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ORGANISATIONAL STRUCTURES, COSTS AND FEES

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ABSTRACT

The development of the German wastewater sector is described, focused on organisational structures, cost and fees. For these, figures are given and compared with other countries.

KEYWORDS

Wastewater, statistics, connection rates, laws, regulation, costs, organisation, privatisation.

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0. INTRODUCTION

The scientific co-operation and exchange of knowledge between Japan and Germany is of specific interest, especially in the wastewater institutional sector:

- Both countries are fully industrialised and developed democratic societies with very high requirements and standards for wastewater management.

- In Japan, the population density, the size of the metropolitan regions is even higher than in Germany. Strong tropical storm waters create additional difficulties, compared to the Central European rainfalls.

- On the other hand, the coastline in Germany is far away from large metropolitan areas, and sewage discharge to the sea was no technical option for most of the settlements.

- The whole country of Germany is classified as "sensitive area", including not only the long and (often) shallow rivers, but also the coastal regions.

This is the reason, why the wastewater sector in Germany began to develop earlier than in other countries, including UK, France, USA.

Regarding organisational structures, Germany's wastewater sector is (by law) operated under public responsibility. Privatisations happen, but only with respect to the specific needs of regulation and control in the wastewater sector. Unlike UK or France, the organisational set-up of the German water sector reflects the issues and discussions prevailing the Japanese development, especially regarding the issue of privatisation. [1]

1. HISTORICAL DEVELOPMENT

Germany was industrialised early on and is a densely-populated country. Unlike in England or Japan, it was not possible to pipe wastewater out of congested urban areas into the ocean by short routes.

At the end of the 1960's / beginning of the 1970's, the water pollution in the Federal Republic of Germany reached a level that caused grave concern. During the years of rapid economic growth, water protection measures could not keep up with the expansion of industrial activities.

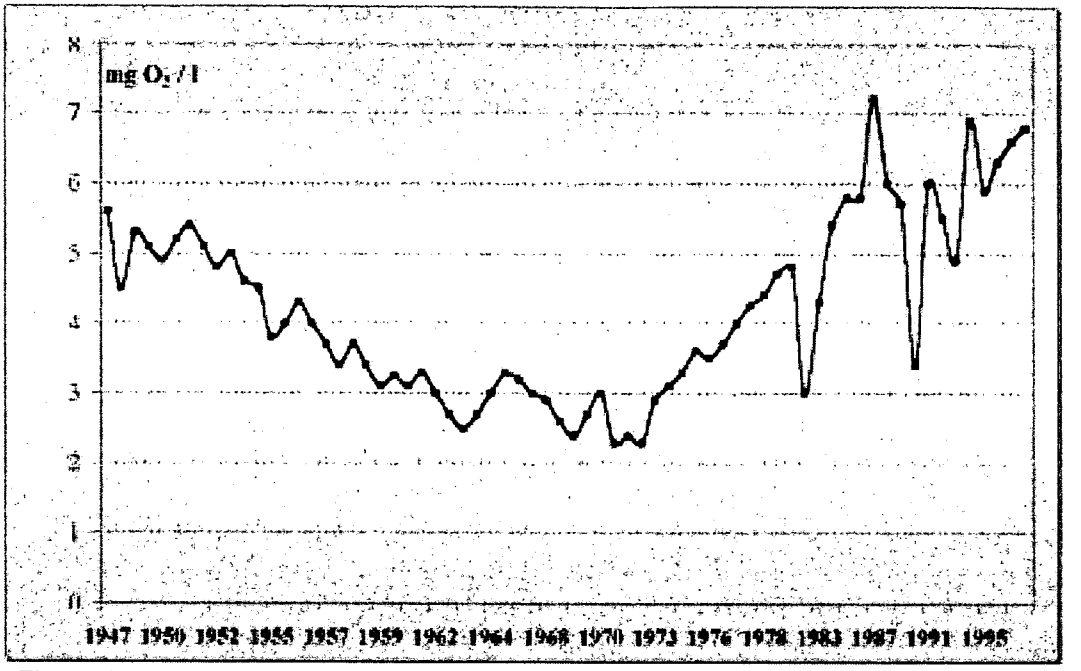

Figure 1: Development of the oxygen concentration of the Rhine [2]

With the construction of over 8,000 biological WWTP's in the municipal sector, as well as intensive wastewater treatment and supplementary internal measures in industrial enterprises, the emission of contaminants and oxygen-consuming, organic wastewater components into bodies of water has been significantly reduced. Decisive improvements in the quality of surface waters have thereby been reached.

At the time of the reunification of Germany in 1989, the water bodies in the eastern part of Berlin and in the newly-formed German states - Brandenburg, Mecklenburg-Western Pomerania, Saxony, Saxony-Anhalt, and Thuringia - were, in part, dramatically contaminated. They needed to be quickly and effectively cleaned up. This required the joint efforts of the nation, the municipalities, the states, and the economy in a national solidarity action with substantial financial means. More than 2,000 WWTP's were erected, hundreds of kilometres of sewer pipes were laid, and entire branches of industry were cleaned up.

Today, Germany is one of the most advanced countries, within Europe and world-wide, in the area of water technology and water management. This is not only true with respect to end-of-pipe water protection (e.g. well-constructed WWTP's with a high percentage of hook-ups), but also with respect to a prudent use of drinking water.

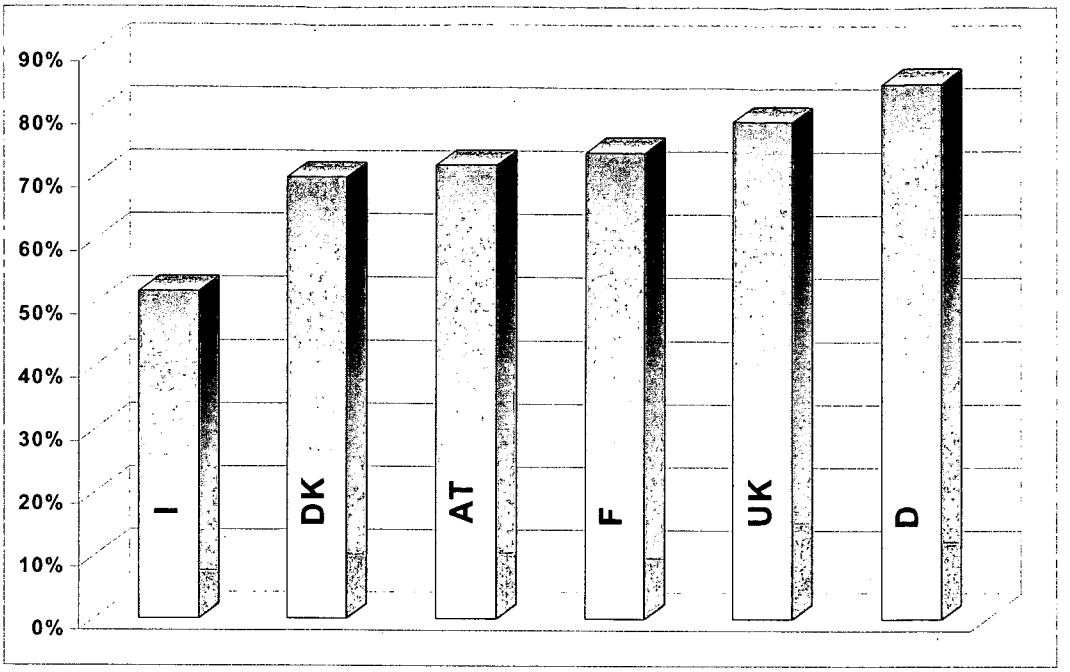

Figure 2: EU-comparison - percentage of wastewater treated in fully biological WWTP`s [3]

