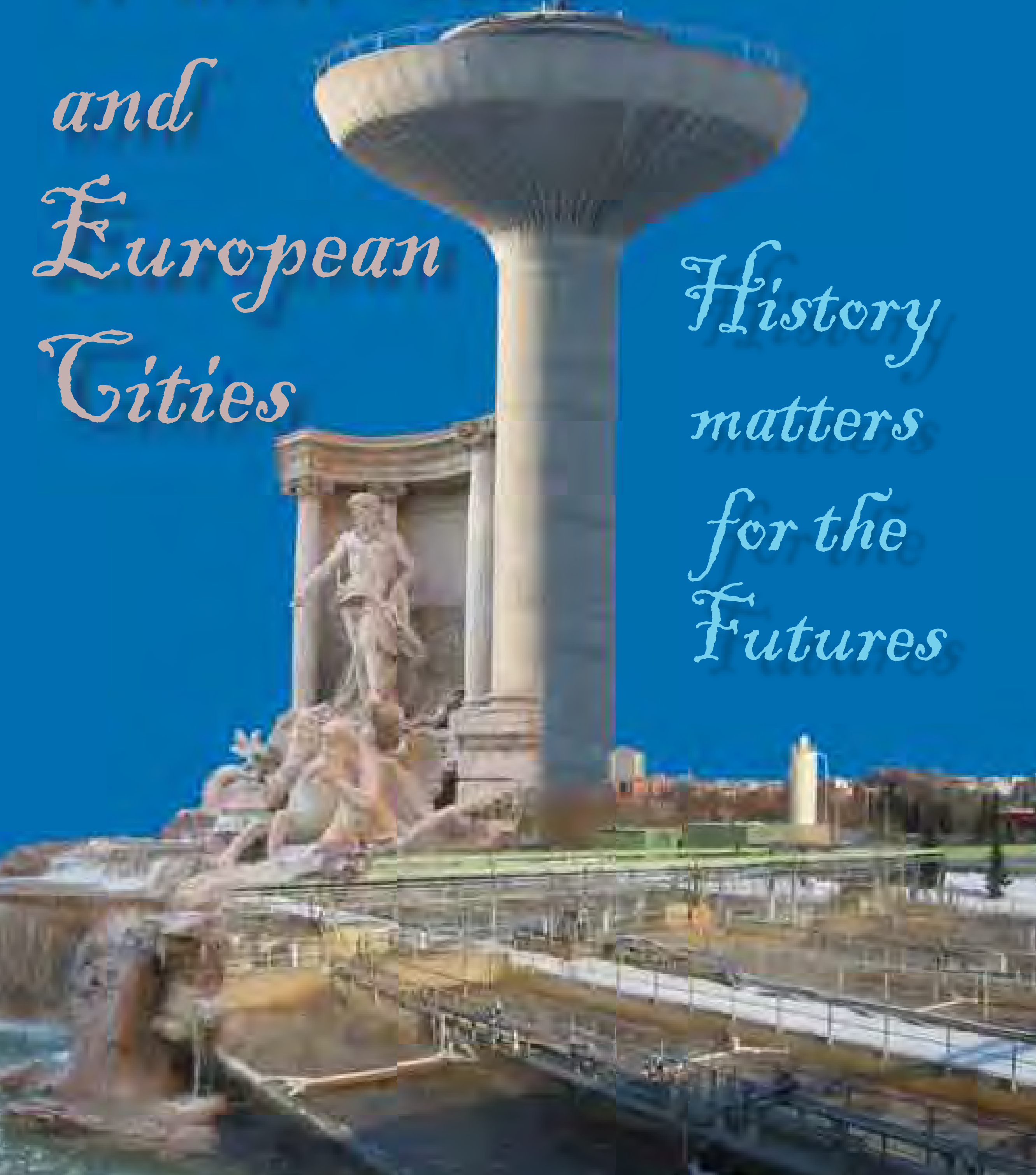
Petri S. Juuti & Tapio S. Katko (Eds.)

Water, Time and European Cities

History matters for the Futures



One Europe, Many Cities — Contemplating the Future of Water and Sanitation

"*Water, time and European cities — History matters for the futures* is a fascinating study, covering a vast and rich field of cultural diversity. The harmonising element is that the editors and co-authors see cities as part of a single Europe; they also share a concern for the future — water. The reader is provided a rich array of information gleaned from 29 cities in 13 countries, each with a different administrative and service supply history and different styles of design strategies and outcomes.

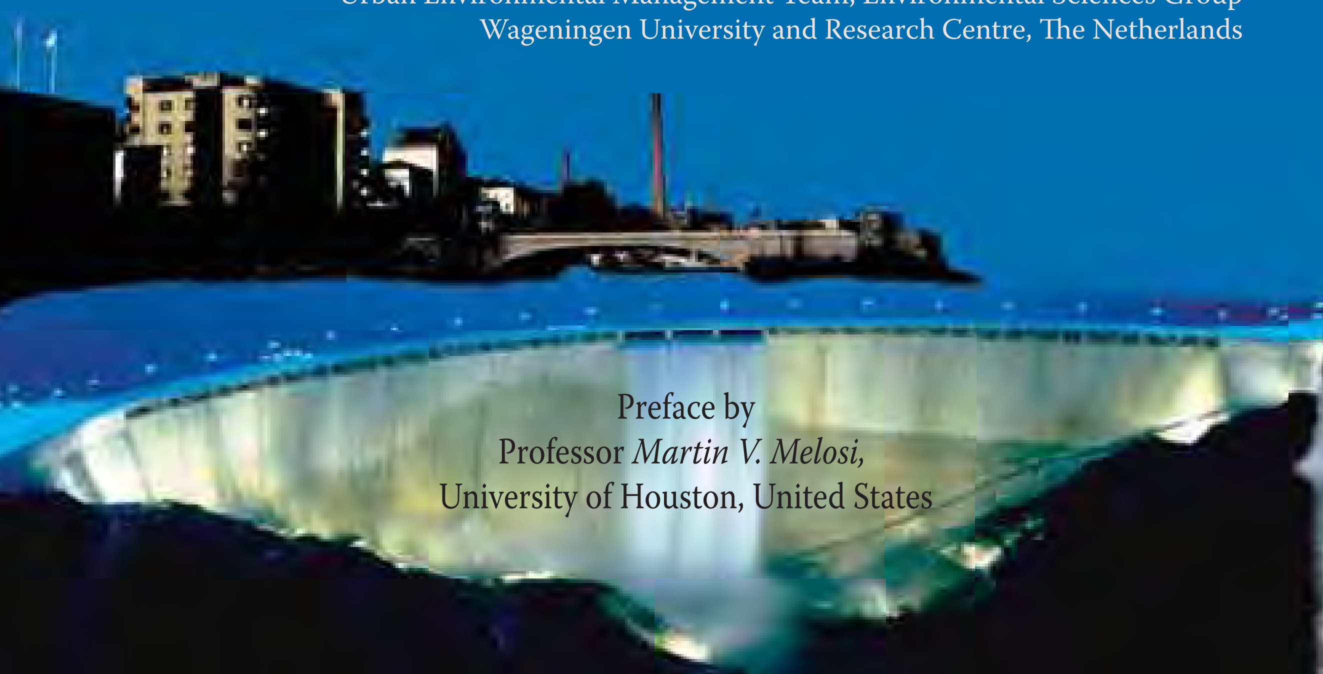
This study brings out the raw essence of individual historical memories and perspectives of tomorrow from dusty archives and state-of-the-art computer simulations. The past–present–future theoretical framework that is a spin-off of this approach holds great promise. The book proposes management and planning strategies for the future and gives due recognition to the right of ordinary people to participate in matters related to the important issues of water supply and sanitation. This type of research could be applied with good effect on the African continent. There is a distinct need to focus on the pre-colonial, colonial and post-colonial era and to determine how the water-related future of the African city needs to be understood. Ultimately, it could even lead us to a better understanding of the past, present and future water needs of global humankind."

Professor *Johann W N Tempelhoff,*
School of Basic Sciences, Vaal Triangle Faculty
North-West University, South Africa

"This intriguing book presents chronological accounts of the evolution of water and sanitation services in 29 European cities. The cases bring out an immensely rich variation in local arrangements for the establishment and exploitation of complex water and sanitation systems in fast-changing urban environments. This diversity of local experiences presents a potent antidote to the simplistic notion that there would be one best way of providing urban water services.

True to its title, Juuti and Katko's compilation of potted histories demonstrates that history does matter. It shows that there is much to learn from the comparative analysis of local evolutionary trajectories. Most of all, it deserves credit for placing the evolution of urban water services firmly on the research agenda."

Professor *Okke Braadbaart*
Urban Environmental Management Team, Environmental Sciences Group
Wageningen University and Research Centre, The Netherlands



Preface by
Professor *Martin V. Melosi,*
University of Houston, United States

Water, Time and European Cities
History matters for the Futures

"Water is the driving force of all nature"

Leonardo da Vinci (1452–1519)

Front cover: From left: *Fountain of Fontano di Trevi in Rome*, Italy, constructed in 1762 (Photo: T. Katko 2005).
In the centre: *Water tower completed in 1982 in Hervanta suburb, Tampere*, Finland (Photo: P. Juuti 2005).
Below: *Viinikanlahti wastewater treatment plant established in 1972,* located close to the expanded city (Photo: T. Katko 2005).

Back cover: From left: *Silhuette of the Tampere city center*, Finland (Photo: P. Juuti).
Below: *"Presa de El Atazar", water intake reservoir for Madrid*, Spain (Photo: Canal de Isabel II).

Petri S. Juuti & Tapio S. Katko (Eds.)

Water, Time and European Cities

History matters for the Futures

Petri S. Juuti & Tapio S. Katko (Eds.)

Water, Time and European Cities
History matters for the Futures

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- ERL, Universidad Complutense de Madrid,Spain
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We believe and hope that these long-term experiences and lessons will be useful for any current planning and policy development of our futures. Hopefully this book will also increase interest towards longer-term views concerning water services which, to a large extent, is also required as a basis for any participative decisions and sustainability.

Petri S. Juuti & Tapio S. Katko

Tampere, 22nd March 2005
World Water Day

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Tables, Figures & Plates

Abbreviations

BOT build–operate–transfer

EBRD European Bank for Reconstruction and Development

FR futures research

DWL Drinkwaterleiding Rotterdam

GW ground water

HHs households

HR historical research

LMU local multi-utility

MBE municipal budget entity

MNC multinational companies

mpe million population equivalent

NCRs National Context Reports

NGO non-governmental organisation

PLC private limited company

PPP public–private partnership

PRINWASS Barriers and conditions for the involvement of private capital and enterprise in water supply and sanitation In Latin America and Africa: Seeking economic, social and environmental sustainability.

RWAs regional water authorities

SSF slow sand filtration

SWC specific water consumption

UWWT urban wastewater treatment plant

WaSN water and sewerage network

WS water supply

WSS water supply and sanitation

WTP water treatment plant

WW wastewater

WWI World War I

WWII World War II

WWS wastewater service

WWT wastewater treatment

WWTP wastewater treatment plant

Preface

It is difficult, if not impossible, to understand the development of cities unless one comprehends how they get their water and how they dispose of their wastes. To most people these are mundane issues; certainly not as glamorous as any number of other concerns. Yet without taking into account the fundamental needs of urbanites, and the services that make commerce, trade, and industrial activity function, we miss the daily pulse of urban spaces. Cities, of course, are not literally organic entities, although they are ever-changing and ever-responding to a range of political, economic, social, and environmental forces. As some scholars have suggested, water supply and related sanitary services are akin to a circulatory system that allows cities to function and grow.

In this ambitious project— based on the original EU-funded study *City in Time*—Petri Juuti and Tapio Katko have taken on the task of working toward a typology of water- and wastewater-systems development. In so doing, they discuss cities from across Europe—and not just the great cities that normally receive most attention, but a variety of cities reflecting the diversity of the European urban experience. The authors also introduce some important tools for evaluating the development of water and wastewater systems, namely path dependence theory and the intersection of historical and futures studies. Path dependence is a particularly useful concept for evaluating choices available to policy makers and the constraints on those choices due to unintended variables as well as changes in time context. Connecting historical analysis with futures studies is particularly novel, but certainly not implausible. One only has to examine the fundamental processes of cause and effect relationships, sequencing of data, trend analysis, and analogy utilized by historians compared to many similar analytical methods employed by futures scholars to appreciate the similarities. That historians seek to evaluate the past as a means of understanding the present, and that futures scholars project their analysis forward beyond the present are more closely linked than we might think.

The new ideas and approaches employed in this project make it an excellent starting point for rethinking the very important water and wastewater services and the policy questions that they engender.

Martin V. Melosi

Professor
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Introduction

"Water is the only drink for a wise man"

Henry David Thoreau (1817–1862)

Water and sewerage services are part of the visible infrastructure of our cities and communities and are often taken for granted. Paradoxically their real importance for people and communities is remembered only when something goes wrong with these systems. However, in many cases it has taken a long time – several decades if not centuries — to develop them into modern systems. And it is also still true in the early 21st century that some European cities lack appropriate water and/or sanitation services.

This book is based largely on the study "City in Time" that was to address the historical differences and similarities in cities' decision-making over the long run and how these affect the decision-making of each case city.

City in Time aimed to use *futures research* to illustrate the interconnectedness of past, present and future decision-making. It sought to study the development of water systems in a wide institutional context covering the political, economic, social, technical and environmental dimensions and to identify long term patterns in decision-making, as well as the underlying driving and constraining factors. City in Time was to study urban water system reform in 29 cities, in 13 countries – originally in eight EU member and five candidate countries, four of which became full members on the 1st of May, 2004.

The major objective of City in Time was to discover the *key strategic* decisions that have affected the overall evolution of water and sewerage services in the city. Some of these strategic decisions may at first have seemed less important while later having proved to be of great importance. The study sought specifically to address the following *research questions*:

- What were the strategic decisions that have mostly affected the development (binding, limiting, postponing)?;
- Who and what factors define and create demand for services?;
- How does the historical context constrain potential best practices for the future?;
- What limits do technical choices of the past impose on decision-making?;
- On what basis have selected strategies been formulated and decided upon in different time periods?;
- How has the role of public-private partnership (PPP) changed over the years, and how is it likely to change in the future?

The *major sources* of data used by City in Time to analyse past and future decision-making included:

- Dates and sequence of key decisions on systems, e.g. special public bodies, respon sibilities of local government or central government, changes in ownership of systems between private sector, national and local governments; changes in opera tors between sectors; changes in pricing and charging methods; introduction of water rights;

- Local and national (and international) past decisions, which constrain and limit present choices, e.g. bulk water supply sources; boundaries of administrative units; taxation and borrowing powers of local governments;
- Factors and interest groups involved in the past, e.g. emergence of public health issues; origins of private sector role; environmental issues and local traditions; economic development; restructurings at entry to and exit from former communist regimes in eastern European countries.

The study used the following main sources:

- *Primary data* collected through case studies; each case study produces a historical report, which will be provided to the lead contractor of this work package who is responsible for producing an annual synthesis. Standardisation and communication will be facilitated through a Web-based information sharing system and an agreement at the outset on common reporting structures;
- *Primary data* collected through the *interactive* national stakeholder meetings to be held in conjunction with the Steering Group meetings. The objective is to make these working meetings provide useful inputs to the project as well as to undertake validation and review functions;
- *Secondary data* identified through case study interviews: the lead contractor will be responsible for following up on information identified through the case studies;
- Use of existing body of local, national and international historical research on urban water systems research;
- Unpublished material and papers;
- Personal interviews of related stakeholders and experts.

City in Time was an essential part of the WaterTime project, funded by the European Commission under FP5: Energy, Environment and Sustainable Development. The WaterTime project directly contributed to the overall aims of *Key Action, City of Tomorrow and Cultural Heritage*, by addressing the question of how to maximise the involvement of stakeholders in decision-making, and the effectiveness of decisions in ensuring efficient and affordable water and sanitation service for all citizens.

