Innovations and Sustainability in the Water Services Sectors – Institutional Framework, Actors, and Policy Instruments

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1. Introduction

The sectors supplying environment-related services, namely water supply and sewage services, are so far characterised by low market competition with a high degree of government regulation. During the last years, the public demands on these sectors have changed distinctively. The pressure to enhance their economic performance is increasing. For some time, the debate in Germany has been dominated by the plea to liberalise the water supply sector. However, during the last months, the focus has somewhat changed to the more general aim to modernise the whole water management system. At the same time, the concept of sustainability requires a comprehensive and long-term orientation in the management of scarce environmental resources. This means e.g. taking into account different effects of using the environment and considering the needs of future generations. Additionally, public participation in decision making in environmental management is demanded. All these developments should result in changes in the innovation performance of the water sector in Germany, which had been largely stable for a considerable time span.

Up to now, there are only few publications that analyse the consequences of these developments for the water services (WS) innovation system in Germany. A study for the European Commission (INGU et al. 1999) compares the innovation performance of the water sectors in different EU-countries including Germany. Moreover, the analysis of the water sector can resort to multiple publications on the effects of deregulation and market liberalization (Brackemann et al. 2001, Kahlenborn/ Kraemer 1999, OECD 1998) as well as on the implementation of the sustainability concept (SRU 2002, Scheele 2001, Ewers et al. 2001, UBA 2000). While there is a substantial amount of literature on the characteristics and determinants of innovation performance in the market, the analyses of the effects of infrastructure market deregulation or of environmental regulations on innovation performance (for many others Hemmelskamp/ Rennings/ Leone 2000, Klemmer/ Lehr/ Löbbe 1999) are more recent. From this literature, experiences can be carried over on the role of innovations in the public sector (Zimmermann et al. 1998) as well as on the effects deregulating public utility markets like telecommunication on innovation performance (e.g. Lewis/ Yildirim 2002, Firth/ Mellor 1999).

On this background, we analyse the German water sector in respect to its innovation performance. Our focus lies on the different actors, their environment and the resulting incentives for their actions. We proceed

- from considering the patterns of innovations in WS innovation systems, based on the theoretical literature on innovation processes and the nature of innovation processes in the water sector (chapter 2),
- to analysing the functioning of the WS innovation system in Germany and showing the role of central actors, institutions and policy instruments (chapter 3),
- to identifying the factors that influenced past performance of the innovation system and to revealing possible future developments (chapter 4).

Within this context, we pose two questions: What are the prospects for increasing efficiency in the WSS? Are the characteristics of the WS innovation system instrumental in generating innovations towards sustainability? These considerations form the basis for identifying policy measures to increase innovation performance of the innovation system.

2. Understanding Innovation Processes in Water Services

2.1 Innovations – Sustainability – Sustainable Innovations

By combining sustainability and innovations, this paper contrasts two concepts that seem to be very different – even contradictory - in the first place. By analysing "novel combinations" that lead to new products, production processes and new organisational features, Schumpeter (1926: 100) aimed at explaining growth processes that determine economic development in dynamic growth cycles. Subsequent authors built on his considerations by assigning innovations a central role for understanding economic development. Sustainability (WCED 1987) has come up as more or less normative political and economic concept that aims at constraining the long-term ecological and social consequences of market processes. However, it appears that both the analysis of innovations and sustainability are based on long-run observations of economic processes and the role that actors play within a given institutional and economic framework. Both concepts do overlap within the notion of "sustainable innovations".

In order to gain a better understanding of innovation processes, several kinds of innovations have been distinguished (for many others Palmberg et al. 1999: 7-15, OECD 1997, Pavitt 1984). In respect to the WS innovation system, important classifications are:

- The difference between inventions as new ideas, innovations which are commercialised by bringing new ideas to the market and the market diffusion through imitation.

- Degrees of innovation in respect to the effects that they have for single firms, industries or economies, ranging from incremental to radical innovations.

- Competence-enhancing vs. competence-destroying innovations.

- Types of innovation like product, process, technological, commercial, organizational, or institutional innovation.

- Levels of innovation in respect to novelty: new to a firm, an industry, or for the world. This concept overlaps with the distinction between innovation and diffusion, as innovative technologies from the viewpoint of the firm mostly represent technology diffusion from the market perspective.

In context of the WSS, technological progress is dominated mainly by incremental innovations. Furthermore, an international account shows that technological innovations in WSS are mainly directed towards systematic and integrated solutions, while individual technical components are mostly already existing (Rudolph/ Schäfer 2001b: 24). In terms of innovation theory, these innovations represent architectural innovations which change the interrelation of the different elements involved in contrast to modular innovations (Henderson/Clark 1990). While these innovations usually are not connected with big changes from the viewpoint of the consumer and the whole WSS, changes can occur for competitiveness of single firms as architectural competencies and networks are destroyed.

In addition, institutional and social innovations play a central role for initiating changes in the WSS system. Besides possible institutions that are newly developed for the specific requirements of the WSS innovation system, the adoption of institutional innovations from other similar areas like telecommunications and electricity, but also the diffusion of management tools that are successfully in use in other countries and for which no experience exist in the affected operators of WSS (benchmarking, yardstick competition) are of central importance for the innovation system.

For the WSS like for other areas/sectors, the concept of sustainable development has resulted in new important public targets not only in respect to environmental, but also economic and social goals that entered the decision-making processes and added pressure to change water management regimes. At the same time, conflicts between different uses of natural environments (water management vs. agriculture) remain one central feature of these decision problems. One example for this pressure is the quest for a comprehensive management of river basins. There are differences in the implementation of sustainability between developed and less developed countries, but also between different developed countries. Central topics in respect to sustainability of WSS are*:*

- The key issues of accessibility of water in sufficient quantity and healthy quality as well as of affordability of water prices.

- Long-term maintenance of the water infrastructure.

- Coordination and conflicts with the general aims of environmental conservation.

The sustainability concept expands the scope of innovations on one hand but leads to a narrowing of their scope on the other hand. Innovations are seen in context of the environmental, social and economic aims that are pursued. Accordingly, the notion of sustainable innovations not only comprises technological and economic innovations but also institutional innovations, aiming at restructuring the framework conditions and regulatory principles in society as well as social innovations that are associated with the development of new values and changes in life-styles (Klemmer/Lehr/Löbbe 1999: 26). Within the multitude of possible economic, institutional and social innovations, sustainable innovations comprise only the ones which match with the aims of sustainability – which do not curtail the opportunities of future generations among others.

2.2 WS Innovation systems

Even if the underlying understanding of innovations is a very broad one, the questions who innovates and which factors influence the process are not obsolete. Possibly they have become more important because of the search for innovations that are not only economically profitable but also are also in accordance to ecological and social aims.

For analysing the effects of institutions and organizations on innovations, the national innovation system (NIS) approach has been widely used (Nelson 1993, Lundvall 1988, 1993). This concept combines a systemic and an institutional view and recognizes that innovating firms and organizations do not act in a vacuum. Studies on innovation systems usually treat individual entrepreneurs, the other firms involved in innovation activities (competitors, suppliers, customers, etc.) and associated organizations such as universities and research institutes as primary actors (similar Lundvall 1988: 365). Also for analysing the innovation processes in water services, such a distinction between the WSS where the technical and organisational structure of water supply and disposal services is distinguished from the much broader WS innovation system makes sense (figure 1).

Core actors within the WSS are the operators that are responsible for water supply and wastewater disposal. They are immediately connected to consumers and users of water resources on one hand and to technology suppliers from the business sector, service firms (e.g. engineering services), universities, and research institutes on the other hand. These operators are – depending on the concrete institutional framework chosen - under more or less strong control of the municipality.