The responsibility for water bodies does not stop at national borders. The federal government has accordingly made international co-operation for the protection of seas and inland waters a special emphasis of its environmental policies. In the European Union, the German government is working towards common requirements for water protection on a high level.

The results of the implementation of this water protection policy can be seen in the development of the water quality in Germany. On the following page are maps depicting Germany's water quality in the years 1975, 1985, 1989, and 1995. The coloured sections indicate the quality class of the water bodies in each respective year. Due to the change in the past few years, a positive development in the quality of water in Germany has emerged.

2. INSTITUTIONAL FRAMEWORK

Germany has a federal structure: the responsibilities of government are divided among the national, state, and municipal levels. The *federal government*, with its headquarters in Berlin since reunification, is responsible for promulgating a national legislative and defining national tasks of water management. There are several federal ministries for various specialised fields: the Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety (*Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit* - http://www.bmu.de) is responsible for the protection of water bodies; the Federal Ministry of Economics and Technology (*Bundesministerium für Wirtschaft* - http://www.bmwi.de) oversees water supply systems and the water industry; the Federal Ministry of Education and Research (*Bundesministerium für Bildung, Wissenschaft, Forschung und Technologie* - http://www.bmbf.de) is in charge of developing new technologies; and the Federal Ministry for Health (*Bundesministerium für Gesundheit* - http://www.bmgesundheit.de) ensures the quality of drinking water. International cooperation is overseen by the Federal Ministry for Economic Cooperation and Development (*Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung* - http://www.bmz.de). The ministries have at their disposal advisory authorities, such as the Federal Environmental Agency (*Umweltbundesamt* - http://www.umweltbundesamt.de) and the Federal Institute of Hydrology (*Bundesanstalt für Gewässerkunde* - http://www.bafg.de), as well as private, commissioned agencies, such as the Project Agency for Water Technology (*Projektträger Wassertechnologie* - http://www.fzk.de) or the Organisation for Technical Co-operation (*Gesellschaft für technische Zusammenarbeit* - http://www.gtz.de).

The *state governments* of the 16 federal states are responsible for the regulation of water supply and wastewater disposal in their territories, within the framework of the federal laws.
The organisation and implementation of the water supply and wastewater disposal belong to the traditional duties of the *municipalities*, in accordance with state water laws. In order to cover incurred expenses, the municipalities charge consumers with tariffs and fees. The municipalities must also maintain smaller water bodies in their jurisdiction.

How do the involved members at the various levels and in the various institutions co-operate in German water management?

First of all, whoever wishes to utilise natural the water resources or water bodies must apply for a permit. Applicants are mostly municipalities, water utilities, or industry that desire to construct a groundwater abstraction facility or waterworks, for example, making use of groundwater. Even when a development area or industrial park is to be built and a regular wastewater disposal system (WWTP and sewer system discharging into a river) is planned, an application for authorisation is still necessary. With the application for authorisation, not only the technical designs need to be submitted, but also (depending on the scope and significance of the project) emission reports, environmental compatibility studies, etc.

The application for authorisation is submitted to the responsible authorising agency. These are (in most states) the so-called lower water authorities (located in county government offices) for "smaller" projects and the upper water authorities (located in district government offices) for "larger" projects. These water authorities use their advisory authorities at the respective levels - that is, the water management or

environmental bureaus [4]. A fundamental, democratic element is the hearing of third parties - for example, nature protection organisations, citizens' action committees, or concerned individuals - which takes place for important decisions through strictly regulated procedures.

If authorisation is granted after examination of legal and technical conditions, the proposed project may be carried out, with the observance of the applicable environmental standards and, if the case may be, special requirements for construction and operation.

The definition of standards takes place at various levels. The overlying framework is anchored in the European Union legislation, including especially the following:

- Directive 2000/60/EC Water Framework Directive (http://europa.eu.int/eur-lex)
- Directive 91/271/EEC, concerning the handling of municipal wastewater
- Directive 96/61/EC, concerning the integrated pollution (IPPC Directive)
- Groundwater Directive (80/86/EEC)
- Drinking Water Directive (98/83/EC)
- Nitrate Directive (Directive 91/676/EEC)
- Pesticide Directive (91/414/EEC)
- Water Protection Directive, concerning the emission of hazardous substances into water bodies (76/464/EEC)
- Bathing Water Bodies Directive (76/160/EEC).

German federal law has been and continues to be conformed to this European law and further developed in consideration of the specific, high demands of an environmentally compatible, organised industrial status. At the federal level, the most important regulations within this framework are:

- The Water Management Act
- The Drinking Water Ordinance
- The Groundwater Ordinance
- The Wastewater Ordinance
- The Effluent charge Act
- The Act on the Impact Assessment of Washing and Cleaning Agents
- The Fertiliser Agents Ordinance.

These federal regulations are further substantiated at the level of the 16 German federal states. Corresponding to the individual circumstances and political objectives of each respective state, a state water law, state effluent charge act, etc. has been empowered.

The requirements and standards are formulated most concretely at the lowest level, where framework requirements of the respective superordinate level must be observed. For example, the final decision with regard to treatment standards for a WWTP is made by the municipality. Nevertheless, the municipality must still heed the conditions set by the district government; the district government, on the other hand, must observe the minimum requirements set by the state and federal governments, which must conform to the EU directive (for municipal wastewater). There are more than a few cases in Germany whereby a municipality has voluntarily installed excessively high-performance wastewater treatment technology (with especially good phosphate elimination or additional wastewater disinfection). In very "sensitive" river catchment areas, the district government (or as the case may be, the state government) determines legal limits

which are significantly stricter that the minimum requirements in the state (or federal) laws (as is the case in the catchment area of Lake Constance, in Bavarian bathing lakes, or at the Baltic See coast).

In the political process, starting from the first discussion through to the final decision, a close network formed between the various decision-making bodies and the municipal council, the county parliament, the Bundestag, etc. Into this network are integrated also all the scientific associations and interest groups, which exert influence - at so-called hearings, for example - on important new legislation.