The general objectives of the WaterTime project were:

- To analyse decision-making processes for the design and organisation of water systems in selected European cities;
- To elaborate a set of recommended best practices for decision makers;
- To elaborate a decision-making model that will enable comparative evaluation of various options resulting in more sustainable water systems and improved quality of urban life;
- To disseminate findings and developed instruments among decision-makers and other stakeholders.

The introduction of this report is followed by a chapter on early diffusion of water and sanitation services, and public-private cooperation in historical perspectives. Thereafter the key points related to strategic decisions and development episodes in the 13 case countries and 29 case cities are described as shown in **Table 1.** Location of each case city is marked on the **Figure 1.**The book is largely based on the material produced for the City in Time reports on the case cities, National Context Reports (NCRs) and some related documents (available at: www.watertime.net).

Table 1. Case countries and cities of WaterTime

COUNTRY	TYPE	CITIES
Estonia	Accession	Tallinn
Finland	North	Hämeenlinna, Tampere
France	North	Grenoble
Germany	North	Berlin, Munich
Hungary	Accession	Budapest, Debrecen, Szeged
Italy	South	Arezzo, Bologna, Milan, Rome
Lithuania	Accession	Kaunas, Vilnius
Netherlands	North	Rotterdam
Poland	Accession	Gdańsk, Lodz, Warsaw
Romania	Accession	Bucharest, Timişoara
Spain	South	Córdoba, Madrid, Mancomunidad del Sureste de Gran Canaria, Palma de Mallorca
Sweden	North	Stockholm
UK	North	Cardiff, Edinburgh, Leeds

The case cities for this study and the original WaterTime-project were chosen on the basis of the:

- diversity of experience of the cities, including diversity within one country, and therefore the potential for improving understanding, developing good practice and disseminating relevant lessons;
- relevance of experience for today's policy makers;
- feasibility of the case studies in terms of the team members' existing level of knowledge and contacts;
- geographical representation — north and south EU, as well as candidate countries thus representing the full range of water requirements and challenges experienced in Europe;
- language capability of the team to work in the cities;
- partnership expertise and knowledge of the cities and countries.

Figure 1. Location of case cities

Rationale of the study

Considering the original objectives and accessible material and sources of the *City in Time* study, it is emphasised that the focus had to be more on the historical evolution of water and sewerage services in their wider institutional context rather than on strategic decisions as such. The main reason for that is that achievable historical documents, books, papers and other material tend to overwhelmingly describe the routine technical expansion of systems while they very seldom describe the arguments and reasons for certain decisions of strategic importance and wider institutional issues. Besides, some decisions have proved to be of strategic nature later — although maybe not recognised as such initially. These limitations and the scope of the study are believed to be justified considering the time and resources available for the study. Yet, in some cases books, papers and other sources dealing with strategic issues have been identified.

This book is based on 29 case cities in 13 European countries. Thus it covers most of the EU member countries and one negotiating about potential membership in 2005. Some other European countries like the Czech Republic, Denmark, Greece, Iceland, Ireland, Malta, Norway, Portugal and Slovakia are not covered and only a few case cities per country were selected. A larger number of case countries and cities would probably have brought even more diversity which should be kept in mind while reading the conclusions.

"*Plans fail for lack of counsel,*

but with many advisers they succeed"

PROVERBS: 15:22

Approach and methodology

"History is the witness that testifies to the passing of time; it illumines reality, vitalizes memory, provides guidance in daily life and brings us tidings of antiquity"

Cicero (106 BC–43 BC)

Approach and theoretical background

This chapter first briefly describes the approach of City in Time — the interrelations of *History Research* (HR) and *Futures Research* (FR). Thereafter, the methodologies together with the implementation of the study are explained.

Futures Research (FR), incorporating Historical Research (HR), is a decision-making framework, which seeks to integrate both historical and future perspectives into today's decision-making processes. In the context of decision-making on water services reform, futures research is innovative in that it seeks to address the nearly universal failure of (institutions and) decision-makers to retain and use institutional memory, while at the same time providing for the evaluation of alternative long-term *scenarios* to achieve the targets set for the future. It is believed that much could be learnt from the past mistakes and successes if we would just bother to delve deeper into past decision.making processes and their impacts. Such a dual perspective ensures that the *diversities of the past* and *pluralities of the future* are taken into account in decision-making (Jenkins and Witzel 1999). **Figure 2** provides an overall conceptual framework for combining HR and FR.

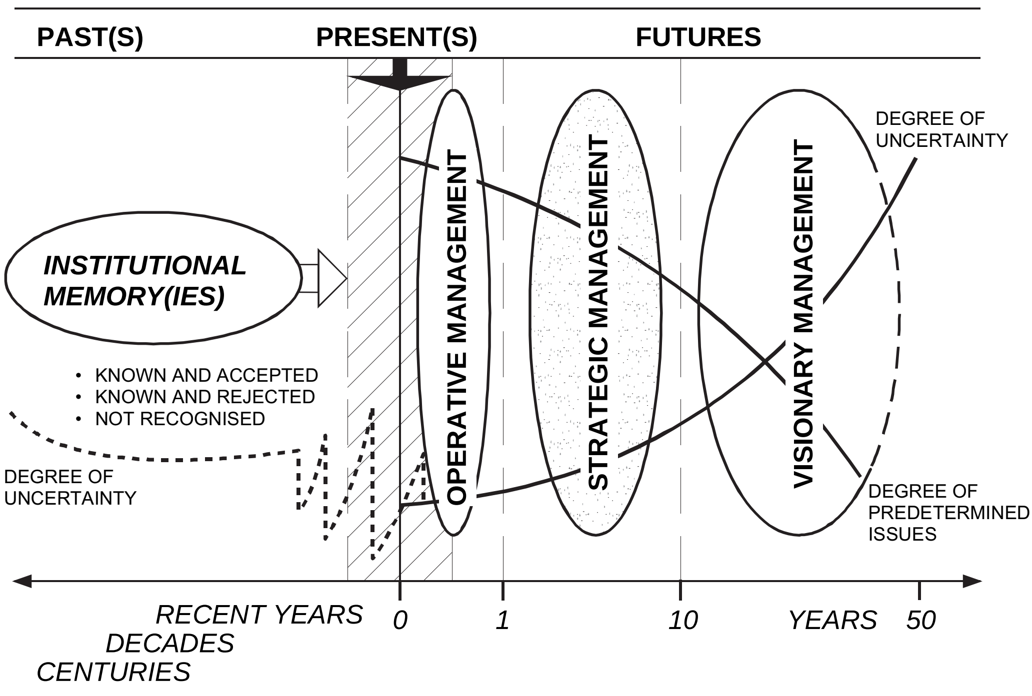


Figure 2. An overall framework for strategic management in relation to pasts, presents and futures
(Kaivo-oja et al. 2004)

In this context the plural form is used deliberately – to point out that instead of only one interpretation we have several interpretations of the pasts as well as presents, and particularly of alternative futures. The past is divided into three time blocks: *recent years, decades, and centuries.* The future in turn is divided into three timescales: short-time *operational management* of the system, *strategic management*, and *visionary management*. In futures research the degree of uncertainty increases with time, while in historical research it increases the more distant the past.

There seems to be discontinuity between the present, recent past and the near future. It could be that due to the tradition of HR, it is more difficult to assess the effects of strategic decisions on the recent past. If more convergence is wanted, the gap should be filled somehow. On the other hand, could it be that FR concentrates more on strategic and visionary horizons while perhaps neglecting the operational horizon of the near future? This would mean a paradox since organisations like water utilities seem to concentrate on operational management instead of longer-term strategic and visionary perspectives.

It seems another paradox that increasing convergence between history and futures also increases diversity. It is also good to remember that each decision should be evaluated against the conditions of its time. As FR might put it — "what were the weak signals of the past?" FR also points out the need to "look in the rear-view mirror while driving the car into the future".

In terms of the WaterTime project, Futures Research provides an opportunity to use the lessons of the past to improve the quality of decision-making in the future. The aim is to demonstrate to stakeholders the role of past decisions in determining — and often limiting — the range of options available in the future, thus underlining the importance of maintaining both a *retrospective* and *prospective* perspective in decision-making.

In the pasts or past presents we have made decisions that either have bound, limited or postponed our options (**Figure 3**). Presents are bound by laws and regulations, their compliancy and enforcement, and political objectives and decisions that inevitably are related to futures. Futures can be classified as possible, credible, and preferable. Analogies and path dependencies, for instance, link pasts, presents and futures to each other.

There are several theories that are applicable to the study *City in Time*. Yet, in this context the so-called *path dependence* theory seems the most useful. Path dependence contends that decisions made in the past are likely to have long-term impacts on water systems by binding, limiting or postponing alternative options. As such, path dependence is linked to history and futures research and their interaction. Path dependence has been offered as an alternative analytical perspective for economics, a revolutionary reformulation of the neoclassical paradigm.

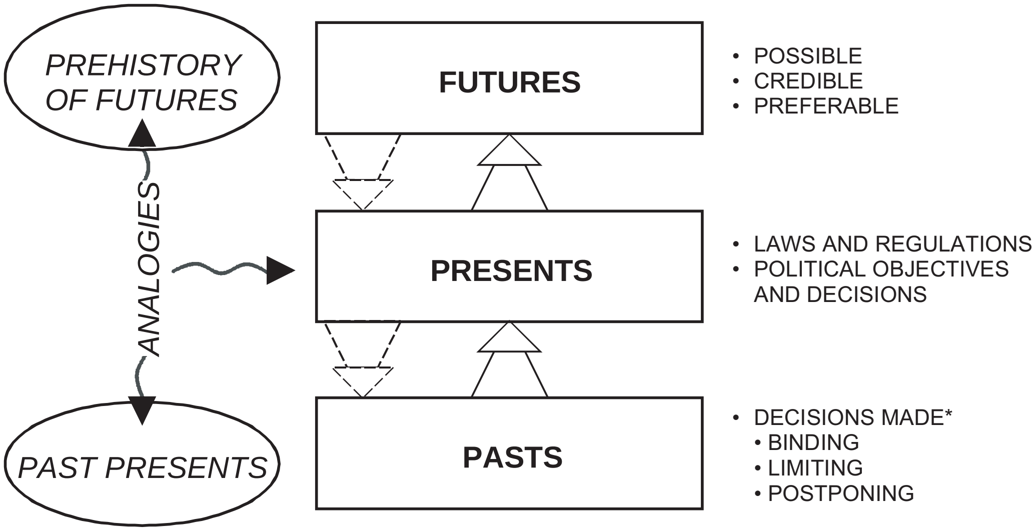


Figure 3. Pasts, presents and futures and their analogical relationships (Kaivo-oja et al. 2004)

The argument for path dependence is that a *minor* or fleeting advantage, or a seemingly inconsequential lead, for some technology, product or standard can have *important and irreversible influences* on the ultimate market allocation of resources, even in a world characterised by voluntary decisions and individuals' maximizing behaviour. Path dependence literature is accompanied and motivated by mathematical literature of non-linear dynamic models, known as chaos or complexity models, where a key finding is "sensitive dependence on initial conditions." There are *three degrees* of path dependence (Liebowitz and Margolis 1995). The first one implies no inefficiency; the second leads to outcomes that are sub-optimal and costly to change; and the third and strongest degree leads to an inefficient outcome.

According to Redding (2002), path dependence can be explained by distinguishing between fundamental and secondary knowledge. The economy moves endogenously between periods of drastic and nondrastic innovation. A microeconomic rationale for path dependence provides four features of technological change: endogenous innovation, uncertainty, a distinction between fundamental innovation and secondary development, and imperfect spillovers of secondary knowledge. Technological change and institutional change are the basic keys to social and economic evolution and both exhibit the characteristics of path dependence (North 1990).

North (1990, vii), one of the pioneers of New Institutional Economics, points out how history matters as "time and context". This understanding of history, however, is seriously deficient in two closely related aspects. On the one hand, despite their allowance to path dependence, the models and concepts are ahistorical, asocial, timeless, and universal. History, time and context are confined to the random shocks or whatever leads to one rather than another pre-determined, if stochastic, path to be taken.

Because the present is not wholly derived from the past, an effective decision maker must balance history with an assessment of the present and future. In terms of organisational memory (Neustadt and May 1986, cited by Walsh & Ungson 1997, 194–195):

(i) Decisions that are critically considered in terms of an organisation's history as they bear on the present are likely to be more effective than those made in a historical vacuum

(ii) Decision choices framed within the context of an organisation's history are less likely to meet with resistance than those not so framed

(iii) Change efforts that fail to consider the inertial force of automatic retrieval processes are more likely to fail than those that do.

In several connections it has been emphasised that history is a scientific story that in a sensible way combines the past with the present. However, it is less understood that in many respects we do not have a single history or present but there are various intepretations of pasts and presents. In any case, this current past–present dichotomy could and should be expanded to cover also the alternatives futures — not just one.

Methodology and implementation

This study has progressed through various phases. Since preparing the project proposal, research theories combining history research (HR) and futures research (FR) have been explored and developed (Kaivo-oja et al. 2004), largely motivated by the needs of *City in Time*.

The first phase of the actual study included a literature survey focusing on public-private cooperation and private involvement in the historical context which started in the beginning of the *WaterTime project*. In parallel with the literature survey, collection of basic background data using a standard format guideline was carried out. It covered such long-term data as identification of key long-term development phases in the case countries as well as factors creating demand for water and sewerage services in the early phase, establishing "modern" water works, sewerage systems and wastewater treatment, public-private cooperation and ownership, and total and specific water consumption in the case cities. In addition, a standard table format was developed to show the key strategic decisions and events and their reasons, together with contingent outcomes and organisational changes and the stakeholders involved.

Each of the partners was in charge of collecting the data on their respective case countries and cities as well as preparing the *City in Time* sections for their case studies. In some cases, access to all these data proved impossible. In addition, the emphasis of this basic data was on case cities and particularly the evolution and key decisions concerning water and sewerage services. This part of the study was of qualitative nature. The research approach can be also seen as constructive since it was largely based on cumulative data and knowledge.

The aim was to identify sources that would describe key strategic changes and decisions. It proved that the available literature largely describes routine technical expansions of the systems. Therefore, a country-focussed survey on Finland was carried out utilising experts' views on the most important long-term strategic decisions related to water supply and sewerage services (**Table 4**) to serve as a basic example of a single country. A similar survey on each of the case countries was, however, not found possible within the limits of the study. As another example, a survey was carried out on the Finnish case cities to estimate the relative shares of the public and private sector in terms of the services, equipment and goods produced by the latter (**Figure 9**).

Based on the views of external peer reviews, partners and steering committee members, the City in Time report was finalised. This study was further developed into a book by the editors.

Historical development of water and sanitation services

"History never looks like history when you are living through it."

John W. Gardner

Over the centuries, acquisition of water from rivers, lakes, wells or springs has been a daily chore for mankind. The water supply network emerged along with the construction of cities and villages. The Romans developed an organised and centralised system of aqueducts, siphons and collection of used water. In the Middle Ages water was distributed largely by human intervention — partly by private water carriers. After the empirical methods of the 19th century, the first modern societies with regard to water supply were born.

From a historical perspective, the current global situation with water is a product of social, economic, and ideological developments attending the advent of industry some two hundred years ago — within the time period 1800–2000 of *City in Time*. The current predicament is a result of the fragmentation of management and a marketing ethos that regards everything as a commodity, and profit as the ultimate objective (Hassan 2001).