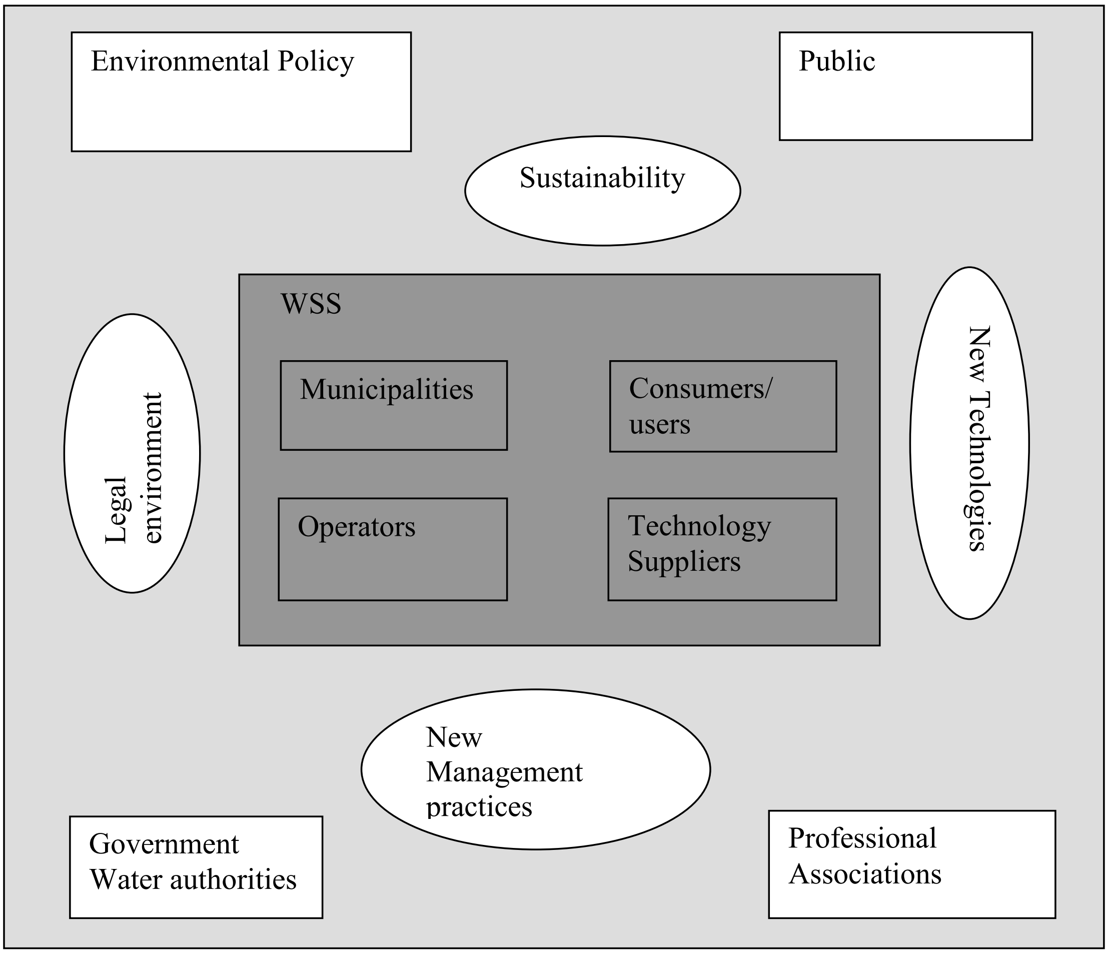

Figure 1: WS innovation system

These "core actors" are faced with a specific institutional environment (framework in a broad sense) which is determined by additional actors. The legal regulations are enforced by governmental water authorities and environmental authorities and supplemented by norms set from professional associations. Sustainability as well as public participation are emphasised by environmental policy and regional interest groups. The experiences with the use of new technologies and new management practices in other countries or similar utilities sectors like telecommunication and energy impose pressure on the actors in the WS innovation system.

In this perception, the WS innovation system represents a collective of actors embedded in a (at least partly) common institutional environment and involved in the creation, implementation and use of new products, processes, and services as well as new designs of organisations and institutions. Within this framework, firms and organizations usually do not innovate alone (Stevens 2000: 32). This insight follows from the fact that perfect competitive markets and the absence of transaction costs are theoretical constructs and that it is otherwise not rational to undertake all innovation activities within a hierarchy and without any notice of the environment. Instead, innovations arise in particular from interactions between firms and other organizations (Nooteboom 2000b: 915 with reference to Lundvall 1988, 1993). Related to this Nooteboom (2000b: 916) proposes "that innovation outcomes, on the level of firms, are to a large extent determined by the forms of co-ordination used for inter-firm relations, and that these forms of co-ordination are conditioned by institutions […].” Similarly, Lundvall (1988, 1993) emphasizes the importance of vertical user-producer relations for innovation activities. Within the framework of the WSS, this central relationship comprises the operator, other firms and public organisations (universities, research institutes) supplying technological solutions. Within this central system of firms, organizations and institutions, the production, selection and diffusion of innovations takes place (Nooteboom 2000a: 231). In the focus of our interest are the different actors involved, their (common) institutional environment, and the forms of their interaction.

Against the background of the sustainability concept and the underlying understanding of innovations it seems to be useful to widen that circle and to regard for example consumer protection organizations, consumers and employees as well. Both, workers and consumers often tend to become almost passive beneficiaries or even victims in relation to innovations, rather than subjects taking an active part in the process of innovation. Between consumers and operators there is a kind of double user-producer relation in the context of water management. On the one hand users play a role as consumers of drinking water, process water or other product variants. On the other hand there is a non market relation between water suppliers and users who are also consumers of environmental quality. Thus not only water suppliers should be regarded as users but also other actors who use functions of water resources. Farmers for example fertilize their fields and affect the quality of groundwater and surface water. This rivalry has lead in several cases to co-operations between water suppliers and farmers.

For the choice of a “national” perspective of the NIS approach one fundamental reason among others lies in the observation that interaction across short geographical distances and between actors with the same language and cultural proximity is easier than across considerable geographical and cultural distances (Lundvall 1988: 360; 1993: 279-280/286ff.).[1] Despite these arguments we will not speak about *national* innovation systems because an innovation system is neither necessarily bounded by national boundaries nor necessarily as large as a country. Nevertheless there are considerable differences between the water services sectors of different countries which for example can be explained to a certain degree with the respective national regulations that may in turn be relevant for innovation activities, too. In Germany where the water market is strongly segmented exist possibly several – slightly different – systems on the same horizontal level. Besides, the NIS literature mostly analyses technical innovations whereas a broader definition of innovations tends to disintegrate a uniform reference. Therefore the innovation system we focus on is in a certain degree sector specific and has in its individual cases a non-uniform spatial dimension.

2.3 Innovation processes in the WSS

The innovation processes in the water supply and disposal industries, which determine the patterns of long-term technological development can be analysed by applying a heuristic

[1] Similarly the international transfer of technology and knowledge is neither costless nor instantaneous. With trading goods only parts of the existing knowledge and the applied technology can be transferred. Some knowledge is exclusively embodied in the labour force that is only limited mobile. Besides an important role for innovation activities is attributed to the national government which sets a substantial part of the formal institutional environment or intervenes sometimes even directly.

model of discovery based on Nooteboom (2000).[2] By characterizing the process of discovery in general principles, the model explains the development and diffusion of innovations in WSS as well as the role of institutional factors and relevant actors in the innovation process. It provides a sequence of steps an innovation passes through from being a new idea to being diffused in the system:

In the beginning, novel combinations are understood mainly by intuition, whereas clarity arises in a process of *consolidation* which is accompanied by a reduction in the variety of solutions. Consolidation "results from a drive towards efficiency and standardisation of operation, application, and production." (Nooteboom 2000a: 175). The underlying speed of the adjustment as well as increase in efficiency and standardization depend on competitive pressure. Consolidation is needed for the exploitation of an innovation on the one side. On the other side these stages are accompanied by a tendency to adhere (as long as possible) to a specific solution etc. (recoup the investment, lock-in effects, "wait" for pressure to innovate again). The outcome serves as a platform for *generalization* into new applications in different contexts. Within this step, attempts are made to carry a successful practice, product etc. into neighbouring areas of application (new markets, new segments of existing markets). The underlying economic rationale is to realise economies of scale or scope. This process is followed by a *differentiation* into versions and extensions with increasing variety in use. Additionally, elements of existing practices are transferred into foreign practices to be used in different contexts (*reciprocation*). As new elements are added to the technology that cannot fully realize their potential, a pressure for radical innovations is building up.