The advantage of such a federal, several-layered structure is that one is able to include all interested parties and experts. For the local parties responsible for water management issues (that is, especially municipal and private enterprises and the water-consuming industry), it is necessary to heed the multitude of laws and regulations with their organisational and technical specifications.

In view of the decentralised decision-making structure, however, it is difficult in Germany to implement all of the central specifications of the European legislation in proper form and in due time. Therefore, complaints have been raised by the EU not only against nations with a less-developed protection of water bodies, but also against the Federal Republic of Germany - despite its undisputedly high standard of execution in comparison with the rest of Europe (Figure 2). The following figure shows the percentage of private households in Germany connected to wastewater disposal. This is representative of Germany's end-of-pipe protection of water bodies.

The supply of water, and even more so the disposal of wastewater, has traditionally been a responsibility of the municipalities. With the increase of technology, the corresponding, gradually rising costs, and, in part, financial bottlenecks, numerous other organisational forms besides the traditional municipal department have been developed and realised (corresponding to the respective requirements of the specific location and political environment) in the last twenty years.

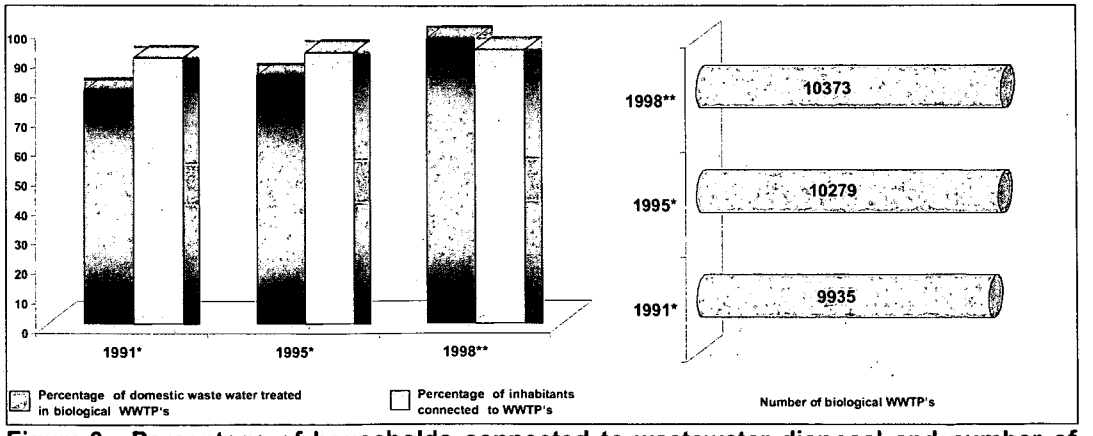

Figure 3: Percentage of households connected to wastewater disposal and number of biological WWTPs [5, 6]

Due to its federal structure and decentralised decision making process, Germany is most certainly the nation with the greatest diversity of organisational forms, whereas the majority of the ca. 450 cases with private involvement consist of a combination of various models for private involvement [7]. The municipalities have a prominent position in Germany because of the legal situation. The national water market is not

dominated by international corporations, as is the case in some other European countries, but rather by a multitude of chiefly medium-sized enterprises and municipal companies [8].

The co-operation between municipalities in water and wastewater associations plays a special role in Germany. This co-operation emerges mostly voluntarily, but it is sometimes also initiated by the state. The associations work to make the organisation of water supply and wastewater treatment, the maintenance of water bodies, and water protection more technically and economically efficient. They differ from one another according to tasks, regional size and form of organisation.

Organisational forms of water supply and wastewater disposal systems

By virtue of the federal and state laws, municipalities are free in choosing the organisational form of "their" wastewater disposal. The municipalities may decide for themselves (according to their political and economical preferences), if and to what to degree they want to privatise or not. There are no central specifications for the so-called "delegation of duties to a third party". Complete privatisation, however, is only permitted in a few states, and then only under considerable stipulations. The most common organisational forms are as follows:

Municipal department (Regiebetrieb):

Operated by the municipality within the scope of the regular municipal administration.

Municipal utility (Eigenbetrieb):

Operated by the municipality in a separate capacity with independent bookkeeping.

Municipal company (Eigengesellschaft):

Private entity company in the hands of the municipality.

Joint venture (Kooperationsmodell):

Municipal utility with the involvement of a private firm.

Operator model – BOO, BOOT, BOT, etc. (Betreibermodell):

Delegation of the plant operations to a private firm, whereas the responsibility for the fulfilment of tasks remains with the municipality.

Management and service contract (Betriebsführungsmodell):

The plant property belongs to the municipality, but the operations and any further management tasks are delegated to a private firm.

Depending on jurisdiction, it is possible that boundaries for associations, water utilities, and municipalities overlap, so that outsiders have difficulty recognising the organisational structure. Therefore, there are water supply associations or private long-range water utilities whose boundaries of operation do not coincide with the boundaries of the local water utilities, which are supplied by the former. Similarly, there are large-scale wastewater associations which are responsible solely for long-distance transportation and for wastewater treatment and whose boundaries do not match up with the municipalities or disposal companies. These municipalities and disposal companies, on the other hand, handle wastewater collection through local sewer systems.

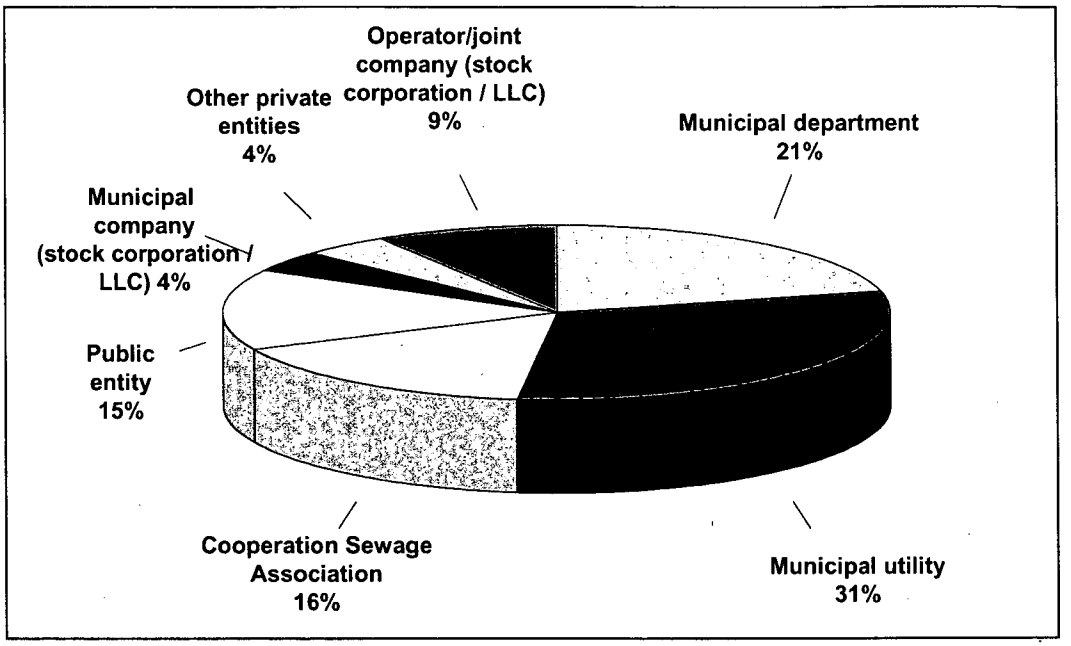

Figure 4: Implementation of wastewater handling in Germany (in % of total population) [own assessments, based on data from the water industry (BDE) and ATV as of 2001]

There is also variation in the composition of the decision-making bodies of regional associations, municipal parliaments, municipal committees, member assemblies of associations, and supervising councils and advisory boards of private water utilities.