Hassan (2001) further points out that from a historical perspective, an integrative ethic of water management is needed. First, it is important to transform the mode of management from technical fixes to community management. This means that people must be informed and included in decision making. Second, the mode must shift from the conventional structural engineering approach to an environmental engineering approach which considers the viability of local, regional and global regimes. Third, in addition to large, hi-tech projects, also small, community projects must be considered. Fourth, the scope of management must be broadened to include the social dimension of water systems. Fifth, global cooperation must be based on an exchange of benefits and cost-sharing, and finally, sixth, ethical criteria for established priorities must be created. Although our study concentrates on cities, these overall water management principles are to be kept in mind. Myllyntaus (2004, 11) points out that "technology has no autonomous power; it is dependent on human decisions and actions. On the other hand, science, technology and political decisions can help solve environmental problems. In the case of water-related problems, technology is not only a culprit but also a helping hand in fixing those problems".

The pioneering thinkers in urban planning of the late 1800s can be divided into two groups: the Anglo-American group and the Continental European group. In England and Wales cities began to spread out after about 1860: first the middle class, and especially after WWI, the working class began to move out of the inner rings to single-family homes with individual gardens (Hall 1987, 42–43). The same process occurred in most American cities though in some cases delayed by the great wave of foreign arrivals. Immigrants moved first to the inner rings and later joined the outward movement. On the European Continent things went quite differently. There industrialisation happened later and most of the middle class, and the entire working class, continued to live at extraordinarily high densities within walking distance of their work. The result was large slum areas in most big European cities. When Continental Europeans began to think about urban planning, they took this preference for high-density apartment-living as a starting point. On the other hand, in Finland industrialisation occurred mainly in new established locations next to water bodies rather than around the big cities (e.g., Hietala 1987).

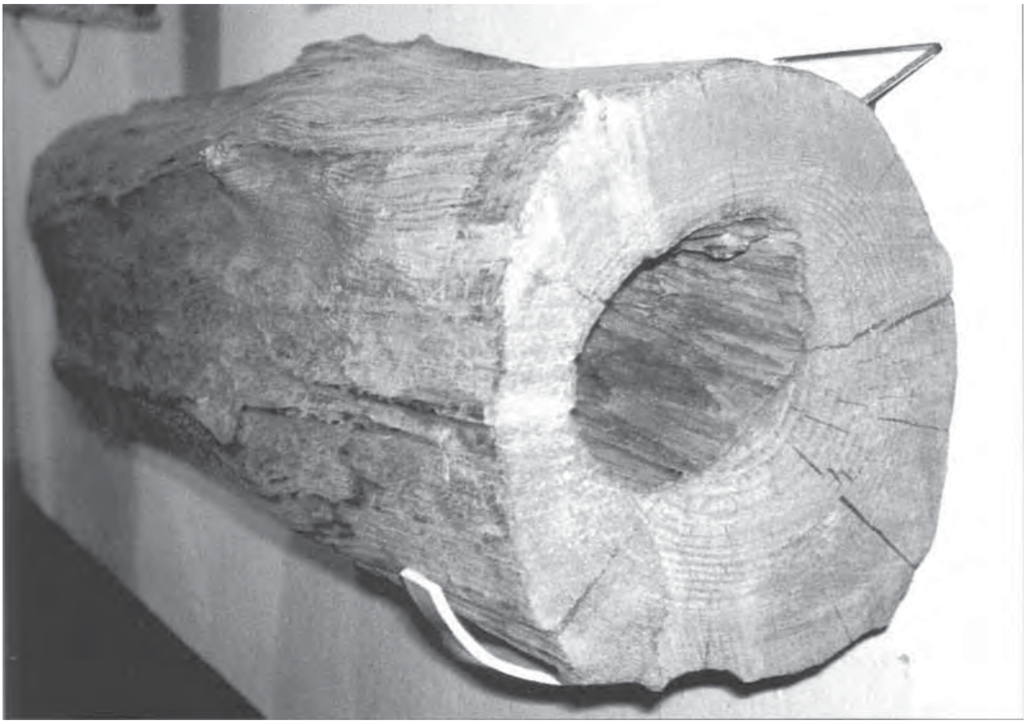


Plate 1. A wooden pipe installed in Berlin, Germany in 1572 (Photo: Bärthel 1997, 21; with the permission of Berlin Wasser)

In the last 100 years urban planning seems to have come full circle. The early phase 1880–1914/22 was followed by the stabilisation and expansion phase from the 1930s to the 1950s. This planning practice was continued until the 1970s. From the early 1900s until the 1970s the planning of growing urban areas was based on the satellite paradigm. The change in the 1970s involved, for instance, lengthy discussions on democracy and participative planning, although some public hearings had been conducted also earlier. In the 1980s urban centres started to follow different development patterns. The general market orientation started to change traditional urban planning systems (Pakarinen 1990). More recently, networked infrastructures and technological mobilities have been stressed in splintering urbanism (Graham & Marvin 2001).

Diffusion of WSS services and management traditions

This chapter tries to show that the demand for water and sanitation in various countries and regions was created by factors which had many common as well as different features. The start of the industrial revolution and the related growth of cities gradually created the need for centralised water and sanitation. In many respects, England was the forerunner of modern water supply and sanitation systems, but the innovations soon spread to Germany, other parts of Europe and the US. As the cities of Europe grew, sanitary and environmental problems overwhelmed city governments to a greater degree than before, and modern technology was often seen as the solution (Hällström 2002, 17; Juuti 2001). Melosi (2000) shows how European water technology was transferred to, and eventually developed, in America.

One of the main features of modern water and sewerage technology was the clearly higher capacity primarily due to stream-driven pumping technology and cast iron pipes. This was linked to the gradual development of water treatment technology as well as self-cleaning sewers. The role and development of municipal organisations was another important feature of this development (Hällström 2002, 18).

The establishment of modern water systems was largely based on private initiatives. Yet, the evidently unsatisfactory quality of private company supplies led to a re-evaluation of the organisational means (Hassan 1998, 18). From 1861 to 1881 the share of municipal water supply in larger provincial towns in England grew from 40 to 80 per cent, and reached some 90 per cent in 1901.

The growth of the urban infrastructure was the most dynamic element of the British economy from the 1870s to the 1930s. If housing is ignored, the investments in public health, local transport, water, electricity and gas were by the early 1900s as much as one quarter of all capital formation in Britain (Millward 2000).

In North America a considerable number of urban water supply systems were built in 1830–1880 while it proved more difficult to fund sewerage systems (Ling 2003). Most US citizens drew their drinking water from private wells or other water sources until the last quarter of the 19th century. According to some researchers — e.g. Joel A. Tarr, Stuart Calishoff and Nelson Blake — the needs of businesses and industries, real estate owners, fire fighting companies and health authorities hastened the birth of water works, making public works necessary. New York and Chicago, among others, started water acquisition and distribution with the help of private enterprises (Keating 1989).

In Rhenish Prussia the rising income of the middle-class voter and demand by industrial users, rather than public health crises, created demand for improved water supply (Brown 1988). Brown further points out that historians credit the sanitation revolution with the decline in mortality, while the spur sanitary reform gave to municipal intervention in local economy through regulation of housing and land markets and provision of services such as water and sewerage, is less well known.

Plate 2. Transporting water from Danube in Pest-Buda, Hungary — lithograph from the 19th century
(Photo: Hungarian Museum of Water Administration)

Hassan (cited by Brown 1988) argues that the demands of industries, such as cloth finishing and dyeworks, persuaded cities to take an active role in water provision rather than the concern for public health. On the other hand, Gaspari & Woolf (1985) show that in 122 cities in the US sewage systems reduced mortality significantly, while water filtration systems had no impact. More recent impact studies from developing countries show certain variation depending on conditions. Yet, the overall trend is that improved water supply results in somewhat reduced mortality and the impacts are bigger when sanitation is introduced. Yet, the best results will be gained if health education is also introduced.

In Finland the first water supply and sewerage systems of urban centres in the 1870s to 1890s were in most cases constructed simultaneously although often under separate organisations. There was demand mainly for fire-fighting water (Hietala 2002; Juuti 1993 & 2001), but drinking water supply and sanitation, and in some cases industrial needs, also played a role. Thus, it is obvious that the impacts of improved water supply and sanitation depend on local conditions, as does demand.

Historically, Barraqué (2003) recognises three main time-related paradigms in public water supply and sanitation: quantitative and civil engineering, qualitative and chemical/sanitary engineering, and the most recent one — environmental engineering and integrated management.

Infrastructure and the built environment of today are the results of decisions and efforts made decades and even centuries ago (Kaijser 2001). Besides, decisions concerning building and rebuilding these systems and structures will shape the material world of future generations. Already for some time historians like Melosi (2000) have been interested in the concept of path dependence — how made decisions bind our alternative development paths. These decisions may be of binding, limiting or postponing nature (Kaivo-oja et al. 2004).

Typology of water institutions in selected European countries

It is important to understand *the current differences and cultures* in water resources and services management and their historical background. Barraqué (2003) has formulated a rough typology of water resources management and institutional cultures in Europe. This typology is based on Germanic vs. Roman legal origin and, on the other hand, centralised vs. subsidiary (decentralised) tradition (**Table 2**). The only three states covered by river-basin institutions are the ones that have historically been centralised monarchies: Spain, England/Wales, and France. Yet, they have evolved differently. Besides, in some countries river basin authorities, like those in the Nordic counties, have been formed on a voluntary basis.

Table 2. A rough typology of water institutional cultures in Europe (Barraqué 2003, modified by the authors)

(Predominantly)	ROMAN ORIGIN	GERMANIC ORIGIN
CENTRALISED	Spain	England
SUBSIDIARY	Portugal, Italy	Netherlands, Germany Nordic countries

In England and Wales water resources policy has been centralised in the postwar period, particularly after the introduction of River Basin Authorities in 1963. Water supply and sewerage systems became centralised in 1974 with the establishment of ten Regional Water Authorities. The more recent extreme example of water privatisation during Prime Minister Thatcher's regime (1979–1990) sets England and Wales clearly apart from other European countries.

Spain, Portugal and Italy have systems built on Roman law, while those of England, the Netherlands and Germany are based on Germanic law. In Spain, Portugal and Italy the political history of the 20th century explains also largely the ways and emphasis of water resources management. Germany has a long tradition of local drainage associations, while river basin management has not been institutionalised except for the famous Ruhrgenossenschaft. Due to the strong subsidiarity, water policy is in the hands of 16 Länder (states) rather than with the Bund (federation). In the Netherlands historical development has led to water-user associations, and around 2000 wastewater management is largely based on water boards (Uijterlinde et al. 2003). The Nordic countries are perhaps the ones with the strongest subsidiary tradition and do thus fall in the same category with the Netherlands and Germany.

According to Barraqué (2003), it is difficult to place France in any of these categories. On the one hand, France is clearly a follower of Roman law and the centralised tradition. Yet, the six water basin authorities have become largely subsidiary institutions. As for water services, the role of municipalities has declined over time. Several Central European, as well as the Baltic, countries were subject to the highly centralised Soviet tradition of state water management after WWII. It will be interesting to see to what extent they will "go back" to the municipal tradition, or whether they will choose the private company tradition for the short or long term.

Although the typology described above applies mainly to water resources management, it also explains the differences in subsidiarity tradition, and thus the role of local governments. This difference is crucial when we take a closer look at the evolution and strategic decisions concerning the management options for water and sewerage services.

Water regimes in selected European countries

A comparative survey of regime development in water management in six European countries – Belgium, France, Italy, the Netherlands, Spain and Switzerland — was made by Kuks (2004). The survey focused on the main regime transitions in each country and explains what has actually changed in terms of water rights and water policies.

In the early 19th century many countries adopted a new constitution and civil code, which formed the start of a simple water regime. In the selected countries the period 1800–1900 was identified more or less as one of a *simple regime*. During the period 1900–1950 these regimes developed into *regimes of low complexity.* In the period 1950–1985 the complexity increases and the period can be divided into one of *medium complexity* (1950–1970) and one of *high complexity* (1970–1985). From 1985 onwards many *attempts at integration* were seen in the various countries. Therefore the period 1985–2000 was characterised as one of attempts at integration, although it was a period of high complexity for most countries. The Netherlands, France and Switzerland attempted integration relatively early, while Belgium, Spain and Italy are lagging behind in very different ways (Kuks 2004). Although this classification emphasises water resources management, it also reflects water and sewerage services and their development.

European traditions in legal and administrative systems

An interesting comparison between the European countries by Newman and Thornley (1996) presents five "families" in terms of their legal and administrative traditions. They argue that there is general agreement in the literature that European countries fall into five key categories: British, Napoleonic, Germanic, Scandinavian and East European (**Figure 4**).

According to Newman and Thornley (1996, 30), the British legal style is largely isolated from the others. Yet, the Scottish legal system maintained its identity because Scotland was an independent kingdom until the early 18th century. In contrast to the isolated development of English law, Scottish law developed into a combination of local customary law and Roman law. This also partly explains the fact that water services in Scotland have developed somewhat differently from those of England and Wales.

The *Napoleonic legal family*, originating in France, is the largest in Europe in terms of the number of member countries. This legal style has the tendency to use abstract legal norms and enjoy greater theoretical debate than the British style. On the Continent, the great jurists have been professors while those in England have been judges. The aim has been to think about matters in advance based on a complete set of rules drawn from abstract principles.

The enduring nature of the commune as a basic building block of local administration still has considerable importance in France, Belgium and Switzerland. Administrative systems placing importance on the local commune are likely to have numerous authorities at the lowest possible level. The commune originally derived from the administrative structures of the Catholic Church. In any case, the historical roots and various paths to democracy led to different administrative structures (Benney, cited by Newman & Thornley 1996, 32).

The *Germanic legal family*, including Germany, Austria and Switzerland, is regarded by Newman and Thornley (1996, 33–34) as a distinctive branch of the Napoleonic one. In Germany there was no central power to impose a unified legal system like there was in England and France. Thus, the existing law in Germany became more and more obsolete, and there was no authority to rationalise the various existing laws. Most continental countries had already developed their codes by the time the German one was formulated. Yet, the German code influenced considerably those in Eastern Europe. The German Constitution is a federal one where the central state shares power with the regions (Länder) which have their own constitutions that vary between regions. For historical reasons there are also some free-standing cities like Hamburg and Bremen.