In the context of water management decisions, innovative processes differ in some respects from the framework that Nooteboom draws (figure 2). However, the main characteristic, the differentiation between explorative search for new combinations that fundamentally change the system and exploitative consolidation and optimisation in performance routines still holds. The traditional water system could be described as being in a state with a strong tendency to adhere. Because of the inferior role that radical technological innovations play within the water system, the pressure for radical changes does not come from these technical parameters. Rather, outside factors that develop in the course of new political aims like sustainability or shortages in public funds that lead to the pressure to cut costs build up pressure in form of a – perhaps even radical – change in the institutional environment.

This outside pressure results to a lesser extent in a new technological paradigm (Kuhn 1973, Dosi 1982), but in a orientation of the system in the direction of new aims which nevertheless give rise to further technological advances and the diffusion of other technological solutions and management practices. Within this newly defined direction of technical change, systemic changes in the water management system may occur in connection with a possible competence destroying effect of innovations from the viewpoint of single firms: The relative importance of different elements in the production system changes and the user-supplier relations may alter. The new solutions to technical and management problems that are quested within the newly directed process of system optimisation can come from own innovation

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[2] Nooteboom's representation of innovative processes is based on the concept of a hermeneutic cycle (Gadamer) which aims at explaining the change of meaning in language use: 'we interpret [language] according to perspectives built on the past and in doing so may change those perspectives to some extent.' (p. 143) By using words in different contexts and sentences (as metaphors), their meanings change. This feature - at the same time using existing possibilities while exploring new ones - is the link to the main characteristics of innovative processes.

efforts, but also from outside the system: Solutions that are already in use in other utilities sectors or in other countries can be diffused within the system.

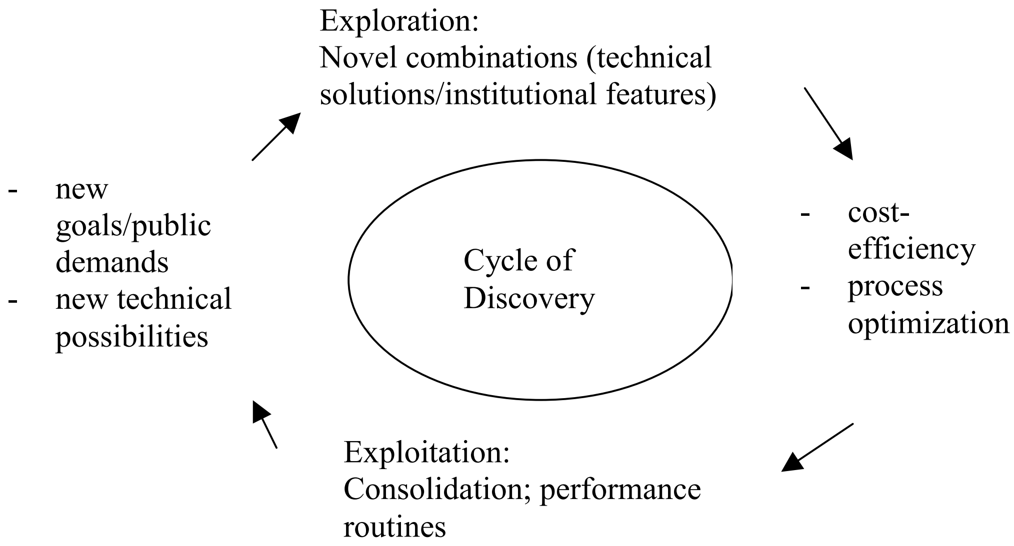

Figure 2: Innovation process in the WSS
Source: According to Nooteboom (2000a): 238.

In "ideal" market systems, the pressure for the adjustment to new technological advances comes from market competition (Schumpeter 1926). New technological possibilities enable entrepreneurs to employ novel combinations in the search for excess profits. Within the market framework, this selection process is driven by customer demand for new goods and the price competition between different suppliers. In water management systems, different factors impede the installation of a competitive market system. In addition to water supply, the output of water systems consists of environmental services like environmental conservation within water protection areas. These services are public goods which cannot be supplied through markets. As mechanisms for selection in the case of public supply of environmental goods, weak mechanisms like elections and migration have been proposed as possible substitutes (Zimmermann/Otter/Stahl/Wohltmann 1998: 23). As the subsequently described experience shows, the underlying processes in water management is mainly dominated by other more intangible factors like the attitudes conciliated within the education of engineers and the principles underlying the water policy approaches.

But even if water markets are deregulated and water operators are privatised, the properties of water as a resource leads to local monopolies with no competition among different suppliers in the market. Therefore, government regulations will be necessary in any case to determine the direction of technical progress by setting the institutional framework for market behaviour. In practice, it is not clear in advance, whether private solutions are better than a government supply of water services, so that a discussion of innovative activities has to take into consideration innovations that are initiated by governmental authorities.

3. The innovation system "Water Services" in Germany

This chapter outlines main characteristics of the WS innovation system by describing the political actors and the actors in the WS market. These actors are embedded in a complex institutional environment.. Therefore, we focus on those institutions and instruments of the WSS that are especially important for the innovative behaviour of the actors.

3.1 Principles of water policy

There are two fundamental features of the WS innovation system in the sense that operators orientate their actions strongly to them. The first aspect is the precautionary principle as main guideline of German water policy. It is laid down in the Federal Water Act. According to this principle, unnecessary burdens on water are to be avoided and necessary burdens are to be kept to a minimum (Hansen et al. 2000: 28). This shall guarantee that waters will not be polluted with harmful substances up to their critical load. According to § 7a WHG discharging waste waters requires the use of water treatment techniques that comply with the "state of the art" (Stand der Technik). Before the WHG-amendment of 1996 only "generally recognized rules of technology" (allgemein anerkannte Regeln der Technik) were prescribed. The Drinking Water Ordinance also refers to the latter rule (§ 4 I TrinkwV) and mentions additionally the so-called minimization rule (Minimierungsgebot, § 6 III TrinkwV). It regulates by law that the concentration of chemical substances in drinking water shall be kept as low as possible according to generally recognized rules of technology and within the range of justifiable expenditures.[3] Furthermore, limits or guidelines are prescribed for more than 50 parameters. In this way, synergy effects of harmful substances shall be prevented from the beginning.

The minimization rule represents the current technological paradigm of the water supply sector. While economists normally do not expect that firms exceed legal standards, the drinking water quality is in many cases actually higher than prescribed by the legal standards. This technically orientated behaviour is surely promoted by present market conditions (chapter 3.4) so that many experts are apprehensive that liberalization could have negative consequences for water quality. Another characteristic of the current system is that especially suppliers under public law monitor quality standards to a certain degree by themselves. Thus, it seems necessary to get to better control mechanism last but not least for these actors (Ewers et al. 2001: 48).

The second feature of the WS innovation system relates to water as a natural resource. The EU Water Framework Directive[4] (WFD) describes water as being "not a commercial product like any other but, rather, a heritage which must be protected, defended and treated as such." In the meantime it has become a popular catchword often mentioned by opponents of a liberalization of the WSS. From a neutral viewpoint, this quotation refers foremost to the fact that water resources are absolutely necessary for (human) life and that water resources fulfil many economical and ecological functions. Connected with the great variety of water uses are rivalries and both positive or negative external effects. Further market failures might occur because of natural monopoly conditions of local networks of drinking water pipes and sewers. Investments in these networks cause sunk costs for the incumbent which constitute an

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3 In contrast to the Drinking Water Ordinance the European Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption contains only minimum requirements (article 4).

4 Directive 2000/60/EC establishing a framework for the Community action in the field of water policy, adopted on 23 October 2000.

economic entry barrier for potential entrants. Even if it is generally accepted that efficient or even "sustainable" allocations can not be reached by "the market" alone and that it is instead necessary to regulate the WSS, the way to do this is not clear from the start. Nevertheless many public suppliers and professional associations seem to believe that the current system is the best one and that any change of the regulatory framework in order to strengthen competition must inevitably worsen drinking water quality. During the debate following the liberalization report assigned by the Federal Ministry of Economics and Technology, the operators and associations put up stubborn resistance to any changes.

