs, the operation of formal institutions also leads to depoliticization. We have identified two mechanisms by which beliefs allow modernization and organizational impacts to be planted within the UWSE. Firstly, the compatibility between the philosophy of modernization and the beliefs of UWSEs ensures the feasibility of institutional structures in relation to the modernization of UWSEs. Then, in the growth of the first mechanism, these beliefs operate a first-rank economization. They establish a climate of confidence to render commitments credible. The result is a reduction in *ex post* transaction costs that promotes specialist market-oriented hybrid governance structures. Thus, the implementation of modernization is based on pro-cooperative beliefs that reduce the application and coordination costs associated with a decentralized and devolved governance structure. We postulated this mechanism by looking at a hypothesis of activating specific preferences, and determining the outcome of the economization of stakeholders by virtue of their procedural rationality. This mechanism attests to the benefit of perceiving institutional embeddedness in the form of a complex system. In fact, if we refer to the hierarchical vision of institutional embeddedness provided by O. Williamson (2000), it is clear that beliefs affect coordination in both a top-down and bottom-up manner.

In fact, the ideology on which the modernization of UWSEs is based appears to be similar to that of English society ($F_{s8,}$ F_{s24}). The Eurobarometer survey (2012) has shown that that English beliefs are most conducive to the depoliticization of the sector, and are the opposite of those expressed in Germany, while French beliefs come somewhere in the middle. The facts confirm the existence of predispositions to modernization, and these predispositions explain in part the organizational phenomena of modernization. In this sense, trust in market governance by the actors of the English UWS facilitates the credibility of commitments and therefore a structure of property rights that cedes an important proportion of that packet of rights to the private system, while the opposite situation can be found in Germany. In other words, the English ideologies and mental models offer a 'space' for a governance structure that comes close to that of the market

($F_{s8,}$ $F_{s12,}$ F_{s14}). Therefore, the actors attempt to implement this structure in order to reduce the cost of governance, which is high in the case of a hierarchy. English ideology reinforces routine behaviours that are based on confidence in the market structure on the one hand, and autonomous adaptation on the other. It promotes the modernization of the UWS in people's minds and directs the development of the institutional matrix.

An analysis of beliefs acutely supports the explanation of the second stylized fact. Liberal ideologies underlying the modernization of UWSEs value the notion of competition and autonomy, so that the circular mechanism of beliefs (Fig. 5.1) develops and intensifies the creative competition discussed by D. North. We have identified three mechanisms that explain the link between modernization and socio-institutional resilience:

- diversification of social interaction;
- an increase in the volume of social interaction;
- an acceleration of the circular mechanism of individual beliefs.

Modernization brings about a decentralization and deconcentration of the organization of UWSEs. It results in an increase in the diversity of actors on the one hand, and a multiplication of inter-individual relations and their institutional and organizational manifestation on the other. As a result, social interactions based on the experience of actors tend to intensify and diversify. This mechanism encourages creative competition, adaptive efficiency and, *in fine*, socio-institutional challenge. Then, the circular mechanism of individual belief is diffused via experience and the social interaction of these changes in mental models, thereby fostering the emergence, or strengthening, of pro-modernization ideologies. This organizational recursion turns out to be even more effective as the individual autonomy brought about by modernization promotes the dissemination of these innovative beliefs. Since beliefs contribute to shaping choices, the current mechanisms explain the positive correlation between modernization and the socio-institutional resilience of UWSEs.

In our case, pro-modernization beliefs facilitate evolution by means of a perpetual quest for efficiency. In addition, as the diversity of beliefs will be greater, so will the range of routine behaviour. Therefore, actors will be able to proceed to certain adjustments without these changes

being seen as opportunism, without considerably increasing the *ex post* transaction costs and without impairing the coordination and conduct of transactions. For these two reasons, depoliticization goes hand in hand with the development of the resilience of the system, which explains the positive correlation between modernization and resilience. German beliefs come into conflict with the ideology of the modernization of UWSEs. Causation models integrated into the ideologies of German society do not coincide with those of the ideology of modernization. Therefore, the stakeholders in German UWSs fear and/or perceive opportunism in the behaviours induced by modernization. However, the link between individuals and beliefs formed by experience may alter this ushering-in of new practices. This analytical prism allows us to understand the corporatization in German UWSs, and confirms the relevance of the issue put forward by C. Ménard and A. Peeroo (2011): does corporatization constitute a step towards liberalization? German beliefs support routines that promote stability of the system and its control. The same situation can be found in France, where the debate on PPP corruption can be interpreted in this way. People fear depoliticization and unexpected behaviours, and political control gives credibility to commitments and reduces transaction costs in these UWSE. In the end, the English UWSs are undergoing permanent and resilient evolution, while this evolution is gradual and a conscious process in German and French UWSs, thereby contributing to a form of resistance of the systems.

This analysis of beliefs validates the hypothesis-conjecture, formulated above, putting the preference of the key players at the heart of the choice of institutional arrangements. The transactional analysis of contractualization in the UWSEs leads to an indeterminacy in the governance structure, which minimizes transaction costs. In addition, we have argued that this indeterminacy is not random, but reflects the preference of the actors for control over public services or flexibility. We can refine this further by adding that these preferences are not solely constructed on the basis of a microeconomic evaluation and transactional calculation of commitments. Beliefs and culture participate significantly in the construction of these preferences. The NIE considers culture and mental models to be the basis of formal institutions, thereby providing a way to deal with uncertainty. Corroborating this model, we have seen that the beliefs of

Germany, France and England match the model of UWS that these countries represent. They participate in the structuring of institutional matrices. Actors mobilize or reinforce them by consulting them during the remediability process, in order to choose a specific institutional arrangement that coordinates the UWS.

An analysis of the elements from the institutional embeddedness at the top supports one of those elements of micro-determinants in explaining stylized facts 1 and 2. It shows the benefit of an approach linking the TCE and the institutional environment within a complex institutional system. We have identified three mechanisms explaining the causality between modernization and depoliticization, then the correlation between modernization and socio-institutional resilience. The first mechanism, the institutional matrix and the informal rules, stems from first-rank economization. This ensures the feasibility of compatible governance structures with modernization. At the same time, this economization promotes hybrid structures of governance that tend towards a specialized market during the selective tests of alignment and remediability criteria. The second mechanism, this feasibility, allows and encourages mitigation and a dismemberment of the property rights that then result in depoliticization and a gain in the resilience of UWSEs. The organization then moves from an adherent shape to a contractual form. Finally, we have seen that, with regard to the circular mechanism between beliefs and individuals, modernization will change or reinforce individual preferences. When the preferences stated are in support of the principles of modernization, they promote creative competition and *a priori* pro-cooperative behaviours that bring about depoliticization and the socio-institutional resilience of UWSEs.

3 Conclusion

This chapter explained the organizational stylized facts by making use of neo-institutionalist theory. An analysis of the micro-determinants of coordination leads to the conclusion that modernization has resulted in a hybridization of the institutional arrangements by orienting towards a specialist market, but the macro-institutional analysis helps explain the manner in which these micro-determinants become active.

The chapter has showed that, in terms of the structure of property rights packages, modernization implies increased attenuation and a change in the identity of the holders. As a result, the residual right of control of public authority is dwindling, generating a depoliticization and an increase in the resilience of UWSEs. Analysing the institutional matrices and beliefs shows the importance of the first-rank economization brought about by these elements, and contributes to the delimitation of feasible modes of governance. Institutional arrangements reflecting the organizational principles of modernization emerge more easily when first-rank economization gives credibility to impersonal commitments and reflects a preference for flexibility. In the end, we support the fact that incorporating the principles of a complex system (recursion, dialogical and holographic) in the analysis of institutional embeddedness allows an articulation *inter se* of all the micro- and macro-determinants, explaining our organizational stylized facts. In support of this proposal, we have pointed to the role of informal institutions as a medium, and presented the circular mechanic of belief–behaviour as unifying elements of a polycentric coordination mechanism.

In the end, the analysis of stylized facts 1 and 2 leads us to reflect on modernization in terms of institutional change in the UWSE. The theme of institutional change represents one of the main research axes of the NIE, in addition to the effectiveness of coordination. The next chapter will address this second axis from the perspective of the sustainability of UWSEs.

Notes

1. Note, that as for transaction costs (Coase 1937), it is R. Coase (1960) that looks at their relevance in terms of an analysis of property rights.
2. Contradicting the TDP, 'Property Economics' notes that this notion of *fragmentation* is only secondary in importance, preferring instead the distinction between *possession* and *property* (Epstein 1998; Steiger 2006). Possession authorizes the use of a resource, while the property symbolizes physical ownership of the resource. Here, we will not use these concepts and instead will maintain the tools provided by the TPR and the NIE in

order to maintain the consistency of our analysis and the compatibility of the results set out in the first and second sections of the chapter.

3. This incompleteness of property rights stems from the existence of transaction costs. Y. Barzel (1982) initiated this reflection by highlighting the problem of measurement. Transaction costs prevent the proper delineation of property rights because 'relative to their value, some of the attributes of the assets are costly to measure' (Brousseau and Nicita 2010: 90). This difficulty causes a misalignment between the right to income and right to control. This informational issue blurs the incentive structure of property rights and affects the quality of the coordination.
4. E. Ostrom considered common property to be an alternative to private property and public property. The title of her 2009 speech, given upon receiving the Central Bank of Sweden Prize in Economics in honour of Alfred Nobel, and published by the *American Economic Review* (Ostrom 2010), is witness to this: 'Beyond Markets and States: Polycentric Governance of Complex Economic Systems'. According to Ostrom, because of common ownership, usage and allocation rules better integrate all of the features of the institutional environment, facilitating self-organization. This property system then allows an efficient mode of governance to be implemented, thereby minimizing transaction costs.
5. The main contributors to this approach are A. Alchian, R. Coase, H. Demsetz and S. Cheung.
6. The TPR sees the exchange and contracts in terms of rights of ownership and not assets. Thus, a contract represents an exchange of property rights, property rights affect transaction costs and so on.
7. This ontology echoes the behavioural assumptions of the TCE and, more generally, results in a hypothesis of procedural rationality shared by neo-institutionalists.
8. The main contributors to this approach are: Y. Barzel, L. De Alessi, G. Libecap and D. North.
9. For Grossman-Hart-Moore.
10. This quote from C. Ménard should be linked with the author's research programme on micro-institutions. It would be prudent to consider the organizational specificities of institutional arrangements that are aimed at maintaining the coherence of the system, making its dynamics 'flow', and ultimately ensuring effective coordination.
11. Specializing in the legal dimension of this field, G. Hadfield (2011) discusses the 'quality of the law'.

12. D. North developed this concept from work undertaken on the path of technological change conducted by P. David (1985) and W. Arthur (1988).
13. The work undertaken by A. Greif (2006) is an example of this type of analysis.
14. To which O. Williamson (2000) adheres.
15. Indeed, in their 2009 research, D. North, J. Wallis and B. Weingast incorporate the notion of power and conflicts between classes as a means of understanding economic development.
16. A pragmatism that O. Williamson also praises through the 'Carnegie Triangle'—be disciplined, be multidisciplinary, have an active mind. The second precept, which particularly interests us here, recommends that we 'be prepared to cross disciplinary boundaries if and as this is needed to preserve contact with the phenomena' (Williamson 2007: 8).
17. D. North et al. (2010: 56) clarify the concept of beliefs by speaking of 'causal beliefs, which establish relationships of cause and effect between actions and their results in the world that surrounds us'. This definition is based on the intentional nature of human consciousness.
18. This point refers to the hypothesis, in the TCE, that informal elements complete formal rules (imperfect) (Brousseau 2008).
19. These details may seem reductive, but we deem them to be necessary. Indeed, the theoretical analysis of beliefs leads to a semantic vagueness: mental models, ideologies, causal beliefs; shared; behavioural and so on. We do not wish to resolve these theoretical debates, but merely to limit confusion in their presentation in order to highlight the mechanism of beliefs in institutional dynamics. The distinctions put forward rely on contributions from P. Vandenberg (2002), D. Chabaud et al. (2005) and D. North (2005; North et al. 2010).
    Here, we present the Northian theory of beliefs. A. Greif offers another theory based on intentionality, which D. North highlights for two reasons. Firstly, D. North distinguishes between institutions of organizations; then, he defines beliefs more broadly than A. Greif (North et al. 2010).
20. In this quote, through the notion of 'creative competition' we can clearly see that beliefs are part of an institutional functionalism. It is the most effective ideologies, and by extension institutions, that persist. D. North calls this *adaptive efficiency*. In the standard framework of the NIE, this concept reinforces the idea of an institutional Darwinism. However, in

his later writings, D. North adds that organizations also play a role in the process. Efficiency becomes the only determinant of the outcome of the creative competition since each organization defends/depends on its ideology.

21. To simplify the explanation of the phenomenon, we will look at the example of a vertically integrated company. De-integrated organization renders the structure of the package of rights more complex, but does not change the substance of the phenomenon.
22. Or at least tend to be, as OFWAT is involved in the regulation of the sector and therefore holds a proportion of the *usus*.
23. MISE are the centres of coordination between the different water-policy actors. The 22 January 1993 circular that created the MISE assigned it the following goal (§2.1): 'The creation of an inter-service water mission in each "département" aims to improve the legibility and effectiveness of administrative action in the field of water. With a view to implementing concrete provisions, as defined by the law on water of January 3 1992, it is intended to ensure the better coherence of State interventions and allow a global approach to the issues pertinent to water by means of coordinating the […] services.' The circular is available at the following web address: http://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000000545090&dateTexte=&categorieLien=id, accessed 23 May 2016.

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6

Institutional Dynamics and Sustainability: The Trade-Off Between Broader Regulation and Consistent Regulation

This penultimate chapter concludes the explanation of the phenomena observed during the first section. It focuses on the third stylized fact, which states that *not only does modernization fail to satisfy its own requirements in terms of sustainability, it stirs up antagonism between the economic pillar and the other pillars.*

To achieve this explanatory goal, we will use the analytical framework created by institutional resource regimes (IRRs). This choice neither questions the neo-institutionalist allegiance to the research, nor its theoretical coherence. The IRR programme draws on neo-institutionalist works and offers a relevant exploration of the issues of institutional effectiveness through the positive heuristics of the new institutional economics (NIE). In this case, the proposed conceptual apparatus is dedicated to analysing the sustainability potential of a mode of coordination. The IRR research programme focuses on the question of the management of resources by means of formal rules, something that coincides with the regulatory method of UWSEs. As part of our argument, we will essentially look at the normative dimension of IRRs in order to explain how the institutional dynamic of modernization limits the potential for sustainability of UWSEs. We will provide evidence for the fact that

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modernization does not offer a coordination solution that maximizes the potential for the sustainability of UWSEs. We will illustrate their *complex* condition by referring to the paradox that is modernization. Linked to the ambivalent effect of the increase in the number of rules, this paradox is revealed in light of an elucidation of the terms of a complex system. The progression of the argument leads us to somewhat exhaust the synergies between the NIE and IRR cited by proponents of the IRRs. Our approach is predominantly to discuss the basic conjectures of the framework, always with the intention of generalizing our conclusions. The use of the IRR thus provide an interesting extension to the neo-institutionalist reflections conducted so far, and the concepts of the NIE reinforce the approach of the coordination under the IRR framework.

This chapter is organized into three sections. Firstly, we will outline in detail the IRR research programme, in its macroeconomic dimension. Then, by applying the exposed concepts, we will demonstrate that the modernization of UWSEs is not able to ensure a priori a sustainable path for the UWSEs. Finally, we will further the dialogue between NIE and IRRs in order to better understand this 'paradox' of modernization.

1 Institutional Management of Resources: A Research Programme Dedicated to Analysing the Sustainability of Governance

This first section sets out the research programme of institutional resource regimes according to a structure that allows the status of the various theoretical elements to be distinguished from each other. We will firstly present the foundations (section "Empirical and Theoretical Basis of the Programme: A Public Policy Analysis Combined with the Institutional Economy") of the programme, followed by its positive aim (section "The Positive Outlook of IRR: Identification of Regulatory Modalities for a Natural Resource") and its normative aim (section "The Normative Outlook of IRR: The Search for an Integrated IRR for Sustainable Governance").

Empirical and Theoretical Basis of the Programme: A Public Policy Analysis Combined with the Institutional Economy

The IRR research programme is based on a double critique, both empirical and theoretical, of European environmental policies (Knoepfel and Nahrath 2005; Varone et al. 2008; Gerber et al. 2009). The empirical criticism relies on works discussing the history of the environment by J. McNeill (2010), where he presents a diagnosis of environmental degradation and the unsustainable path of human development, as well as a statement on the limitations of current environmental policies (Nahrath 2003).

J. McNeill (2010) offers an anthropocentric analysis of the history of the environment by dealing individually with each of the zones of the atmosphere: lithosphere, atmosphere, hydrosphere and biosphere. He states that, as a consequence of human development, the planet has, since the nineteenth century, seen exceptional changes in intensity, and that our ways of life and beliefs have adapted to the current state, but could suffer greatly from these changes. In support of this thesis, J. McNeill addresses the notion of ideas and politics at the end of his work. He thereby demonstrates the relative inefficiency of environmental policies in addressing the problems identified:

> Regarding the history of the environment, the environmental key ideas have meant little more than thoughts that were focused explicitly on the environment. Even if the ideas and policies of the environment became an integral part of the new mindset that governed companies after the 1960s, they could in no way supplant the ideas and policies in place, which were completely embedded in the realities of the time. (McNeill 2010: 429)

S. Nahrath (2003) agrees with this general finding of ineffectiveness of environmental policies and elaborates on it. He lists seven notable facts that are at the origin of the inefficiency observed in environmental policies (Nahrath 2003):

1. environmental policies are internal to sectoral policies;
2. in most cases, it comes down to clawback policies, rather than preventive policies;

3. the sectoral breakdown of environmental policies poses problems of coherence and internal coordination, and can generate a 'phenomenon of problem displacement';
4. there is a significant focus on emissions, which is not enough to fully grasp the issue of environmental protection;
5. environmental policies are seldom, if ever, designed to coordinate all the uses (exploitation, protection, etc.);
6. the question of the distribution of property rights is rarely taken into account by environmental policies, although it is an element affecting behaviours;
7. policies are often related to profit pur cause de vicinage, which leads to a reduction in considered 'sustainability space' (Mayer 2008)

From these first analyses, the proponents of IRR distinguished three concepts of environmental policy and discovered their paradox. The first concept, the *classical concept*, is less sustainable and *is merely thought of in terms of limiting polluting emissions* (Knoepfel and Nahrath 2005: 207). The second concept assigns the objective of sustainable development to environmental policies: it is about reconciling ecological, economic and social requirements around the uses of a resource. It is possible that this kind of policy may well represent an improvement on the first approach, but it is nevertheless not wholly satisfactory. Indeed, *sustainability policies* should focus essentially on 'the terms of distribution of the quantities of resources being exploited' in order to meet the above ecological, economic and social requirements (Knoepfel and Nahrath 2005: 207). This logic presupposes a fairly abundant resource that can ensure the continued production of the requested assets and services. Moreover, as is seen with classic concept policies, standards only constrain the ingress of immissions and polluting emissions. Therefore, an '"ecologically clean" overexploitation of the resource' may occur, and the trajectory of uses becomes unsustainable (Knoepfel and Nahrath 2005: 208).