It becomes apparent that the strength of Germany's water management lies by no means in a central and tightly-organised arbitration or in the controllability of the system "from above". Its strength is found rather in the obligatory and widespread hearing of experts and interested parties of all relevant groups and in the *democratic and constitutional consideration of various interests and viewpoints*. This all leads in the end to a consensus, or as the case may be, to a compromise. The more drawn-out and difficult the way to a consensus or compromise is, the more pertinent and successful the implementation of the solution will be.

2.1 IMPORTANT, SPECIFIC REGULATORY INSTRUMENTS

The technical and economical regulation of water management takes place in Germany on the basis of the above-mentioned laws according to various operative principles that supplement one another. The following regulatory instruments will be addressed in greater detail:

- Price control
  With various regulations for the supply of water and disposal of wastewater.

- Financial incentives
  By which the participants' interest in a sustainable use of water bodies is to be strengthened. For example, the abstraction of groundwater or the discharge of wastewater is controlled by charges (Water Abstraction Fee - *Gundwasserentnahmeentgelt*; Effluent Charge - *Abwasserabgabe*).

- Minimum requirement standards
  With quality requirements for drinking water or, as shown below, for effluent from WWTP's, corresponding to the Ordinance on Wastewater - as well as standards for the technology and operation of plants.

- Prohibitions and obligations
  Mostly for the limiting of substances hazardous to water bodies, as is then shown in the example of the Act on Washing and Cleaning Agents.

Beyond these, there are several environmentally relevant principles in the area of water management (Figure 5). They concern the fundamentals of a sustainable water management policy which, in practice, cannot be perfectly implemented at all times and in all places. Nevertheless, these principles offer the decisive orientation for politics and the economy in view of a sustainable use of resources.

2.1.1 MUNICIPAL CHARGES ACT AND ANTITRUST LAW

Price mechanisms for water supply are based on principles and regulations which differ from those of wastewater disposal. *Wastewater disposal* is subject to the cost recovery principle; that is, the municipalities responsible for wastewater disposal allocate the costs to the consumers, but they may not include a profit margin.

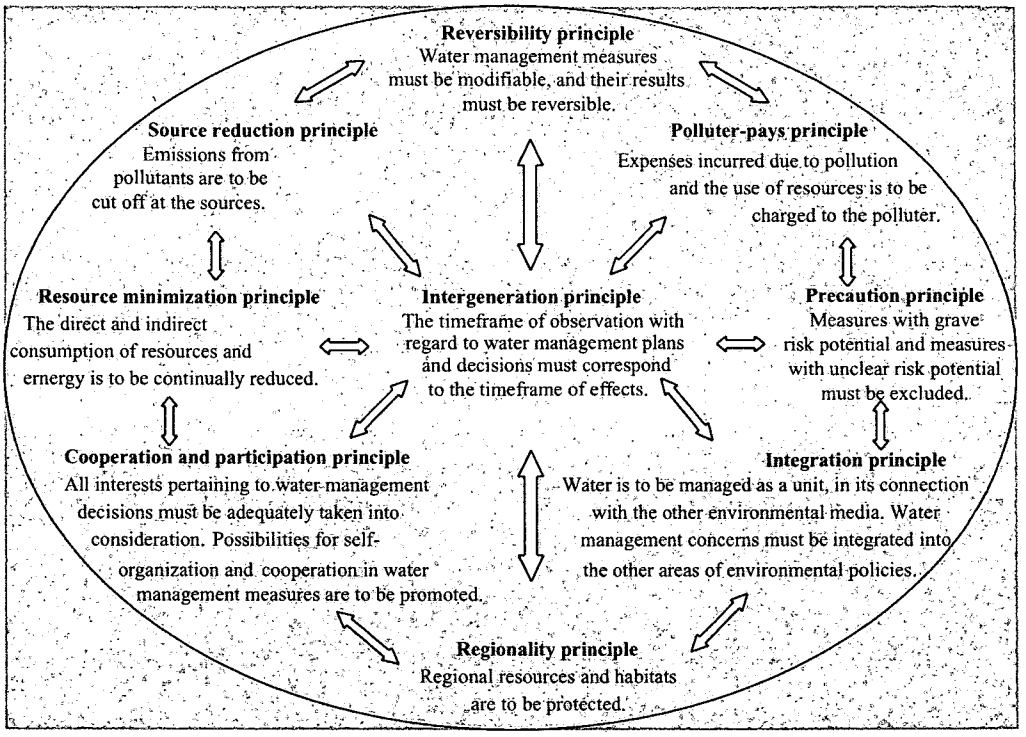

Figure 5: Interaction of principles relevant to water management [9]

In practice, there is an abundance of precepts and relevant court decisions dealing with approaches in the individual cost positions. Figure 6 presents an overview of types of costs and their part in the calculation of wastewater fees.

Water supply systems organised as private entities are regulated in a different manner. The municipality is not responsible for their supervision, but rather the antitrust agency (which, incidentally, also regulates the supply of gas and electricity). Upon inquiry, water utilities must be able to verify, and if need be, demonstrate, that their water prices are not higher than those of comparable companies and suppliers.

If the antitrust agency conducts an investigation due to suspicion of "misuse of pricing", the technical standard and cost structures are closely examined and then compared to those of similar companies (which corresponds, in part, to Cost Benchmarking - *Kosten-Kennzahlenvergleich*).