The *Nordic legal family* (Nordic is a more accurate term than "Scandinavian" as used by Newman & Thornley: authors' note) includes Denmark, Finland, Norway and Sweden. This family is clearly different from the British one and closer to the other two. The historic dealings between Nordic countries were largely based on conquests by the Danish and Swedish empires. In medieval times Nordic laws were based on Germanic law but were later influenced by the French revolution. Towards the end of the 19th century cooperation between Scandinavian lawyers increased. The Nordic region developed

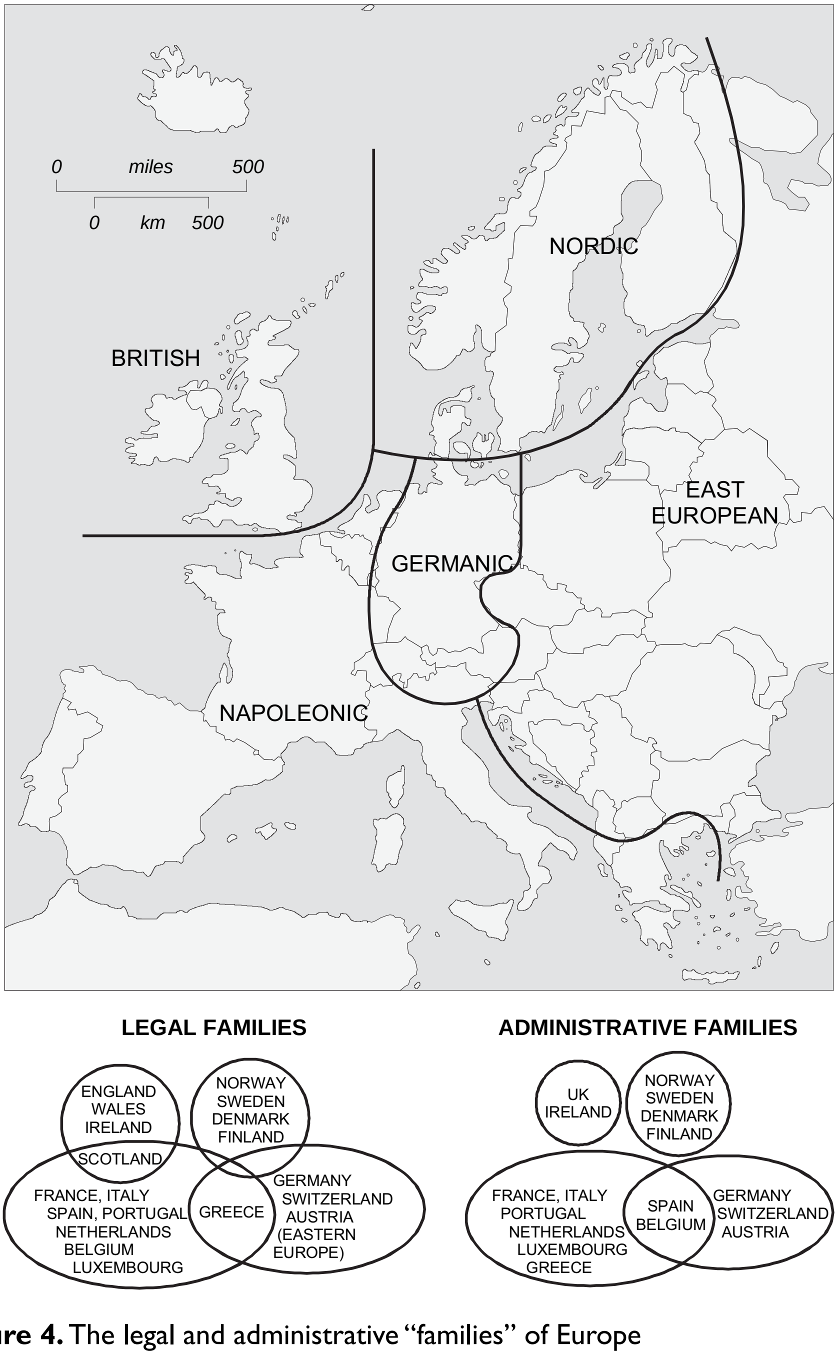


Figure 4. The legal and administrative "families" of Europe
(Newman & Thornley 1996, 29; modified by the authors, with the permission of Routledge)

its own path. The administrative structure of the family is regarded a hybrid: the central government normally has its own agency operating at the regional level. Although local authorities have gradually been reorganised into larger units over the years, local self-government has a long history and is seen as one of the cornerstones of the Scandinavian constitutions (Newman & Thornley 1996, 34–35). Nygård (2004b) suggests that Finnish health legislation was largely based on the English and other Scandinavian countries' tradition until 1927, while the municipal legislation followed mainly the German (Prussian) tradition.

In *Eastern Europe*, from the end of WWII to the early 1990s, administrative systems were highly centralised. The uniform idea of state authority gave no room for local policies. Although each country wants to and seems to proceed along its own path, a common past is likely to cause similarities (Newman & Thornley, 35–36). As for water services, at least the East European countries seem to have selected several paths in the 1990s after the collapse of the Soviet Union. Within the Baltic Sea catchment area the so-called HELCOM (Helsinki Commission) has promoted water pollution control activities since 1974 while the actual improvement of the so-called hot-spots started in the early 1990s. In that connection the Nordic and German governments, among others, supported the improvement of water and sewage utilities in the Baltic region. Cities like Stockholm, Helsinki, Hämeenlinna, Oslo and Copenhagen were involved in twinning activities with their counterparts in the Baltic regions, such as the WaterTime case cities of Tallinn and Kaunas. (HELCOM 2004)

When comparing the trends and developments of local governments in Europe, Batley (1991, 216) recognised three main types of reforms in terms of service delivery. One is the trend to expand the role of local government, and to free it from restrictions: examples are the shift to general grants in the Netherlands and Norway; a more dramatic one is the deregulation and free commune experiments in Scandinavia. The second type relates to the improvement of public service practices including, e.g., the setting of performance standards, staff training for greater responsiveness, strengthening user influence and neighbourhood decentralisation. The third one is the incorporation of business methods and competitive practices into the public sector, such as devolution of budget responsibilities, contracting out and charging fees for services.

In the early 1990s, according to Batley (1991), a clear distinction was made between the services where contracting out, franchising and business methods are appropriate and those that should remain under direct administration or the voluntary sector.

At the same time Stoker (1991) pointed out how the establishment of local government in Eastern Europe is seen as central for establishing and maintaining a democratic process. Stoker also reminded how post-war growth in public spending, especially in connection with the welfare state, increased service provision and local government activities. Yet, the more difficult economic climate from the mid-1970s on led to a concern about public spending. However, as Stoker (1991) mentions, the challenge of local government is broader than the "fiscal crisis" — a wider economic and social change affecting the operational environment of local governments. The challenge facing local government is to find more responsive and effective organisational forms.

The European comparison of local governments (Stoker 1991, 4) confirmed the general message that "there are alternative routes to making local government more open, responsive and effective". Considering the changing nature of central–local relations, three models of relationships were presented. First, the *relative autonomy model*, which gives independence to local authorities while not denying the reality of the nation-state. Here local authorities raise most of their revenue through direct taxation. Second, the *agency model* where mainly local authorities carry out the central government's policies which are ensured by detailed specification in legislation. Third, the *interaction model* where the spheres of action of central and local government are difficult to define because they involve a complex pattern of relationships emphasising mutual influence.

In the early 1990s most of Europe was moving down the path of greater decentralisation. The establishment of viable local democracy was seen vital in Spain and Italy, while France and Italy had also undertaken decentralisation measures. The Nordic countries have traditionally had a local government focus. Stoker (1991) argues that Britain in contrast was moving in the opposite direction — towards a more centralised system where local government would have more of an agency status. Such power relations between the central and local governments and the clear differences in their traditions and present status should also be kept in mind when thinking of the key long-term changes in water services. Globalisation, European integration, and the developments in Eastern Europe in the 1990s have also influenced these patterns.

All in all, it is obvious that the different legal and administrative traditions, "families", related to urban planning, as well as the trends and changes in the roles of local governments in different regions and countries, certainly also have implications for the development of water and sewerage services and thus sustainable decision-making in the long-term. Historical traditions have obviously also influenced how services, including water and sewerage, have developed and are managed even today.

Trends in urban planning

Urban planners often point out that, in fact, water and sanitation have often been the first public infrastructure systems and services in urban areas.

In the last 100 years urban planning seems to have come full circle. According to Pakarinen (1990), so-called modern urban planning covers the period from the mid-1800s until today, although the history of urban building goes far back in history. The early phase of modern urban planning is placed between 1870–1914/1922, followed by the expansion phase from the 1930s to the 1950s. The practise was continued until the 1970s, while criticism was also presented. The change in the 1970s involved, for instance, lengthy discussions on democracy and participative planning. By the 1980s most agreed that urban planning was in a crisis. In the early phase urban planning was seen more as a physical planning exercise which could ignore all social aspects. The planning of growing urban centres was for long based on the so-called satellite paradigm. Then, the participatory planning approach was introduced. In the 1980s, instead of unified planning approaches, communities set out on different development paths. This was followed by the introduction of market economics and approaches that were looming already at the turn of the 1990s. In the 1980s urban studies started to pay attention to local governments and communities.

As for the history of urban planning, Pakarinen (1990) recognises two major traditions: the German and the Anglo-American one. In the German tradition urban planning is seen as an applied science, while the Anglo-American tradition pays more attention to policies and policy changes. Peter Hall (cited by Pakarinen, 1990) calls the latest planning phase "city enterprise". By 1990 the emphasis on reformist regulation started clearly to give way to the promotion of market economics. According to Kurunmäki (2005, 19–20) urban planning in recent decades has shifted from "town planning" to "urban development", the latter described by the concepts of policy-implementation, structure-agency, government-governance, and public-private relations.

Cultures and organisations

Management cultures are described shortly next based on the famous studies of Hofstede (1994) who has since the 1960s done research on cultural differences – the impact of national cultural differences on the way the people in a country organise themselves. Hofstede has identified four key dimensions and indices of national culture: power distance, individualism-collectivism, masculinity and femininity, and uncertainty avoidance. *Power distance* is defined as "the extent to which the less powerful members of institutions and organisations within a country expect and accept that power is distributed unequally", while *uncertainty avoidance* refers to "the extent to which the members of a culture feel threatened by uncertain or unknown situations". *Femininity*, in this context, "stands for a society in which social gender roles overlap: both men and women are supposed to be modest, tender and concerned with the quality of life". *Masculinity*, again, refers to a society with clearly distinct roles where "men are supposed to be assertive, tough and focused on material success" (Hofstede 1994, 261–262).

With the risk of oversimplifying the findings of Hofstede, **Figure 5** presents the state of 50 countries and three regions in relation to masculinity–femininity and individualism–collectivism. The upper half of the diagram contains the collectivist countries, and the lower half the individualist ones. While masculine countries tend to resolve international conflicts by fighting, feminine countries prefer compromise and negotiation. It also shows the remarkable differences between the case countries of this study.

Hofstede (1994) has further located a number of characteristics known from organisation literature and projected them onto a power distance-uncertainty avoidance matrix (**Figure 6**).

Figure 6 indicates that mutual adjustment is in line with the market model of organisations and ad hoc negotiations in the Anglo countries. Standardisation of skills is typical of countries like Germany and Switzerland, while standardisation of work processes fits the French concept of bureaucracy. Direct supervision is applied in countries like China, and standardisation of outputs is preferred in the US. Whatever the truth, the above studies in any case show remarkable variations in cultures and organisations. Hofstede (1994, 236) points out that the main cultural differences among nations lie in values. Research on these values has *"shown repeatedly that there is very little evidence of international convergence over time, except for an increase of individualism for countries that have become richer"*. Thus, in spite of globalisation and increased contacts, the value differences described a century ago still existed in 2000, and, according to Hofstede, that cultural diversity will remain for the next few hundred years.

Water being largely a local issue, it is no wonder that even in a country like Finland, with only five million people, different cultures exist. It proves that the management methods found appropriate in one environment do not necessarily fit others.

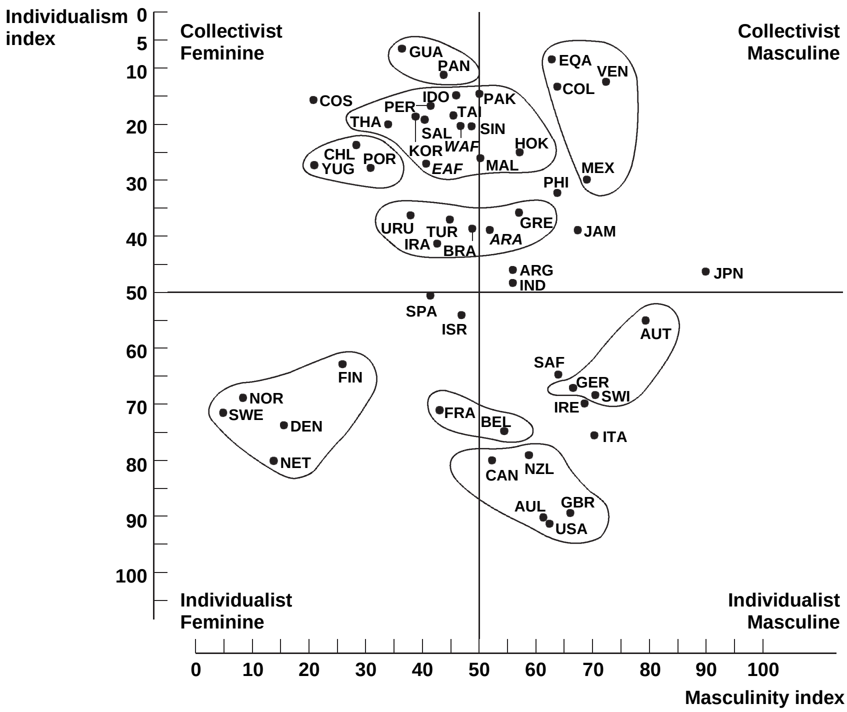
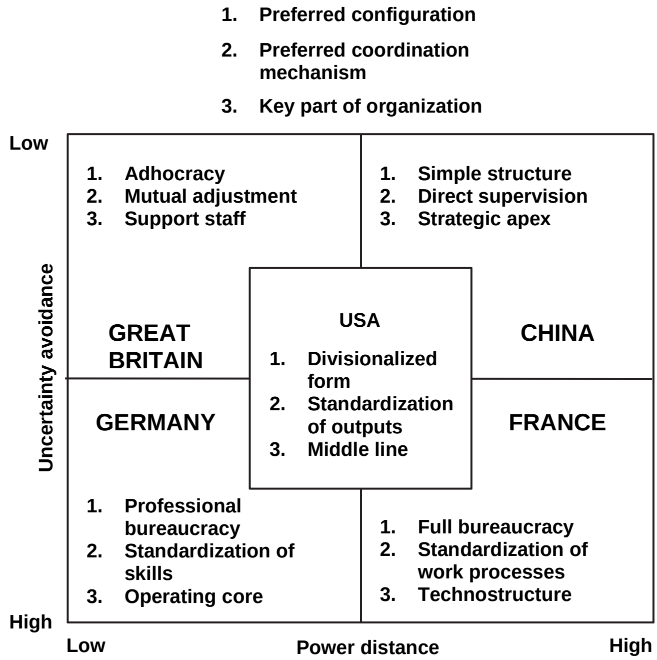


Figure 5. The position of 50 countries and 3 regions on the masculinity–femininity and individualism–collectivism axes
(From Hofstede G. 1994. Cultures and organisations. Intercultural cooperation and its importance for survival. Software of the mind. Harper Collins Business. pp. 99, reproduced with permission from Geert Hofstede BV.)

Figure 6 The preferred configurations according to Henry Mintzberg projected onto a power distance — uncertainty avoidance matrix with a typical country for each configuration (From Hofstede G. 1994. Cultures and organisations. Intercultural cooperation and its importance for survival. Software of the mind. Harper Collins Business. p. 152, reproduced with permission from Geert Hofstede BV.)



Technological trajectories

One example of technological trajectories in water supply and sanitation is the use of lead pipes. The technology needed in manufacturing lead products was quite simple, and consequently lead was widely used already during antiquity. For instance, in the Roman World between about 200 BC and 500 AD roughly 18 million tons of lead was mined (Nriagu 1983, 205). The water distribution systems of Roman cities included a lot of lead pipes although some ancient authors (e.g. Vitruvius, Galen) expressed reservations against their use. Due to the differences in Roman and modern water distribution systems, it is probable that lead contamination of water was not a serious problem during the Roman Era. The use of lead in plumbing systems was also popular in Europe during the Middle Ages and later. Concerns about lead exposure from leaden plumbing systems have been expressed since the 16th century (Nriagu 1985). Despite several reports of waterborne plumbism, especially in the 19th century, the use of lead in plumbing systems continued. In the early 2000s there is a growing concern about the use of lead pipes in house connections in many of the pioneering countries of water services, in Europe and North America, as well as in former colonies. This shows the long-term effects certain strategic decisions may have.

This introduction to legal and administrative traditions, trends in urban planning, differences in cultures and organisations, and the example of a technological trajectory brings us to considering how the roles of the public and private sector have changed over the years in Europe as well as a wider international context in water services delivery.

Public–private cooperation in historical perspective

Although public-private cooperation and related issues are not defined as the only strategic decisions to be considered in this study, they often seem to be the only ones of strategic importance that have been written about.