The criticism of environmental policies arising from these two concepts gives rise to the proposition of a third concept which aims to actually coordinate uses in a sustainable way. Some authors defend the effectiveness of those environmental policies that are necessary in order to

distinguish the resource from its uses (Gerber et al. 2009; Varone and Nahrath 2014). This thesis sets out a realistic point of view of all the debates on water management, and it is a position that is being increasingly widely accepted. Its main advantage lies in the fact that the resource is separated from the service. It then becomes possible to think in more detail about the use, ownership and so on without taking an a priori normative position on the status to assign to the resource. Ultimately, this distinction facilitates a dialogue between stakeholders and the approach gains in realism and effectiveness because of its increased accuracy. We will call this third group of policies *distinctive sustainability policies* (Bolognesi 2014b).

The theoretical limits of the approach taken by public policies come together with the empirical limits that we have just set out and are twofold.[1] Firstly, this approach only addresses the resource through sectoral analyses that are isolated from each other, which therefore means it is not possible to gain an overall grasp of the issue of sustainability (Knoepfel and Nahrath 2005; Varone et al. 2008; Gerber et al. 2009; Varone and Nahrath 2014). This limitation is the result of a concept of public policies that tends to cut out the problems that have been identified (see above, remarks 1 and 3 in the extract from S. Nahrath 2003). Secondly, given that property rights do not form part of the analytical framework, we must forego, on the one hand, the understanding they provide us with of the strategies of actors and, on the other, the ability to anticipate the impact of the measures. In summary, the public policy approach allows precise inroads to be made with regard to the object being studied, but it is lacking in transversality and does not include all of the essential determinants of the key players' behaviour.

To address these limitations, proponents of the IRR suggest articulating a public policies approach to the institutional economy. Indeed, as we have seen in the previous chapter, institutional economics focuses on the coordination of stakeholders around a given problem. Property rights, as well as other concepts that provide an insight into the process of coordination, lie at the heart of an analysis that is then able to detangle the links between different public policies. The concept of property rights within the framework of the IRR is referred to primarily in the work of

D. Bromley (1991, 1992) and E. Ostrom (1990, 2002; Schlager and Ostrom 1992).

We can infer from these references that the IRR approach is strongly influenced by thoughts on common assets, and an input by means of resources. It also places the analysis of property rights within their specific institutional context. With regard to the first point, affiliation with the idea of common assets implies that the uses being analysed are in competition with each other but are not exclusive and *in extenso* leads us to think about commons in terms of impure public assets. Looking at the second point, the input by the resource allows the focus to be placed on the uniqueness of the use of assets and services to be associated with a natural resource. This entry appears to us to be a positive point in this approach and it only increases its relevance. In addition, the authors show a real will to theorize the concept of resources, including references to the works of L. Kebir (2004, 2010; Kebir and Crevoisier 2004). As for the third point, it should be noted that this approach to property rights in their institutional environment belongs to the second generation of the classical theory of property rights, as discussed in the previous chapter. The inclusion of the institutional context is intended to account for the effectiveness of coordination and expand the scope of analysis beyond the contractual relationship. This way of looking at property rights adds a macroeconomic dimension to the IRR that allows us to continue our comparative approach to explaining the stylized facts. This contribution to the second generation of the classical theory of property rights makes the theoretical approach in Chap. 5 coherent and we will refer to it over the following pages. It appears as a communal ontology between the two research programmes although, compared to the NIE, the IRR accentuates the role of conflict in the coordination process.

The IRR research programme postulates a compatibility between the analysis of public policies and institutional economics. Thus enriched by the complementarity between the two approaches, the research programme moves beyond the theoretical limits highlighted at the beginning of the section (Gerber et al. 2009). These introductory remarks allow a characterization of the approach by the IRR. This approach combines an analysis of public policies and of institutionalist economics specific to the

study of the management of natural resources. In particular, it questions the sustainability of the management practices of a resource and of its assets and related services. Its axiom limits the field of study to the territories in which formal rules are the primary source of regulation—essentially the OECD countries. As we have seen, the work of the AFD on the database of national institutional profiles confirms it is indeed relevant to restrict the analysis to formal rules in OECD countries, illustrating the high degree of formalization of regulatory systems (Meisel and Ould-Aoudia 2007). This focus on written regulations allows the essential elements of motivating factors to be set out, thus framing the choices of key players involved in UWSEs (Bolognesi 2014a).

This description reflects the IRR research programme in its original version. Recent theoretical developments seek to complement the macroeconomic side of the analytical framework by inserting the specificity of localized coordination through, in particular, the notion of arrangements of localized plans (ARL) (Bréthaut 2012, 2013; Nahrath et al. 2012; Schweizer 2012, 2015; De Buren 2014). The concept of ARL seeks to account for local declines in the formal rules contained within an IRR. It seeks to increase the realism of the approach in terms of IRR, and is similar to the rules proposed by E. Ostrom (1990, with Schlager and Ostrom (1992)). C. Bréthaut (2012: 61) insists on this dichotomy between IRR (general) and ARL (local):

> All of these formal rules constitute the [IRR] of urban networks of water. On a local level, these rules are then re-appropriated by the key players according to the conditions and needs resulting from the particularities of the perimeter. Therefore, the [IRR] materializes by means of formal rules, but also through a local regulatory framework consisting of a configuration of specific actors, self-organization and informal arrangements.

C. Bréthaut then defines the ARL as:

> a set of decisions that, more or less formally, and more or less robustly compared to the formal rules of the IRR, define usage rights on assets and services produced by one or more resource systems. (62)

In the end, as in the analysis by J.R. Commons (1934) which looks at 'working rules', actors adopt strategies in the face of the IRR regulations: implementation, completion, workaround, diversion. Despite the relevance of such strategies, this broadening of the research programme's positive heuristic is not seen here. The main reason for this choice is the concordance between our observation phase and the data that is necessary when using the concept of ARL. Beforehand, ARL requires a fine analysis of the strategies of actors with regard to the regulations within a defined contingent environment. However, the observation phase of this research would have needed to be in another form to make the transversal phenomena of the modernization of UWSEs emerge.

The Positive Outlook of IRR: Identification of Regulatory Modalities for a Natural Resource

The positive aim of the research programme is to account for the governance mechanisms at work in regulating a natural resource, and to demarcate the principal economic approaches that have the same objective:[2] the classical theory of the economy of the environment, the theory relating to 'common pool resources' and new institutional economics.[3] I. Calvo-Mendietta (2005, 2006) highlights the reasons why these main approaches are inappropriate for proponents of the IRR:

1. These do not adhere, a priori, to the idea of a supremacy of the private ownership regime and the regulation by the market in the strict sense;
2. the framework for an analysis of 'commons' is too restrictive and does not allow for an analysis of situations in which there are multiple uses of the resource (Ostrom 1990, 2011);
3. in the case of natural resources, the analysis must be put in context and confined to certain territories. The contingency of the studies is defended.

Box 6.1: The Limits of Classical Environmental Theory and of 'Common Pool Resources' for Supporters of the IRR

Traditionally, classic environmental and economic theory is divided into two branches. The branch resulting from the work of R. Coase calls for an allocation of resources through the market and considers the private property regime to be most likely to meet the efficiency criteria. The Pigouvian branch 'advocates active intervention by the state through direct regulation of so-called "economic" instruments' (Calvo-Mendietta 2006). Three main criticisms can be levelled at these approaches. Firstly, the assumption of a dominance of private ownership is increasingly unfounded. Secondly, the effectiveness of public policies based on economic instruments is not assured, because these instruments may be inappropriate. Finally, the notion of territory is eliminated.

An analysis of common pool resources integrates territories (institutional and local specificities). It comes close to the specificity of the terrains studied in relation to conventional analyses that are ahistorical, that are not sited and that only take into account the state and the market (Ostrom 1990, 2010; Berkes et al. 2001). However, analytical hypotheses are very restrictive; for example, when looking at less than 15,000 users and uniform usage (Ostrom 1990: 40–42). Thus, as illustrated by Young (1992) and Knoepfel et al. (2001) the 'common pool' is only relevant to instances of single usage, such as a community of irrigators, for example. Such instances do not occur in relation to the urban management of water in Europe (Gerber et al. 2009). This framework is therefore too restrictive for us.

An IRR is a method by which to govern the uses of a natural resource within a particular territory. There can be multiple users and heterogeneous practices (Table 6.1). Thus, an IRR is defined as the sum of public policies and property rights regulating the uses of a resource (Knoepfel and Nahrath 2005; Varone et al. 2008; Gerber et al. 2009). As highlighted in the previous section, for the sake of realism, the analytical framework results in a focus on public policy and the structure of property rights. Therefore, in order to take into account the interactions between these different regulatory elements, an IRR splits into two components—design policy and the regulatory system—that refer respectively to public policies and property rights. The influence of the two components in the regulatory structure varies from one IRR to another, allowing plans that are mainly organized according to the structure of property

Table 6.1 Classification of situations of usage and relevant theories

Number of users	Types of use	
	Uniform use: a single asset or service	Multiple uses: wide range of assets and services
Single user	Single use	Multiple uses
Multiple users	Common use ➔ *Common pool resources*	Joint uses ➔ IRR

Source: Gerber et al. (2009: 800)

rights to be distinguished from those where policies are the main mode of coordination. Seen within the context of a UWSE, these components largely belong to water institutions and more particularly to the institutional structure of a UWS, and they impact the urban water cycle. This framework provides methods with which to explain the third stylized fact, in terms, and from a point of view, identical to those which were used to help construct our observation phase of the modernization of UWSEs.

The political design includes six items and the public policies that deliver them (Knoepfel and Nahrath 2005). These six building blocks take up the classic elements of an analysis of public policies. It comes down to:

1. definition of the issue and collective goals;
2. the causal model[4];
3. Public policy actors: targets, beneficiaries and administrative stakeholders;
4. policy instruments;
5. politico-administrative arrangements;
6. and outputs.

The political design leads to the formulation of a public policy that impacts on how the resource is used. As part of the IRR, an understanding of public policy is achieved by means of a study of public law,[5] postulated to be the formal manifestation of public policy. Finally, the design policy and public policies contribute to the definition of usage rights of the resource.

The second component of an IRR, the regulatory system, includes formal property rights apropos the resource, as well as usage rights and

ensuing disposal rights.[6] *Private law*,[7] corresponding to the French civil code, formally expresses the rights of the regulatory system. Thus, private property rights result from the regulatory system, while usage rights are jointly defined by the regulatory system and design policy. F. Varone et al. (2008) explain this joint definition by the fact that, in general, public policies limit or refine those usage rights distributed elsewhere:

> The definition of these usage rights results from the combination of standards ensuing from private and public rights. While private law established in the Civil Code is the basis of absolute ownership, public law tempers this absolute right by imposing usage restrictions through public policies (cf. Article 641 of the Swiss Civil Code). (Varone et al. 2008: 7)

The possibilities for articulating these two components are multiple and form four types of different regulatory models (Knoepfel and Nahrath 2005; Varone et al. 2008; Gerber et al. 2009). Modes of regulation are distinguished from each other on the basis of the impact of the political design and the regulatory apparatus pertaining to the rights of ownership and use (Fig. 6.1). Those modalities falling under type 1 are neutral to the system of rights and are essentially the creation of incentive mechanisms. Type 2 modalities have a low impact on the structure of rights by means of clarifications or limitations *ex post* to the distribution of rights. Type 3 modalities change the extent and content of rights by redefining the institution that is the formal property, for example a change in the civil code. Finally, type 4 modalities redefine the distribution structure of property titles, as in the instance of privatization. During the empirical application, the identification of these modes specifies the driving forces for coordination within an IRR, and helps explain the direction of the evolution of the regime (Kissling-Näf and Kuks 2004). Modes 3 and 4 are the most stable over time because they rely on changes in rights.

Beyond the operation of different modes of regulation, the framework provides a representation of a usage system for a resource as perceived within the framework of the IRR. It is possible to distinguish three central entities: the IRR itself, the actors and the resource. These entities are all linked together. This concept turns out to be compatible with our definition of a UWS from two points of view. Firstly, the institutions are

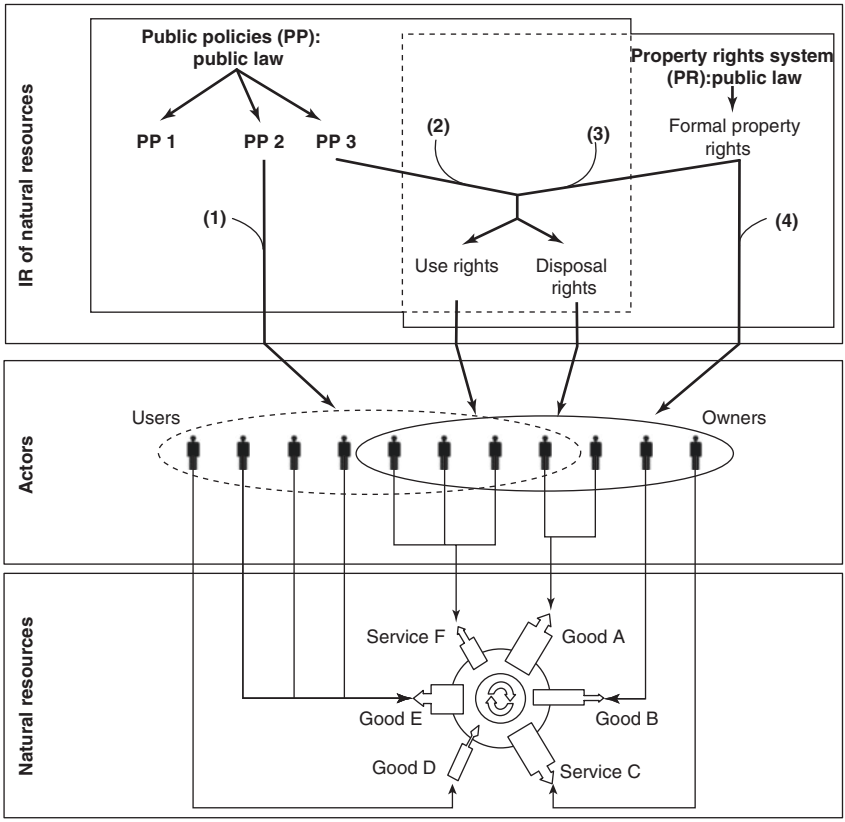

Fig. 6.1 Regulatory terms within an IRR (Source: Gerber et al. 2009: 804)

separated from socio-economic uses, hence we have *water institutions* and the *urban water cycle*. Secondly, the actors are twofold: owners and users, respectively representing the *deviation process* and *urban uses* in the UWS. For us, the resource remains an exogenous variable that is found within the territorial component of the institutional environment, while within the IRR framework, the notion of a resource becomes the subject of theoretical questions.

The Normative Outlook of IRR: The Search for an Integrated IRR for Sustainable Governance

The normative focus of the research programme is the formulation of recommendations to increase the degree of sustainability within the regulatory systems governing a resource. It is based on the explanation of a nomology that links the governance of a system to its potential for sustainability. The logical architecture of this outlook is structured around three analytical steps: identification of the perimeter of an IRR; its categorization; and the formulation of conjectures linking the characteristics of an IRR to its potential for sustainability.

> One of the major contributions of the IRR framework is its ability to describe the different configurations of regimes, both theoretically and empirically, and to predict their effect on the sustainability of a resource based on the hypothesis that high levels of regime extent and coherence are necessary preconditions for sustainability. (Gerber et al. 2009: 798)

The perimeter of an IRR is delimited by its *extent* and its *coherence*. As per this perimeter, the IRR being studied can be located in a generic typology of the IRR. Finally, depending on the extent and type of IRR, we are able to comment on the potential for sustainability of the system by means of three conjectures.

The notions of coherence and extent define the perimeter of an IRR. The extent refers to the number of assets and services regulated by an IRR. The extent refers to the quantity of rules and reports, and takes into account the breadth of the spectrum of activity of an IRR. To assess the level of the extent of an IRR, all assets and services associated with the use of a natural resource have been listed for different natural resources, including water (Reynard et al. 2001; Bréthaut 2012) (Fig. 6.2, Tables 6.2, 6.3, and 6.4). The ratio between the extent that has been observed, and all assets and services used, gives the *relative extent* of the IRR. This ratio indicates the possibility of non-regulated rivalries when it remains lower than 1, since it then means that the number of assets and services used exceeds that of regulated assets and services. On the other hand, when it exceeds 1, it results in over-regulation, i.e. assets and services that

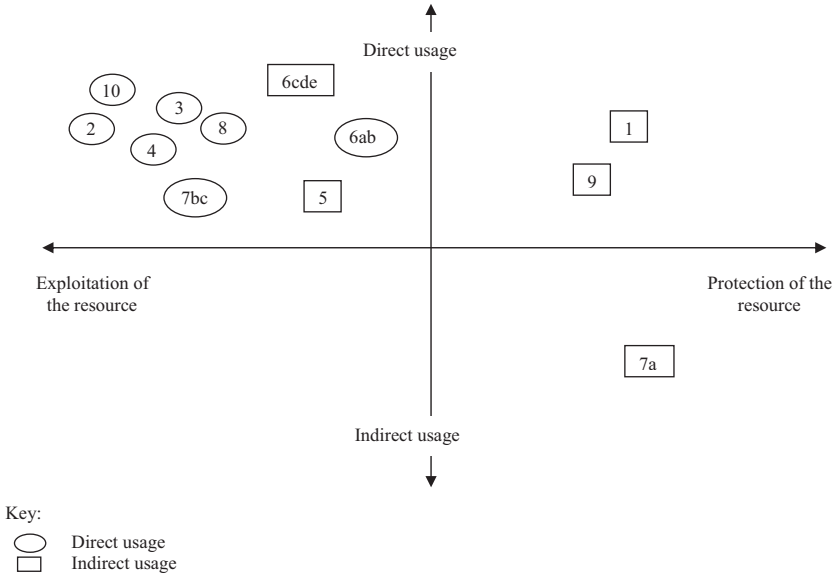

Fig. 6.2 Distribution of usages according to their purpose (Source: Reynard et al. 2001: 106)

have been used can simultaneously be the subject of several regulations. The difficulty in evaluating the extent lies in identifying the different uses of the resource and the associated regulatory acts.