3.2 Actors involved in the water policy

3.2.1. German federal government

In Germany, the competences relating to water management are divided between the regional authorities on three levels. The federal government obtains only a general competence to regulate the legislation of the Länder regarding the water supply (Wasserhaushalt) (Art. 74 I GG). The framework of the water management legislation that is formulated partly on the basis of European directives includes particularly the Federal Water Act (Wasserhaushalts-gesetz, WHG), the Waste Water Charges Act (Abwasserabgabengesetz, AbwAG) and the Drinking Water Ordinance (Trinkwasserverordnung, TrinkwV).

On the ministry level the competences are divided between five ministries: Water pollution control is the duty of the Federal Environmental Ministry, water supply and water industry are under the responsibility of the Federal Ministry of Economics and Technology, the Federal Ministry of Education and Research focuses on innovations and new technologies, and the Federal Ministry for Health fixes the standards for drinking water (Rudolph/Block w.y.: 10). Last but not least, the Ministry of Transport, Building and Housing is in charge of the waterways (rivers and canals).

This means that the competences of the Federal Environmental Ministry are limited and that aspects like water pollution control and sustainable water management are not generally more important than other forms of using water resources. Nevertheless, in principle an integration of all the water related aspects of the different policy areas would be reasonable because of the multiple functions of water resources and the relationships between different environmental media.

3.2.2. Länder

The Länder take a position between the Federal State and the municipalities. They adopt the national laws into regional water laws (Landeswassergesetze) and issue a number of regulations and ordinances. In order to enforce the water regulations, most of the Länder have a three level split of water authorities (Hansen et al. 2000: 19-21):

- The Supreme Water Authority (Oberste Wasserbehörde) is a Federal State Ministry, at present the Federal Environmental Ministry. Its functions are in particular strategic decisions in water management, and supervision of lower water authorities.

- The Upper Water Authority (Obere Wasserbehörde) is settled at the regional government (Regierungspräsidien, Bezirksregierung) and is responsible for regional water management planning and several administrative procedures.

- The Lower Water Authority (Untere Wasserbehörde) is part of the municipality. It grants permits and licences to water users, monitors and enforces the local water policy.

Beside that, the Länder have established some institutions in order to co-operate with each other. The most important of these is the LAWA – Länderarbeitsgemeinschaft Wasser (Working Group of the Federal States on Water Problems) – that was founded in 1956. The aim of this working group is to discuss questions arising in the areas of water management and water legislation, to formulate solutions and to put forward recommendations for their implementation.

Apart from the Länder's active role in water management their constitutions as well as water laws have assigned water supply and waste water disposal to the municipalities as their duty (Brackemann et al. 2001: 47).

3.2.3. Municipalities

Regardless of this assignment, the municipalities have a right of self-government that is granted by Art. 28 II of the German constitution (Grundgesetz). Accordingly, the municipalities are entitled to govern „all affairs of the local community in their own responsibility". Thus, the municipalities play a substantial role in water management policy.

They can decide on the mode of fulfilling the tasks of water supply. Therefore they are able to determine the institutional and organisational arrangements. These arrangements differ in respect to the actors involved and the legal status of the provider. The provider can either come under public law or under private law (table 1 shows some of the alternatives). If the arrangement comes under private law, a formal privatisation or a material privatisation can be preceded. The former denotes only a change from a public to a private legal structure of a publicly owned firm whereas in case of the latter a municipality sells (parts of) its utility to private firms. In this case of material privatisation it is also possible that the municipality delegates not only the fulfilment of its duty to supply water but also the duty itself (so-called delegation of duty).[5] At both regimes (public and private) inter-municipal co-operations are possible so that a service area can comprise several administrative districts.

In addition to the choice of the organizational form, the municipalities can obligate the residents to have a connection to the public network and to enter into contract with the public supplier (Anschluss- und Benutzungszwang). These obligations that constitute entry barriers for potential competitors are often justified as instruments with the alleged objective to ensure a high-quality and low-cost water supply.

Generally speaking, the task sharing between different political actors regarding water policy can be described with two catchwords: Federalism and subsidiary principle (INGU et al. 1999: 148). For the most part, water management policy is not a federal matter but the subject of policy processes at municipality and state level. Yet, municipalities have a remarkable autonomy to organize local water supply services and to exclude competition from their district. If they involve private firms they have – at least in principle – a good deal of autonomy to choose the design of the contracts (Brackemann et al. 2001: 58). Consequently, there is neither a uniform national water management policy nor a single set of actors within just one innovation system.

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[5] See Holzwarth/Ewens (2001: 47-52) for a overview of the arrangements under public and private law.

Organisational arrangements under public law	Organisational arrangements under private law
Government operated system (Regiebetrieb)	Municipal enterprise (kommunale privatrechtliche Eigengesellschaft)
Semi-autonomous agency (Eigenbetrieb)	Mixted enterprise (Gemischtwirtschaftliche Gesellschaft)
Public co-operation (Zweckverband or Wasser- und Bodenverband)	Private Firm (by delegation, concession agreement)

Source: According to INGU et al. 1999: 150.

Table 1: Organisational arrangements of public utilities

The decentralized organization of the water sector leads on one hand to a greater variety of "models" and solutions than a centralized organization. This has the positive consequence that innovations may be less restricted in their direction. Thus, the assertion has been made that there is competition between "managements models". Whether this competition really takes places, seems doubtful because effective competition requires that inferior solutions are sanctioned. On the other hand, the degree of freedom with regard to the choice of technology seems relatively small despite decentralization. The reason is that co-ordination does not only take place between the Länder but also with help of professional associations.

3.3.4. Professional associations

In Germany, professional associations like the ATV-DVWK (The German Technical and Scientific Association on Gas and Water)[6] and the DVGW (German Association for Water, Waste Water and Waste)[7] have a prominent position within the WS innovation system. Both professional associations have as well corporate members as individual members who mostly work in municipalities, engineering consultancies, public authorities and water and waste water firms. Their numerous working groups define or redefine national rules, standards, and guidelines. These standards and rules are often worked out down to the smallest detail. Although these norms do not pass automatically into law, they obtain a status similar to legal force in practice. Even if a proper technical practice defined by professional associations does not enter into a formal rule, it will diffuse widely. Altogether, these professional association have a remarkable influence on the German water policy but the underlying objectives are only partly prescribed by political actors.

According to Kahlenborn/Kraemer (1999: 136), the character of these associations and their working groups can be described as a closed club. This characteristic makes it difficult to bring in new ideas from outside of the water management institutions as well as from their bottom. The associations show a specific tradition in solving water problems by having a one-sided focus on technical solutions.

3.3.5. Technology Suppliers

Another group of actors belonging to the WSS which is closely cooperating with the water operators are technology providers. The relationship between suppliers and technology providers is mainly based on market transactions; the German suppliers are normally not vertical integrated. R&D in the field of water technology is often stimulated or accompanied

[6] Deutsche Vereinigung des Gas- und Wasserfaches e.V. – Technisch-wissenschaftlicher Verein.

[7] Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e.V. The ATV-DVWK is the association representing German specialists working in the fields of waste water, waste and water management.

by professional associations. The outcomes of these activities are foremost technical solutions whereas comprehensive solutions and non-technical innovations have not been in the focus of attention of these actors so far (INGU et al. 1999: 152). Professional associations contribute to the diffusion of these technical innovations by organizing workshops, training courses etc. and by publishing own periodicals.

Unlike the operators (with the exception of RWE) German suppliers of water technology are well represented on international markets. The RCA-values for water/waste water technology were positive during the nineties, but lower than in the fields waste management and air-pollution control (Legler et al. 2000: 165).[8] On the whole, Germany is the second largest exporter of environmental technology behind the USA. With respect to R&D and technological innovations, the collaboration between universities, research institutes and providers of environmental technology is an important feature. Between 1994 and 1997, German firms applied for relatively more patents in environmental technology than on average of all sections of European Patent Classification. Here, the specialisation in water/waste water technology is equal to environmental technology in general (Legler et al. 2000: 205).