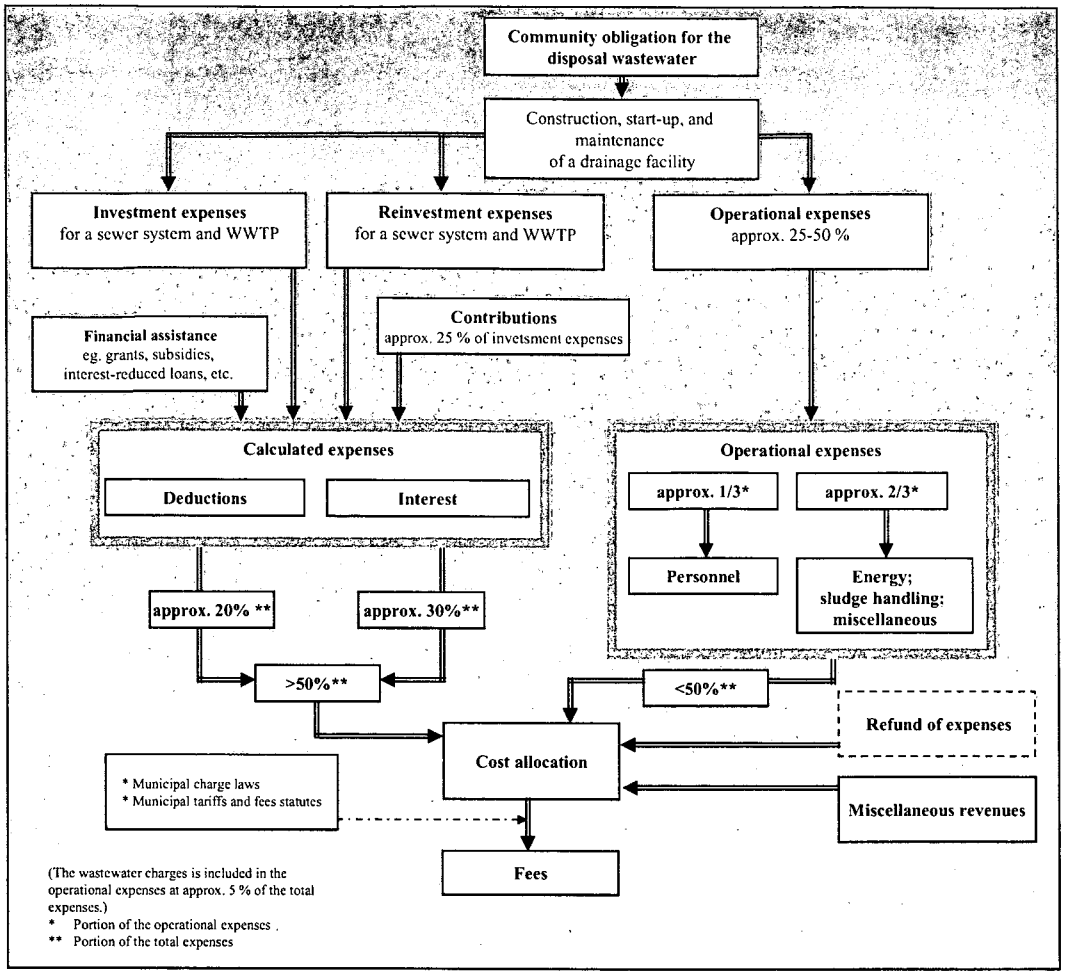

Figure 6: Breakdown of the most important types of expenses in wastewater disposal [5]

This approach is essentially not any different than in countries with central price regulation*. Germany's approach differs from these others, however, in that it uses no uniform formulas applied from a central agency, but instead considers each situation individually, which corresponds to Germany's federal, decentralised structure [5, 10].

2.1.2 EFFLUENT CHARGES ACT (*ABWASSERABGABENGESETZ, ABWAG*)

The Effluent Charges Act of 1976 (last amended in 1994) makes the provision that a charge must be paid for the point source discharge of treated wastewater into a water body. Generally, the payment of effluent charges in no way exempts one from the responsibility of treating wastewater. *This charge is the only nation-wide environmental charge in the area of water that functions as a deterrent.* The polluter-pays principle is brought to bear with this charge, for point source dischargers must be held liable for at least a portion of the costs of the utilisation of the environmental resource of water. The charge is calculated according to the amount and harmfulness of the respective substances discharged.

The charge per pollutant has been raised, in several steps, from DM 12 (ca. € 6) in 1981 to DM 70 (ca. € 35) since January 1, 1997. Economic incentives are to be created with this charge for reducing as many point sources as possible. For that reason, the AbwAG (Effluent Charges Act) also provides discounts for cases in which the payer meets certain minimum requirements. In addition, certain investments for the improvement of wastewater handling can be offset against the charge.

The effluent charge is paid to the states. It is to be used strictly for the conservation of water bodies. On average, the effluent charge comprises about 5% of total costs. In Germany, this corresponds to approx. € 5 per inhabitant per year. The economic deterrent function is greater in individual cases, however, since fines need to be calculated into the total if a plant exceeds the so-called monitoring standards. Such fines apply most of all to point source dischargers with deficient WWTP's, but also to operators of modern plants who, because of their poor operation, do not attain to a satisfactory level of treatment.

Table 1: Contaminants and pollution units (*Schadeinheit*, SE)* according to the Effluent Charges Act (AbWAG)

Rated contaminants and contaminant groups	**Measurements constituting one pollution unit**
Oxidisable substances in chemical oxygen demand (COD)	50 Kilograms Oxygen
Phosphorus	3 Kilograms
Nitrogen	25 Kilograms
Halogen compounds as absorbable organic halogen compounds (AOX)	2 Kilograms Halogen as organic chlorine
Metals and their compounds: Mercury Cadmium Chromium Nickel Lead Copper	 20 grams 100 grams 500 grams 500 grams 500 grams 1000 grams metal
Toxicity to fish	3000 cubic meters of wastewater divided by the dilution factor G_F, by which wastewater is no longer toxic to fish

* "One SE corresponds roughly to the harm caused by the raw waste water produced by one inhabitant in one year (inhabitant equivalence)." - http://www.umweltbundesamt.de/uba-info-daten-e/daten-e/waste-water-charges-act.htm

2.1.3 WASTEWATER ORDINANCE (*ABWASSERVERORDNUNG*, ABWV)

The Wastewater Ordinance sets technical standards, such as legally binding pollutant limits, which are for various kinds of wastewater. The ordinance was one of the first measures for the implementation of the sixth amendment to the Water Management Act, which took effect in November 1996. It regulates, among other things, the requirements for the discharge of wastewater within the scope of municipal handling of wastewater and implements European requirements for the protection of water bodies. Altogether, there are 54 appendices with specific regulations for domestic wastewater and for various industries. Table 2 lists some of the appendices for selected industries.

Table 2: Appendices to the Wastewater Ordinance (*Abwasserverordnung*, AbwV)

Area / branch of industry	Example
Municipal disposal	Appendix 1 Municipalities / domestic wastewater
Foodstuffs industry	Appendix 3 Milk processing Appendix 7 Fish processing Appendix 10 Meat processing
Animal feed industry	Appendix 14 Drying of plant products for the production of Animal feed
Chemical industry	Appendix 9 Manufacturing of coating materials and varnish Resins Appendix 22 Chemical industry Appendix 45 Petroleum processing
Metalworking industry	Appendix 24 Part A Iron and steel production Appendix 24 Part B Iron, steel, and malleable iron foundries Appendix 40 Metalworking, metal processing
Waste management industry	Appendix 51 Aboveground landfills
Electrical industry	Appendix 54 Manufacturing of semiconductor components

These discharge requirements are *minimum requirements* within the scope of a federal law. It is left to the states and their water authorities to define and enforce higher standards on an individual basis, where this is necessary due to an especially sensitive water body ecology and other reasons for the protection of the common good. Therefore, there are many municipal WWTP's that have a higher discharge standard than the minimum requirements listed in Table 3.