The list drawn up by C. Bréthaut makes reference to the rest. This work accurately details the different uses of urban water. In addition, the list states the type of network associated with each usage, clearly referring to the two phases of the deviation process, the main rivalries and typical users. This valuable work, which draws comparison between the different elements of a UWS, also facilitates a continuation of the analysis. However, it should be noted that these lists remain anthropocentric, while the notion of the resource occupies a unique and central place in the ontology of the IRR research programme. To complete this list, we have referred to the Common International Classification of Ecosystem Services (CICES) (Potschin and Haines-Young 2013).[8] This classification

Table 6.2 List and generic classification of the uses of water resources

No.	Categories of use	Types of use by categories	Types of users
1	Vital environment	Food, reproduction	Living organisms
2	Consumption	Drinking water supply	Public communities (producers), households (final consumers)
3	Production	3a. Industrial water supply	Private, industrial or artisanal firms
		3b. Cooling of thermal power plants	Private or mixed companies
		3c. Agricultural water supply	Private farms, associations of irrigators
		3d. Drainage of wetlands for agriculture	Private agricultural companies and public authorities
		3e. Production of mineral waters	Private companies
		3f. Leisure and tourism infrastructure	Private companies or public authorities
4	Energy production	4a. Hydroelectricity (with dam and chute)	Private or mixed companies
		4b. Hydroelectricity (run-of-river)	Private or mixed companies
5	Transport and removal of waste and sediments	5a. Transport and removal of household, industrial and agricultural emissions	Public communities (producers), households and companies (final consumers)
		5b. Transport of sediment	
6	Support for economic or recreational activities	6a. Commercial navigation	Private and public companies
		6b. Pleasure boating	Individuals
		6c. Extraction of aggregates	Private companies or public authorities
		6d. Commercial fishing	Private companies or independent professional fishermen
		6e. Recreational fishing	Individual fishermen, fishing clubs
7	Recreation	7a. Landscape	Individuals
		7b. Sport	Individuals
		7c. Thermal baths	Individuals

(*continued*)

Table 6.2 (continued)

No.	Categories of use	Types of use by categories	Types of users
8	Medical	Thermal baths	Clinics (producers), individuals (end users)
9	Geomorphological changes	9a. Terrain model	Public communities (producers), population and companies (end users)
		9b. Regulation of the hydrological cycle	Public communities (producers), population and companies (end users)
10	National stockpile	10a. Reserve in case of war	Public authorities, population
		10b. Fire supply	Public authorities, population

Source: Reynard et al. (2001: 105–106)

is intended to assist a consideration of ecosystem services by proposing a methodology that anchors the concept empirically, and facilitates the dissemination and exchange of factual information. Three main classes can be subdivided to distinguish between services: supply services; regulation and maintenance services; and cultural services. Combining these two taxonomies of water usage provides a holistic view of the urban water cycle and a base for considering its dynamics in terms of co-evolution.[9]

The second dimension of the perimeter of an IRR, *coherence*, refers to the content of and the coordination between the different regulatory sources of an IRR (Gerber et al. 2009). To complete the notion of extent and the idea of regulation quantities, it can be said that, to a certain degree, coherence relates to an indicator of the quality of the regulations. It reflects the intrinsic capacity—and, in their juncture, also the political design and regulatory system—to be relevant, effective and non-contradictory. Therefore, there are three distinct forms of coherence. The *internal coherence of the political design* ensures compatibility between its six constitutive elements on the one hand, and between the various public policies on the other. The *internal coherence of the regulatory system* means that property rights are clearly defined and non-contradictory. Finally, *external coherence* takes into account the good relationship

Table 6.3 Lists of the direct uses of water resources in a UWS

Uses	Categories of assets and services	Types of water supply network	Examples of rivalries	Types of users (examples)
Raw-water abstraction	Raw-water abstraction with regard to drinking purification	RWS	Quality of water harvested for the production of drinking water vs. agriculture within a protected area boundary of the source	Public authorities/private companies: network managers
	Runoff abstraction, protection from swells and floods	RWN	Runoff abstraction vs. ecosystem services delivered through rainwater flow	Public authorities/private companies: network managers
Raw water storage	Water storage before purification for drinking	RWS	Water purification vs. irrigation or artificial-snow production	Public authorities/private companies: network managers
Transport of raw water	Transport of raw water	RWS	Uses of network infrastructures for transport of raw water vs. use of water leaks for different ecosystem services	Public authorities/private companies: network managers
Production of drinking water	Treatment of raw water for drinking-water production	DWS	Lowering the level of raw water reservoir through hydroelectric production vs. quality of raw water used for drinking-water purposes	Public/private companies: producers Households/tourists/ industries: end consumers

(*continued*)

Table 6.3 (continued)

Uses	Categories of assets and services	Types of water supply network	Examples of rivalries	Types of users (examples)
Storage and distribution	Drinking-water storage	DWS	Capacity and storage time for drinking water vs. quality of water supply	Public authorities/private companies: network managers
	Distribution of drinking water	DWS	Distribution of drinking water vs. quantities of water available for hydropower	
Amenity purposes	Leisure and tourism	RWS, DWS	Amounts of raw water available for drinking-water production vs. artificial-snow production	Public authorities/private companies/households/ tourists
	Aesthetics (fountains, ponds, cleaning and watering	RWS, DWS	Watering gardens with drinking water vs. availability of drinking water as drinking water	
National stockpiles	Provision of the fire defence network	DWS	Maintenance of minimum storage reserves vs. use of reserves to offset peaks in consumption	Public authorities/private companies
	Storage of minimum quantities of drinking water in reservoirs	DWS		

(*continued*)

Table 6.3 (continued)

Uses	Categories of assets and services	Types of water supply network	Examples of rivalries	Types of users (examples)
Productive uses	Hydroelectricity (with reservoir, or run-of-river turbine)	RWS, DWS, WWS	Storage of water in a plant outside of the catchment area vs. amount of raw water available for drinking water	Public authorities/private companies
	Industrial water Agricultural water (irrigation, livestock) Production of mineral water	RWS, DWS	Industrial pollution vs. protection of sources or abstraction	Industrial, artisanal and agricultural companies; associations of irrigators
Drainage and treatment of wastewater	Evacuation of waste water for treatment	WWS	Waste-water evacuation capacity vs. overloading of the network due to rainwater	Public authorities/private companies: managers of the WTS
	Rainwater disposal	RWN	Sewage disposal vs. overloading of WTS if not separated into different networks	
	Treatment of waste water by a WTS	WWS	Optimal operation of WTS vs. seasonal variations of quantities of water to be processed	

Source: Bréthaut (2012: 51–52)

Key: *RWS* raw-water system, *RWN* rainwater network, *DWS* drinking-water system, *WWS* waste-water system, *WTS* water-treatment station

Table 6.4 Lists of the indirect uses of water resources in a UWS

Uses	Categories of assets and services	Types of water-supply network	Examples of rivalries	Types of users (examples)
Land use planning	Demarcation and development of building areas	RWS, RWN, WWS, DWS	Tourist urban development vs. rational management of the network of drinking water according to demand	Public authorities/property developers/landowners
Production of real-estate capital gains	Use of the infrastructure for land valuation of a building zone	RWS, RWN, WWS, DWS	Use of the network for the production of real estate capital gains vs. use of the network for coherent planning of the territory	Public authorities/property developers/landowners
Political use of the urban water network in a balance of power	Political use of network infrastructure in a balance of power	RWS, RWN, WWS, DWS	Political uses (supply capacities for a municipality that is well endowed with infrastructure) vs. water supply (dependent municipality with little of own infrastructure)	Public authorities/private companies: network operator

(*continued*)

Table 6.4 (continued)

Uses	Categories of assets and services	Types of water-supply network	Examples of rivalries	Types of users (examples)
The network as a mandate	Design, maintenance, or renovation of the network by a service company	RWS, RWN, WWS, DWS	Intended financial objectives of a private operator vs. quality of the services provided	Public authorities/private companies
	Financial investments in the network infrastructure	RWS, RWN, WWS, DWS	Intended financial objectives of a private operator vs. price of a cubic metre of drinking water sold to the tourist sector	Private companies
Hydroelectric production	Use of the drinking-water network or waste-water network for hydroelectric production	WWS, DWS	Production of hydroelectricity through the drinking-water network vs. ecosystem services benefiting from leakages in the drinking-water supply network	Public authorities
Navigation	Use of the raw-water network for navigation	RWS	River transport vs. hydroelectric production (flow variation)	Private companies

Source: Bréthaut (2012: 53)
Key: *RWS* raw-water system, *RWN* rainwater network, *DWS* drinking-water system, *WWS* waste-water system

between the two components of the IRR, for example correspondence between the target group and holders of rights. The assessment of the level of coherence then proceeds the other way round. It should be noted that it is about empirically identifying the number, importance and so on of the inconsistencies in the system, and then determining its level of coherence. There is no standardized, universal method of doing this, but experience shows that the number of disputes and the role of case law in the juncture between the components largely reveals the limits of the coherence of the system (Knoepfel and Nahrath 2005). Therefore, these two indicators are a good proxy of the level of coherence in an IRR.

These two concepts allow the extent of the IRR to be established, and their intersection constructs the axes of a typology that sets out four possible types of IRR: *non-existent, simple, complex* and *integrated* (Knoepfel and Nahrath 2005; Varone et al. 2008; Gerber et al. 2009) (Fig. 6.3). A non-existent IRR testifies to the lack of regulation of the uses of a resource; its extent and coherence are weak. A simple IRR reflects the emergence of regulations relating to the resource. Relatively few assets and services (low extent) are taken into account, but they are coherent (reduced number of sources of inconsistency). An IRR becomes complex when a significant proportion of the assets and services used is regulated (extended extent) but the regulation suffers from shortcomings (low coherence). Finally, an integrated IRR signifies a coherent regulation of all assets and services used (extended extent). This form appears more often when the regulation is public regulation or is handed down from a powerful local operator (Knoepfel and Nahrath 2005). Each IRR studied is classified on the basis of this typology.

Beyond its ability to provide a classification, we can interpret this typology as the 'life cycle' of the governance of a natural resource. Looking at it from a similar point of view, I. Kissling-Näf and S. Kuks (2004) use the term 'phase'. In carrying out this exercise, each IRR type represents a different stage of the development process involved in the long-term governance of a natural resource. Thus, if no regulations exist at its origin, the IRR is non-existent. Following the identification of collective action problems (on both a small and large scale), a number of regulations emerged. Their low number then simplified the alignment of the system by reducing the risk of incompatibilities and so on, resulting in a simple

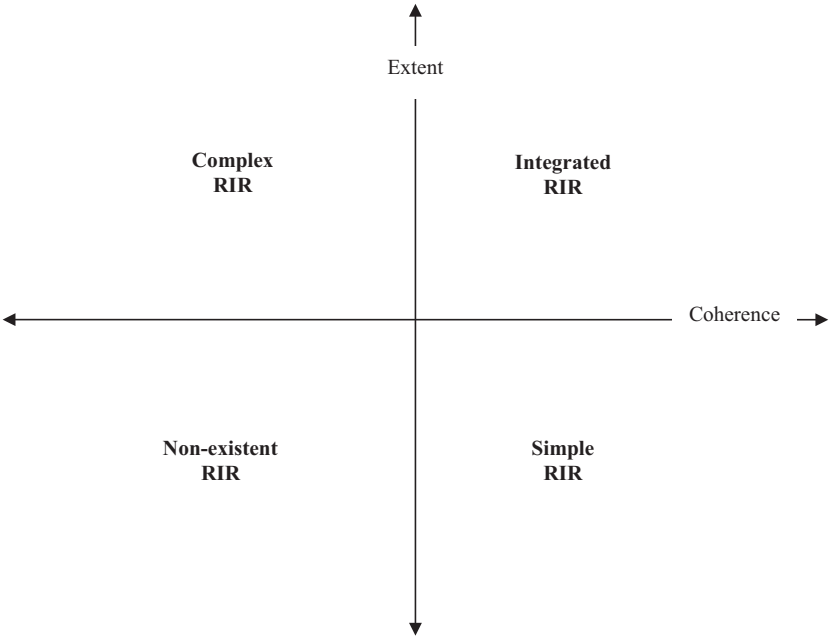

Fig. 6.3 Typology of IRRs according to their extent and their coherence (Source: Gerber et al. 2009: 806)

IRR. With usages multiplying (both in number and diversity), the number of regulations grows. The extent of the IRR increases to the point of being wide-ranging, but coherence then decreases because incompatibilities and implementation difficulties appear, resulting in a complex IRR. Finally, any governance issues are solved, and under the assumption that new sources of inconsistencies do not emerge, the IRR is characterized by its extent and high level of coherence—it is an integrated IRR. This is the ultimate form and is typically ideal because it maximizes the potential for sustainability of the IRRs.

At this point, it is worth making two remarks about the dynamics of regimes. Firstly, the sequence complex IRR—integrated IRR demonstrates a specific vision of institutional dynamics. Indeed, this sequence is based on the implicit assumption that the construction of governance operates through a process of trial and error, which is then consistent with accepting the rationale put forward by E. Ostrom (1990, 2005):

> If external factors do not change during a period of trial and error of the regulations, [the actors] should potentially find a set of rules operating relatively well in their circumstances. (Ostrom 2008: 62)

Secondly, there are no irreversible states or conditions in the governance development process. The sequence of types of IRR that a company is aware of is not necessarily as linear as the way in which we have presented it. In particular, it is reasonable to imagine that there is a significant amount of toing and froing in the transition from a simple IRR to a complex one, because of the adjustment of the governance process: changes in regulations, resolution and identification of new problematic areas, for example. Similarly, these steps can be skipped, which is what happens when a complex IRR or non-existent IRR returns to being a simple IRR.

Understood from the point of view of marking the steps taken in the process of developing a governance of natural resources, this typology can offer two different approaches to research: a positive or a normative one. A positive approach provides a way to account for the development as well as the state of governance and its mechanisms, either by synchronic and/or diachronic comparison, as can be seen in the early work on the IRR (Reynard et al. 2000; Aubin and Varone 2001; Knoepfel et al. 2001; Kissling-Näf and Kuks 2004). Moreover, the perception of the typology as a life cycle of governance can be found in a normative approach. In this second instance, the typology is implicitly based on one of the following two axioms: with the first axiom, the development of governance generates better coordination with each stage; the second axiom is that the development of governance encourages the system to improve regulations pertaining to usage of the resource (the real progress being seen at the final stage of evolution). This stage then succeeds a functionalist approach by the institutions: the remaining modes of regulation are the most effective in terms of coordination.

Also involved in a normative approach is that proponents of the IRRs formulate assumptions linking the typology of the IRRs to the potential for sustainability, which, in our view, is the major contribution of the IRRs.[10] It should be noted that the research programme tends to rely on the second axiom, which is necessary for the coherence of such a prescriptive approach (the development of governance leads

to improved regulation) and therefore embraces the idea of an institutional functionalism. Thus, conjectures on causation linking the expansion and the alignment of an IRR on the one hand, to the potential for sustainability on the other, are formulated.[11] The first conjecture states that moving closer towards an integrated form increases the potential for sustainability, resulting in two subconjectures, each specific to the extent and coherence of the IRR.

> It presupposes the existence of a causal relationship between the type of regime (in other words, its extent and its coherence) and the sustainability of the uses of a resource and therefore its reproductive capacity. Therefore, the more a regime comes closer to integration, the more chances to create conditions for the sustainable use of the resource. […] Hypothesis 1.1 is based on the idea that a lack of regulation in the behaviour of the users—in the absence of a precise description of usage rights provided by Government policies or the system of property rights—might cause strategic behaviours that could lead to overexploitation of resources. Hypothesis 1.2 is based on the idea that gaps or inconsistencies in public policies or the system of property rights (internal coherence), as well as between the two components of the IRRs (external coherence), are a major cause of overexploitation. (Varone et al. 2008: 12)

The second subconjecture refers to the evolution of an IRR. It establishes positive causality between the level at which resources are threatened, the perception of this as a collective action problem and, therefore, the expansion and coherence of the IRR.

> The hypothesis stipulates that the more the sustainability of the resource is threatened, the greater the probability that there is an increase in the extent of the system (new regulations for new uses) or an improvement in coherence (by introducing more binding mechanisms to coordinate the actions of different actors). (Varone et al. 2008: 12)

This game of speculation turns around the normative focus of IRR research programmes, in which sustainable usage of a resource is achieved through increased extent and coherence of the regulations. The approach thus makes sustainability a central objective in the governance of a natural resource and supports the need to build an integrated IRR.

Having presented the subject of analysis and theoretical elements, we will now use this analytical framework to explain the third stylized fact, establishing a pessimistic outlook on the condition and prospects for the sustainability of UWSEs.

2 Modernization and the Persistence of Inconsistencies: UWSEs in Complex IRRs with Limited Potential for Sustainability

This second chapter section applies the analytical framework to the case of UWSEs in order to explain the third stylized fact. We have divided this into three subsections. Firstly, we have prepared the subject of the analytical study by presenting the terms of governance of UWSEs as IRRs (section "The Modernization of UWSEs: Simple and Distinctive Sustainability Policies"). Then, there is a more detailed investigation, which aims to define the perimeter of UWSEs during their modernization (section "Definition of the Scope of UWSEs as IRR: Increased Extent and Low Coherence"). Finally, looking at these two stages, we have deduced the potential for sustainability in UWSEs, as brought about by the process of modernization (section "The Complex Form of UWSEs: An Explanation of the Lack of Sustainability of UWSEs After Modernization").

The Modernization of UWSEs: Simple and Distinctive Sustainability Policies

This chapter explains the third stylized fact using the analytical framework provided by the IRR. We adhere to the founding idea of the IRR research programme. An analysis of cross-institutional economics and public policies identifies, in an original way, the mechanisms that prevent the UWSE from following a sustainable path. This framework gives rise to a new explanation of the lack of sustainability of UWSEs in general, and in particular of the intensification of tensions based around the

economic pillar of sustainability. Initially we will resort to the positive capacity of the research programme in order to prepare our study subject for the normative analysis. This will allow us to consider the obstacles standing in the way of the sustainable development of UWSEs, as well as the way in which they are manifested. It is this normative stage that particularly interests us in this sixth chapter, because it offers the tools to directly respond to the problems posed by the explanation of the third stylized fact.