3.4 Market Structure

Within the water management sector, the water supply and the waste water treatment are physically and administratively separated in most cases. At present, there are approximately 6,600 predominantly municipal enterprises with more than 17,000 water works on the supply side. A majority of these public utilities has a status of government operated system or semi-autonomous agencies. Whereas the former is an integrated and a non-autonomous part of the local administration, the latter is partly independent of the local administration. Moreover, they differ considerably with respect to their size: just 25 percent of the utilities provide 83 percent of the population with drinking water (Scheele 2001). This means, that the average number of customers of most of the utilities is less than 3,000. Large public co-operations covering vast areas like the Ruhrverband that supplies the urban zones along the river Ruhr are the exemption. In fact, the merely 15 integrated water supply and waste water utilities that existed in the former German Democratic Republic up to the reunification were split up into more than 500 suppliers under private law and more than twice as many waste water utilities. Altogether, the market structure of the disposal side is similar so that on the supply side: about 8,000 waste water service firms currently exist in Germany. While water supply is classified by law as entrepreneurial activity, waste water service is a sovereign task (Kemper 2001: 23). A material privatisation or delegation of this task to a third party was not allowed until the Water Management Act was changed in 1996. Thus, organisational arrangements like government operated systems or semi-autonomous agencies play a greater role so far than in the water supply sector.

In comparison with the market structures in countries like England and Wales or the Netherlands, the market in this country can be regarded as very fragmented. In the Netherlands, where in the seventies about 110 enterprises existed, only about 20 water suppliers remained after a targeted consolidation process was initiated. In England and Wales, just ten integrated enterprises and 16 which supply only water do exist. They are subject to a

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8 The revealed comparative advantage (RCA) compares the comparative advantage of different sectors. It is defined as quotient of the export-import ration of a given commodity and the export-import ration of all commodities in a country.

restrictive yardstick regulation conducted by the independent regulator OFWAT (Clausen/Scheele 2002: 24-39).

Although the markets in Germany are quite small and separated, changes in the organizational arrangements and the operating companies can be observed. Firstly, as table 2 shows, the share of non-autonomous utilities decreases while arrangements under private law become more popular. Secondly, there is a growing participation of private firms. Even though the (material) privatisation is to some extent driven by the bad financial situation of the communes, it means that the link between different supply areas slowly gets stronger because these firms operate nationwide. Some firms, for example RWE that bought Thames Water, try to win plenty operating contracts and at the same time pursue a multi utility strategy. This way, innovations may diffuse faster and also between different spheres of activity (e.g. between power supply and waste management). Although also big French companies are already active in German water markets, we do not have by far a situation comparable to France where the market is dominated by few companies (Elnaboulsi 2001).

Organisational arrangement	Share of total number		
	1995	1997	1999
Government operated system (Regiebetrieb)	4.2	5.0	1.9
Semi-autonomous agency (Eigenbetrieb)	51.5	48.3	39.3
Public co-operations (Zweckverband, Wasser- und Bodenverband)	20.8	21.1	20.3
Arrangements under private law	23.5	25.6	38.5

Source: Brackemann et al. (2001): 18.

Table 2: Organisational arrangements of public utilities[9]

A change with respect to organisational structures that is widely demanded is a stronger horizontal integration of water supply and waste water treatment. It is expected that by integrating both parts of water services, economies of scope could be realized and that the utilities may deal better with new challenges if they operate at both ends of the stream. Currently, different value added tax rates for utilities under private and under public law counteract the integration of both sides (Ewers et al. 2001: 68; Brackemann et al. 2001: 209). This difference is an effective barrier to organisational innovations.

3.5 Use and consumption patterns

According to the Agenda 21, a change of consumption patterns is an important step towards sustainability. As influencing factors on both how and how much freshwater is used for human purposes, the OECD (1998: 20) names among others:

- economic factors (e.g. notably the price of water, and tariff structures),
- technological and managerial capabilities,
- socio-economic conditions (e.g. land-use patterns),

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9 The data include only about 20 percent of the 6,600 utilities. Most of the utilities not counted are probably government operating systems or semi-autonomous agencies.

- cultural habits (e.g. landscape and gardening practices, domestic water use patterns);
- political, legal and institutional structures (e.g. water rights, institutional arrangements to manage water).

Compared with other countries, the natural water supply in Germany is generous in quantity so that the water demand can be served relative easily. As table 3 shows the biggest water users are thermal power stations. They use almost exclusively surface water for cooling their plants. The public water management sector that supplies mainly households and small businesses has a share in the water abstraction of 14 percent. This is about one billion cubic meters less than in the early 1990s. The current amount of 5.5 billion m³ fresh water splits up into 65 percent (1991: 63 percent) groundwater, 9 percent (1991: 9 percent) spring water, and 26 percent (1991: 28 percent) surface water (Statistisches Bundesamt 2001: 11).

	Freshwater abstraction		Ground and Spring Water	
Industrial Sector	In total	Share	In total	Share
Public Water Management	5557.3	0.14	4102.5	0.74
Processing Industry, Mining Industry	8497.9	0.21	2447.5	0.29
Thermal Power Stations	26372.4	0.65	40.3	0.00
Agriculture (Irrigation)	163.1	0.00	119.6	0.73
In total	40590.7	1.00	6709.9	0.17

Source: Statistisches Bundesamt (2001): 8.

Table 3: Freshwater abstraction by major use (1998, million cubic metres)

The most important customers of public suppliers are households and small businesses. As table 4 shows, households and small businesses consumed nearly 80 percent of the public water supply to consumers in 2001. Although this share is higher than the share of this customer group in the early 1990s, the amount consumed per capita and day has sunk. While an average person in Germany needed 144 litres a day in 1991, she consumes today only 128 litres – this is the second lowest per capita consumption in Western Europe. In this context two things are worth noting: Firstly, that the average water consumption in Eastern Germany is distinctively lower than in Western Germany, in fact it was only 97 litres in 1998. Secondly, that in 1991 the average water consumption in the eastern part was nearly on a level with that in Western Germany. Within the following years it dropped about thirty percent whereas the average reduction in Western Germany was less than six percent between 1991 and 1998. However, the reasons for these disparate developments are not apparent at first glance. A change to a tariff structure based on use after the reunification is one factor that has contributed to the water savings. Besides, the consumption patterns seem to be generally different.

Furthermore, table 4 shows that especially the demand of industrial consumers has decreased in recent years. Getting 1.6 billion m³ water in 1991, they consumed only less than 1 million m³ water ten years later. This is equivalent to a share of 21 percent of the total water supply to consumers. Thus, industrial consumers have contributed considerably to water savings although it is also possible that some industrial consumers have substituted purchase by self-supplying. However, such a substitution requires that they do not underlie an obligation to enter into contract with the public supplier.

	1991		1995		1998		2001*	
	In total	Share	In total	Share	In total	Share	In total	Share
In total	5748	1.0	5094	1.0	4859	1.0	4785	1.0
Industrial customers	1620	0.28	1222	0.24	1045	0.22	995	0.21
Households and Small businesses	4128	0.72	3872	0.76	3814	0.78	3790	0.79
Litres per capita and day	144		132		129		128	
- Western Germany**	144		138		136			
- Eastern Germany**	140		103		97			

Source: Statistisches Bundesamt (2001: 15), (1998: 15), (1995: 13).
*Data for 2001: BGW (2002); **Own calculations.

Table 4: Water supply to consumers, 1991-2001, million cubic meter

While the industrial demand can switch from public supply to self-supply, the consumer demand depends on the public supplier. The possibilities to replace water purchases by self-supply are limited. Nevertheless, the domestic water demand is not necessarily price-inelastic as international comparisons show (Löbbe et al. 2002: 294).

3.6 Instruments of German water policy

In this chapter we outline the main environmental orientated instruments of the German water policy. These are both command-and-control instruments (permits, licences, regulations of water prices) and so-called economic instruments (e.g. water extraction charges).