There are examples of cities' involvement through some level of water services provision already from the Middle Ages. It may have occurred in the form of public wells or, like in the case of Tallinn, the services of water carriers that were paid by the town council in the 1330s. As for disposal, the so-called Lübeck Act was adopted in Tallinn in 1257. This Act stated how toilets and pigsties were to be located in relation to streets and neighbouring bounds (Kaljundi 1997).

In the mid-1800s most western nations, if not all, started to develop urban water and sewerage services through privately owned companies or private operators. Yet, in most countries the utilities were fairly soon taken over by municipalities. Only in France private operators, such as Veolia Water (earlier Vivendi and the Compagnie Générale des Eaux), have survived and expanded since 1853. This is largely due to the fact that in 2000 France still had some 36,000 municipalities. It is very difficult to imagine individual municipality-owned utilities managing their water services. There are several other policy instruments that have favoured, and still favour, the use of private operators. In some places, such as Barcelona and Venice, private companies have maintained concessions for over a century.

One of the basic tenets of water and sewerage services (WSS) is that the WSS infrastructure is a *natural monopoly* — a concept introduced by John Stuart Mill (1806–1873) in 1848 (Sharkey 1982, 14). Accordingly, it is feasible to construct only one such system per service area.

From early concessions and operators to public utilities, 1800s to the early 1900s

The first modern water systems were built on the basis of builder-owner or concession models in many European countries, and particularly in North America. In most cases, however, municipalities soon took over these water and sewerage systems. For example, in the early 20th century, 93 per cent of the systems in German urban centres were municipal, as were all the urban WSS systems in Sweden and Finland (Wuolle 1912). During the 19th century, the previously private systems came under public ownership and public provision because of the inefficiency, costs and corruption connected to them. In the late 19th century, the emphasis was on municipalisation. Democratically elected city councils bought existing utilities and transport systems and set up new ones of their own. This resulted in more effective control, higher employment, and greater benefits to the local people. Councils also gained the right to borrow money to invest in the development of their own systems (Hall 2003, 7).

In the middle of the 1800s a clear distinction developed between the public/general and private spheres of society. The private sphere was considered to consist of "private social groupings" — individuals, families and local communities. Local level services were largely managed by private entrepreneurs because there was hardly any legislation on local governments. The state could have an impact on these matters only through legislation, such as the acts enacted in the 1860s and 1870s (Kilander 1991, cited by Nygård 2004a, 164; Nelson & Rogers 1994, 27).

Nelson & Rogers (1994) point out the background and birth of the First Public Health Law in Sweden that came into force in 1874. Initially it was clearly influenced by the British Public Health Act of 1848. The committee drafting the 1874 Act considered the promotion of preventive health care of utmost importance. Along with the Act, for instance, public health boards became compulsory in each town. The Swedish Act also served as a model for the Health Decree of 1879 in Finland (Nygård 2004b).

Yet, in historical context it is good to remember that it was characteristic of the whole of Europe that the working classes had no representation in municipal government. For example, it was not until 1903 that the first representative of the working class became a member of the Stockholm city council (Hietala 1987, 55–56).

Plate 3. Public well from the 18th century in the old city of Stockholm, Sweden (Photo: T. Katko, 1990)

European examples

In Britain, the continuous period of private water undertakings started in London in 1681 following the Great Fire of 1666, as the city administration granted the use of the first arch of London Bridge for water supply purposes to Peter Morris for 500 years (London's Water Supply 1953, 9: 1–15). The private sector started operating other water works at the beginning of the 19th century, and parliamentary regulation was introduced gradually. As in many other countries, the responsibility for most water works, and practically all sewerage systems, belonged to local governments by the end of the 19th century or, at the latest, in the beginning of the 20th century. During the 20th century financing by the central government increased continuously. Modern WSS (water supply and sewerage) systems were born in England, although the birth of sophisticated WSS systems dates back to antiquity or even earlier. The novel idea that emerged in England in the 1840s was that these services were the responsibility of the Government (Juuti 2001). From England these "modern" systems spread to Germany and other parts of continental Europe starting in the 1840s. The first systems in England were privately owned. On the continent, however, the public sector had a more central role from the beginning, except for France.

The British were still more advanced in water management than their continental counterparts around 1870, and English companies became involved in the establishment of water and sewerage works in many cities in continental Europe. This came about in three ways (van Craenenbroeck 1998):

(i) An English enterprise provided financing or became an owner;
(ii) An equipment and appliances manufacturer established the water works to guarantee a market for itself; and
(iii) Development of the works was started by hiring English experts as managers.

In *England*, the lobbying for state-run WSS services began in the 1880s. For instance, Joseph Chamberlain (1836–1914), a member of the Liberal Party, campaigned strongly for the state to take over responsibility. He argued in 1884, for instance, that: *"It is difficult, if not impossible to combine the citizens' rights and interests and the private enterprise's interests, because the private enterprise aims at its natural and justified objective, the biggest possible profit."* Castro et al. (2003) point out that in England, particularly in London, the poor quality of private water services prompted complaints since the 1850s, but it took half a century to put the water companies in public hands. In London it happened in 1902. The arguments raised by Lord Avebury (John Lubbock, 1834–1919) in 1906 in England, in favour of privatisation, seem interestingly similar to those presented by its promoters some 90 years later. Bakker (2003) pointed out that the experience from laissez-faire management of water supply as well as other utility services in the 19th century in the UK and the notion of "market failure" made public ownership of water supply infrastructure justified.

In *Germany*, the idea of municipal enterprises was already so well established by 1900 that there were no protests against the transfer of electricity, gas or waterworks under municipal ownership. Many politicians, in fact, thought that if services were managed by cities or communes the general public could benefit from the profits. As Hietala (1987, 152) points out, "the services were not only useful but also lucrative for the cities".

In *France* private companies have participated in the operational management of water works for over a hundred years (Kraemer 1998a, 335). The best known enterprise, the Compagnie Générale des Eaux (later Vivendi and Veolia Water), was founded by an imperial decree already in 1853 (Goubert 1989, 175). The Antwerp water system in *Belgium* also dates back to that period. An English engineering company, Easton & Andersson, started work on it on the basis of a concession contract in 1879. The concession ended in 1930, although the city had tried to take over the works earlier (van Craenenbroeck 1998).

According to Barraqué (2005), in France local authorities have historically built close relationships with private companies — to protect themselves from centralisation. Barraqué argues that very special relations exist between local and central governments in France. For instance, lending at cheap rates through local councils was forbidden for long. French local governments have been mature politically, but not financially. This, again, has to do with the large number of local councils there mentioned earlier.

In Barcelona, *Spain*, the concession has run for 125 years, until early 2002. Societé General des Eaux de Barcelonne (Agbar) was created in 1867 as a Belgian Company. Some years later it was bought by Societé General des Eaux et de l'Eclairage (Lyonnaise des Eaux) which, again, was bought by Catalan Banks (Sociedad General de Aguas de Barcelona) in the 1920s. Except for the period of the Spanish Civil War in 1936–1939, Agbar has been a private company as it still is in 2005. Thus, the entire network and all pumping stations, reservoirs and treatment plants are owned by it. Agbar grew with the city and connected villages (3.2 millions inhabitants). The City Council is, by Spanish law, ultimately responsible for the service and fixes tariffs and service conditions as a regulator, not as an owner. The Agbar company has various types of contracts also in other parts of Spain and abroad: private, delegated-managed, mixed companies, concessions, etc. (Molina 2003). In Venice, *Italy* Generale des Eaux held the concession for water supply for about a century, from the end of the 19th century to 1973 (Lobina 2003).

In *Portugal*, the *Companhia das Águas do Porto* of the second largest Portuguese city was municipalised in 1927. It was a long process, which started in 1920 with the creation of a committee to analyse the conditions of water supply in Oporto. In Lisbon, the process was very similar, but in the end municipalisation did not occur. The high cost of the compensation for dismantling the monopoly before the expiry of the contract was one of the reasons. Another one was the different situation in Oporto compared to Lisbon with regard to water supply. The situation in Oporto was worse as concerns both the quantity and the quality of the water provided. The French company invested very little in the waterworks, and its response to the difficulties generated by the war was lowering the quality of the service provided. In addition, the *Companhia das Águas de Lisboa* had a large number of mainly Portuguese stakeholders (da Silva 2002, 29).

A clear example of the limited competition in connection with re-tendering for long-term concessions is provided by the case of Aguas de Valencia in Spain. In 1902, the city of Valencia awarded a water concession to a private company, AVSA. The contract specified that the monopoly would last for 99 years. Thus, in the late 1990s, for the first time since 1902, the city of Valencia began to draw up tender documents. At this point AVSA, part of the SAUR-Bouygues multinational group, on advice of the international accounting firms Pricewaterhouse and Arthur Andersen, announced that if it lost the tender, it would demand a compensation of 54 million euros for investments it had made in the system (Expansion 2001). The invitations to tender contained a clause stating that the winner would have to pay 54 million euros to AVSA. Not surprisingly, there was not a single competing bid. AVSA, now in a joint venture with the council, will enjoy the concession for a further 50 years. In 2050, the city of Valencia will have had 150 years of private water monopoly without a single competitive bid (Alfonso 2001, 6). In Barcelona, Aguas de Barcelona has enjoyed an unbroken indefinite concession for 136 years, with no prospect of a competitive tender in the near future for the same reasons as in Valencia (Hall & Lobina 2004).

The US experience

In the USA the biggest cities usually owned the water works and were responsible for their operation at the end of the 19th century and in the beginning of the 20th century. Only a few of them had the engineers and expertise required for design and construction. Many cities hired consultants to make designs and supervise construction. Some engineers of the consulting companies later became city engineers and chiefs of public works while others designed and supervised construction works in different parts of the country (Keating 1989). This is an early example of public–private cooperation or, in fact partnership — although not in the same sense as somewhat misleadingly claimed by several current donors. In the western parts of the country, in California in particular, individuals and private companies took care of the provision of water services to a large extent. This situation lasted considerably longer on the west coast than in other parts of the country, until cities assumed the responsibility for provision of public water services. Public water systems were established primarily for irrigation — not for domestic water use (Keating 1989).

According to Melosi (2000, 74, 119–120), the water works was the first important public utility, and the first municipal service in the US, that demonstrated a city's commitment to growth. In 1830, some 20 per cent of the 45 water works were publicly owned and 80 per cent privately owned. The share of public water works increased gradually, being about 50 per cent in 1880 and 70 per cent in 1924. Melosi (1999) points out that US cities wanted to take the responsibility for public services for four main reasons. They wanted to look after their own interests (so-called home rule), and to direct the cash flow from the services to the city instead of giving money to the private sector. In the case of water and solid waste management services, cities considered that the safeguarding of hygienic and healthy conditions was their responsibility, and they did not have confidence in the private sector's ability to manage these affairs. The cities also considered the feedback from the customers regarding the quality of the services. Further, according to Melosi, the nature of the political system in the States explains the tendency to emphasise services owned by the public sector. Private sector involvement has been greater in solid waste management than in water and sewerage management.

Nordic experiences

In Tampere, *Finland*, the industrialist William von Nottbeck (1816–1890) offered to build a water pipe at the request of the municipal authorities in 1865. He proposed that a one-kilometre wooden pipe be constructed from the head of Tammerkoski Rapids to the Central Square at a cost of 7,500 silver roubles (105,000 euros in 2004). In his second proposal, a network covering the whole town would have cost 28,000 roubles (400,000 euros). He was then asked to submit his conditions for running the water supply. These conditions, consisting of ten paragraphs, can be summarised as follows: the industrialist would take the money and the town would take all the risks. Although the implementation of the plan might have been a considerable financial risk for the town, revenue from the planned water pipe would have been only a tiny fraction of the enormously rich aristocrat's income. His dividend income alone was in the six figures at that time. (Juuti & Katko 1998) The town decided, however, not to accept his tender and started developing the water works under municipal administration (Katko et al. 2002).

A similar proposal was made also in Sundsvall, *Sweden*, in 1874. The industrialist J.W. Bergström from Stockholm made an offer to build a water pipe for 250,000 rikstaler (5 million euros). The town, however, approached J.G. Richter from Gothenburg and asked him to submit a plan for both a water pipe and a sewer. In Linköping, another Swedish town, a private water system was constructed in the 1870s based on a 30-year concession. There may have been a few other similar arrangements in Swedish municipalities, but the works have for the most part been under municipal administration (Isgård 1998).

In 1866, a proposal for the establishment of Helsinki water works was made, originally at the request of the Senate. Yet, at that time municipal legislation made it too difficult to establish a municipal water and sewage works. Instead, tenders were requested for private concessions (Herranen 2001, p. 18). Later, the entrepreneur W.A. Åbegg made two separate proposals to implement the approved plan, and after lengthy negotiations the town signed a concession with Åbegg in 1871. He was also given a special permit to distribute water against payment. The concession was given for 75 years, but Åbegg withdrew from the project and sold the concession further to the Neptun Company from Berlin in the summer of 1872.

Under direction of the engineer Robert Huber (1844–1905), the new company started constructing the water works, but because of the Europe-wide recession, the project could not be completed within the agreed time (Norrmén 1979, 7; Turpeinen 1995, 223). Neptun had financial difficulties and had to stop water pipe construction in several towns including Helsinki, where construction halted almost completely in 1874. After long negotiations, the town bought back the concession, and the company made a commitment to finish the work (Waselius 1954, 25; Norrmén 1979, 8). After a transition period the town started operating and maintaining the system in the beginning of 1883 (Lillja 1938; Herranen 2001, 21–29).

Reintroduction of privatisation since 1989 in England and Wales

Until 1974, most water supply and all wastewater services were developed by local governments, with increasing support in the form of central government subsidies. During that time, there was no enforcement system to safeguard drinking water quality. In 1974, the UK Parliament decided to transfer the provision responsibility for water and sewage services in England and Wales from local authorities to regional water authorities (RWAs). The boundaries of these authorities were set in accordance with the watershed areas. The RWAs were owned and managed by boards nominated jointly by national and local governments (Summerton 1998; Gustafsson 2001). Twenty statutory private water supply companies, serving some 25 per cent of the population, were allowed to exist alongside the RWAs (Castro et al. 2003). Sewerage systems were still operated by local governments, but as agents of the RWAs.

During the oil crises of 1974 and 1979, the British government used the water sector as a macroeconomic regulatory instrument. In order to control public sector borrowing requirements, and to keep water charges low for political reasons, central government cut its financing to RWAs heavily. As a result, investments at the beginning of the 1980s were only one third of those at the beginning of the 1970s. This meant that the government overlooked the long-term environmental protection requirements while also disregarding the fact that Britain was about to join the European Union. It had actually promised to increase sector investments, which at the time of reorganisation were already barely enough to maintain the systems. As the WSS systems were very old, there was a desperate need for extra finance (Summerton 1998).

One of the key problems was that the central government did not give RWAs permission to borrow enough funds (Semple 1993). Thus, the main reason for the privatisation of water and sewerage, which happened with many other infrastructure services as well, was political and ideological. Okun, a “grand-old-man” in the water sector (1992, cited by Kubo 1994, 36), too, pointed out that an important factor leading to the privatisation was that the Thatcher Government limited the RWAs´ ability to borrow money for capital projects. Originally, the government owned the works completely. The companies were privatised by floating the majority of the shares in December 1989. The rest of the shares were sold through the stock exchange. French sector companies also own stakes in English and Welsh water companies. At the time of privatisation the decision was considered feasible by many, and as Bakker (2003, 9) notes *“few would have predicted that, within a decade, managers of more than one water company would be proposing a return to public ownership of assets”.*

The private companies reacted to the 1999 reduction of prices and, of expected profits, by cutting down investment programmes, reducing staff, and searching for alternative management models. At this stage, at least two of the ten water and sewerage companies presented plans for partial or total mutualisation and becoming not-for-profit operators (Castro et al. 2003). This was first proposed by the Kelda Group in Yorkshire, but OFWAT, the regulator, rejected the application mainly on technical grounds. Interestingly enough, Yorkshire Water promoted its mutualisation proposal as follows: *"Much of the debate over the water industry in recent years has its origins in public discontent with the concept of privatisation of this particular industry: the importance of clean water and efficient sewage disposal to the health and well-being of the community contribute to an intuitive feeling that these assets are more appropriately held in community ownership"* (Yorkshire Water 2000, cited by Bakker 2003, 10). This is quite close to what Bernard Wuolle stated in his presentation on the roles of municipalities and public services at the first Finnish Municipal Days in Helsinki in September 1912: *"Would it not, therefore, be better to reform legislation instead of encouraging a return to private enterprise even in sectors which are more naturally served by municipal utilities?"* (Hukka & Katko 2005).