The evolution of the European regulation of water allows the singularities of the modernization of UWSEs to be highlighted by mobilizing the notions and concepts of the IRR. The different existing chronologies agree on the existence of three phases or generations (Kallis and Butler 2001; Kaika 2003; Allouche et al. 2008) (Table 6.5). In all cases, the modernization of UWSEs corresponds to the third phase of regulation. G. Kallis and D. Butler (2001) expand upon the work of G. Kallis and P. Nijkamp (2000) by limiting the three 'waves' identified by the latter in the following way: (1973–1986); (1987–1992); (1993– present). This first timeline is politico-administrative because it focuses on markers relating to the periodicity of European planning and the evolution of its goals. Thus, the first phase corresponds to the first three programmes of community action for the environment. The objective assigned to this phase is the harmonization of governance practices and protection of public health. The second phase spans the duration of the fourth framework programme, under which the Maastricht Treaty made the environment a fully-fledged European policy and placed a focus on environmental protection and pollution control. Finally, the third phase covers the fifth (1993–2000) and the sixth framework programmes (2000–today), and maintains the environmental protection objective, pushing for deregulation and strengthening the principle of subsidiarity.

M. Kaika (2003) proposes a legislative timeline. It sequences European regulation by looking at the normative acts that witnessed a turning point in the subject of European legislation, and not according to the tempo of the Community institutions. This study by M. Kaika uses the following periods of time: (1975–1990); (1991–1996); (February 1996– present). The first phase opens with the European directive on surface water and

Table 6.5 A look in parallel at the three different chronologies of the European water policy

	G. Kallis and D. Butler (2001)		M. Kaika (2003)		J. Allouche et al. (2008)	
	Date	Content	Date	Content	Date	Content
Phase 1	1973–1986	Harmonization Environmental protection	1975–1990	Water quality	1973–1988	Protection of water for usage
Phase 2	1987–1992	Environmental protection Pollution control	1991–1996	Limiting of emissions	1988–1995	Specific measures Command and control
Phase 3	1993	Environmental protection Deregulation Subsidiarity	February 1996	GIRE	1995	GIRE

Source: Created by the author with reference to Kallis and Butler (2001), Kaika (2003), Allouche et al. (2008)

reflects a focus on objectives relating to water quality. During the second phase, European legislation adopted an approach in terms of limiting emissions. The framework directive on urban waste water (UWWD) starts this phase. The third phase starts with the February 1996 communications from the Commission regarding European water policy. The new objective of the European water regulations lies in the implementation of the integrated management of water resources (IWRM).

The timeline put forward by J. Allouche et al. (2008) is based on the Euromarket Research Programme (2003–2005), and updates it. The periods of time based on this differ little from those presented by the other two analyses cited. This relative similarity can be explained by the fact that the timeline is based both on the pace of European planning and paradigmatic changes in legislation; in reality it layers the agenda of European directives. Allouche et al. propose the following sequence: (1973–1988); (1988–1995); (1995–present). 'Critical' directives are the 1975 surface water directives, the UWWD of 1991 and the European framework directive on water (WFD) of 2000.[12]

By reimagining these three timelines, we can summarize the way in which the content of European urban water regulations has evolved (Table 6.6). During the first regulatory phase, the European Union establishes rules to control the quality of the resource and to limit impact on usage, mainly via drinking-water standards and pollution thresholds. This type of regulation regulates the immission of polluting substances.[13] It forms part of two European policy objectives of the time: the harmonization of environmental rules—with an emphasis on facilitating trade—and the protection of public health (Kallis and Nijkamp 2000). The phase II regulations continue this effort and complete it by directly dealing with the sources of pollution and by targeting specific areas (urban water and so on). The regulations take the form of a system of command and control and focus on the emitting sources of substances that are degrading the resource. The aim of this pollution control is to achieve the objective of environmental protection, and not just to protect usage. It should be noted that these two generations of regulation are anthropocentric, while the second leaves a little more room for the environment (Euromarket 2003). Referring to the grid by P. Knoepfel and S. Nahrath (2005), these two generations fall under the classic design of

Table 6.6 Synthesis of the evolution of European regulations on UWSEs

	Phase 1	Phase 2	Phase 3
Objectives	Quality control Limitations impacting on usage Harmonization of EU environmental policies Public health protection	Continuance and strengthening of phase 1 Environmental protection	Sustainable development Rationalization
Instruments	Immission standards: Drinking-water standards Pollution thresholds	Immission standards Emission standards Specific targets: sources, sectors, etc. Command and control	Immission standards Emission standards Integrated water resource management Market mechanisms
Political design	Conventional policies	Conventional policies	Sustainability policy Distinctive sustainability policies
Regulatory system			Privatization Liberalization
Type of IRR	Simple	Complex	Complex

environmental policies. The regulation takes place mainly through mode 2 of governance: regulation by means of public policies impacting the value and content of property rights.

The third regulation phase, currently underway, is a paradigmatic break with previous periods. Rather than continuing to manage the resource and its uses in an ad hoc and sectoral way, the European Union advocates IWRM. The objectives remain environmental in nature, but their achievement must be compatible with the development of human activities. At the heart of this generation is a strong focus on sustainable development, in addition to implementing the means that lead to such a development; the WFD sets this out in its fundamental principles (Bolognesi 2014b). The modernization of UWSEs is based on sustainability and gradually implements elements of distinctive sustainability policies. With regard to the forms of UWSEs such as IRR governance, the paradigmatic break brought about by modernization occurs at two

levels: a change in the content of the elements of political design, and the transformation of the content and balance of the types of regulation.

Modernization brings about a change in six of the elements of the political design of UWSEs (Bolognesi 2014b). The first element, which pertains to collective objectives, is found in the implementation of sustainable development, and not only in the protection of urban uses. The second element is that the causal model radically changes. Now, the formulation of the policies takes into account the fact that economic incentives and market mechanisms are best able to coordinate uses and allocate resources from a sustainable perspective. By way of proof, article 9.1 of the WFP postulates that 'water-pricing policies provide adequate incentives for users to use water resources adequately, and thereby contribute to the environmental objectives of this directive'. The third element is that the panel of stakeholders in public policy is growing. In fact, the participation of users, as well as the appearance of third-party players (regulatory agencies, etc.), becomes a key element of the policy. The fourth element is that, as a result of the change in the model of causality, the nature of the instruments used is also changing. The economic incentive takes on more importance and the rules try to establish the necessary conditions for the search for efficiency by means of market mechanisms (privatization, liberalization, use of price signalling, transparency, etc.). In corroboration of this statement, G. Kallis and H. De Groot (2003) attribute three strong trends that are common to all UWSEs undergoing modernization: 'naturalization', 'marketization' and 'rationalization' (see Chap. 2, section "The Shock of Modernization: Content, Dynamics and the Goal of Reforming UWSEs"). Finally, to put into practice the evolution of these elements, the politico-administrative arrangements and public policy also mutate.

Under the impetus of modernization, modes of regulation are transformed. Chapter 5 explained in detail the organizational developments involved in the development of the fifth element of the political design (politico-administrative arrangements), and we are simply rephrasing them with terms specific to the IRR. Two strong trends mark these developments. On the one hand, modernization enhances the use of regulation under type 1 and 4 modalities whereas, on the other, use of type 2 terms is maintained (F_{s19}, F_{s20}, F_{s48}). Among the policy instruments that

have been mobilized, the use of price signals and market incentives more generally means using regulatory modality 1. An incentive for public–private partnership (PPP), and the privatization and liberalization of the sector, are the modalities of type 4, which were barely present during the previous phases of regulation. Finally, the pursuit of a classical normalization aims to limit and frame the use of property rights that perpetuate the use of the modalities of type 2 regulation, the main instruments of the first two phases of European regulation. Multiplied as a result of the hybridization of governance, the contractual renegotiation procedures that form part of the contracts also belong to this type of regulation.

The lists of possible usage detail how tension has intensified in terms of the economic pillar of sustainability ($F_{s34,}$ F_{s42}, F_{s50}). In particular, C. Bréthaut (2012) illustrates that the deviation process provides indirect uses, such as the *network as a mandate*. The rivalries identified around this type of usage are equivalent to the tensions we have observed in relation to the network, i.e. a difficulty in encouraging operators to invest while the quality of the infrastructure degrades. A dichotomy can appear between the natural aims of private operators (profitability, etc.) and those of the delegator (quality of public service, etc.). S. Nahrath and P. Csikos (2007) talk about conflict between regulatory functions. The authors report eight regulatory functions in a liberalized public sector, a model that corresponds to a UWSE after modernization:

1. the physical management of the network;
2. the definition of access conditions and operation of the network;
3. the definition of the legal status of the operators and the owners of the network;
4. the rules of competition between operators;
5. the definition of public service obligations;
6. the arbitrage between usage rivalries and conflicts between users of the network;
7. the conditions of access to energy and natural resources;
8. interconnection with other networks.

Thus, the *physical management of the network* (regulatory function 1) is not in step with the functions of regulations 4 and 5, respectively the *rules*

of competition between operators and the *definition of public service obligations*. The paralleling of the various rules involved in the expansion of UWSEs explains the polarization of tensions around the economic pillar of sustainability.

Definition of the Scope of UWSEs as IRR: Increased Extent and Low Coherence

The modernization of UWSEs changes their perimeter. On the one hand, resorting to normalization increases the extent of UWSEs (section "Modernization as a Step Towards Sustainability: An Expansion Factor of UWSEs") while, on the other, modernization does not allow total alignment of UWSEs. Some inconsistencies persist and new ones emerge (section "The Persistence of Inconsistencies in Regulations: Limits to the Integration of UWSEs").

Modernization as a Step Towards Sustainability: An Expansion Factor of UWSEs

We have observed that modernization follows and continues the important process of standardization within the UWSEs. In this way, the modernization has the effect of increasing the absolute extent of the perimeter of UWSEs. At the origin of this expansion we can separate two different dynamics, each resulting from separate regulatory modalities (Table 6.7). The first dynamic identified refers to the classical development of technical normalization, and is mainly the result of type 2 regulatory modalities. We call it *expansion by control*. The second dynamic refers to the change in the form of the provision of services and is the result of the *self-organization* of the actors of the urban water cycle; it mainly develops with type 4 regulatory modalities.

The ontological principles upon which our analysis of UWSEs is based provide an initial characterization of these expansions. In the first place, the complex-system axiom brings about two expansion dynamics that are partly interdependent. On the one hand, they confront or

Table 6.7 The two expansion dynamics contained in the modernization of UWSEs

	Expansion through regulatory measures	Self-organization expansion
Definition	Increase of binding rules issued by public authorities	Increase of rules related to the implementation of governance principles
Sources	Public intervention (welfare state) Control on UWSEs' economic activity	Implementation of coordination conditions different from authority
Operating mechanisms	Formulation of technical standards, etc.	Property rights formalization Contractual coordination
Types of regulation concern	Type 2	Type 4 (for the most part) Type 1
Source in the institutional polycentrism	Institutional environment Legal structure	Organizational structure Water markets
Impact on extent	Absolute extent	Relative extent: uses require existence of specific rules
Examples	Prescriptions relative to the evacuation of wastewater by sewage works (UWWTD 1991/271EEC, Appendix II) Procurement procedures of entities operating in the water sector (Directive 2004/17/EC)	Sharing of responsibilities and property in contracts Specific modalities of contractual renegotiations

Source: Bolognesi (2014b: 276)

complement each other in order to bring about coordination (dialogical principle) and, on the other, they co-evolve and take into account the past and real impact (principle of recursion). The dialogical relationship between regulations based on control, and those originating from self-organization, involve a dual relationship, both antagonistic and complementary, between the two expansion dynamics. The principle of recursion characterizes the dialogical relationship between the two expansion dynamics. They shall then be interpreted as self-centric and intersectional reactionary functions. For example, the evolution of procedural standards for the recovery of costs (expansion by means of control)

depends on both pre-existing standards (expansion by means of control) and the constraints faced by the actors of the urban water cycle during the contracting and transaction (expansion by self-organization). This recursion, which links the rules, suggests a form of reflexivity in the process of governance (Brousseau et al. 2012). The dynamics of the expansion are the result, in part, of a strategy built from self-reflexivity and reflection on others, something that the circular mechanics between beliefs and preferences allows us to understand (see Chap. 5). To take up once more the tetragrammaton of E. Morin, order is thus the result of isolated disorders in interaction.

The work of G. Teisman (Teisman et al. 2009; Teisman and Edelenbos 2011) addresses the issue of fragmented coordination in terms of the theory of complexity (Cilliers 1998). The resulting output is in addition to our identification of the two expansion dynamics. The quality of the coordination is the synchronization of different modes and coordinating elements in the system. From this perspective, 'synchronization can be described as the occurrence of confluent circumstances, of two or more meaningful converging events or activities' (Teisman and Edelenbos 2011: 106). Within our framework, the integration of UWSEs depends on the external coherence level of the expansion dynamics by means of control and self-organization.

Secondly, the axiom of multilevel polycentric organization implies that the regulations arising from expansion happening by means of control or self-organization do not give rise to the same components of a UWS, and impact in differentiated ways (especially in terms of modalities of coordination and the stakeholders involved). As such, an expansion brought about by control results in more generic standards than expansion by means of self-organization. Expansion by means of control orients different urban water cycles, while regulations as a result of the process of self-organization are specific to a transaction. Finally, this interpretation of the modernization of UWSEs within the working framework of the IRR leads us, on the one hand, to conclude that the extent of UWSEs is high and, on the other, to argue that there are two different dynamics that animate this expansion (Bolognesi 2014b). Now let us specify the expansion of UWSEs in terms of shape and dynamics.

We define expansion by means of control as being an increase in the regulations issued by the public authorities aimed at guiding and restricting the practices of actors in the urban water cycle. The regulations involved in expansion by control focus on actors and, in relation to the evolution of the generations of European regulations, ensure that not only the quality of the services is upheld, but also the compliance with modalities of office (F_{s5}, F_{s23}). The process of technical normalization of uses of water, such as that in the UWWD, contributes to expansion by means of the control of UWSEs. This dynamic results from the multiplication of standards of immission, emission and process that are produced mainly by the public authorities to regulate water usage and its impact. The strong increase in criteria for drinking water illustrates this dynamic. In France, since the decree "limites et références de qualité des eaux brutes et des eaux destinées à la consommation humaine" of January 11 in 2007, about standards for water consumption, there were 56 regulatory parameters compared to five at the start of the twentieth century and about 20 in the 1950s ($F_{s48,}$ F_{s51}). These standards do not necessarily mean an increase in the absolute extent of the IRR, but they may be combined in order to clarify pre-existing criteria, which illustrates the iterative nature of the construction of the IRRs, as discussed in the first section of this chapter. Similarly, procedural rules that impede the contractualization proceed from an expansion by means of control.

The timeline of European regulations allows the meaning of this expansion to be broken down and specified; it appears that the very objective of control has evolved. Originally, technical standards were used to achieve health goals and they restricted the immission of polluting materials in the resource in a general manner. Subsequently, it was an environmental objective for the protection of the resource itself, to which emission standards corresponded, enriching the expansion (F_{s10}). This 'revival' of the expansion took place in the 1970s (Kissling-Näf and Kuks 2004; Aubin 2007; Bolognesi 2014b). At the same time, identification of particularly sensitive areas leads to the production of specific technical standards in the areas targeted, as illustrated by the tables in the Appendix of the UWWD. Finally, over the course of modernization, attempts at a harmonization of practices and so on led to the emergence of procedural standards. These standards control usage within their very execution (for example, obligation for technical sanitation), and as a result governance is no longer just a matter of

assigning performance targets. This expansion also grows in response to an increase in environmental considerations and sustainability objectives, i.e. new public issues appear and require coordination solutions. Moreover, the reason for the control has also evolved. The development of the market's hold and of private actors in the provision of urban water services pushes public authorities to more systematically provide a framework for the activity by means of standards that address possible negative externalities and maintain the general interest linked to the resource.

We define expansion by means of self-organization as being a mechanical increase of rules resulting from, and necessary for, the implementation of a form of governance, typically contracting between private actors. It takes the form of an increase in the number of formal property rights and contracts (F_{s20}), and represents the contingent features of an institutional arrangement: identification and structure of property rights, contract clauses and so on. In comparison to expansion by means of control which, from a teleological perspective, focuses on the goal of coordination, then expansion by means of self-organization expresses a stronger coordination modality for actors, following the modernization of UWSEs (F_{s11}, F_{s17}, F_{s20}). It embodies a choice of hybrid institutional arrangements and the increased reliance on contracting for organizing the urban water cycle.

Expansion by means of self-organization helps put the economic pillar of sustainability at the centre of the IRR. The formulation of rights of property for market governance illustrates this dynamic. This second expansion dynamic of the regulation of UWSEs is a direct consequence of the application of governance principles incorporated in modernization. Indeed, modernization encourages changes in the terms of regulation of UWSEs, two of which appear to be essential. On the one hand, the encouragement of the PPP, and privatization in general, leads to a redefinition of the structure of the distribution of property rights (regulation mode 4), with the privatization of the English RWA in 1989 being the most symptomatic example. On the other hand, the generalization of the use of economic instruments with a view to rationalizing management increases the importance of regulatory mode 1 in the governance of UWSEs. The change in substance or form of these two modes of regulation brings about the liberal orientation of modernization highlighted in

the first section. It confers a growing importance on the market, and market coordination implies formal regulation (Ménard and Ghertman 2010). Thus, we have seen an increase in sectoral rules specific to European and national levels, but also the proliferation of generic rules affecting the organization of public procurement, contracting procedures and territorial governance (F_{s19}, F_{s20}).

The marketization of UWSEs is the central engine of this second dynamic of expansion. Indeed, market exchange firstly requires the existence and/or the definition of property rights and then operates via the formation of contracts between actors. With contracts being regulatory acts, we affirm that liberal regulation and the market supply of urban water services essentially result in an increase in the scope of the assets and services regulated formally in UWSEs. Indeed, prior to the exchange, privatization and liberalization in a capitalist economy imposes the formulation and definition of property rights. In addition, by increasing the number of different actors in the urban water cycle, the de-integration of the sector still multiplies the number of formal acts governing the activity of UWSEs. These actors exist within the UWSEs as holders of property rights, and are linked together by contracts. The fragmentation of property rights subsequent to the modernization of UWSEs therefore accelerates the dynamic of expansion by means of self-organization. The number of required property rights increases, as do formal acts regulating the use of these property rights. In this sense, the modernization of UWSE governance represents an expansion of the IRR as a result of its very process. In particular, it signifies a relatively large expansion, because each property and service used will be formally regulated by the market, since these are not an exception.