3.6.1. Entry barriers and regulation of water prices

As described before, the markets for water and waste water services are protected from competition by legal entry barriers. These barriers are the consequences of the municipalities' right of self-government and the exception made in German competition law. Regardless whether entry barriers result from economies of scale and investments in industry-specific assets (irreversible capital commitments) or from a legally restricted market access, a price control is necessary in order to prevent incumbents from using their market power. Therefore, water prices are determined in conjunction with local authorities or controlled by supervisory bodies respectively (Boscheck 2002: 143). Prices set by public utilities have to comply with the rules of the local taxes act (Kommunalabgabengesetz) and budgetary laws. A crucial rule – also in the context of international comparisons of water prices – is that the prices have to cover total costs. It is obvious that prices depend on both natural and economic conditions and the type of cost allowed to calculate. Moreover, the answer to the question whether it is allowed to assess replacement values or not may be relevant to investment and innovation behaviour of network owners.

In addition to these pricing rules the water prices of most of the suppliers are subject to a supervision according to the competition law. this price monitoring concerns not only utilities under private law but also utilities under public law unless they are not part of the public authority like Regiebetriebe (Kahlenborn et al. 1999: 20-21). Crucial is rather whether the supplier has a monopoly position or a dominant market role.

Despite of pricing rules and price monitoring, the prices of drinking water increased in Germany on average about 44 percent between 1991/92 and 2000/01. The prices of waste water services rose even stronger, namely by almost 60 percent between 1991/92 and 1998/99. Because of this rise in prices many consumers are now reluctant to pay more for these services, also because charges of other public services (especially for waste disposal) have increased considerably, too. Thus, more frequently price-sensitive consumers establish a kind of pressure on municipalities and firms to run their services to "reasonable" prices. Following Söderbaum (2000: 441) it seems contrarily imaginable that consumers are not only interested in the price and quality of water services in a narrow sense but bother also about environmental impacts of the management and use of water. Thus, they may have a willingness to pay prices being judged as "reasonable" or "fair" if they believe that the resource management is according to the concept of sustainable development. A possible innovation that surely would not be accepted is the supply of chlorinated drinking water.

International comparisons of water prices are complicated by the fact that some countries subsidize the sector. Operating costs are mostly included in the prices, whereas infrastructure costs (capital costs) and also environmental costs are often paid by the public budget. In Italy and some other countries, most part of the water and sewerage infrastructure has been subsidized (Massarutto 1999: 11 Scheele 2000: 18). In some German communities, sewerage charges are subsidized despite of the cost coverage rule while cost covering is generally given for drinking water prices (INGU et al. 1999: 150). Moreover, international price comparisons prove to be difficult because suppliers may do mixed calculations of prices for private and commercial customers.

In the future, water prices have to fulfil rules defined by the WFD. According to article 9 WFD, member states shall

- take account of the principle of recovery of the costs of water services, including environmental and resource costs,
- ensure that water prices provide adequate incentives for users to use water resources efficiently,
- ensure in accordance with the polluter pays principle an adequate contribution of the different water uses to the recovery of the costs of water services.

Especially the obligation to consider systematically environmental and resource costs constitutes an innovation for almost every European country. Environmental costs are costs owing to damages of the environment and ecosystems while resource costs result from using water above its natural regeneration rate. Though this is a condition for efficient and sustainable allocations the idea is deficient in a piece of advice how the costs can be determined and assigned to water users (Hansjürgens/Horsch 2001: 231). However, the WFD makes a contribution to the use of the polluter pays principle as well as to a water management with regard to river basins.

3.6.2 Environmental orientated instruments

Relating to water allocation, command-and-control instruments dominate: In principle, all water uses require an official permit or a licence (§ 2 WHG). The term water use comprises among others

- to withdraw and drain water from surface waters,

- to dump substances into surface and ground waters,
- to extract ground water,
- to retain or to lower surface or ground waters.

The use of water resources without a permit or licence is only allowed in some well defined forms. These exceptions from the general requirement of a permit or licence apply to specific "old rights" and some uses that do not affect the rights of a third party or damage the natural resource.

Permits and licences can be limited in time, but in exceptional cases their term can be longer than 30 years. Applications for permits and licences are refused if the intended use could reduce the welfare of the general public, especially if it could constitute a risk for the public water supply (§ 6 WHG). In this context, individual interests are to treat in accordance with the welfare of the general public (INGU et al. 1999: 149). In order to avoid or offset negative external effects, permits and licences can be accompanied by additional conditions.

Further environmental orientated instruments applied in water resources management are water management plans and sewage disposal plans (Kahlenborn/Kraemer 1999: 142-145). These planning-based instruments originate often from other politics like land use planning, transport planning and construction planning. Besides, water policy also applies so-called economic instruments. At present ten of the 16 Länder raise a charge on water extraction.[10] The charges are based on federal state law and differ in design and level of the tariffs. While the share of the charge in the water tariff amounts to 17 percent in Berlin, it is between three and six percent in most of the other Länder. In Lower Saxony for example the water extraction charge (Wassergroschen) was introduced in 1992. About 40 percent of the revenues (in total 71 million Euro per year) is earmarked for conservation and for protection of drinking water (Niedersächsisches Umweltministerium 2002: 45). This share of the revenues is utilized for four different measures (§ 47 h III NWG):

- Co-operation: the district administration, water utilities, and farmers develop consensus and flexible measures for groundwater protecting. Currently more than 100 co-operations exist in Lower Saxony.
- Consulting services.
- Voluntary measures: Farmers can get a compensation for economic disadvantages due to non-polluting agriculture.
- Promotion of the acquisition of areas: In case of especially endangered groundwater resources, the acquisition of catchment areas is promoted. The promotion that requires extensive utilization for at least 20 years adds up to 90 %.

In other regions like Baden-Wuerttemberg, and Hamburg, the use of the charge is uncommitted, Hesse even intends to get rid of its water extraction charge.

On discharging waste water into a water, a waste water charge is imposed since slightly more than 20 years by federal law. The charge levied by the Länder depends upon the amount of noxious substances (e.g. phosphorus, nitrogen, the metals mercury, cadmium, chromium,

[10] See BMF (2000: 31-34), and BGW (2002) for a brief overview.

nickel, lead, and copper) the waste water is loaded with (Art. 3 AbwAG). The rate levied per unit of noxiousness adds up to € 35,79 since 1997 (at the beginning it was ca € 6). Actually, the rate can change in certain circumstances. If quantity *and* noxiousness of waste water will be reduced by abatement measures to the degree required in § 7a Federal Water Act[11] or to a stricter degree made as condition for the discharge permit, the waste water charge will be cut by half. Nevertheless, actors who want to emit waste water have incentives to reduce the harmfulness of waste water by saving water in production processes or cleaning it on their own. The revenue accruing from waste water charges shall only be used for specific purposes connected with measures for maintaining or improving water quality (Art. 13 I AbwAG).

Altogether economic instruments play a less important role in water policy than command-and-control instruments. Although the water extraction charges differ considerably, they are not calculated consequently according to the availability and quality of water resources. Often, fiscal aspects rather than allocation purposes determine the use of the instrument (Kahlenborn/Kraemer 1999: 149).

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11 Since recently, a permit to dump waste water into a water requires that the waste water will be cleaned before by the best available technology (Stand der Technik) whereas the former standard was a bit weaker (§ 7a WHG).

4. Driving forces and development trajectories within the cycle of innovation

For assessing the possible developments in the WSS it is important to judge whether the WSS is able to start a development into new trajectories and cycles of innovation from itself (internal development) or whether outside impulses or pressures (external factors) are necessary. Of course, this separation is partly artificial from the empirical point of view. Some changes in the – formerly strongly determined – institutional structure are already going on, which may partly be caused by external factors and assimilated by the internal system. However, the distinction is important in analytical point of view and in respect to the question as to how far the changes will occur without further external pressure. Central questions to be discussed within this framework are:

- What actors determine (possible) developments?
- What would be the role of institutional vs. technical innovations within the different development paths?

Furthermore we try to assess how strong the pressure to innovate has been so far for the actors within the WSS and to what extent the nature/character of the innovation system might change subsequently. By doing this we pay special attention to the demand for more competition within the sector and to the concept of sustainability.