Another quite similar proposal for mutualisation by Welsh Water (Glas Cymru) was, however, approved by OFWAT in July 2001 (OFWAT 2001, cited by Castro et al. 2003). This Welsh case represents the first serious departure from the model institutionalised in 1989 with full privatisation of the water industry.

Privatisation and regionalisation of water services in England and Wales are quite obviously linked to the relative long-term declining role of local authorities. Millward (2000) mentions that in the early 20th century a more regional focus for utilities became necessary — electricity grids and water basin development being the examples. This shift to a regional focus was one of the first steps in undermining the influence of local governments in the provision of utilities. One could, though, argue why were technical infrastructure services considered a whole instead of distinguishing between water resources management and water services as almost everywhere else. On the other hand, Okun (1977) considered the regional and river basin approach of England and Wales also highly positive in terms of water and sewerage services.

France

France has a particularly large number of small municipalities and a long tradition of private companies and municipal water and sewerage works competing for the production of WSS services. In 1990, there were about 37,000 municipalities and 14,000 independent water works (Morange 1993). Around 2000 there were some 16,000 water utilities and some 16,800 sewage utilities (Barraqué 2002). In France, the prevalence of private companies in the water and sewerage sector can be explained largely by the great number of municipalities.

In general, the municipality or a federation of municipalities has responsibility for the provision of the services. Municipalities also have the right to determine service charges independently, regardless of who the service producer is. The law allows municipalities to select their service production model (Haarmeyer 1994). A municipality or a federation of municipalities can produce the services or contract them out to private companies. Contracting out is very common — 45 million French citizens, or three quarters of the population, are supplied water on the basis of management or lease contracts (Beecher 1997). The share has almost doubled during the last 40 years. Water and sewerage works can be managed by any of the following options (Barraqué 2002, Morange 1993, Moss 2002): (i) Ordinary municipal works, (ii) Economically independent municipal works, (iii) Concession, (iv) Lease contract (*affermage*), (v) Management or service contract, (vi) Fixed management contract (gérance), (vii) Service contract based on results (*régie intéressée*) (viii) Public corporation under private status (*Société d'Economie Mixte*).

Concessions were widely used in France in the 1800s but are quite rare nowadays. On the other hand, French companies have increased the use of concession-type contracts in other countries (Barraqué 2002, Kraemer 1998). With regard to sewerage services, some 55 per cent of the population is served by public utilities (Barraqué 2002, Moss 2002). The relative share of private operators in service production has also grown. In any case, with as many small municipalities in France as noted above, it is practically impossible to have WSS utilities run by individual municipalities. In principle, French municipalities have the option of returning to municipal management, though many would question how realistic it is. According to Moss (2002), French government statistics show that the concessionaire has been changed in some 15 per cent of the cases, and in one per cent operations have reverted under direct municipal management. Desmars (2003) reports that more than 500 contracts expire annually. In some 20 per cent of the cases local councils study the possibility of reverting to public management, but only in one per cent a new "regie" is established.

The Netherlands

The history of water and sewerage works in the Netherlands can be divided into three stages:

(i) 1854–1920, when private companies operated the majority of the works;
(ii) 1921–1975, when the majority of the works were under municipal administration;
(iii) After 1976, when the works have been owned by municipalities and provincial governments, but have been managed quite autonomously according to com mercial principles (Blokland et al. 1999).

The number of water and sewerage companies peaked in 1938, after which it has constantly decreased. In 1957 a new water law was enacted, which required the establishment of larger companies. At the end of the 1990s there were about 30 companies. Some water and sewerage companies were merged with public energy utilities. Even if an energy utility were to be sold to a foreign company, water would remain public. The intention was to change these rules, but in September 1999 the Dutch government decided that water services will remain in public hands (Petrella 2001, 14).

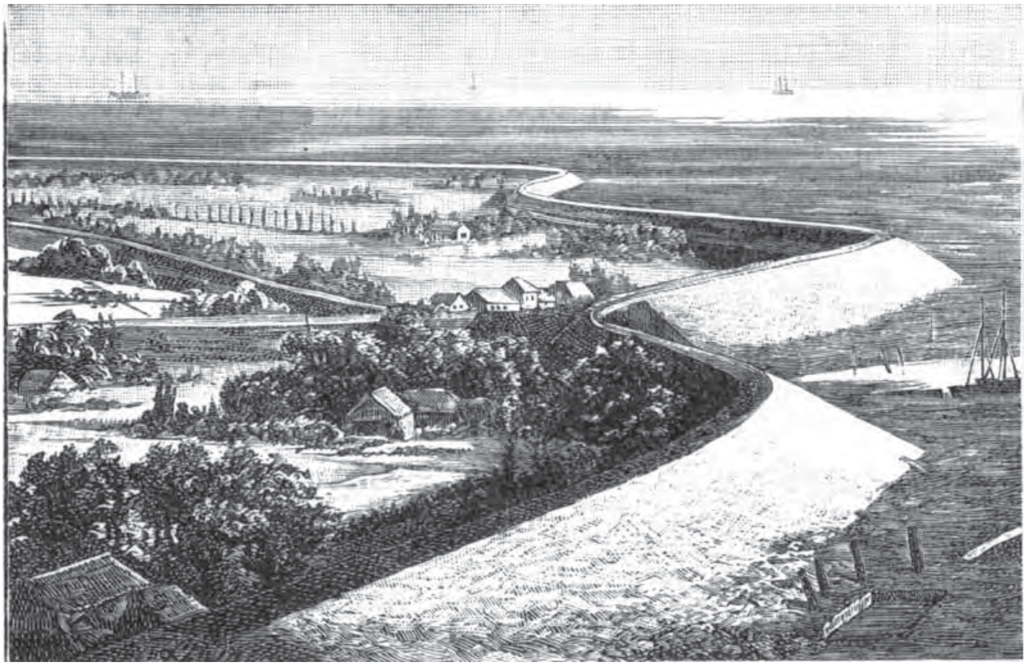


Plate 4. Illustration of a Dutch dyke from the late 1800s (Source: Topelius 1899)

Germany

In Germany, municipal enterprises have proved very successful in the late 20th century and the early 21st century, and it has been acknowledged that they have been managed according to sound business principles. About 6,000–7,000 small organisations, mostly municipal, supply the bulk of the water. Germany's Federal Environment Agency (FEA) has expressed its concerns about liberalisation of the water industry. It concluded that the current structure has guaranteed drinking water quality and has protected the environment. The report stated (Reina 2001): *"These accomplishments would be jeopardised if regional influence was to be reduced and the consumer's connection to 'his' waterworks was weakened by opening the market, which would further increase the rising costs of companies."*

In the 1990s, to some extent encouraged by the privatisation of WSS services in England and Wales, and particularly on the basis of the so-called "Washington consensus", international donors started to support concession and operational contracts — in practise the interests of multinational companies. Based on literature we can argue that this quite dramatic policy change was not based on evidence and experiences but rather on ideology as in the UK (e.g., Hukka & Katko 2000, Stiglitz 2002). Based on German experiences, Schramm (2004) points out how "the new debate on privatisation of the water infrastructure is led without historical consciousness". As for bilateral donors, it would be logical for them to first look at their own development experiences instead of promoting models that they have hardly any experiences of in their own countries. No wonder that the naive belief in the benefits of private concessions or long-term contracts in developing countries proved erroneous as noted, for instance, by a representative of a leading financial institution in 2003: "we and others largely overestimated what the private sector could and would do in difficult markets" (Anon 2003). Around the mid-1990s it was believed that private investments would increase substantially while the opposite has happened as is plain to see now. Thus, it looks that after a short period of experimentation, the real constraints related to such operations have become apparent. Comparative analyses of the EC funded PRINWASS research project — covering some 15 countries in Latin America, Africa and Europe — clearly support the need to recognise the importance of diversity and adaptation to local conditions of the institutional arrangements and policy options for WSS services (Vargas & Seppälä 2003).

Based on the US experiences, Melosi (2004) noted that cities are particularly wary of multinational companies that have no local ties but are the driving force of privatisation. Handing over control of water supplies and water delivery to the private sector is not the same as making a public good into a private one, but a "fundamental erosion of local authority well beyond more traditional tensions between city and region, city and state, and the city and the federal government". Jacobsen and Tarr (1996, cited by Melosi 2004) stated that "Although it is widely believed that today's movement toward privatisation represents a major shift from public to private supply of infrastructure, history provides examples of many shifts in both directions".

Urban environmental history also draws attention to the 'software' dimensions of environmental problems: "certain patterns of wasteful and inefficient resource use and pollution have developed as the result of social and cultural adaptations to historically new technologies" (Schott 2004). Thus, a combined approach, considering both the material infrastructure as well as the related manifestations in law, administration and urban culture is to be considered.

In any case, our historical and long-term experiences show that there are, on the one hand, obvious traditions of WSS services related largely to the role of local government and subsidiarity, and, on the other hand, external pressures that seem to completely ignore local conditions. In the following we will compare these trends with the actual findings on the case countries and cities.

Plate 5. A public well constructed in Vaasa, Finland in the late 1800s (Photo: P. Juuti, 2004)

Long-term strategic decisions in 13 countries and 29 cities

"Society, my dear, is like salt water,
good to swim in but hard to swallow"

Arthur Stringer

This chapter aims at describing the key strategic long-term decisions and episodes by country — first with regard to case countries and then by case cities. It should be noted that most available historical documents — books and articles — concentrate on describing the technological expansion of water supply and sanitation systems while much less attention is paid to various types of institutional changes. In reviewing the case studies this limitation has to be taken into account.

Estonia

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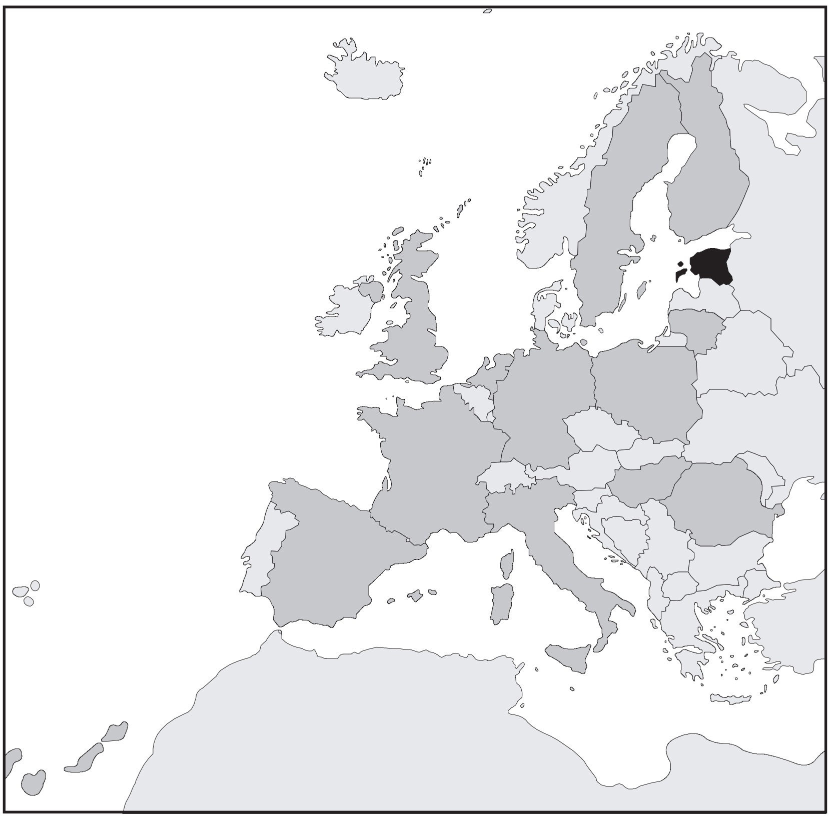

The overall development of Estonian water supply and sewerage services can be divided into several key periods:

(i) Early medieval systems;

(ii) Private concession in Tallinn from 1865 to 1881;

(iii) Establishment of municipal water and sewerage works till WW II;

(iv) State water companies till renewed independence in 1991;

(v) Development and reconstruction of municipal utilities, except in the case of Tallinn, which sold its company in 2000.

The overall development of water and sewerage services in Estonia is based on municipality-owned systems. Yet, the city of Tallinn let a concession for the operation of its water supply and gas services to a private party from 1865 to 1881.

During the Soviet occupation after WWII, which lasted until 1991, the WSS systems were nationalised and came under direct state control. Obviously the major bottleneck of the state-managed water period was that utilities did not have an economic incentive to improve their performance. Water was very lowly priced, if not free, as was energy. Just after the country regained independence in 1991, Lasnamägi, one of the biggest suburbs of blocks of flats, had an estimated specific water consumption of some 1,200 l/capita/day. Yet, some 90 per cent of this water was lost through leakages and the level of actual service was quite low.

After 1991, WSS utilities came once again under municipal administration. A more recent development is the privatisation of Tallinn water and sewage works in 1991 described below.

Tallinn

The history of the case city, Tallinn[1], dates back nearly 1000 years. The fortress on Toompea hill drew its water from wells, and the city grew slowly nearby. During the Middle Ages there were plenty of water sellers who drew water from wells and springs outside the city.

The city's population grew slowly: in the 1400s it was a little over 4,000. An open slate stone canal, which was later covered, was built from Lake Ülemiste to the city. At about the same time a pipe network of oak was laid in the city centre and remained in use for almost 400 years. The first mention of wooden sewer pipes was in 1422. The city was ravished by many great fires, the biggest of them in 1684, which destroyed most of the "upper town".

Near the fortress, in the upper town, there were twelve wells in 1822, originating from the Middle Ages. Yet, according to the opinion of specialists, these wells did not anymore yield ground water that time but collected possibly surface water. Wooden water pipes were later replaced by cast-iron pipes. The territory of the city expanded over the years, and people on the outskirts took their water from wells and from the river Härjapea, which started from Lake Ülemiste.

Plate 6. An old public well called "Rataskaev", well with windlass in Tallinn
(Photo: Kaljundi 1997, 6)

[1] This case is largely based on Sinirand (1992).