Knowing that the extent of UWSEs has increased allows the characterization of UWSEs to be refined by using the typology of the IRRs, and delivering an intermediate opinion on their potential for sustainability. Firstly, among the four forms of IRR, only the complex IRR and integrated IRR display high extent. The UWSEs belong to one of these two categories and the forthcoming analysis of their coherence will allow us to decide which one. Then, by virtue of the conjecture 1 of the IRR framework, which links extent and sustainability, we can assume that modernization exercises a beneficial trend on the sustainability of UWSEs by

increasing their extent and ensuring a high level of relative extent. This high level of extent reduces a priori the regulation deficits in UWSEs and should ensure the coordination of the actors around all assets and services exchanged in UWSEs. However, the quality of governance depends on both the extent and governance. Presently, the coherence criterion is decisive for judging the overall potential for sustainability conferred by the modernization of UWSEs.

The Persistence of Inconsistencies in Regulations: Limits to the Integration of UWSEs

An analysis of the coherence of an IRR consists of the study of coherence of policy design, the regulatory system and their cross-consistency. To conduct this analysis we are looking for inconsistencies and malfunctions both within and between the various elements of regulation of UWSEs. For example, in England, the cues coming from OFWAT and the EA diverge and generate inconsistencies on the basis that both entities deal with a pillar of sustainability without working with the other controller. Similarly, in France, strong inconsistencies appear between the upheld tariff policy (incentive pricing and recovery of total costs) and local practices (volumetric pricing) (F_{s56}). These inconsistencies are also very visible when the German ideal-type of management is considered. This is quite resistant to the principles of modernization as it defends a local public management that is strongly related to politics, and one which does not take the scale of the catchment area as a reference point. In the end, the results confirm the conjecture that inconsistencies remain, despite the obvious attempt of modernization to end these limits to sustainability by way of harmonizing European water management principles, common procedural rules and a rationalization of the public order. In other words, these inconsistencies provide a first explanation for the third stylized fact. We set out the level of coherence of UWSEs by distinguishing different forms of coherence—in ascending order of inconsistency, the internal consistency of the regulatory system, followed by the political design and finally the external coherence that is common to these two components.

The regulatory system turns out to be the most coherent component of UWSEs. Users and actors in the deviation process are the sole owners of property rights in a UWS. In addition, an analysis of the internal coherence of this component results in an emphasis being placed on the distribution of property rights within the urban water cycle. This is to determine if the rights are well defined and if they are clearly divided from each other, which a priori seems to be the case due to the very field of study. Indeed, European territories are particularly appropriate for an analysis in IRR terms thanks to their predominantly formal regulatory systems (Meisel and Ould Aoudia 2007). However, this long tradition of coordination based around property rights has enabled all institutions and organizations to be in a position to ensure the coherence of the regulatory system. Accessible registers identify existing property rights, the definition of property rights and contractual terms takes place based on common operating procedures that are known by the actors, proceedings ensure a common and homogeneous use of these formal acts and rights are protected, and so on. All these measures help to ensure the internal coherence of the regulatory system of UWSEs.

However, it should be noted that this internal coherence is not necessarily equivalent to stable and clear management during interactions between actors. Indeed, the multiplication of stakeholders also generates an increase in sources of strategic uncertainties and opportunities for conflicts which, thanks to the internal coherence, will be processed and/or regulated as a second stage. The development of public bureaucracy, as noted above, through dispute settlement bodies and the implementation of case law, forms part of these second-stage adjustments. Analyses undertaken by K. Bakker (2000, 2001, 2003, 2010) on the privatization of urban water systems illustrate the harmful effects of this incompleteness and the imperfection of contracts; in particular, English ones from the turn of the 1990s.[14] K. Bakker shows that operators have taken advantage of privatization and the price-capping system to increase their profits without either taking or providing all the investment needed for the English UWS (F_{s28}, F_{s33}, F_{s34}). This opportunistic drift was subsequently countered in two ways. Firstly, regulators forced operators to increase their transparency, defined the notion of excessive prices, and changed the price ceilings (OFT 1999; OFWAT 2000). Consequently, regulators

considered eliminating identified arbitration and protecting themselves from aftershocks. Then, users applied to the courts for companies to readjust their practices (Bakker 2003). This example highlights that the evolution of property rights (regulatory mode 4) does not produce the expected effects and the problem of the level of investment in UWSEs is a crucial issue (Chenoweth 2012; Stern 2012; Bolognesi 2014a) (F_{s26}, F_{s27}, F_{s28}).

The analysis of the internal coherence of UWSE design policies gives rise to a consideration of water institutions, including multiple links between the socio-economic dimension of the institutional environment and the three different institutional structures (legal, organizational and political). The analytical objective lies in the identification of friction between these four different elements. The political design of the modernization of UWSEs suffers more from internal inconsistencies than the regulatory system. The two major revealers are the debate on achieving a good environmental condition of bodies of water and, more generally, the difficulties of ensuring that local management complies with European directives (F_{s45}, F_{s48}). The objective of waters reaching a good environmental status before 2015, a goal in which urban usage plays a major role, has not been achieved and is facing an explosion of exemption measures (Bolognesi 2014b, 2014c).[15] There are two important pieces of data: currently, one-third of European water bodies are the subject of an exemption, and in 1/3 of EU countries, at least 50% of the country's water masses are exempt. In addition, scientists have reservations about the methods used for measuring efforts and the results achieved with regard to their rigour and comparability/diversity; thus, it is possible to relativize the classification of certain waters (Hering et al. 2010; Beniston et al. 2012). Compliance at a local level with the governance advocated by the WFD is no longer obvious (Bolognesi 2014a). One example of this is the German resistance in the face of privatization. Thus, coordination between different levels of governance of UWSEs presents malfunctions that reduce the coherence of the political design of modernization. The main elements questioned are the policy instruments and administrative arrangements. Nevertheless, European adjustments should be noted: the WFD has been amended three times, on the point of flexible possibilities for external financing in the water sector, for example.

The main sources of coherence within UWSEs lie at the crossroads of political design and the regulatory system (Bolognesi 2014b). To identify them, the interaction between water institutions and the urban water cycle should be examined. All disputes between the states and the European Commission reflects these external inconsistencies. Representing about 20% of the litigation, water is one of the areas that sees the most frequent violations of European environmental law (Keller 2011). With 56 and 57 offences respectively, the United Kingdom and Germany see fewer offences than France (74). Belgium comes bottom of the class with 109 offences identified in December 2010. In order to consider the risks involved, the sanctions pertaining to French case C-280/02 that covers urban waste water are estimated at several hundred million euros (Keller 2007). These poor statistics illustrate the difficulty of achieving the required objectives by means of modernizing UWSEs through incentives and the implemented regulations.

Equally, it appears that technical standardization leads to a complexification of the deviation process within urban water cycles of UWSEs. This increased complexity generates dysfunctions in the system as operators struggle to integrate the new rules. The evolution of the standardization of drinking water illustrates this complexity. B. Barraqué (2005) recalls that in the nineteenth century the level of drinking water was assessed against six criteria, whereas today, more than 60 are needed. This expansion by means of control explains the proliferation and strengthening—based around the economic pillar—of the obstacles to UWSE sustainability. Moreover, the positive phase of the analysis stressed that the issue of the assets of UWSEs focus on a prominent antagonism between the strategies of key players and the objectives integrated into public policies of modernization. In reference to usage lists and work on regulatory functions carried out by C. Bréthaut and S. Nahrath, external coherence issues in particular signal an inability to manage the indirect uses of the urban water cycle in an integrated and harmonious manner (service quality vs. economic efficiency, for example). Thus, the policy instruments involved with modernization do not seem to be at all effective and can generate overloads that slow the alignment of UWSEs (F_{s50}, F_{s51}, F_{s52}).

The coherence of UWSEs is not high, mainly because of the difficulty of organizing a multiscale and harmonious policy. This lack of coherence

appears in particular on an external level. Members therefore strive to increase coordination between the different regulatory elements of UWSEs. Knowing the perimeter of UWSEs, we can deduce the type of IRR to which they belong and the potential of sustainability conferred upon them by the modernization process.

The Complex Form of UWSEs: An Explanation of the Lack of Sustainability of UWSEs After Modernization

Looking at the characteristics of their perimeter—strong extent and weak coherence—we can deduce the type of IRR to which the UWSEs belong (Table 6.8). The two expansion dynamics that are injected with modernization place UWSEs with the IRRs in which the extent is high. This feature eliminates the possibility of a 'non-existent' or 'simple' IRR. The difficulties in organizing multilevel governance lie in maintaining the coherence of UWSEs to a level going from low to medium. This second characteristic precludes the possibility of an 'integrated' or 'simple' IRR. Therefore, the modernization of the management of water in Europe helps shape the UWSEs as 'complex' IRRs. If the will to solve coherence problems that are still present is taken into account, we can qualify the UWSE of complex IRRs as an attempt at integration. Identifying the evolution characteristics of the perimeter of UWSEs during their modernization allows the UWSEs to be classified in the typology of the IRRs and to deduce from them the sustainability potential resulting from the modernization process of UWSEs. We will then mobilize the normative dimension of the research programme, including assumptions of sustainability potential attributed to the types of IRR. These postulate that complex IRR are regulated by a governance that does not maximize the potential of sustainability, which explains why the modernization of UWSEs does not guarantee the achievement of a sustainable state (stylized fact 3).

This result provides a first explanation of the third stylized fact. Indeed, the analysis of the evolution of the perimeter of UWSEs during their modernization shows an increase in their scope at the same time as the

Table 6.8 Positioning of UWSEs within the typology of the RIR: modernization generates complex RIR

	Low coherence	High coherence
High extent	Complex RIR Impact of modernization on UWSE: Multiplication of formal rules (standards, contracts, etc.) Technical complexity Decentralization and self-reliance of behaviours	~~Non-existent RIR~~ Inconsistent with the low coherence of UWSE: Difficulties with implementing multilevel governance Organizational frictions Mild and variable efficiency of incentives
Low extent	~~Integrated RIR~~ Inconsistent with the high extent of UWSE: Strong technical standardization Property right formulation Multiplication of contractual relations	~~Simple RIR~~ Inconsistent with the low coherence of UWSE: Difficulties with implementing multilevel governance Organizational frictions Mild and variable efficiency of incentives Inconsistent with the high extent of UWSE: Strong technical standardization Property right formulation Multiplication of contractual relations

Source: Bolognesi (2014b: 278)

emergence of new problems, mainly around the economic pillar of sustainability. The expansion of the regulations is the result, on the one hand, of a greater integration of the environment and the resource in the governance and, on the other, of the adoption of liberal economic mechanisms designed to improve the efficiency of UWSEs. By imprinting these dynamics, the modernization process develops the sustainability potential of UWSEs. However, this multiplication of formal rules produces perverse effects, such as the growing complexity of the regulations or the exacerbation of organizational tensions, which reduce the coherence of the regulations, and consequently the sustainability potential of UWSEs. These tensions polarize at the interface between the economic pillar of sustainability and the difficulty in dealing with the condition of

the infrastructure, or cost-recovery measures, which speaks volumes about the potentially perverse effects of the expansion (Stern 2012; Bolognesi 2014a) (F_{s42}, F_{s48}, F_{s51}, F_{s56}). This first result offers an overview of the dynamics at the origin of the third stylized fact and develops the theoretical and empirical paradox to be discussed in the following section, which refines the identification of mechanisms leading to the fourth stylized fact.

3 Explanation of the Paradox of Modernization, or the Need to Extend the Dialogue Between NIE and IRRs

The results that have been obtained allow the third stylized fact to be explained, but equally highlight the paradox of modernization that results in a questioning of the analytical framework. This paradox is a challenge to the theoretical framework at the level of its founding conjectures (section "The Paradox of Modernization: An Intrinsic Inability to Integrate the UWSE and an Injunction to the Theoretical Review of IRRs"). By delving further into the complementarity between the NIE and the IRR, we shall propose theoretical clarifications relating to the issues that have been identified (section "Synergy Between NIE and IRR to Simultaneously Understand the Link Between Scope and Coherence and Discuss the Conjectures of the Explicative Model"). By always referring to the empirico-formal mode, we can work on these theoretical results to refine the explanation of the third stylized fact (section "Failure to Comply with the Requirements Governing Validity of the Conjectures of the IRRs: The Cause of Polarization of the Obstacles to Sustainability Based Around the Economic Pillar").

The Paradox of Modernization: An Intrinsic Inability to Integrate the UWSE and an Injunction to the Theoretical Review of IRRs

According to the previous analysis, modernization in its current state does not ensure that sustainability is developed to the maximum of its

potential. This consequence of the analytical order is based on the ambivalence of modernization. The explanation of the third stylized fact passes through a clarification of this ambivalence towards the simultaneously positive and negative effects of expansion by means of control and expansion by means of self-organization on the sustainability of UWSEs.

Expansion by means of control increases the amount of regulated assets and services, which directly enhances the potential for sustainability of the systems. However, it also alters this potential by rendering the system more complex. Through the standard, this regulation increases the technical complexity of the provision of services, which erodes the coherence of the system. Operators are struggling to integrate the new regulatory burden. Indeed, in some cases, they use this difficulty to satisfy regulatory requirements so as to create discrimination in putting forward their business strategies. Thus, L. Guerin-Schneider and M. Nakla (2003) illustrate that the three main french water companies resort increasingly to certification to improve their image among users on the one hand, and to increase their chances of eligibility under a tender procedure on the other.

Beyond this technical aspect, compliance represents a financial cost that may threaten the internal coherence of the policy design and the external coherence of UWSEs. This cost is not negligible since it represents the majority of the increase in supplier costs. It mainly comes from the emergence of sanitation standards and the growing complexity of the drinking-water processes necessary for compliance with the rules. Indeed, expansion by means of control increases the costs of providing the service by expanding the requirements related to the production process and making them more complex. However, in the face of these additional costs, the framework and rationalization of the governance processes set out by the procedural rules reduces sources of funding. The total cost recovery and the principle 'water pays the water' illustrates this type of regulation (Bolognesi 2014a). Tension therefore grows between the increasing costs on the one hand, and diminishing funding opportunities on the other (F_{s42}). It is in this way that the question of investing in infrastructure poses a major problem for the management of UWSEs (Bolognesi 2014a, F_{s33}, F_{s34}, F_{s44}).

These two remarks on the coherence of the IRRs attest to the existence of an area of tension between the technical component and the economic-institutional component of the process of expansion by means of control. This friction causes regulatory inconsistencies and ultimately results in the sustainability potential of the UWSEs being reduced. In addition, expansion by means of control reinforces the tension between the socio-environmental and economic objectives necessary for the achievement of the sustainable management of urban water services in Europe. This tension is in line with the third stylized fact, confirming that the limits for achieving the sustainability of UWSEs crystallize around the economic pillar of sustainable development, as well as efficiency issues and sustainability. This area of tension is one of the main sources of inconsistencies in the UWSEs and, to this end, constitutes a key element of the explanation of the third stylized fact.

Expansion by means of self-organization produces a similar effect on the sustainability of UWSEs. Through the use of property rights and contracts, it increases the extent of the system, ensures a relative extent of less than 1 and improves the potential for sustainability. Because of the characteristics of market coordination, this action does however reduce the coherence of UWSEs and reduce the potential for sustainability. Indeed, institutional economics is born from the notion of the incompleteness of property rights and contracts: they cannot take into account all possible evolutions of the transactions and do not completely remove any uncertainty (Demsetz 1964; Furubotn and Pejovich 1972; Alchian and Demsetz 1973; Barzel 1982). Market coordination does not eradicate *ex ante* uncertainty, so contracts require adjustments, and safeguards must support the contracts and property rights over time. This uncertainty implies organizational layout difficulties between the different regulatory elements and is a hindrance to the alignment of the IRR. In addition, the dialogical relationship between expansion by means of control and by self-organization becomes unbalanced because of more pressing antagonisms between the two dynamics. In general terms, G. Teisman (Teisman et al. 2009; Teisman and Edelenbos 2011) tends to speak about the desynchronization of coordination. As part of the IRR, we support more specifically the view that modernization limits the sustainability of UWSEs due to strengthened external inconsistencies.

We note that the positive impact of the two processes of expansion is counterbalanced by the appearance of inconsistencies, weakening the potential for sustainability of UWSEs. In this sense, modernization has a negative effect on the potential for sustainability of UWSEs. On the one hand, modernization increases the extent of UWSEs through extension by means of control and self-organization, but on the other, the terms of these two mechanisms generate inconsistencies and prevent the full integration of those UWSEs. It would thus appear at first glance that modernization develops the sustainability potential of water management in European cities, giving rise to rules that enhance the regulation of systems. However, on closer inspection, we see that coordination costs associated with these rules do not seem to be included by modernization in its current state. This lack of integration generates inefficiency of incentives and expresses itself institutionally through the emergence and maintenance of inconsistencies. This paradox limits the sustainability potential of the management of UWSEs.

In their collective work, I. Kissling-Näf and S. Kuks (2004) also discuss the lack of coherence of UWSEs. The Euwareness programme confirms the integration of European IRRs; the findings, however, do not reveal the paradox that we have just demonstrated. The authors argue that the IRRs find themselves in a phase of adjustment that should lead to the establishment of an integrated IRR. This thesis is grounded in the perspective put forward by E. Ostrom, since it leads us to confirm that regulators and actors of the urban water cycle in Europe remain in a 'trial-and-error' phase of management, which will succeed an integration phase of the IRR.

In speaking of the paradox of the modernization of UWSEs, we contend that the difficulty UWSEs face in reaching an integrated stage is more fundamental because we consider that the process of modernization, by its very nature, stops this status being reached. Thus, this paradox leads us to reconsider the first hypothesis of the research programme of the IRR for two reasons. Firstly, the paradox reveals a link between the concepts of extent and coherence that the hypotheses of the research programme, to the best of our knowledge, do not address. Then, this paradox leads to a questioning of the potential of sustainability according to the drivers of the IRR being studied (public policy and property rights)

and therefore to a conditioning of the correlation between extent/coherence and integration. Notably, we share the view of I. Kissling-Näf and S. Kuks, who state that 'integration is not a spontaneous development, but is more deliberate in character' (2004: 19), because we observe a redundancy in the structuring of various integrated IRRs, such as the existence of an actor with one strong restraint power over the others (Knoepfel and Nahrath 2005; Bolognesi 2014b). However, we wish to add an extra assessment to that provided by the second hypothesis of the research programme. These theoretical questions will allow us to better understand the explanatory factors behind the fourth stylized fact.