These standards are to be observed for continuous operation, even in unfavourable pollutant conditions. With regard to the minimum requirements for the parameter $P \leq 1$ mg/l, for example, an even better operational standard (e.g. $P \leq 0.7$ mg/l) is set, in order to maintain a sufficient margin of safety above the minimum requirement. In Germany, if these prescribed standards are not observed, an administrative offence is to be assumed. Under certain circumstances, the violation of the prescribed minimum standards is a punishable act that is prosecuted by the authorities.

Table 3: Minimum requirements concerning the discharge of municipal wastewater according to the AbwV

Size classes of WWTP's	Chemical oxygen demand (COD)	Biological oxygen demand in 5 days (BOD_5)	Ammonium nitrogen	Total nitrogen as total of ammonium-, nitrite-, and nitrate nitrogen	Phosphorus total (P total)
Population units	mg/l*	mg/l*	mg/l*	mg/l*	mg/l*
less than 1,000	150	40	---	---	
between 1,000 and 5,000	110	25	---	---	---
between 5,000 and 10,000	90	20	10	---	---
between 10,000 and 100,000	90	20	10	18	2
larger than 100,000	75	15	10	18	1

1 population unit = 60 g BOD_5/d in untreated wastewater *Qualified sample or 2 hr mixed sample

2.1.4 WASHING AND CLEANING AGENTS LAW

The Washing and Cleaning Agents Law of 1975 (amended in 1994) sets requirements for the environmental compatibility of washing and cleaning agents. The use of water-polluting substances can be forbidden or limited. The law obligates makers of washing and cleaning agents to inform the Federal Environmental Agency (UBA) of the basic contents of their products. Furthermore, the law requires that the consumer be informed by the packaging of the respective product about the most important components and the quantity to be used.

On the basis of the Washing and Cleaning Agents Law, the Ordinance on Surfactants and the Ordinance on Maximum Permissible Amounts of Phosphate were enacted. The Ordinance on Surfactants stipulates that surfactants contained in washing agents must be at least 90% primary biodegradable.

Phosphate-free washing agents have become widely available on the market. Due to this change in cleaning agents, the emission of phosphate into water bodies through washing agents in domestic wastewater had decreased from 42,000 tons of phosphate in *1975* to approx. 2,000 metric tons in *1993* (in the former West Germany).

In addition, in 1993, after foundations were laid with strict criteria concerning the complete biological degradability and the toxicity to water organisms, the "Blue Eco Angel" (a voluntary product symbol) was first awarded to a cleaning agent in the modular construction system, in order to support product users in making their households environmentally friendly. In 1995, criteria that had been worked out under German leadership were passed for a European Environmental Label for cleaning agents.

2.1.5 THE TECHNOLOGICAL REGULATORY FRAMEWORK OF GERMAN WATER MANAGEMENT

The implementation of water management tasks does not just take place on the basis of regulations from governmental agencies. Scientists and representatives of water management work closely together with governmental agencies in the conceptualising of uniform technological specifications. With this approach, the co-operation and participation principles are allowed for in German water management.

The implementation of uniform technological regulations makes a significant contribution to the effective and economical protection of the environment and of real assets. Through the continual process of revising and updating, based on the current state of science and technology, the regulatory framework supports policy issues, administration, and industry. The specifications are important for the designing, constructing, and operating of water supply systems and WWTP's. Even statements concerning the maintenance and monitoring of plants are taken into consideration by experts in the drafting of the regulatory framework. A selection of topics in the technological regulatory framework and its contents are summarised in the following table.

Table 4: Examples of topics in the technological regulatory framework

Area	Contents
Water supply	Protected water areas Mechanical equipment in waterworks Optimisation and cost reduction in waterworks
Drainage systems	Planning / calculating Construction / repair Operation
Municipal wastewater treatment	Assessment Treatment processes Small WWTP's
Industrial wastewater	Technology-related water protection
General water management	Hydrology Groundwater Water quality Ground protection Nature protection and ecology

The following regulatory frameworks, among others, used in German water management are also available in foreign languages:

Table 5: German regulatory frameworks in foreign languages

Regulatory framework	Language
ATV standards (Abwassertechnische Vereinigung e.V. www.atv-dvwk.de)	German; partly in English, French, Spanish, Polish
DIN standards (Deutsches Institut für Normung e.V. www.din.de)	German; partly (depending on demand) in English, French, Chinese
DVGW regulatory framework (Deutsche Vereinigung des Gas- und Wasser www.dvgw.de)	German; some excerpts in English, French, Russian, Polish

German regulatory frameworks and technological standards (DIN: http://www.din.de) are being increasingly adapted into the European standards, the so-called CEN Standards. As a result, legislatures as well as licensing and supervisory authorities revert to such regulatory frameworks in defining standards and in evaluating individual cases.

It is remarkable that such regulatory frameworks arise out of the independent responsibility of experts, organised by professional associations of water management. To such an extent, even regulations and standards are the result of a consensus or compromise-finding process into which various viewpoints have entered. The current trend "away from detailed standard specifications for measures in the sense of input definitions - toward a result-oriented regulation of operational performance in the sense of an output-oriented definition" will help expedite matters so that the dynamic of technological innovations is not slowed down through far-too-sluggish standardisation processes and obsolete regulatory frameworks.

2.2 WASTEWATER DISPOSAL

Every densely-populated area of Germany, without exception, possesses a central wastewater disposal system. According to information from the Federal Statistical Office, the total volume of wastewater in 1998 was approx. 9.6 billion m³, including about 4.9 billion m³ of domestic and commercial wastewater. The predominant amount of wastewater (99.5%) was treated in public WWTP's. Only 0.5% of the wastewater was handled in industrial plants. The portion of external water that entered into the sewer systems in 1998 was estimated at about 2 billion m³. Point source discharges without any treatment were reduced from about 115 million m³ in 1995 to about 65.3 million m³ in 1998.