Table 3. Key long-term decisions on Tallinn water and sewerage services, 1841–2000

Year	Event	Reason	Outcome	Organisational change	Stakeholders
1841 – 1843	Council's decision to switch to cast-iron pipes. At the same time slate arched sewers constructed.	Wooden pipes didn't last long	Work was completed in 1860		Various groups among local councillors
1862	Council's 1st attempt to create a joint stock company to run the gas and water works		Not accomplished		
1864	Council signed a contract with Weir & Co (from Riga) to build a gas and water works	Medieval water supply system was inadequate	Pipelines completed in 1867. Seen as the start of the gas and water works system of Tallinn. Quality of water improved	Gas and water works, concession	Various groups among local councillors, private foreign company
1881	City council decided to take out a loan and buy the gas and waterworks, approved also the plans to reconstruct and expand the waterworks	It was estimated that city could itself run the finances of the gas and water works; intense growth of population	The renewed pipelines, pumping station and water tower were completed in 1883	City-owned waterworks	Local councillors
1898 – 1915	Numerous researches to increase the quality and quantity of water in Lake Ülemiste	During dry periods the water of the lake was insufficient for the needs of the city	In 1915 plans of water supply for the needs of 300,000 people – war prevented realisation		Local councillors
1924	Contract with British W. Paterson Engineering Co Ltd to design and build a water treatment plant	Quality of water was continuously poor	Water treatment plant completed in 1927 – "start" of the modern waterworks. Billing based on meters, rates were increased > consumption decreased		Local councillors, foreign contractor
1947 – 1950	Reconstruction of the water treatment plant.	Devastation of the war, increased population.	Increased population required operating plant at full capacity already during the year of completion.		State, various groups among local councillors

Year	Event	Reason	Outcome	Organisational change	Stakeholders
1960 – 1980's	Water treatment plant reconstructed and expanded several times	Population increased due to "Russification" by Soviet Union	Despite the efforts, quality of water got worse		State, various groups among local councillors
1997	Establishment of As Tallinna Vesi		City council's decision to sell 33% of share capital to a strategic investor, 1999		Various groups among local councillors, private companies
2000	City council's decision to sell majority of share capital and voting rights	Hoping to get private funding.		In December sold to United Utilities	Private company, city councillors

In the middle of the 19th century it was clear that the medieval water supply system was not sufficient for the needs of the growing city. The city government also decided that there was an urgent need for a gas and water facility. Eventually, the building of water supply started with the building of a cast-iron network of about ten kilometers from Lake Ülemiste to the old city (**Table 3**). In 1867 the newspaper Revalsche Zeitung wrote about the great pleasure brought by clean water.

In Estonia, Tallinn is an exception as concerns the general trend and early phases of the works in the 1800s. From 1865 to 1881 the city did business with a concessionaire (*Revaler Gesellschaft für Wasserleitung und Gasbeleuchtung*) after which the city assumed the major responsibility (Sinirand 1992, 33–34). In the outskirts of the town, city-dwellers did not have this luxury yet. At that stage there were about 20,000 city-dwellers, but the population was growing rapidly.

In 1883 a large network extension was completed and at the same time the network was divided into high and low pressure zones, and a pumping station and water tower were constructed. By 1905 the sewer network was extended to 46 km. At this stage the river Härjapea was polluted and this former source of water transformed into an open sewer canal. The city's wastewaters flowed to the Gulf of Finland through eight sewer canals.

At the beginning of the new century, the city's water supply and sanitation system was struggling with problems caused by rapid population growth. There were problems with water quality, pressure, and even quantity. In 1914 the city population was 150,000 and 80 per cent of them used piped water. City councillors ordered water supply and sanitation system plans to support the needs of a population of 300,000, but WWI interrupted these plans. Still, between 1883 and 1915 the water distribution network grew over threefold and connections over fivefold.

Estonia gained her independence in 1918. In Tallinn, a water treatment plant was completed by an English company in 1927. At the beginning there were problems with quantity because of the high water consumption (about 200 l/capita/day) — there was no metering at that stage. There were even plans for another water treatment plant, but city dwellers were instead obligated to get water meters after which consumption decreased rapidly. In the next decade growth was steady — estimated at two per cent. Until WWII population growth was surprisingly fast pushing the total above 200,000. Thus, it was time to start planning another water treatment plant.

The problems from the second half of the 19^{th} century to the end of the Soviet era were basically the same: firstly, the growth of the city outpaced the rate at which the authorities were able or willing to develop the water supply and sewerage works (especially in the 1920s the city's decision-making was lethargic) — naturally the size of required investments would also have been large. Secondly, water quality was continuously poor with the exception of a short period before WWII.

In terms of Estonian society and water services, WWII and the Soviet occupation represented monumental changes — until independence was regained in 1991. The population of Tallinn decreased during and after WWII, followed by growth till the 1970s, and a new decline in the 1990s after independence was regained.

After 1991 the Tallinn water and sewage works was rehabilitated and its management was improved mainly through twinning with the cities of Stockholm and Helsinki, supported by the Swedish and Finnish governments. However, in 2001 the city of Tallinn faced a dramatic change when it decided to sell 50.4 per cent of its water company to a foreign company. The discussion before and after the decision, as shown by the Tallinn case study in WaterTime's Work Package 2 (www.watertime.net), was largely based on the naive belief that by this arrangement the city would get funding through private sources more easily. Already by 2004 it was clear that this was not the case.

Had the City Fathers taken a longer term perspective, they might have arrived at a different conclusion than was the case in the early 1990s after independence was regained: it was believed that placing the water supply and sewage works in private hands would ensure its more efficient management. The conclusion was likely the result of traumas of the Soviet era — the guiding principle of the new prevailing policy was "less state" as well as other societal administration.

Plate 7. Paljassaare Wastewater Treatment Plant, Tallinn, Estonia (Photo: AS Tallinna Vesi)

FINLAND

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The overall development of Finnish water supply and sewerage services can be divided into the following key periods:

(i) Early discussions and proposals for private concessions until 1880;
(ii) Establishment of the first water supply and sewerage systems in the biggest cities, 1880 to 1917, as municipal departments and works;
(iii) Expansion of the systems and establishment of new ones, 1920 to 1940;
(iv) Reconstruction followed by major expansion of systems including stronger water pollution control measures, 1950 to 1980;
(v) Increasing autonomy, inter-municipal cooperation and outsourcing of non-core operations, 1980–2000.

In Finland, fire insurance companies have contributed significantly also towards the development of water services. Water has been needed for extinguishing fires as well as for domestic use which has motivated villages, municipalities, cities and fire insurance companies. At first, Finnish houses were insured, if at all, with the General Fire Insurance Fund in Stockholm. The "semi-official" Finnish Fire Insurance Bureau was established in 1809 with state support. The issue of fire insurance became increasingly topical immediately following the Great Fire of Turku in 1827.

The General Fire Assistance Company of the Grand Duchy of Finland was established in 1832. (Nikula 1972, Nuoreva 1980). Later on cities received funding from this company on good terms for establishing water works. The company operated under the Superintendent's Office with its domicile in Helsinki. It was a government body, not owned by cities. In 1858 the company was renamed the General Fire Assurance Company of Finnish Cities.

The Finnish Rural Fire Assurance Company was founded in 1857, while in 1871 the Finnish Cities' Fire Assurance Company was set up to insure chattels. In 1873 fire services became a municipal responsibility for good. In 1882 the Fennia Fire Insurance Company opened up for business and was the first in Finland to write industrial fire insurance. The above companies supported the acquisition of fire-fighting water and equipment in different ways.

The quite advantageous loan from the fire insurance company considering the prevailing interest rates (average about 6 per cent in the second half of the 19th century) played as large a role in financing the establishment of city water works as other forms of financing. Especially the taxes from spirits distilleries were of significance. In each locality a company was given the exclusive right to distill spirits against the payment of a liquor tax.

Normally a small amount of capital was raised over time for the establishment of a water works: about 10 per cent of the total required — through taxes and quite substantial donations and willed sums. Loans were also taken from local banks where necessary. A loan from the fire insurance company was nevertheless generally the largest single source of financing, and the interest charged was clearly lower than with other creditors.

House owners were solely responsible for sewerage until sewage works were set up. In exceptional cases, a city could implement some minor works in the core area. No wonder then that house owners eagerly supported the establishment of sewage works. They also bore the financial responsibility for street maintenance which made them support measures to improve the condition of streets such as putting in sewers. Waste disposal was also left to house owners which made them also favour municipal waste collection and disposal (Juuti 2001).

In Finland, a total of 16 urban water supply and sewerage systems were established by 1917 when the country gained full independence, after having been an autonomous Grand Duchy of Russia since 1809. The first one was established in the capital of Helsinki in 1876. In most cases water supply and sewerage systems were created simultaneously. **Table 4** shows a list of assessed key strategic decisions on Finnish WSS services from 1866 to 2002 as well as the related reasons and outcomes. The period divides into eight development phases: (i) Initiation; (ii) Emergence of first works; (iii) Diffusion phase; (iv) WWII; (v) Reconstruction; (vi) Rapid growth; (vii) Stable growth; and (viii) Recent and futures development (Katko 1997).

After the decision for municipal ownership and responsibility, some technology-related selections were made, including metering-based billing, ban on lead pipes, and the acceptance of flush toilets. Ground water was used initially, abandoned largely in the 1920s, and reintroduced gradually after WWII together with artificial recharge.

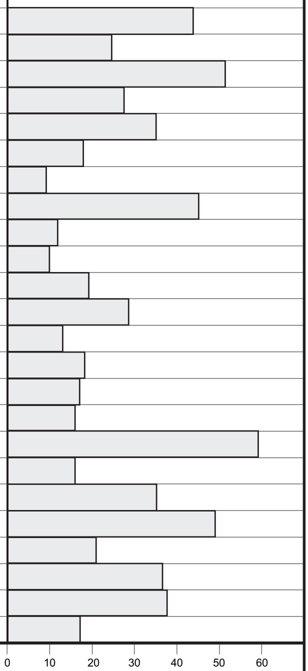
A few cities started wastewater treatment in the 1910s while the actual boom in modern wastewater treatment happened in the 1960s and 1970s, mainly due to Water Act that came into force in 1962. For the first time, this Act had the necessary legal enforcement and permit mechanisms to make communities start modern wastewater treatment and management. This was preceded by the introduction of separate sewers that made it technically feasible to treat wastewaters. Important social and political reforms such as municipal reforms and universal suffrage also certainly influenced sector development. Private companies offering sector goods and services have emerged gradually based on demand (Hukka & Katko 2003, 120). WSS exporting activities as well as related development cooperation started in the 1960s. Human resources development and sectoral associations have gradually developed alongside them.

Comments on **Table 4** by 13 sectoral experts showed that legislation and the various decrees and acts are considered very important as regards the overall development. Yet, it must be noted that compilation of a similar comparative table for other case countries would require major extra efforts and resources. Therefore, this country-specifc table is to be seen rather as an example of the key strategic decisions. Other countries, at least those outside the Nordic region, have experienced different development paths and decisions.

Table 4. Key strategic decisions on Finnish water supply and sanitation, 1866–2001

RANKING OF KEY STRATEGIC DECISIONS RELATED TO WSS DEVELOPMENT IN FINLAND, 1875-2001

YEAR	STRATEGIC EPISODE/DECISION	IMPORTANCE (N=13*)→
1875	LOCAL GOVERNMENT ACT	
1876	1ST URBAN WATER WORKS	
1879	HEALTH DEGREE	
1882	HELSINKI WATER WORKS BACK TO CITY-OWNERSHIP	
1890	BILLING BASED ON METERING ONLY, HELSINKI	
1890	USE OF LEAD PIPES FORBIDDEN	
1892	1ST GROUND WATER SYSTEM, VIBORG	
1900	WATER-BASED TOILETS ACCEPTED	
1902	WATER RIGHTS ACT	
1906	GENERAL & EQUAL RIGHT TO VOTE FOR PARLIAMENT	
1907	COOPERATIVE ACT	
1910	1ST WASTEWATER TREATMENT PLANTS	
1938	1ST SEPARATE SEWERS	
1951	1ST GOVERNMENTAL FINANCING ACT	
1954	START OF DOMESTIC PLASTIC PIPE MANUFACTURING	
1956	FIWA´S PREDECESSOR ESTABLISHED	
1962	WATER ACT	
1967	1ST PROFESSOR IN WATER SUPPLY AND SANITATION	
1970	WATER ADMINISTRATION	
1974	WASTEWATER SURCHARGE ACT	
1977	ACT ON PUBLIC WATER AND SEWERAGE SYSTEMS	
1995	FINLAND JOINED THE EU	
2000	ENVIRONMENTAL PROTECTION ACT	
2001	WATER SERVICES ACT	



* KEY DECISIONS FROM 10 TO 1; COMPILED BY TK; 27 JAN, 2004

Hämeenlinna

Table 5 summarises the key long-term events in Hämeenlinna[2]. After decades of discussions, the water works started to operate in 1910 using ground water. Yet, after WWII, a shift to surface water occurred — probably more due to fashion than actual need. In the 1970s surface water was abandoned and artificial recharge was introduced.

A sewerage system was completed concurrently with the water works in 1910. The system was planned with a possible future wastewater treatment plant in mind: all the main sewer lines led to the northern side of the city. A sewage pumping station and a pressurised sewer were also built. On its completion, the Hämeenlinna water and sewage works was the eighth such facility in the country. **Figure 7** shows the continuous expansion of water and sewerage networks in Hämeenlinna.

In addition to the urban water and sewage works, the Vuorentaa water supply association was established in Hämeenlinna rural district in 1921. A special feature of that association was that the municipality was also a stakeholder. The association served an elementary school and a few farmhouses. In 1973 the town's water works assumed responsibility for the association's system. A tradition of such consumer-managed water cooperatives in rural areas, mostly on a small scale, has existed in the country since the 1870s (Katko 1992).

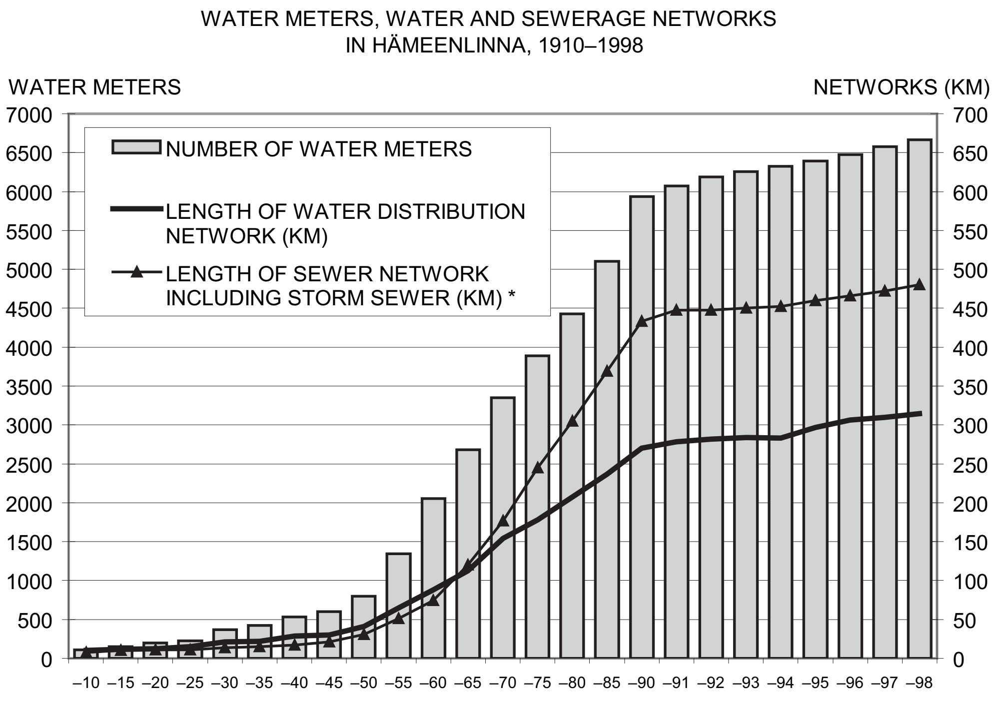


Figure 7. Evolution of water supply and sewerage in Hämeenlinna, 1910–1998

[2] This case is largely based on the book by Juuti et al. (2000)

Plate 8. Diver installing water intake pipe in icy Lake Katumajärvi in February 1955 in Hämeenlinna, Finland
(Photo: Hämeenlinna Regional Water and Sewage Company)

As for wastewater treatment in Hämeenlinna, a biological activated sludge plant was taken into use in 1966, followed by a biological-chemical process of simultaneous precipitation in 1974. This treatment, as well as the oxidation of ammonium nitrogen, began in Hämeenlinna in 1990 — quite early compared to other Finnish cities. One of the key long-term episodes, or chains of episodes, is linked to the gradually increasing cooperation between the neighbouring municipalities, both in water supply and sewerage services. In wastewater treatment this started in 1974. This development, for its part, resulted in the establishment of the supra-municipal water and wastewater company for Hämeenlinna and its neighbours in 2001.