Synergy Between NIE and IRR to Simultaneously Understand the Link Between Scope and Coherence and Discuss the Conjectures of the Explicative Model

In order to look at the explanation of the stylized facts in more depth, it is necessary to clarify two points within the framework of the IRR: the relationship between extent and coherence (section "Identification of Influences Between the Concepts of Scope and Coherence"), as well as the mechanisms of the first hypothesis of the framework (section "Emphasis on the Functional Mechanisms of the First Conjecture of the IRR").

Identification of Influences Between the Concepts of Scope and Coherence

At the heart of the research programme of the IRR, there is, on the one hand, a desire for realism in research around the sustainability of governance of natural resources and, on the other, a complementary combination of the analysis of public policies and institutional economics (Nahrath 2003; Kissling-Näf and Kuks 2004; Knoepfel and Nahrath 2005). Our theoretical reflection on the first hypothesis of the research programme explores a further complementarity in the combination of the analysis between public policies and institutional economics. In order to maintain the coherence of the work as a whole and to capitalize on the

results that have already been detailed, the following investigation relies largely on the theoretical framework developed in the previous chapters.

The first hypothesis on IRRs refers to a change in governance; in neo-institutionalist terms, it is a conjecture on the institutional dynamics of the coordination process. The paradox of the modernization of UWSEs and construction of the research programme leads us to conduct an analysis in two stages in order to single out the mechanisms that are set in motion: the study of the relationship between extent and coherence, and the analysis of conditions based around hypothesis 1 (e.g. integration contribute to frame more sustainable use). We consider that the paradox of modernization does not lead to a rejection of the conceptual framework, but calls for a development of the positive heuristics of it. To understand the institutional dynamics of an IRR, we will once more look at the two main coordination mechanisms, which are extension and alignment. We assume that correlations exist between the extent and coherence, i.e. there is an interaction between the quantity and the quality of the rules. Identifying these correlations will allow us, during a second stage, to specify and consolidate hypothesis 1 of IRRs. In questioning the influence of the expansion of an IRR on its coherence,[16] we only focus on the type of relationship, the one observed in the modernization of UWSEs.

The theoretical framework of the NIE allows the coordination process to be broken down into details when dealing with the interaction between the individual and institutional levels. The contribution of this approach lies in its ability to develop generic models of institutional operation, where the limit is not about internalizing the genesis of a rule. Thus, the factors of institutional change often appear as exogenous elements; it becomes possible, however, to pronounce on their impact (Saleth and Dinar 2004; Saleth 2006; Brousseau et al. 2011). In this sense, the NIE provides the means of knowing how the rules affect the quality of the coordination. Therefore, the use within the IRR framework of the concepts of bounded rationality, transaction costs and feasibility clarifies the mechanisms through which the extension of the evolution of the coherence level can be influenced; then, in a second stage, it highlights the mechanisms underlying hypothesis 1.

Transaction costs and feasibility refer respectively to the micro and macro characters of the incentives generated by institutions. The impact

of limited rationality is of a different order since it is a characteristic of behaviour, and not of cause. The NIE postulates that institutions coordinate the actors of a system based on certain desired outcomes.[17] However, this assumption comes from the observation that the rules are not able to ensure perfect coordination. The entire research programme of the NIE therefore exists to explain the gap between the goal and the means. Re-entering this central debate allows us to understand the marginal effect of a regulation on the coherence of an IRR.

The limited rationality of actors opposes both their lack of information and of cognitive abilities in the face of using the information that is being held. As seen (cf. Chap. 5), O. Bouba-Olga et al. (2008) take an empirical point of view and demonstrate the importance of cognitive abilities in choosing the method used for managing water. This study offers a stable basis for considering that limited rationality has an effect on the coherence of an IRR. We will look in particular at three mechanisms from which the limited rationality of agents links the expansion of an IRR to its coherence.

1. The rules can be unknown or misinterpreted (in terms of their objectives). Thus, a new rule can reduce the coherence of the whole of the IRR because regulators cannot predict the impact of new regulations on behaviour. The rule might be badly worded, resulting in perverse effects. The system of rules is expanding, but the gap between the planned coherence and the effective coherence can widen. This mechanism leads to a reduction in the coherence of the IRR. Intuitively, it particularly manifests itself in the case of *ex post* adjustment of the regulatory system through political design.
2. Actors can not, or are not able to react to a rule because they do not understand it. The debate around pricing illustrates this point insofar as a technical refinement of tariff structures is not systematically oriented in the desired direction. The actors of the urban water cycle may ignore the new architecture or perceive it as being too complex to try to maximize their budget based on the options it proposes (Rogers et al. 2002; Olmstead et al. 2007; Schleich and Hillenbrand 2009).
3. The rationality of users connects extent and coherence through the use of mental models. There is little conflict between formal and informal

institutions (internal to the stakeholders). The IRR framework does not incorporate the informal rules, but these play a role in the coordination process. They allow the formal rules to be interpreted, and together with the formal rules they can guide behaviours (see Chap. 4). A link may exist between the extent and the coherence of the system through informal rules, as observed by the research programme of the IRRs (in its macro version). A conflict between these two sources of coordination can lead to the development of *de jure* regulation, reducing the quality of de facto regulation. In other words, the preferences of the key players may conflict with the control established by the rules.

We have seen how the ratio of agents to regulations may explain the influence of the expansion of an IRR on its degree of coherence. Moreover, the structure of the incentives, i.e. before the behaviours, is home to two other levers of influence: transaction costs and feasibility. Transaction costs belong to the hard core of the NIE and revolve around the incompleteness of formal rules (property rights, contracts, etc.) (Ménard 2003). Their integration into the research programme of the IRR is useful because these costs and this incompleteness directly connect the concepts of extent and coherence. Indeed, every formal regulation changes the structure of transaction costs and therefore the constraints and opportunities of the actors' choices (see Chap. 4). Through this mechanism, expansion systematically impacts the coherence of a system because it alters the structure of transaction costs for the actors, as well as coordination in a more general manner (Dixit 2009). After these changes, the discriminating alignment then makes it possible to ensure the coherence of the regulation. 'Discriminating alignment can work well and reasonably quickly when the decision is made by one actor, or by a small group with common interests' (Dixit 2009: 19). However, the UWSEs are complex systems and do not match this hypothetical case.[18] In this way, achieving expansion by changing the rules and possibly the institutional balance acts on the coherence of the system.[19]

The incompleteness of the contracts creates a need for safeguard mechanisms. These mechanisms differ according to the modes of governance and reduce uncertainty and transaction costs. In UWSEs, because of the

strong specificity of assets, these mechanisms are paramount and we have seen that modernization, in pushing to change modes of governance, can lead to an evolution of safeguard mechanisms (see Chap. 4). Thus, the expansion can induce *de jure* an evolution in modes of governance, but if the system is unable to provide adequate backup mechanisms, the coherence of the system can again be altered due to the involvement of transaction costs. This latter influence-mechanism of expansion over coherence opens up an analysis of the macro elements of coordination.

Each level of institutional embeddedness is home to transaction costs, for these mechanisms also occur on the macro level. The transactional analysis of contracts only shows that a part of the coordination process of the actors—the property rights—plays an essential role, and their analysis fits into a broader vision of the regulation. Looking at the second generation of property rights we can note a strong compatibility (at least on an ontological level) between the framework of the IRR and the NIE. This strong point of view considers that the institutional environment helps determine the quality of the regulation. The context in which a rule is inserted constitutes a dominant variable, and a form of institutional complementarity becomes necessary with regard to the effectiveness of governance and the regulations (Brousseau et al. 2011: 11). In addition, the macro-institutional concepts of the NIE allow the dynamic interrelationship between the extent of a regime and its coherence to be specified.

An analysis of the regulations in their institutional environment refers to the concept of UWSEs as polycentric complex systems. Two things link the institutional environment and the regulations. Firstly, the institutional environment provides an organizational framework—the institutional matrix—in which the regulations apply (see Chap. 4). Then, the institutional environment integrates other institutions acting on the UWSE that define the feasibility of regulations specific to UWSEs. Thus, according to D. North, 'Just changing the formal rules will only produce the desired results when the informal standards—which are complementary to this change, and in addition to their effective implementation mechanisms—are perfect, or at least consistent with the rules that have been changed' (North 2005: 28).

The institutional matrix contributes to the proper application of the regulations and to their 'operational' support (Williamson 2000;

Brousseau et al. 2010). It offers the means of coordination, including by identifying the possible types of safeguards, and it impacts on the structure of transaction costs. For example, in the case of UWSEs, it allows property rights to be secured, contracts to be enforced, information and so on to be created, which facilitates the process of modernization. Therefore, the adequacy of the regulations extending an IRR in the face of the constraints and opportunities of the institutional matrix shape the coherence of the system. There is thus a macro-institutional relationship between the level of the extent and the coherence of a regime that is covered by the concept of feasibility of the NIE. Similarly, the rules extending to an IRR fit in more generic institutions (informal rules, political development, etc.) and the compatibility between these institutions at different levels affects the degree of coherence of a system. The difficulty in organizing multilevel governance within UWSEs, the main source of the latters' incoherence, results from these questions of feasibility regarding the increasing formal rules induced by modernization. The analysis of the institutional environment of the regulations therefore illustrates that, by potentially changing the institutional balances, the expansion of an IRR affects the coherence of the regulation.

This use of the NIE has therefore developed into a fruitful dialectic between institutional economics and the analysis of public policies within the IRR research programme. It clarifies the correlations between the expansion of an IRR and the change in its level of coherence. This theoretical investigation assumes a number of realistic remarks to become more relevant. We have dealt with the various institutional components without taking into account their internal diversity. Indeed, the notions and concepts considered cover a polymorphic set of realities under one term. In addition, we would suggest pushing the investigation by making three distinctions between:

1. the different types of rules: technical, procedural, substantial, and so on;
2. different modes of governance: market, hybrid, hierarchical; and
3. the formulation of the regulation and its application.

These distinctions increase the realism of the research programme and its ability to explain the effectiveness of regulation in terms of potential for sustainability. The relevance of these distinctions is based on several assumptions and makes it possible to refine the explanation of coordination by the macro branch of the IRR.[20] We can postulate that the technical and procedural regulations and so on do not act on the perimeter of a system in an identical way. Accordingly, it is clear that, conditioned by its stage of development, the integration of an IRR can proceed only by specific combinations of regulatory modes. In other words, in a given status of an IRR, some types of rules reinforce integration, while others do not. Moreover, we see an evolution of the coupling sequence between integration and the type of regulations necessary. This leads to the second assumption, according to which different modes of governance do not necessarily have the same capabilities of system integration, i.e. the architecture of the coordination is not neutral in terms of the potential for sustainability. The finding of this paradox of modernization and the observation of organizational redundancies within the integrated plans legitimize this assumption. Finally, distinguishing the regulation from its application should refine the explanation of the dynamics of an IRR.

Emphasis on the Functional Mechanisms of the First Conjecture of the IRR

Working from the links between extent and coherence, and from these assumptions, we can highlight the mechanisms used to support the institutional dynamics assumed by hypothesis 1 of the research programme, while identifying certain conditions as to its validation. The hypothesis stipulates that the integration of an IRR increases its sustainability potential (Gerber et al. 2009). It is then about explaining the articulation of the relationship between the evolution of an IRR and its potential for sustainability. This theoretical discussion will subsequently allow the understanding of the paradox of modernization and the third stylized fact to be refined. As we have explained the links between the expansion and variation of an IRR coherence, we can now deal with the subconjectures of hypothesis 1 separately, specifying that the extension and alignment

inherently improve the potential for sustainability of an IRR. We will first of all look at the conjecture related to the expansion of the IRR, followed by the one related to its alignment. For each conjecture, the mechanisms at work are explained and then the requirements governing validity are formulated.

The first subconjecture sets out that 'the lack of regulation of user behaviour […] risks engendering strategic behaviours that can lead to the over-exploitation of the resource during times of scarcity' (Gerber et al. 2009: 807). One of the corollaries is that the increased extent of an IRR increases the potential for sustainability of the system. Within this framework the institutions coordinate the actors, because they are binding[21] (North 2005; Brousseau et al. 2011). Formal regulations shape an incentive structure for the key players. Accordingly, behaviours are directed and regulated by the regulations formulated to pacify conflicts of use. This regulation then leads to an alignment of usage that should increase the potential of sustainability.[22] Therefore, the expansion of an IRR develops the potential of sustainability because it extends the number of regulated uses and users and therefore increases the proportion of coordinated conflicts of use. Managing a greater quantity of usage rivalries reduces strategic behaviour that is harmful to the sustainability of the system. In other words, the expansion of the scheme makes heterogeneous usage preferences appropriate and facilitates the emergence of a compromise between the three pillars of sustainable development.

However, the paradox of modernization and the discussion in the previous section show that these theoretical coordination mechanisms can be stopped, partially falsifying the conjecture. The alteration to the proper functioning of the coordination comes from two main sources. The first source is that expansion generates complexity. In the image of the 'spaghetti bowl' in international economics (Baghwati 1995), the new rules are cumulative to the previous ones, without improving the transparency of means of governance. On the same line, Bolognesi and Nahrath (2017) demonstrate the existence of an Institutional Complexity Trap that is caused by Transversal Transaction Costs, which limits the ability to frame a sustainable path. This results in the asymmetries of information between actors being accentuated, and because of their behavioural characteristics,

the actors should thus increase strategic uncertainty within the IRR. As a result, the old rivalries of use and governance tensions will not necessarily be curtailed, while others may appear. The second source is that expansion is unable to improve suitability between heterogeneous preferences. The incompleteness of the contracts and property rights form part of this failure. The rules are not sufficient in themselves and, as we have seen, they must be accompanied by organizational support measures and so on in order to be effective. In more general terms, we find here that one of the principal channels of influence is expansion over coherence.

These frictions that focus on mechanisms based on the first subconjecture testify to the fact that the extension process of an IRR results in transaction costs that may alter the effectiveness of the coordination regarding development of the potential of sustainability of that IRR. This conclusion leads us to make two proposals to refine the conjecture linking expansion and the increase in potential sustainability of an IRR:

Proposal 1: *Expansion develops the sustainability potential of an IRR, providing that the coordination costs associated with the new governance structure are still lower than the costs generated by previously unregulated conflicts.*

The example of regulating the quality of drinking water aids understanding of this proposal. The different phases of European regulation, and the modernization phase in particular, have contributed to an expansion by means of control over the sanitary quality of usage and the resource. These standards regulate the antagonism between users who wish to drink water of the highest possible quality, both in terms of health and taste, and suppliers who are focused on profitability. However, these standards render the deviation process more complex and additional costs in terms of governance and coordination are created, based around the transaction (conformant production, controls, etc.). However, as pointed out by B. Barraqué (2005) when he spoke of 'incompatible complexification', we can legitimately ask ourselves to what extent these standards have solved more coordination problems than they have created.

Proposal 2: *The gains associated with the expansion of the field and the scope of governance can manifest themselves in a more distant horizon than that of political evaluation. This gap may reduce the incentive to adopt an effective arrangement due to a strong preference for the present.*

The dilemma found between public-service quality and efficiency of action or activity is illustrative of this proposal. The arrangements adopted as part of modernization attest to this preference for the present (cf. Chap. 4). Modernization tends to reduce the duration of contracts and empower actors in order to improve competitiveness and adaptability from the perspective of searching for efficiency. However, it also seems that these rules encourage actors in the urban water cycle, to a certain extent, to postpone investment in the renewal and durability of the infrastructure (Bakker 2010; Chenoweth 2012; Bolognesi 2014a) (F_{s37}).

The second subconjecture of the research programme of the IRR stipulates that 'gaps or incoherences in the policies or property-rights system (internal coherence) and between the two components of the IRR (external coherence) constitute a major cause of the over-exploitation of resources' (Gerber et al. 2009: 807). The corollary that interests us is that the alignment of the IRR increases its potential. As defined by the research programme, alignment is one of the sources of the effectiveness of the rule. It shows *ex ante* the quality of the regulation. Therefore, the subconjecture relies on two main mechanisms. The first mechanism, the coherence of the system, helps reduce uncertainty and transaction costs associated with the uses of the resource, while at the same time, public policies and the regulatory system gain credibility. This first mechanism facilitates the emergence of routines and reduced incitement to opportunism. By way of illustration, the appearance of performance indicators led to a desire in the French UWSE to reduce users' mistrust and potential abuse during a delegation contract. With the second mechanism, consistency increases the feasibility of the arrangements wanted by decision-makers, which develops the operative potential of the regulation. The formal rules thus gain in coordination ability. The conjunction

of these two mechanisms favours the emergence of a balanced compromise between the three pillars of sustainable development, and therefore increases the potential for sustainability of the IRR.

As in the case of the first subconjecture, we can identify two causes that are likely to affect the smooth running of these mechanisms. Firstly, institutional complementarity may not be strong enough to ensure the feasibility of institutional arrangements inspired by the structure of the formal rules.[23] The fact that the regulations pertaining to the sustainability of the English UWSE are divided between two independent agencies—OFWAT and the EA—who collaborate very little is a case in point. The sustainability of the IRR can be an institutional arrangement that does not minimize the transaction costs as perceived by the actors. The existence of high governance costs[24] and major conflicts with informal rules (beliefs or mental models) reinforce the importance of this second factor limiting the scope of the conjecture.

These factors impeding the smooth functioning of the mechanisms and converting an improvement in consistency into a gain of sustainability potential attest to the fact that the consistency of an IRR neither ensures the adoption of the agreement prompted by formal regulation, nor the emergence of a balanced compromise between the three pillars of sustainable development. This conclusion leads us to formulate a complementary proposal to the second subconjecture of the research programme.

Proposal 3: *In order that the alignment of the system increases its potential for sustainability, actors must adhere to the mode of development put in place by the regulations.*

This proposal aims to recall the important role of participatory processes in governance. We know now that the participatory process promotes the functioning of governance; however, the modus operandi of these processes remains largely dependent on local conditions and embraces a wide variety of possibilities (OECD 2015; Hassenforder et al. 2015). The reform in water management in the city of Munich in the

1990s illustrates the contribution of a participatory process (Pointereau 1999; Krimmer 2010). The mayor of the city implemented an active policy to protect the resource, thus ensuring the quality of the drinking water. The main tools in this reform were the purchase of land areas encompassing capture zones and the establishment of an incentive, funded by the citizens of Munich, to convert conventional agriculture into organic agriculture. The success of the reform here lies in the fact that the citizens of Munich agreed to pay for the expensive water to ensure it remained untreated, and in the acquiescence of farmers, who changed their economic practices. This example demonstrates the interest in dialogue from a governance perspective aimed at the qualitative improvement of the mode of development (Bolognesi et al. 2013).