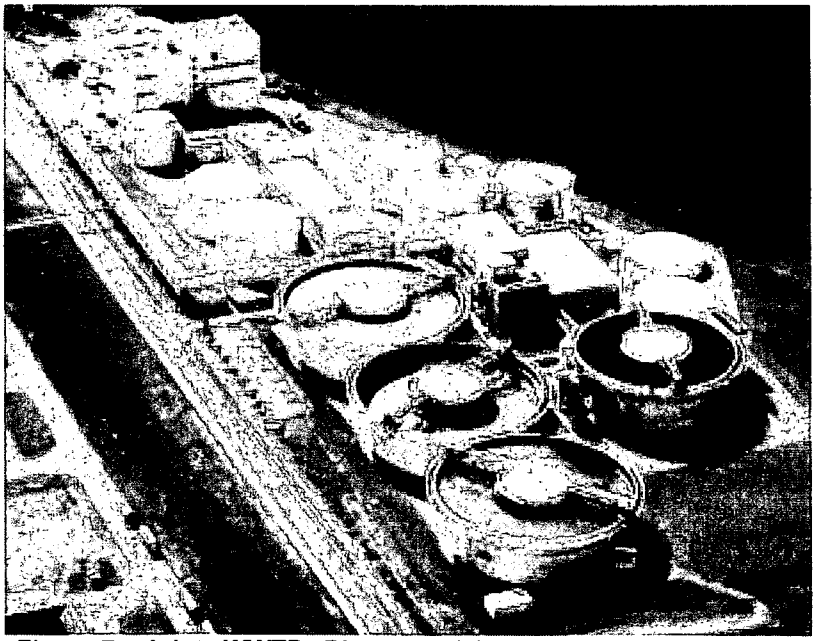

Figure 7: Joint WWTP Bitterfeld (above-ground bioreactor - population equivalent = 453,000) (pilot project of the BMU for the joint handling of domestic wastewater and industrial chemistry wastewater) [11]

From 1970 to 1994, over € 78 billion were invested by the municipalities in former West Germany for the construction, expansion, and renovation of sewer systems and WWTP's. Twenty-three billion Euros went for the expansion of WWTP's, and approx. € 55 billion were appropriated for *investments* in the area of sewer systems. From 1991 to 1996, approx. € 22 billion were invested in the overall area of WWTP's in Germany. The annual expense of municipalities and wastewater associations for public wastewater disposal amounts to over € 6 billion.

The term "wastewater"

The term "wastewater" defines water that ends up in the sewer system and has come from one of these sources: water that has been altered, in particular contaminated, through domestic or commercial use, surface run-off, or rainfall (cf. WHG, AbwAG, DIN 1045). There are thus two kinds of wastewater: contaminated water and meteoric precipitation.

Contaminated water originates, for example, from clean water that has been altered in its chemical or physical properties through use as wash or rinse water. In the Wastewater Charges Act, the distinction is often made whether the alteration of the water is ecologically detrimental, inconsequential, or even advantageous.

Regarding the term "contaminated water", it is irrelevant where the water originates - that is, whether it was taken from groundwater before alteration through use, from surface waters, or from a water supply line.

If the water, however, is extracted only for storage purposes and is discharged again (e.g. at excavation sites), it does not fall under the term "contaminated water", unless it was used for another purpose (e.g. as wash water or for flotation purposes) before it was discharged.

According to 1998 statistics, only 6.8 % of Germany's population was not hooked-up to a public sewer system in that year. With a 93.2% connection, one can speak of a practically complete sewer system in Germany. There are still gaps in the newly-formed German states, where, according to individual states, between 12% (Thuringia) and 31.4% (Brandenburg) of the population is not hooked-up to public sewers. There are connection gaps in other areas of Germany as well, particularly in several rural areas. But even there, wastewater is practically completely disposed of through private septic tanks with periodic faecal sludge removal and treatment.

Altogether, there are approx. 445,700 km of usable public sewers in Germany, about 51% of which are mixed-water sewers, in which contaminated water and rainwater are transported together. There are about 134,000 km of sewers in the public sewer system that only transport contaminated water. In these sewers, faeces are carried off for treatment along with grey water from domestic and commercial use. Rainwater is drained in about 85,000 km of separate rainwater sewers. Alternatively, rainwater seeps away on-site. Besides the public sewer system, there are privately owned sewer systems, as is the case with large industrial enterprises. Accurate figures for the length of these sewers are currently not available.

According to a survey taken by the Association for Wastewater Technology (*Abwassertechnische Vereinigung e.V.* – ATV – http://www.atv.de), 33% of all *sewers* were less than 25 years old or less in 1997. More than one third of all public sewers were between 25 and 50 years old. Eleven percent were in the 50 to 75 year-old age group, and 16% were between 75 and 100 years old. Only 4 % of all public sewers in Germany were more than 100 years old. Somewhere between 40,000 and 80,000 km of public sewers were in need of repair. The repair and modernisation of present systems is a future task in Germany, after all necessary sewers and treatment plants have essentially already been built.

About 60% of the approx. 2.5 million Mg (1998) of *wastewater sludge*-dry matter that accumulates during wastewater treatment is reused. Wastewater sludge is used as fertiliser in the preparation of nutrient-rich soil for agriculture and gardening. However, the high level of recycling in agriculture is to be greatly reduced. According to resolutions by the responsible authorities in the summer of 2001, it is intended that, in the future, sludges be predominantly burned. Responsible for these decisions to "exit" out of recycling wastewater sludge by agricultural means were incalculable microbial and chemical risks with regard to the depositing of wastewater sludge onto agricultural areas. Starting in 2005, no more organic wastewater sludge is to be deposited in landfills. Therefore, thermal resource recovery (e.g. in thermal power plants) will gain in importance.

Although re-investments for upgrading, modernisation, rehabilitation of wastewater plants and networks dominate the needs of the decade, there is a remarkable market potential for improved technologies, especially, if cost-optimised or integrated to lean operational schemes [14]

Mandatory connection and use

In the statutes for wastewater disposal in the municipalities, mandatory connection to and use of wastewater disposal facilities has been made binding for the land within the municipality. Therefore, every property owner in the area of jurisdiction is obligated by these statutes to connect the property to the local wastewater disposal system as soon as wastewater accumulates on the property (mandatory connection). The landowner is then further obligated to discharge the total amount of wastewater generated on the property into the wastewater disposal system (mandatory use). There are also exceptions, however, which the statutes regulate for selected cases, such as agricultural production.

Mandatory connection and use in Germany traditionally belongs to duties delegated to the municipalities and is part of the public health protection policy.

The intended purpose of public wastewater disposal is the continual guarantee of the cleanliness of groundwater, in the interest of the common good. Regulations for exceptions apply to individual solutions; however, they must not be beneficial just for industrial firms or private households, but must be technologically and economically purposeful also for the entire disposal area.

It is obvious that mandatory connection and use involves many conflicts. When centralized water supply system was introduced in rural areas after WWII, in the 1950's and the beginning of the 1960's, there were time and again individual citizens who were satisfied with their own private wells and - despite the many hygienic risks involved in a private water supply - categorically refused to connect to the municipal facility. With regard to wastewater disposal, there are cases still today in Germany in which the connection to central wastewater collection and treatment is fought against with sever means, in one case even with a long-lasting hunger strike. Reasons for such opposition are most often the costs of wastewater disposal, but sometimes also ecological arguments and a grassroots-democratic striving for autonomy.