4.1 Internal innovation capabilities of the WSS

From the characterization of the WSS given in chapter 3, we derive that the innovation system in Germany is very specifically developed and has a strong deep structure which together highly prevent radical changes.[12]

The key actors within the WS innovation systems are foremost the operators. Of course, especially the publicly owned operators are at close range to other important actors like the municipalities and lower water authorities. In the past, the innovation behaviour of the operators (and with it their demand on markets for environmental technology) has been driven mainly by engineers and their views of water (or environmental) problems. This was facilitated by the sector’s protection from competition and the pricing rules that allowed to finance innovative techniques without the usual entrepreneurial risks. For decades, the evolutionary development of the technical paradigm and subsequently dominating incremental innovations were strongly influenced by the professional associations. They represent the nodes of the network of operators and other actors of the WSS and accelerate the diffusion of innovations as well as the generation of (technical) inventions in the field of water/waste water technology. On the other hand they consolidate the innovation system with their specific perception and interpretation of challenges and impede possibly more radical innovations.

Actually, this strong technical focus has mainly contributed to the high reputation of the German drinking water quality and the quality of waste water treatment. It can be regarded as an appropriate answer to the previous sanitary problems that emerged especially in highly industrialized and densely populated areas. These dangers to health and later also environmental problems had a lasting effect on the efforts to improve disposal techniques. In

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[12] Cf. Nooteboom (2000a: 97f.) for the term deep structure. It describes the existence of fundamental categories of perception and interpretation concerning the relation between organization and its environment.

difference to other countries, the water legislation in Germany requires not only to meet certain standards but also to exceed these standards. The minimization rule of the Drinking Water Ordinance has ensured an innovation behaviour that would be questioned in a typically competitive system.

Nevertheless, the WS innovation system also shows some weaknesses. In practice, water treatment processes in use could not always keep pace with the adjustments of the environmental law that have often been pushed by the professional associations. It can be suspected that maintaining the standards has been difficult in particular for some of the plenty small utilities. While apart from these gaps, spot sources of emissions in water (public sewage plants, industrial sources) are well regulated, diffuse sources are not well covered by the water policy so far (Hansjürgens/Horsch 2001: 227-228). Reducing theses emissions of diffuse sources that result particularly from agriculture is much more difficult. Since end of pipe solutions seem just to a certain degree suitable for this, the WS innovation system has to search for innovative ways in order to deal with this challenge. On one hand, the water (or environmental) policy should also address polluters not belonging to the WS innovation system in a narrower sense. On the other, hand the current WS innovation system may have the potential to deal with these problems. Instruments like the water extraction charge in Lower Saxony and other Länder present a flexible opportunity for (more or less formal) arrangements with farmers in order to compensate them for economic disadvantages due to non-polluting agriculture. Thus, a – at least limited – opening of the WSS with respect to both institutional innovations and towards actors not belonging to the inner circle of the innovation system seems possible.

Recently, further fresh impetus to the WSS was given by the European water policy which prescribes river basin management and the inclusion of environmental and resource costs in water prices. Besides, it introduces the so-called combined approach according to which instruments that can be enforced by water authorities shall be combined with other instruments that directly restrict emissions of polluters. Altogether, the German WS innovation system should be able to meet these requirements as easily as other countries.

Finally, ongoing (formal and material) privatisations as well as the increasing presence of firms with market experience in other utility services contribute to a better perception of non-technical aspects of water management. Nevertheless, the WS innovation system shows a strong persistence against new demands. In the following section we discuss to what extent the demand to improve its efficiency and to manage water resources according to the vision of sustainability could be reached in the WSS by so far and what future developments are conceivable.

4.2 External factors

4.2.1 Demand to improve the efficiency of the WSS

Since several years, the WSS is confronted with an increasing pressure to innovate due to its supposed inefficiency. At first, the criticism was voiced in an assessment of the Worldbank according to which the German WSS is technological powerful but inefficient (Briscoe 1995; Barraqué 1998 for the opposite standpoint). The following debate culminated recently while possibilities to liberalize the water supply sector have been examined by order of the Federal Ministry of Economics (Ewers et al. 2001, for a more sceptical standpoint UBA 2000). Especially in the public debate the prices which appear to be high compared to other countries act as simple indicator of the inefficiency of the WSS. In this context, primarily institutional and organisational innovations (e.g. changes of the legal environment, new management methods) or their diffusion respectively come into question while technological innovations should play a minor role. However, institutional innovations also have consequences for the technique in use as well as the investment in new assets and future research efforts. If for example a municipality delegates its water services tasks to a private firm but remains the network assets, then appropriate incentives to maintain the water pipes and canalisation may lack.

Although it seems as if the government has dropped former ambitious intentions to open the protected water supply markets, a strong demand to improve efficiency remains. One reason for this demand is the price-awareness of consumers that leads to political pressure. Outside the WS innovation system, manifold experiences have been gained with different forms of competition, regulation methods or privatisation so that numerous alternatives are already well explored. However, it is not entirely clear at the moment which method will be adopted. The exploitation of these experiences/ideas has begun, although it is somewhat unsystematic and partly more driven by intention to raise funds than to improve efficiency.

One example is the current tendency of local politics to sell water utilities that goes along with the tense financial situation of communities. The privatisation of former entirely publicly owned utilities and the fact that big private utilities play a growing role in the market also change the behaviour of public utilities. Some of them already expand their operations regardless the "communal locality principle" (kommunalwirtschaftliches Örtlichkeitsprinzip), according to which publicly owned suppliers are not allowed to operate outside their administration district. Additionally, there is a growing market for consultants that are specialized in franchising contracts. These consultations are needed because many communities do not have much experience in regulating complex delegation problems between principals and agents. Although private firms may realize economies of scale or scope and run water services at lower costs as well as raise extra capital easier, long-term efficiency is not guaranteed. The crucial aspect for efficiency is rather the degree of competition than the (private or public) ownership structure (Megginson/Netter 2001, Lambert/Dichev/Raffiee 1993).

At present, different forms of competition in the water sector are discussed not only by researchers but also within the WSS. Its actors show increasing interest in foreign water systems. Traditionally, attention has been paid mainly to the English and Welsh water sectors that were fully privatised in 1989 and are now strongly regulated by the independent authority OFWAT. Even though these institutional innovations have significant implications for traditional approaches to water management (INGU et al. 1999: 59), in this country the focus has shifted from this – in view of the operators and professional associations deterring – example towards systems that have more in common with the German one. Especially the Dutch systems receives attention. The reason is that both competition within the market and the English and Welsh system of yardstick competition do not promise unrestricted positive innovations (cf. SRU 2002 for a summary).[13] It is expected that competition within the market with third party access would lead to more long-distance transports and would require disinfections of water. Besides, it necessarily ought to be accompanied by additional regulations and monitoring instruments. Even in England and Wales, no firm has applied for an access to a network of a competitor while cross-border competition through inset appointments with separate pipes exists. While the latter might be a useful innovation, it is questionable if the efficiency gains of the former would exceed the additional regulation costs and other disadvantages. Altogether, both third party access and a central regulation authority

[13] The relationship between the design of yardstick competition and firm's investment incentive are analysed by Dalen (1998) and Sobel (1999).

would mean a radical change of the WS innovation system. The municipalities who belong to its central actors at present would be dropped out of the inner circle. An opening of the monopolized markets would break up the deep structure and considerably speed-up the concentration process.

The interest in the Dutch water system mentioned above is due to the fact that the neighbouring country swims against the current. Instead of a far-reaching privatisation and liberalization, the Dutch water policy takes different measures in order to increase efficiency, among others the duty to do benchmarking as a kind of substitution for competition (Clausen/Scheele 2002: 55-61). In the German WSS, benchmarking that is commonly used by firms in other sectors has been picked-up until now only by few initiatives. These first adoptions mostly comprehend merely few processes and services. The results will be used internally in the first place and are not comparable to indicators of firms outside the initiative. Thus, the adoption of benchmarking by the WSS is just in its infancy, the process of consolidation and generalization within the WSS has just begun. Currently, it seems as if the central actors within the WSS would not be able to reveal the full potentials of benchmarking. Consequently, political impulses should speed up the end of the uncoordinated and half-hearted use of benchmarking. An obligatory benchmarking could have the potential to

- cause a greater awareness of the outputs of the water management system (drinking water, conversation services) and the costs of the related processes,
- increase the transparency of the WSS to municipalities, local politics, and the public,
- support the local price control by creating data that are comparable to other (neighbouring) communities.