Formulation of Terms Defining the Scope of Validity of the Conjectures

This theoretical deepening of the combination of the NIE and the analysis of public policies, based around the question of articulating the institutional dynamics of an IRR with regard to its sustainability potential, aims to better understand the paradox of modernization and, ultimately, the explanation of the third stylized fact. Also, on the basis of the review conducted, we note five empirical conditions that define the scope of validity of the proposals. In our opinion, it is necessary that:

1. Sustainable development minimizes transaction costs. This condition allows arrangements brought about by the regulations to overcome the remedial ability criteria of the actors, thereby allowing them to be chosen.
2. The regulation is effective. This condition ensures the credibility of commitments and reinforces the power of coordination (coercion, incentive, etc.) of the regulations of the IRR.
3. A multiplication of regulations reduces uncertainty. This condition moves in the same direction as the previous two and avoids the emergence of new opportunistic arbitrations that are likely to create new rivalries of original uses.

4. A leader and/or strong ideas emerge. This condition increases the likelihood of adhering to the content of standards and facilitates a change in routines, i.e. the concordance between individual mental models and shared ideologies.
5. Adjustments are not made so slowly that the regulation of usage implemented always responds to the obvious problems of collective action. It is therefore about reducing the gap between temporality of governance and the users.

Failure to Comply with the Requirements Governing Validity of the Conjectures of the IRRs: The Cause of Polarization of the Obstacles to Sustainability Based Around the Economic Pillar

This theoretical discussion provides the key to a better explanation of the third stylized fact through the paradox of modernization. We found that the evolution of UWSEs was not sustainable, even though it is one of the beacons of modernization. In addition, it appears that the source behind this problem is found predominantly in the form of tensions based on the economic pillar of sustainability. Using the tools of the IRR through the paradox of modernization details this finding and provides a conclusion on the three explanations of the stylized fact. Firstly, the expansion of UWSEs takes place based on two distinct dynamics (*by means of control* and *by means of self-organization*) with each having ambivalent effects on the potential of sustainability. Secondly, significant coherence problems persist and restrict the ability of the UWSEs to integrate. Thirdly, the economic objectives dominate the others and reduce the capacity of finding a balanced compromise between the pillars of sustainability. Using the theoretical propositions of this chapter, we return to these three factors to explain the stylized fact further.

The institutional changes brought about by modernization are a major source behind the ambiguity of the effects of the expansion of UWSEs. Indeed, we have seen that hybridization towards a specialist market involves a mutation of forms of coordination, impersonal regulation, contracts and the dissemination of information becoming key

elements. This process changes the structure of the transaction costs and develops uncertainty *ex post*. This uncertainty becomes a real obstacle to the integration of UWSEs when remote governance mechanisms fail, which is the case in UWSEs. The dialogical relationship between expansion by means of control and self-organization produces external inconsistencies. Indeed, debates surrounding the validity of performance indicators (Canneva and Guérin-Schneider 2011; Tsanga-Tabi and Verdon 2014; Renou 2015; Brochet et al. 2016, Bolognesi et al. 2016), and of indicators relating to the environmental status of waters (Beniston et al. 2012),[25] etc. show that uncertainty remains a part of the management process. Indeed, the management of these indicators is faced with technical difficulties and local resistances, leading to important biases in the image of the reality they reflect. Moreover, liberalization of the sector reduces property rights and increases the incompleteness of formal rules. What then follows is an accentuation of the strategic character of behaviours and opportunity. This reduces the ability of the IRR to steer the UWSE towards a more sustainable form, with the long-term impacts being exogenized by the actors. Numerous readjustments in English governance illustrate this second source of uncertainty, and the difficulty in articulating the coordination brought about by the rules emanating from public authority and those formulated by the actors of the urban water cycle.

In the end, within the framework of the modernization of UWSEs, expansion has ambiguous effects on the potential of sustainability, in particular because the fourth condition we have identified for the successful integration of an IRR is not present. It would appear that the proliferation of rules does not reduce uncertainty and that new usage rivalries emerge. This fact allows us to consider that the modernization process does not respect proposal 1 of this chapter. The modernization of UWSEs encourages the implementation of a governance structure that generally does not compensate for costs generated by regulated conflict. This result is based on the dualism of European regulations which, on the one hand, tighten control over the impact supply, and on the other, creates a space for growing economic freedom for the actors in the deviation process. The search for flexibility seems to not be in itself a solution to the problems of sustainability. In our view, it is the main explanation for the

paradox of modernization. This finding reaffirms the interest in comparing the ability of the three generic modes of governance to integrate an IRR.

The persistence of inconsistencies, the second explanatory factor of the stylized fact, finds its origin in the difficulty faced by modernization in respecting conditions 1, 3 and 5. Although participation is one of the obligations of the WFD, its implementation is problematic. As a result, there are new disputes that illustrate the non-sustainability of the urban water cycle (disputes between users and operators or with the EU). These problems of participation can be explained partly by the fact that modernization favours *autonomous adaptation* instead of *conscious adaptation*. Moreover, it should be noted that, in Germany, recourse to conscious adaptation maintains the ability to implement alternative institutional arrangements that increase the potential for sustainability. As such, the Munich example is eloquent (Krimmer 2010). This example builds a bridge and highlights the need to respect condition 5. Munich's solution is only feasible providing that farmers and users subscribe to the idea of the municipality. However, the de-integration of the value chain and the depoliticization of the governance of UWSEs complicate the emergence of a leader and/or innovative ideas. This trend therefore reduces the possibilities of building a consensus around alternative arrangements, in contrast to the case of Munich (see condition 5). Finally, the difficulties that were stated with regard to the expansion of UWSEs are obstacles to achieving condition 3.

The focus on the economic pillar of these obstacles to UWSE integration, found within the modernization process, is explained by the importance of governance costs (terms 2 and 6) and the intensification of diverging interests (conditions 3 and 5). The difficulty in ensuring sustainable arrangements, and the scarcity of spontaneous appearances of such arrangements, suggest that sustainability is not a solution that reduces transaction costs, as believed by the actors of the urban water cycle. Thus, expansion by means of control takes on its full meaning when limiting *a posteriori* the possibilities offered by the contracts and property rights. However, these adjustments take a long time to emerge and prevail. For example, there were almost five years between the

English drought and the enactment of laws that responded to the related issues. Next, the difficulty in the scope of conditions 3 and 5 intensifies the heterogeneity of preferences, the feedback from which complicates compliance with these conditions and risks, pushing the UWSE into a vicious circle, preventing it from moving from a complex state to an integrated one. This dynamic also explains the entanglement that has been observed in the IRR in complex forms, and strengthens the hypothesis that it is necessary for a learning process to be followed in order to achieve an integrated state.

4 Conclusion

This chapter has provided an explanation of the third stylized fact, according to which, *not only does modernization fail to satisfy its own requirements in terms of sustainability, but it also stirs up antagonism between the economic pillar and the other pillars.* By combining an analysis of property rights and an analysis of public policy, the IRR research programme offers a holistic approach to the issue of the quality of coordination. Its application leads us to support the notion that the third phenomenon is the result of a paradox of the modernization of UWSEs. Indeed, it is accompanied by an increase in the number of rules intended to regulate UWSEs in a harmonious and sustainable way; however, it appears inherently unable to bring about such a development. This failure comes from the ambivalent effect of the increase in the number of rules in UWSEs, which both generates regulations and inconsistencies. This multiplication of the number of rules stems from two different mechanisms of UWSE expansion. Firstly, expansion by means of control is a classic tool used by public authorities to frame activity within the urban water cycle. Next, expansion by means of self-organization is part of the autonomous formulation of formal rules by the actors of the urban water cycle (property rights, contracts, etc.). Theoretically, these expansion dynamics should increase the potential for sustainability of UWSEs, but their dialogical relationship negatively impacts on the level of coherence of UWSEs. In the end, the obstacles inherent in the modernization

process that impede good coherence of UWSEs also limit UWSEs' potential for sustainability.

The explanation of the third stylized fact via the paradox of modernization leads us to question the link between extent and coherence in the explanatory model of the IRR, and to discuss the first set of conjectures of the research programme. This discussion provides them with the opportunity to increase the positive heuristics of the IRR by recalling the key concepts of the NIE. The result of this work is materialized by the formulation of three proposals intended to clarify the mechanisms of conjecture within the IRR by specifying the link between extent and sustainability, and then between coherence and sustainability. In addition, five conditions defining the scope of validity of the conjectures are formulated. These conditions take into account the coordination structure and the properties of the rules.

Conclusion of the Section

The proposed explanation of the stylized facts in this second section has mobilized and created a dialogue around the NIE and the IRR. The theoretical interpretation of the impacts of modernization that we have defended fits into the perspective of complex systems and organizational polycentrism. This has resulted in three types of contributions that are in response to the double subject assigned to this second section. Firstly, we presented the explanatory mechanisms of the phenomena of modernization of UWSEs that fit into the general question of institutional change. Then, the results we obtained benefited from a generalized character that allowed a more 'universal' knowledge of the engines of coordination and institutional evolution to be developed. Finally, we have made available an original account of the explanatory models; in relation to the NIE this was achieved by using all the elements of institutional embeddedness and combining this notion with the idea of a complex system; in relation to the IRR it was done by extending the dialogue between the IRR and NIE in order to comment on the hypotheses of the base model.

First Stylized Fact: Modernization and Hybridization of Institutional Arrangements

The first stylized fact comes from an organizational phenomenon and states that *the modernization of UWSEs brings about the process of their depoliticization.* To explain this, we look at the transaction costs economics (TCE) along with an analysis of the institutional environment. The transactional analysis of the modernization of UWSEs highlights the micro-determinants of the depoliticization of UWSEs using the analytical triptych of transaction–behaviour–governance. This takes place in two stages. Firstly, we identify the changes in transaction costs induced by the regulatory shock of modernization, and then we deduce the impact in terms of choice of institutional arrangement. We can corroborate that modernization causes a change of alignment of transaction costs—a governance structure that is demonstrated by a hybridization towards the specialist market of institutional arrangements chosen by the key players in the urban water cycle. The depoliticization of UWSEs then results from four main micro-determinants:

1. a reduction in coordination by the fiat;
2. a decentralization of governance, generating transfers of responsibility;
3. a reduction in public-sector participation in the deviation process; and
4. a transformation of expressed preferences.

However, the TCE fails to demonstrate the supremacy of one modality of institutional arrangement over others simply by the mere minimization of calculated transaction costs. This indeterminacy is explained by the limited rationality of the actors and the role of preferences based on faith in the selection process and remediability criteria.

We therefore agree that the analysis of the institutional environment provides a way to override this indeterminacy by integrating macro-determinants into the explanatory model. The explanation of the depoliticization process of UWSEs is thus furthered. Indeed, the institutional environment becomes a first-rate economization that defines the feasibility of the institutional arrangements and the distribution of transaction

costs. We can therefore assume that modernization changes the feasibility of institutional arrangements in UWSEs. The argument relies on the identification of three macro-determinants of the depoliticization of UWSEs:

1. a mitigation of the property rights packages as a result of modernization;
2. a transformation of adherent organizations into contractual organizations as a result of making the organizational principles of modernization credible by means of the institutional matrix; and
3. the development of pro-cooperative beliefs that render modernization credible through a circular mechanical of beliefs and preferences.

All of these determinants ultimately interact with each other thanks to a rereading of institutional embeddedness in terms of complex systems. To this end, we substantiated the role of beliefs as a cross-medium within embeddedness by means of a circular mechanic of beliefs.

Second Stylized Fact: Modernization and Activation of a Preference for Flexibility and a Low Aversion to Opportunism

The second stylized fact, also dealing with the essence of organization, states that *the degree of integration of the principles of modernization in a UWSE is positively correlated to a resilient socio-institutional dynamic, rather than a resistant one.* The explanation is based on the same theoretical apparatus as that of the first stylized fact. At the level of micro-determinants, hybridization goes hand in hand with an increase in socio-institutional resilience, achieved through three channels:

1. an increase in the use of incentives rather than orders;
2. a strengthening of unilateral autonomous adaptation rather than concerted adaptation; and
3. enabling preferences for flexibility and autonomy through neoclassical and/or changing contracting methods.

Socio-institutional resilience manifests the development of innovation in the concrete fixtures of institutional arrangements and the autonomy of the key players. On a microeconomic level, these features increase transaction costs and require a strong ability to make commitments credible through parts of the institutional environment.

To explain the positive correlation between modernization and the resilience of UWSEs, an analysis of the institutional environment proves essential, since a strong need for credibility is supported by the development of socio-institutional resilience. We put forward three macro-determinants to explain the theory behind this phenomenon:

1. a greater willingness for innovation in coordination methods, thanks to attenuation of property rights;
2. increased credibility of autonomy, thanks to confidence-building by organizations within the institutional matrix; and
3. an acceleration of organizational recursion due to diversification and the increase in volume of social interaction within transactions, as well as a greater encouragement of the circular mechanic of beliefs and preferences.

Once more, the principles of a complex system and polycentric multilevel organization improve the consistency of all these theoretical mechanisms and intensify the acuteness of the explanation.

Third Stylized Fact: Modernization and Complex State Regulation Due to Lack of Consistency

The third stylized fact refers to the quality of coordination and recalls that *not only does modernization fail to satisfy its own requirements in terms of sustainability, but it also stirs up antagonism between the economic pillar and the other pillars.* The theoretical explanation mobilizes the IRR and is based on the idea of the paradox existing in modernization whereby UWSEs are maintained in a complex state and their potential for sustainability is not maximized. Speaking of the paradox of modernization, we support the notion that modernization is intrinsically unable to produce

a track that maximizes the potential for sustainability of UWSEs because of the very evolution of the regulatory terms. The paradox demonstrates the ambivalent effect of regulation. On the one hand, more uses are regulated to ensure their sustainability (extension), but, on the other, inconsistencies emerge between regulations, which impairs the ability of the IRR to integrate.

We can distinguish two analytical categories within the expansion of UWSEs: expansion by means of control, which emanates from the regulatory activities of public powers; and an expansion through self-organization originating from the rules autonomously formalized by the key players in urban water cycles. These two sources of regulation are interlinked in a dialogic relationship, which currently generates incoherence. Indeed, the aim of the two extensions appears to be more confrontational than complementary, particularly at interfaces with the economic pillar. The polarization of the inconsistencies based around the economic pillar can be explained by the polycentrism of the extension. Public authority provides a set of rules that attempt to address the issue of sustainability in an integrated manner, while rules originating from self-organization respond to the imperatives of urban water cycle activity encountered by key players, which leads to over-focusing on the economic dimension at the expense of others. This argument underlines the existence of relations between extension and alignment, i.e. the number of regulations and the quality of their coordination. To address this link and refine the explanation, we must communicate the concepts of the NIE within the explanatory model of the IRR. In the end, taking into account the uncertainty, as well as the incompleteness of rules, transaction costs and credibility, helps us to formulate three precise assumptions on the IRR proposals as related to the performance of governance of a natural resource.

Notes

1. For a precise description of the different theoretical approaches to policy process, the reader might like to refer to the works of Howlett and Ramesh (2003) or Sabatier and Weible (2014).

2. A. Vatn (2005) compares these different approaches and shows how their basic assumptions guide the results. He distinguishes the 'individualist' approaches of neoclassical and neo-institutionalist research programmes from 'socio-constructivist' approaches that are defined by whether they have a predominantly positive or normative outlook. His analysis focuses on the dichotomy between calculating individual behaviour and socially constructed behaviour.
3. The primary goal of the NIE is not the protection of natural resources or the environment, but the coordination process based around the problem of collective action per se. Therefore, the application of the working framework proposed by the NIE can be applied to specific cases, including the use of natural resources or the 'management' of the environment (Ostrom 1990; Libecap 2008). J. Paavola and N. Adger (2005) present the extent to which the NIE is used to analyse environmental issues and, more recently, C. Ménard (2011) argues that the crossover of the NIE and environmental issues has proven to be a fruitful and innovative research thread for the topic:

   > This short essay suggests that the new institutional economics can provide powerful tools and useful insights in analyzing environmental problems and assessing potential answers. Three key concepts developed by NIE, property rights, contracts, and transaction costs, are particularly relevant in that respect, since they help to understand the intertwined role of organizational solutions and their institutional settings. (Ménard 2011: 219)

4. A causal model identifies the key players responsible for the collective action issue and the mechanisms that can change their behaviour in the way set out in item 1. The model also takes into account elements 3 (actors) and 4 (instruments) of the political design.
5. Some authors are aware that the distinction between private and public law appears clearly in the tradition of Roman law, but is less significant in legal systems under common law (Knoepfel and Nahrath 2005; Varone et al. 2008; Gerber et al. 2009).
   In the legal systems of the Roman tradition, public law regulates interactions between private actors and the state.
6. The differentiation between usage rights and the right of disposal is specified within the categories of Roman law (*usus, fructus* and *abusus*). The right of disposal segments *abusus*, and applies to the transfer of the

resource, while the usage right includes *usus* and the prerogatives relating to the modification of the resource in the *abusus*.

7. In the legal systems of the Roman tradition, private law regulates interactions between private actors.
8. The European Environment Agency lists the work based on this classification and is developing it for the European territory on the following webpage: http://cices.eu/, accessed 13 March 2013.
9. Perceiving it in terms of co-evolution appears more natural than some researchers transposing the CICES into the accountancy of a business in order to assess the interdependence between economic activity and its environment (Houdet et al. 2012). This 'biodiversity accountability' project responds to the very real problems facing large multinationals. The thesis by C. Ionescu continues this work and the creation of the Synergiz association embodies the research axis, http://www.synergiz.com, accessed 13 March 2013.
10. These authors speak of sustainability. We prefer to talk about the potential for sustainability in order to qualify the scope of conjecture. Indeed, the IRR built up a driving force, but this is not necessarily expressed in its entirety, particularly because of the issue of operating regulations. Recent developments in the research programme suggest that proponents of the IRR adhere to this idea because, they are interested in contingency procedures for exercising IRR regulations, including the concept of ARL (Knoepfel et al. 2011; Bréthaut 2012; Nahrath et al. 2012; Schweizer 2012).
11. In our opinion, and based on the epistemology by Lakatos (1994), these conjectures shape both the cornerstone and the stumbling block of the research programme. They are a cornerstone because they establish the originality and the major contribution of the corpus, yet are also perceived as a stumbling block because these conjectures have not been demonstrated, and the normative and predictive outlook of the IRR seems unstable. However, experience does not refute the conclusions nor render false the results of the research programme. This then allows us to use the IRRs with caution. This apparent lack of strength in the research programme is a testament to how young it is, and demonstrates that it is still in its maturation phase. It also suggests that the development of its positive heuristic is a major part of its future growth.
12. The negotiating agenda of the WFD lasted three-and-a-half years and was the subject of tough negotiations. M. Kaika (2003; Kaika and Page

2003; Page and Kaika 2003) presented a comprehensive analysis of the process. A strong conflict between European decision-making bodies, who are subject to the pressures of lobbyists (the Parliament and the Council of Ministers), has generated a new need for changes in policy processes, leading to wider participation in NGOs and so on.