Indeed, no nonsensical centralized system may be implemented beyond the mandatory connection and use system. Technological advances today allow for the secure operation of even very small WWTP's. For that reason, decentralized and semi-decentralized concepts have gained increasingly in importance in designs for wastewater disposal.

The *costs of wastewater* disposal basically need to be covered by the fees and tariffs paid by private and commercial connected parties. Therefore, mandatory connection to and use of the public water supply and wastewater disposal is generally necessary.

According to surveys by the Association for Wastewater Technology and the Federal Association of German Gas and Water Management, the average total cost for wastewater disposal in 1996 amounted to € 108 per inhabitant per year. In the newly-

formed German states, in comparison to the old German states, there was an € 18 lower charge per inhabitant per year. The reason for this is that, despite higher average wastewater fees, water consumption in the newly-formed German states is lower than in former West Germany. For initial investments in WWTP's, states offer much support to municipalities by means of subsidies in varying amounts.
The distribution of cost types (see Figure 6) for wastewater disposal, as the basis for calculating disposal fees, varies with the regional peculiarities in the respective municipal disposal areas. In 1998, on average, amortisation accounted for 27% of costs, interest payments for 24%, personnel for 15%, the cost of electricity and materials accounted for 14%, waste disposal took up 4%, and the rest went to "miscellaneous expenses".

Water tariffs and wastewater fees

In a densely-populated industrial nation like Germany, the reliability and quality of a water supply system and of water protection is extremely important. Germany's level of technology and logistics is comparatively high; however, so are the costs, which are largely paid by the consumers by means of water tariffs and wastewater fees (full cost recovery).

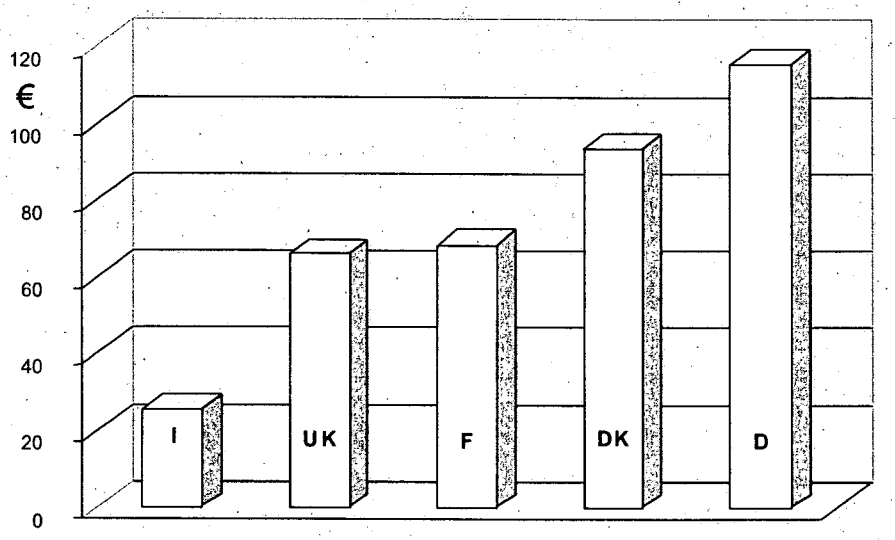

Figure 8: International comparison of wastewater treatment fees 1998 (per inhabitant per year) [6, 12]

In the former GDR, the wastewater treatment facilities were in a deplorable condition; in many places, WWTP's were non-existent. The water prices in the socialist planned economy didn't even come close to covering the costs of water treatment.

After German reunification, the systems needed to be repaired and newly built in as short of a time as possible. While the costs could be somewhat cushioned by state subsidies, etc.; primarily industry and the population connected to the systems had to bear the drastically increased water prices, including capital and operational expenses. This led to protest and political problems in many places.

There were similar problems also in several municipalities in western and northern Germany. Brought on by a few undesirable developments or extremely high costs, due to the rural structure and unfavourable conditions (construction grounds, topography, small receiving waters), doubts arose concerning the fairness of prices.

continuation of Water tariffs and wastewater fees

The solution to such problems and the transformation that was achieved in the ecological remediation of the former GDR can serve as a model for many nations world-wide which are currently struggling with the same basic problems in the water sector.

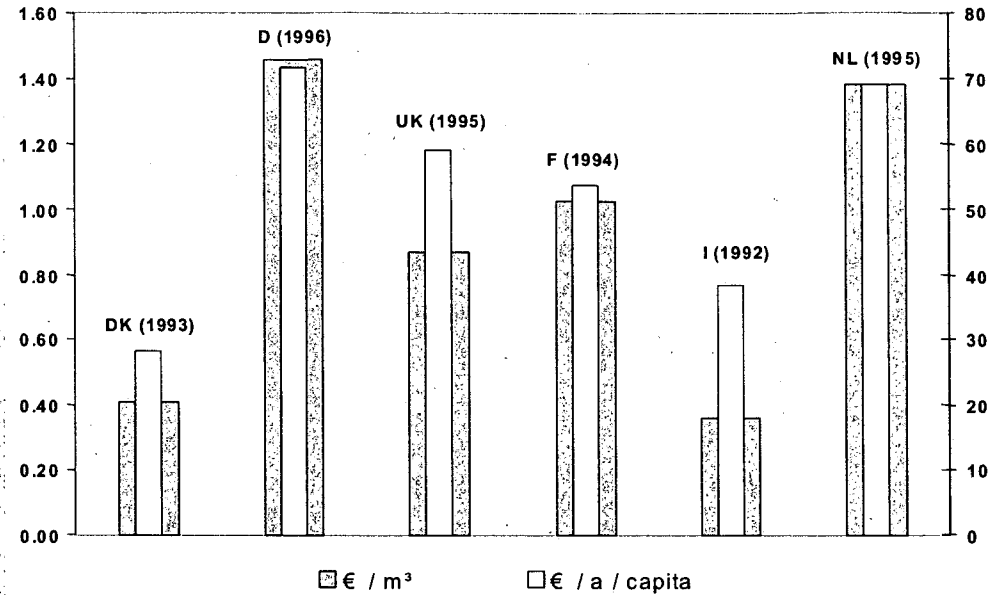

Figure 9: International comparison of the water prices 1998 [13]

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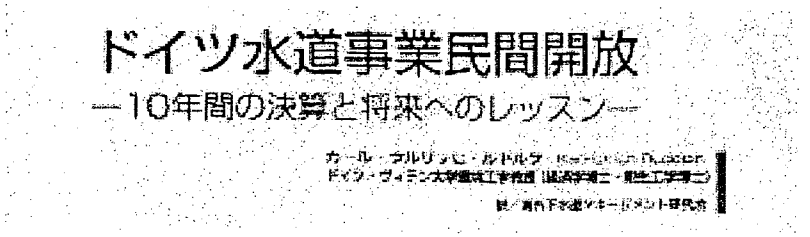
[1] 

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