This way, an acceleration of the innovation cycle with regard to economical aspects could be achieved without a radical change of the WS innovation system. It can be expected that best practices (technics, way to solve rivalries between different water uses etc.) will be diffused faster. However, it must be emphasized that benchmarking can never be a full substitution for competition within the market, rather it can function as a complement of “competition for the market”.

4.2.2 Sustainable Water Management

Sustainability gives rise to a new innovation paradigm in water management. Social and environmental aspects are becoming more important. A more systemic view on economic, environmental and social effects of water management comes up. One way to incorporate the concept of sustainable development or environmental and social criteria into the WS innovation system is to set appropriate incentives for sustainable innovations. This can be done by regulating market behaviour of private operators, but also the water management of public operators and municipalities. In order to reach the aims formulated in the sustainability concept, environmental goals like groundwater protection and nature conservation should be taken into consideration when regulating the WS innovation system. Furthermore, an increased public participation in the decision making process is demanded. From the viewpoint of the WS innovation system, these institutional changes restrain the window of opportunity especially for its central actors. At the same time, the enhanced public participation in decision making processes may lead to an increasing dynamic of the whole system.

General principles of sustainable water management (see table 5) which are formulated – with a similar content - in different publications can be derived from the management rules on sustainable development (Enquete-Commission 1994: 42-53). In international context, the basic principle of sustainable water management was put down in chapter 18 of the Agenda 21, which was adopted by the UN-conference in 1992 and in the WFD. In Germany, the opinion prevailed that the existing water management system already was in accordance to the principles of sustainability (Drewes/Weigert 1998: 700, Ewers et al. 2001).[14] Because of the strong environmental regulation in place and the emphasis on the precautionary and prevention principle, which does in practice lead to the use and exploration of technologies that are able to limit pollution according to much higher standards than in other countries, the system has even been characterized as mid to strong green (INGU et al. 1999: 21,157). Indeed, this focus of the innovation system has lead to the development and diffusion of advanced technologies in respect to the reduction of pollutions and the realisation of security of water supply.[15]

Principle of Sustainability	Content
Regionality Principle	Regional orientation in the management of water resources; avoidance of interregional externalities (definition of regions in accordance to hydrological criteria).
Integration Principle	Water is to be managed in its context to other environmental media. Integrated view of ecological, social and economic demands of the concept of sustainability.
Polluter-Pays-Principle	Allocation of cost of water use according to the use of water resources.
Co-operation and Participation Principle	Sustainability as common task of state and society. Public participation in decision making.
Minimisation of Resource Use Principle	Reduction of resource use and increased use of regenerative natural resources.
Precautionary or Prevention Principle	Avoidance of measures with high potential of damage and/ or risk. In practice: Principle of minimisation, put down in the Drinking Water Ordinance
Point of Pollution Principle	Prevention of a release of harmful substances at the place where they emerge, i. e. no end-of-pipe technologies as far as possible.
Reversibility Principle	Consequences of measures in the field of water management should be reversible as far as possible.
Intergenerational Principle	Taking the interest of future generations into account.

Source: in accordance to Kahlenborn/Kraemer (1999: 25-41), Brackemann et al. (2001: 108-110).

Table 5: Principles of Sustainable Water Management

Thus, the weakness of the WS innovation system in Germany lies in the one-sided focus on securing a water supply with high quality for all anthropogenic uses. In addition to an increasing emphasis on cost-efficiency (see section 4.2.1), a reorientation would require an integration of water supply and disposal services, a better adjustment of water regulations into other aspects of environmental policy, and increasing transparency in decision making.

14 At last, the obligation to meet the needs of the public water supply priory by local resources (regionality principle), which is in accordance to the implementation of a river basin management, has been incorporated into the Federal Water Act.

15 The German principle of „Versorgungssicherheit", see Ministerium für Umwelt und Verkehr Baden Württemberg (2000: 6), Niedersächsisches Umweltministerium (2002: 9). Some states like Lower Saxony and Baden Wuerttemberg have called commissions of experts who formulated concepts of a sustainable water supply. However, in Lower Saxony the experts failed to reach consensus about the appropriate principles and proposals for the State water policy. Additionally, they were strongly focused on the conservation of water as a regenerative resource and failed to take into account other aspects of sustainability.

The integration principle demands to link the water supply and the disposal service sector, both of which are separated in Germany in most cases. With an integration of both areas, the requirements of both sides of the water circle would be considered in the search for innovations and the diffusion of technical progress in the water system. Thereby, the search for technological solutions could shift away from end-of-pipe solutions towards integrated technologies in order to avoid the contamination of water resources more efficiently.

This integration of both sides of the water cycle represents one aspect of a general integration of all environmental concerns into the WS innovation system. Taking into account the emissions caused by agriculture could help to solve the problems of diffuse sources of groundwater pollution. (see 3.6). Additionally, water operators could be obligated to preserve water protection areas for goals of environmental conservation with compensation from a state funds. Such measures could increase transparency in respect to the range of outputs of the water system and at the same time improve the incentive system in respect to the externalities caused by different kinds of activities.

The use of management instruments like benchmarking and fostering public relations are one way to achieve increased transparency of water management. Another instrument, which is demanded in chapter 18 of Agenda 21, is public participation. These agenda initiatives could be used in order to integrate the consumers into the decision making process as central actors of the WSS in addition to the lower water authorities and operators. In Germany, at least indirect participation of the public is already part of the water system through the influence of local city councils on the public/ private operators. Apart from this, different forms of participation would be possible. In context of the WS innovation system, increased public participation would help to strengthen public preferences in considerations in respect to the conflict of aims between water costs and water quality in the research for and application of new technologies. Transparency may lead to increased efforts to find new, innovative solutions in order to control costs of water management (i.e. decentralized water supply).

5. Conclusions

The paper has analysed the German water sector with focus on the determinants of innovation performance. In that context, we focused on the prospects for increasing efficiency in the WSS and on the possibilities of redirecting the innovation system towards the aims of sustainability. We found that, presently, the WS innovation system in Germany is in a process of reorientation. The system had been successful in reaching the aim of securing water supply with a minimum of pollution in drinking water both in respect to its organisational structure and the technical system. Increasing demands to cut costs and the implementation of the concept of sustainability demand a change in the regulatory and organisational structure which ought to lead to a changing focus within the whole system. At this time, the flexibility of the WSS system to adjust to new framework conditions without impulses from outside can be questioned.

This situation opens up new opportunities for policy interventions, which at the same time do bear certain risks: Generally, the alternative exists whether central state regulations should be preferred or whether the responsibility for the adoption of water management should be left at the decentralized levels, i.e. especially of municipalities and operators. While central government regulations, like compulsory benchmarking or the specification of public mechanisms for participation, could give impulses and accelerate the reorientation of the WSS, the options for pursuing innovative institutional ways to adapt to new demands on water management could be reduced.

Both increasing efficiency and implementing the concept of sustainability requires increasing transparency of the relation of the different actors and the decision making process. Clear cut definitions should be made in respect to the output of environmental services (water supply, nature and groundwater conservation) that are demanded from the system. The relation of the different actors should be defined clearly – both in privately organized water supply and under public management. Among others, this concerns the relation between the lower water authorities and (especially public) water operators and possible schemes of work-sharing between them.

While there is a domain of harmony between cost efficiency on one hand and social and environmental goals on the other hand in respect to transparency of the system, there are also conflicts between these goals. Increasing environmental quality as well as public participation are surely costly to accomplish. This conflict can partly be solved by technical innovations as well as the use of less costly institutions. Beyond this, the underlying appreciation of values should be left to the decision making process on the regional level.

Our analysis points to some promising fields for further – especially empirical - research: The relationship between operators and technological suppliers, which proves to be central for understanding innovation performance in respect to research activities, is not yet analysed in a systematic way. Furthermore, not much is known on the R&D activities of providers of water/waste water technologies. Another promising direction for research would be to analyse practical examples of including consumers and other stakeholders into water management decisions.

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