13. The immission refers to the pollutant concentration in the resource, while the issuance takes into account the action of diffusing air pollutants in the resource. In the first case, we're interested in the host environment of the pollutants, and in the second, we look at their source.
14. K. Bakker (2000) focuses on the management of the drought of 1995 in Yorkshire to illustrate the limits of the English model of UWS and the adjustments made. This drought revealed that the price-capping system had not prompted operators to invest in the development of infrastructure in order to maintain the balance between supply and demand. Subsequently, the regulatory authorities and the government sent new price signals in order to remedy this.
15. All of the Member States' reports to the European Commission are available at: http://www.eea.europa.eu/themes/water/reporting-obligations, accessed 27 September 2012. For more information on France in particular: http://www.rapportage.eaufrance.fr/; for England: http://www.environment-agency.gov.uk/research/library/data/97343.aspx; and the report for Germany: http://www.umweltdaten.de/publikationen/fpdf-l/3771.pdf.
16. The opposite causality also deserves to be studied, i.e. the influence of alignment on the extent of an IRR. However, since it does not appear as clearly in the process of modernization of UWSEs, and therefore the way in which it is illustrated provides no direct explanation of the third stylized fact, we will not deal with it here.
17. It must be remembered that within this framework, the institutions are the formal and informal rules of the system and a certain functionalism is present in that the rules emerge in response to the issue of collective action. 'Throughout history, institutions have been designed by humans to create order and reduce uncertainty in the action of exchange' (North 1991: 97).
18. It should be noted that the IRR research programme stands apart from other institutionalist approaches to governance of a natural resource in that it postulates a diversity of users with heterogeneous uses, hence heterogeneous preferences.

19. E. Brousseau and S. Saussier (2009) illustrate the potential evolution of transaction costs as a function of different contractual forms linking the state and third-party operators. S. Rossiaud (2011, 2012) shows the impact of a change in the tax system on transaction costs. He applies his analysis to the case of the structures of governance relating to oil in Russia.
20. The other way to increase this relevance is to integrate the contingency and strategy of key players in the analysis, as permitted by the concept of ARL.
21. Organizations creating the laws—and their members—can also be included in the analysis; it should be considered all the same that a certain functionalism drives them (North 2005). They seek to resolve a collective action problem; nevertheless, the proposed solutions may depend on their self-interest and their level of information (Myerson 2009).
22. It is worth remembering that sustainable development is perceived as a compromise between several non-congruent interests.
23. This is a configuration that is often found in economies in transition (North 2005; North et al. 2010). It seems all the more realistic here that many researchers are approaching sustainable development from the perspective of a transition, whether that be economic, organizational or energy, for example (Review: *Environmental Innovation and Societal Transitions*; Holling 2001; Smith et al. 2005).
24. And that are possibly distributed unevenly (Gibbons 2003; North et al. 2010; Wallis 2011).
25. The recent Onema scandal reinforces the fears of scientists.

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7

General Conclusion

This book has looked at the impact of the modernization of UWSEs on their organization and potential for sustainability. The adoption of an institutionalist perspective has made it possible to specify the effects—some of which are unsatisfactory—of this regulation in an original way that complements the existing literature, especially in the disciplinary fields of economy and management. The promulgation of the WFD in 2000 is considered to be the inciting act for this modernization. The initial goal was to improve the performance of the governance process and engage the UWSEs on a sustainable path. To characterize and explain the changes induced by the regulatory impact of modernization, we have put forward a comparative approach of the ideal-types of German, French and English UWS. The focus of interest has remained centred on the analysis of institutional mechanisms and the institutional environment, as proposed by North (2005). The advantage of this is that it ensures that our conclusions can be applied on a general basis and can be transferred to other cases.

Because the diagnosis of modernization is neither clear nor stabilized, we opted for an approach that formally separated the empirical and theoretical phases. The demonstration therefore proceeded in three stages,

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gradually becoming more abstract. In opening, we defined the concept of a UWS by proposing that a UWS is:

1. a complex system (Morin 2005, 2008);
2. directed by institutions (Coase 1998);
3. organized in a polycentric manner and on multiple levels (Ostrom et al. 1961).

Using the statement and alignment of salient facts noted during the empirical phase, we characterized modernization by using three stylized facts. Finally, we explained these facts using tools developed as part of the neo-institutionalist research programme and the institutional resource regimes (IRR) research programme.

From an empirical point of view, we have shown that the modernization of UWSEs takes place using three characteristic phenomena:

1. Modernization generates a process of depoliticization of UWSEs.
2. The degree of integration of the principles of modernization in a UWSE is positively correlated to a resilient socio-institutional dynamic rather than a resistant one.
3. Not only does modernization fail to satisfy its own requirements in terms of sustainability, it stirs up antagonism between the economic pillar and the other pillars.

The first two stylized facts are organizational in nature and reflect the impact of modernization on the governance of UWSEs. The third stylized fact relates to the effectiveness of the governance of UWSEs from the perspective of sustainability.

The change in the terms of governance of UWSEs is explained using neo-institutionalist theory. Modernization materializes in the form of a hybrid governance structure that tends towards a specialist market. This hybridization contributes to depoliticize the UWSE and goes hand in hand with an increase in its socio-institutional resilience. Both micro- and macro-institutional determinants form part of this general mechanism.

On a micro-institutional level, the depoliticization of UWSEs is the result of a *realignment of the governance structure and transaction costs*. Modernization alters the structure of transaction costs and encourages key players to opt for institutional arrangements that lead to less direct control of the state over the UWSE; for example, a reduction in the fiat and decentralization of governance. These choices demonstrate how preference is shown for flexibility rather than radical risk aversion. An analysis of the *institutional environment* completes this first explanation. Indeed, modernization changes the feasibility of institutional arrangements and is part of a first-rank economization that leads to a demonstrable depoliticization. The governance principles of the modernization of UWSEs therefore gain credibility through institutional matrices and the development of pro-cooperative beliefs.

In other words, even if there is a common shock, modernization happens differently in the ideal-types because the institutional matrices strongly impact on the ways in which regulations are transposed. The English ideal-type therefore appears to be fertile ground for modernization, facilitating the process of decentralization of governance and fragmentation of property rights. The result is the transformation of adherent organizations into contractual organizations, as well as mitigation of property rights that are directly involved in the depoliticization of UWSEs.

The positive relationship between modernization and socio-institutional resilience is the result of institutional arrangements that facilitate adaptation during a transaction. At the micro-institutional level, we have demonstrated that the modernization of UWSEs has favoured neoclassical and/or evolving methods of contractualization, therefore reinforcing the *use of incentives* rather than orders, and *autonomous adaptation* rather than forced adaptation. By way of illustration, regulation is based on price signals sent to operators (price-capping) in order to guide them in their choice of management. Socio-institutional resilience is a source of uncertainty. In order to be irremediable, institutional arrangements therefore require a high capacity of *credibility* and *effective backup mechanisms*. An analysis of the institutional environment highlights that the institutional matrices and informal institutions of the more modernized UWSEs meet this need for credibility (Bolognesi 2014c). In the end,

an acceleration of organizational recursion, confidence-building by organizations and the attenuation of property rights explain the concomitance between modernization and resilience.

The comparison of German, French and English ideal-types, by level of modernization, validates the theoretical mechanisms that have been examined (Lorrain 2005; Ménard and Peeroo 2011; Bolognesi 2014c). Indeed, the institutional dynamics that have been derived from the explanatory model are confirmed by the observed behaviours of the key players. For example, in Germany, the UWS has proven to be relatively politicized: the public sector retains control over the deviation process and its regulation; prices seldom, if ever, encourage key players; and property rights are less attenuated than in the French or English ideal-types. Furthermore, the organizational structure of German UWSs has changed little in the short term; they are rather more resistant and changes emerge as a result of a consultation process (Krimmer 2010). By contrast, in England, the UWS shows more resilience and depoliticization is greater. The state transfers part of its regulatory responsibilities to the Office of Water Services (OFWAT) or other independent agencies. Similarly, privatization, which is total in England and takes the form of PPPs in France, mitigates and divides up property rights and, as a result, reduces the extent of direct public control over the deviation process. Backup mechanisms and market-coordination mechanisms gradually supersede those of the hierarchy. Information and prices play a major role in the evolution of behaviours.

By using the IRR we are able to explain the inability of modernization to maximize the *potential for sustainability* of UWSEs, the third impact that has been noted with regard to their modernization. We have highlighted the existence of a *modernization paradox,* which is revealed through the ambiguous effects of regulatory development—an increase in the framework of the deviation process and greater inconsistency.

The identification of a paradox in modernization allows us to explain the pessimism displayed towards the prospect of sustainability of UWSEs. We have demonstrated that modernization leads to *two dynamics of extension* of the regulation of UWSEs, one by means of *control* (public policy) and the other through *self-organization* (private property rights).

However, although theoretically the extension promotes sustainable management, in our case, these two dynamics produce new *inconsistencies* that impede the full integration of UWSEs as IRRs. The reason behind these inconsistencies is that the two forms of extension have proved to be more confrontational than complementary. Because of persistent or new inconsistencies, we therefore support the notion that modernization keeps the UWSE in a *complex state* and that they prove to be inherently incapable of achieving their goal of sustainable development.

In fact, we have demonstrated that public authority provides a set of rules that attempt to address the issue of sustainability in an integrated manner (extension by means of control), while rules originating from self-organization (contracts, etc.) respond to the imperatives of urban water cycle activity encountered by key players. This results in a polarization of the obstacles to sustainability around an economical dimension. By way of illustration, technical standards regulating the activity have become more complex, and increase the costs incurred in the provision of services, thereby increasing tension over already strict financial constraints as a result of the obligation to cover the costs and the reduction in contracts (Bolognesi 2014a, b). Accordingly, operators have little incentive to invest in a renewal of infrastructure, even though this remains an imminent imperative for the sustainability of networks. More generally, representing 20% of litigation, the water sector appears to be one of the areas that sees the most frequent violations of European environmental law (Keller 2011). Finally, we have shown that modernization struggles to coordinate the different polycentric levels of a UWSE.

1 General and Transferable Research Contributions

On an empirical level, we note two main contributions. The first refers to the concept of a UWS. This is based on a holistic approach in terms of a complex system and polycentric governance. The concept enables an original analysis to be undertaken on the management of water and

could guide research in other countries. The majority of current frameworks are based on the pioneering work of Ostrom or Saleth and Dinar (Ostrom 1990; Saleth and Dinar 2004; Pahl-Wostl et al. 2010; Ferguson et al. 2013). The result of this is a strong focus on institutions and, potentially, important negotiating arenas for key players. However, the link with the economic dimension of the sector remains limited. The notion of UWSEs bridges this gap by explicitly linking the economy and institutions (Bolognesi 2014a). As we have shown, this originality proves to be relevant and necessary when confronted with the challenges faced by today's economy, namely an understanding of the relationship between institutions, choice of actors and the socio-economic environment.

In addition, the UWS provides an analytical grid that facilitates research, its *reproducibility* and its *comparability* to other cases. If we therefore look at the case of the urban management of water, the UWS could be applied to other systems, including the provision of services reliant upon an infrastructure network, such as electricity and telecommunications. Naturally, this transposition will be fruitful provided that it is repositioned in relation to the system/sector being analysed. We are thinking in particular of the cost structure, the organization of the value chain and the management of the institutional environment.

The other empirical contribution lies in the very process of characterization. Like Beniston et al. (2012), many authors emphasize the incompleteness, the lack of robustness and the uniformity of existing data on the modernization of UWSEs. Without solving this problem, the empirical phase *collates and makes available a set of data and sources, the consistency of which is discussed*. Without creating new data, we therefore contribute to developing the overall knowledge of the modernization of UWSEs. This pooling of the variables of three ideal-types of UWSEs into one plan is the first step towards a systematic analysis of the governance of UWSEs.

On a theoretical level, a study of the effects of the modernization of UWSEs has posed the more general problem of the institutional dynamic at the heart of current considerations (Young 2010; North et al. 2010; Hodgson and Knudsen 2010; Brousseau et al. 2011; Caballero and De Soto 2015). This apprehension leads to two inputs. Firstly, we

have proposed an interpretation of the concept of *institutional embeddedness* in terms of a complex system in order to break with the initial linearity of the concept (Williamson 2000). In fact, it is about grasping the institutional dynamic as being the product of dialogical, recursive and multidirectional interactions between multilevel components. Without finishing work in this area, and in relying on major authors (Aoki 2007, 2011; North 2005; North et al. 2010), we have shown that informal institutions constitute a privileged medium for the complex dynamics of institutional change. In particular, we highlight that this media operates under a *circular dynamic between beliefs and preferences*. The role of beliefs and the way in which they interact with the experience of the agents is therefore highlighted in training preferences and the reduction of transaction costs. The link between the perception of and definition of a public service, and the ease in implementing the principles of modernization, illustrates this dynamic.

The second theoretical contribution covers the simultaneous analysis of property rights and public policies in the governance of natural resources. We have shown that if an extension of the applicable scope of governance and improving its coherence are supposed to integrate governance and improve the potential for sustainability of the social-ecological system in question, this dynamic is not linear. Indeed, the extension could impact negatively on coherence, rendering governance more complex and altering the potential for sustainability (Bolognesi 2014b). The dynamics of expansion therefore enter a phase where the marginal impact on the quality of coordination is decreasing or negative, through its effect on the overall consistency. It was apparent that this phase could become a constant state in the system as it requires deep reform to regain such consistency. In looking at this phenomenon and state, we would therefore suggest that there is a kind of "institutional complexity trap" through which the social-ecological system passes, changing the improvement in that system's governance in terms of sustainability. We can therefore contribute to the analysis of the quality of coordination from the point of view of the sustainable use of a resource, a fast-growing area of research (Ostrom and Janssen 2004; Ostrom 2005; Vatn 2005; Gerber et al. 2009; Ménard 2011).

2 Limitations of the Research

We have identified two main limitations to the analysis in this book: knowing the level that is limited by the specificity of the empirical analysis; and the fact that the system resources of water are not taken into account. It should be noted that while these limits do not invalidate the subject matter and yet influence the scope of the remarks, they could also appear as many possible extensions.

The first relates to the choice of a generic analytical level, i.e. a focus on the ideal-types of the German, French and English UWSs. This choice prevents us from embracing the diversity and details of the contingency of UWSEs. The research is therefore confined to explanatory purposes and does not allow comprehensive findings to be made regarding the modernization of UWSEs. For example, the study of the French ideal-type does not look at the impact of the new contractual forms permitted under law No. 2010–559 of 28 May 2010, which created a battery of different methods of organization through local public companies. As a result, the research does not look at counterexamples, making these a logical and necessary extension to this work. We think, for example, of the recent transformations in governance in Italy and Eastern Europe (Arnaudo 2011; Guerrini and Romanon 2014).

The second limitation relates to the definition and the mobilization of the concept of the UWS. The book looks at the management of water, but the 'resource' dimension is seldom present in the architecture of the UWS. This limit has implications insofar as, on the one hand, our work takes into account few physical constraints of the research subject and, on the other, the physical flow analysis neither corroborates nor disproves the socio-institutional analysis, as ecological economists can usefully do. Equally, in reducing the scope of the UWS, we did not consider the dimension of power relationships that could be expressed within a UWSE, and which often prove to be central in literature looking at the management of water. This choice was justified by the level of abstraction that has been chosen, but it should however be noted that it impacts on the rest of the analysis, including the theoretical phase.

3 Research Perspectives

Two types of research perspectives open up from this research. The first is to address the aforementioned limitations in order to increase the relevance and the consistency of this work. The second leads to remobilization of experience for further analysis.

With regard to the integration of limits, carrying out specific case studies (a comparison of several UWSE on an urban level, etc.) would represent an extension that would firm up the guidelines of this work, adapting the analytical grid to individual specificities. These case studies would also enable an analysis to be carried out, starting from the micro-level and looking at the redistribution of responsibilities between key players as a result of the modernization of the UWS, focusing on both local aspects and on the different levels of governance. In turn, this would result in the testing of hypotheses looking at the relationship between the local organization and the vertical organization of governance. Indeed, the theoretical work of the thesis has underlined the importance of these links on the final coordination result.

The complex system appeared to us to be a fruitful track and we have favoured this in the second type of extension of this work (Wells 2012). We have highlighted the contributions of this axiom and suggested ways to integrate it in an explanatory model. Strengthened by this enrichment, and with hindsight, we can understand the effects of the modernization of UWSEs, all while opening up broader research questions. By way of illustration, the analysis in terms of complex systems shines a clear light on the phenomenon of depoliticization. Indeed, we have shown how the reallocation of property rights and their fragmentation—brought about by modernization—depoliticizes the UWSE. However, one can legitimately think that the key players develop new strategies to rebuild power relationships within the networks of governance of the UWS. The systemic analysis enables an understanding of this organizational counter-stream.

Our three stylized facts have been dealt with in isolation, but, if the modernization of UWSEs proves to be a complex dynamic, they co-construct. There is therefore a question over the impact of depoliticization

and a dynamic that is resilient, or rather resistant, to the quality of governance of a natural resource. We have shown that the English UWSs are the most resilient, as opposed to the German UWSs, which are more sustainable and adapt differently. It therefore seems that the ability to deal with an external shock in an efficient manner is down to both resilience and resistance, and that these two characteristics can fit together in many ways. For example, in the short term, the English system is resilient, but in the long term, it reveals rather more characteristics of resistance. Conversely, as evidenced by the situation in Munich, German organization is resistant in the short term, but becomes a form of resilience in the medium term. Therefore, some resistance in the short term, and the development of consultation mechanisms to guide institutional change over the longer term, seem to be beneficial to the quality of governance of a UWS. Is that a case-specific conclusion or is there a potential for generalizing it? Focusing on exploring this conjecture could, without doubt, lead to an extension and refinement of the results.

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