Table 5. Key long-term decisions on Hämeenlinna water and sewerage services, 1869–2002

Year	Event	Reason	Outcome	Organisational change	Stakeholders
1869	1st City Police Order	Inadequate cleanliness	City's cleanliness improved		Various groups among local councillors
1882	1st Health Committee (board) meeting	Health Act of 1879	City takes control over environmental and health matters	Health Committee (board)	Various groups among local councillors
1889 and 1890	A. Bremer and Fr. Kiuttu's proposals for waterworks	Need of fire-fighting and household water, pollution and wastes control	Proposals postponed, several committees and small improvements	Several committees	Various groups among local councillors, experts
1908	H. Lilius' plan for water and sewerage systems	Need of fire-fighting and household water, health, pollution and wastes control	Modern waterworks in 1910	1st City Waterworks in 1910	Various groups among local councillors, city council, waterworks, consumers, experts
1910	Metering based billing				
1910	1st phase of sewers		Pollution of surface waters in the long run, better quality of city life in the short term		City council, experts
1953	Plan for surface water plant	Inadequate quantity	1955 Katuma plant, more capacity, used until 1980		City council, waterworks, experts
1966	1st wastewater treatment plant at Paroinen	Health and environmental aspects, Water Act of '61	Receiving WW from Hattula since 1974; from Renko municipality since 1993	Based on bilateral contract	City council, waterworks, consumers, the state, experts, Hämeenlinna, Hattula, Renko
1976	Alajärvi artificial recharge	Inadequate quantity	More capacity		Waterworks, experts
2001	Hämeenlinna Regional Water and Sewage Company	Foreseen benefits, favourable conditions	Inter-municipal services	Inter-municipal company	Several municipal councils, Reg. Env. Centre, Regional Council of Häme

Plate 9. Artificial recharge in Ahvenisto eskar area in Hämeenlinna, Finland (Photo: H-S. Helmisaari)

Tampere

Tampere[3] is currently the largest inland city in the Nordic countries and the traditional industrial centre of Finland. In many respects, this city represents the development of water supply and sanitation in the whole country. Along with industrialisation the city grew rapidly. The systems were established in Tampere quite early compared to other parts of Finland. As a big industrial city on the Nordic scale, Tampere also influenced the choices of other cities trying to solve their water problems. The first municipal "water pumping installation" in Tampere, and probably the whole country, was founded in 1835. The system was quite simple and was soon abandoned.

The evolution of sewerage began with free-flowing ditches leading from the northern parts of the old city to Lake Pyhäjärvi and the rapids. As years went by and Tampere grew, the ditches were straightened, opened and covered. These measures, however, proved to be insufficient and the dirt and filth continued to spread. **Figure 8** shows the continuous expansion of water networks in Tampere while **Table 6** presents the identified key long-term decisions in Tampere.

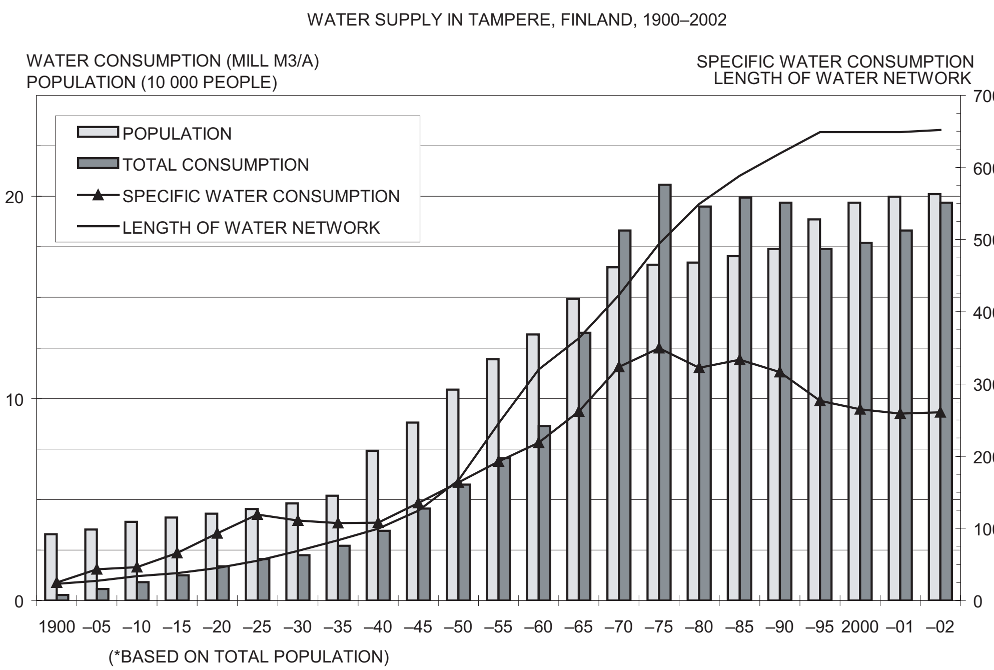


Figure 8. Evolution of water supply in Tampere, 1900–2002

[3] This case is largely based on the book by Juuti & Katko (1998).

Plate 10. Underground high-level water reservoir in the Pyynikki eskar in Tampere, Finland — constructed in 1898, still in use in 2005
(Photo: P. Juuti, 2005)

After rejecting two private proposals, the city assumed responsibility and at first had a low-pressure gravity water system constructed in 1882. This was followed by a high pressure system in 1898. Yet, this system lacked the proposed slow sand filtration, and partly due to this the city had a severe typhoid epidemic resulting in some 300 deaths in 1916. In 1917 chlorination was started, whereafter no typhus epidemics have occurred. During the typhoid epidemic, there were discussions about whether Tampere should begin to use ground water, which in terms of healthfulness and taste was better than the water of Lake Näsijärvi. Extensive ground water inventories were made but in 1920 the city council finally abandoned the plans for establishing a ground water intake. This decision probably also influenced the "city fathers" of other Finnish urban centres of that time. The share of ground water started to increase after WWII and constitutes currently about 40 per cent of total consumption in Tampere (Juuti & Katko 1998, 101–107; Juuti 2001, 190–194).

In spite of the typhoid epidemic, it was decided not to do anything about wastewater at that time: it was assumed that the Tammerkoski Rapids could purify it sufficiently. It was even believed that wastewaters from industries could be useful in eliminating typhus and would thus improve the health situation (Juuti 2001). The matter was taken up again only in the 1950s, and in 1962 the first wastewater treatment plant with an activated sludge process was completed in Rahola, for the western suburbs of the city. Yet, the city was among the last big cities in the country in introducing modern biological-chemical treatment of all its wastewaters in 1982.

Table 6. Key long-term decisions on Tampere water and sewerage services, 1835–2002

Year	Event	Reason	Outcome	Organisational change	Stakeholders
1835	1st municipal water pumping system	Lack of fire-fighting water and safe household water"	City's 1st action in this sector		Various groups among local councillors
1865	Private concession proposal by von Nottbeck is rejected	City would take risks and von Nottbeck earn a secure income	City decided to organise waterworks itself; City Health Committee in 1866	Several committees followed	Various groups among local councillors, City councillors
1874 1880	Too old-fashioned and too modern systems are rejected	Wooden gravity pipe seen as old-fashioned; high pressure system too expensive	Systems postponed		City councillors
1880	Modern system proposal by A. Ahlberg is rejected	Too modern and expensive,	Cheaper, but inadequate gravity system with low pressure in 1882, high pressure system chosen in 1895, in use in 1898, lack of SSF caused typhoid epidemic in 1915-16	1st City waterworks	City councillors, city council, experts
1887	Decision to construct major sewers	Economic resources available, land drainage for health reasons	Better quality of city life over short term		Local councillors, Health officers
1897	Metering based billing	Metering required at all connections	Over 90 per cent metered		City council, waterworks, consumers
1898	WC accepted	Easy way to solve excreta removal	Pollution of surface water, increasing no. of WCs		City council
1920	Ground water option rejected	Experts in conflict, mistrust of yield estimates	Kaupinoja surface water treatment plant, 1928; 1st GW plant in Mustalahti in 1950		Experts, local councillors, water works
1962	Rahola wastewater treatment plant	First proposal in 1921 rejected, quality problems with surface water, 1961 Water Act	1st wastewater treatment plant in the city, 2nd in Viinikanlahti in 1972, WW gradually from neighbouring municipalities		City council, experts, water works, several municipalities, consumers

Year	Event	Reason	Outcome	Organisational change	Stakeholders
2002	Tavase Ltd.	Better quality raw water (artificial recharge)	Regional bulk, joint-stock water supply company	New organisation	10 municipal~~city~~ councils, tech. committees and boards, one NGO, Reg. Env. Centre, Council of Tampere Region

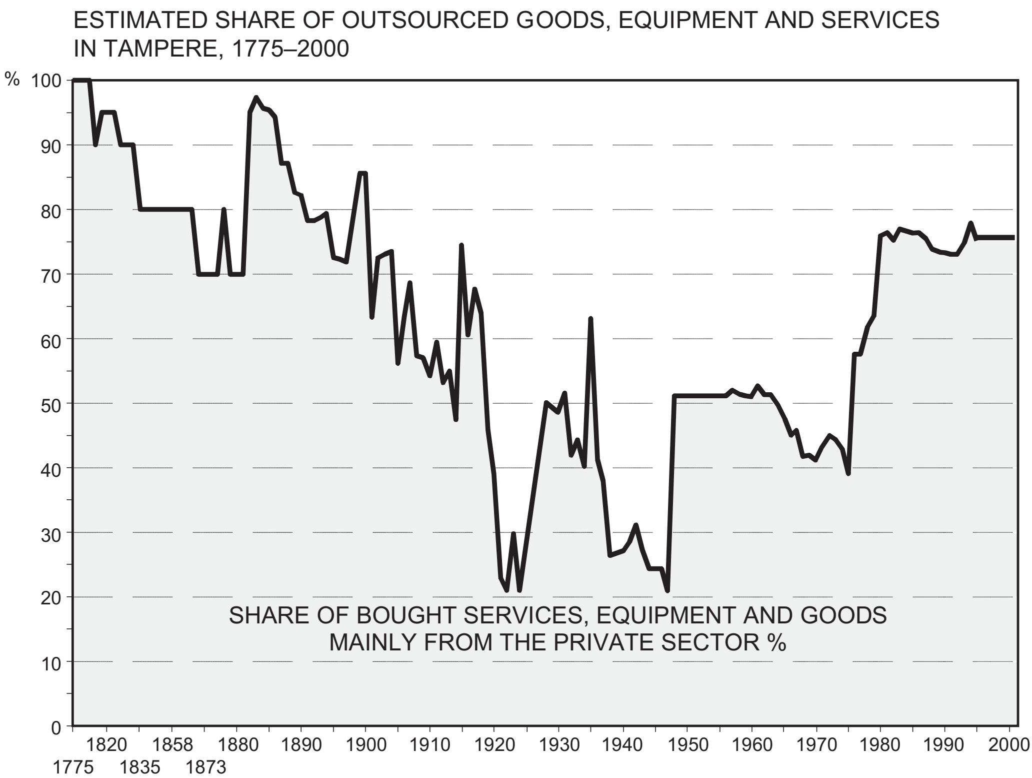


Figure 9. Rough estimate of the relative shares of public and private sector in terms of the services and goods produced in Tampere, 1775–1999 (compiled by P. Juuti 2004)

Plate 11. Water tower completed in th Tesoma suburb of Tampere, Finland in 1969 (Photo: P. Juuti, 2005)

After World War II, the water works grew rapidly. At the turn of the 1960s, the pollution of the raw water of the nearby lake by the forest industry became a concern. Lake Roine, situated in a neighbouring municipality, became the new source of raw water in 1972. It constituted at the time one of the best raw water basins in the country.

In 1973 the water and sewage works were merged as in many other cities in Finland those days. In the late 1970s the utility started to discharge and treat wastewaters from neighbouring municipalities as well as to sell and buy water on a contract basis with its neighbours. It is planned that by 2008 a regional wholesale water company will produce ground water through artificial recharge to serve the city and its neighbours. Thus the question of whether to use ground or surface water has been there for a century. Yet, each city and municipality wants to have its own water and sewage utilities for providing these services within their own boundaries. As for wastewaters, the long-term plan is to build a large centralised plant underground for treating wastewaters from several municipalities, possibly by 2015 or 2020.

Figure 9 shows a rough estimate of the share of annual money flows that have finally benefited either the public or the private sector as payment for services and goods. For most of the period since the late 1700s till 2000, the city boards or utilities in charge of water and sanitation services have bought a large share of their goods and services from the private sector or other city departments. Only from 1918 till 1946, in the inter-war period, the share of bought services remained considerably low which is explained by the relatively low investment rate at that time (Juuti 2004).

FRANCE

By Emanuele Lobina, PSIRU, University of Greenwich <E.Lobina@gre.ac.uk>

Pezon (2003) recognises the following three distinct regimes in the history of water management in France:

(i) The concession Period A (1848–1900): investment and operation were realised by private entrepreneurs while the connection rate remained very low;

(ii) The Régie Period B (1900–1970): investment and operation were realised by municipalities while the connection rate increased from 2 per cent in 1900 to 65 per cent in 1950 and 90 per cent in 1970;

(iii) The Affermage Period C (1970–2001): population supplied by the Regies de creased initially and at an accelerated rate after 1985 when large cities started switching from the Regie to Affermage.

As shown in the third chapter, the current policy has favoured increasing the share of affermage with private companies as operators instead of other options. In spite of this main trend since the mid-1980s, and the gradual relative increase of affermage, some "régie" (direct operation) systems seem to be still running well.

In Amiens, one hour from Paris, water and sewerage services are managed by a *régie simple* — a department of the city services without financial autonomy or legal standing. In addition, the "régie" takes care of storm water and maintenance of canals. Amiens also sells water to several communes and collects sewage from nine communes. Although several services in the city were given out to private management in 1989, it was decided to keep water services as "régie". According to Barraqué, de Gouvelle & Grand d'Esnon (2001), Amiens supplies good quality and sustainable water and sewerage services at a very reasonable price — using good accounting practices. Further, according to them, the key condition for success in Amiens has been the employees' qualifications and elected officials' awareness of water management being a long-term issue. This is not the case with cities, where mayors have favoured delegation to a private company. (Barraqué et al. 2001) As shown earlier, there are also other incentives for promoting the trend. Private companies could also get their VAT payments refunded until the 1990s (Barraqué 2005).

Grenoble

Decision making on water service provision since the late 19th century to the 1960s (**Table 7**) has been dominated by the imperative to secure sufficient supplies to a city in continuous expansion, both in terms of population and economic activity. In this sense, all decisions have focused on how to tap adequate water sources and manage demand.

As regards tapping water sources, a decision was made in 1882 to tap abundant and pure ground water from nearby mountains and the works were completed in 1884. Falling ground water levels due to over-abstraction and the construction of a dam for hydroelectric purposes, together with the occurrence of droughts in 1911 and 1921, required further action. The initial measures focused on demand management: introduced by municipal regulations in the late 1880s, metering became compulsory for all buildings worth more than 1,500 francs in 1930, and all fountains were equipped with taps. Efforts were also made to increase water abstraction capacity, and in 1947 a syndicate consisting of Grenoble and a number of neighbouring municipalities (called SIERG) was set up, which started to explore a number of technical alternatives including the use of surface water from a lake, at first, and later the construction of new wells for abstraction from another ground water reservoir.

Plate 12. Construction of a drain collector in the late 1800s in Grenoble, France (Photo: Régie des Eaux de Grenoble)

It was only six months later, in May 1948, that the commune of Grenoble decided to leave SIERG as it was not sufficiently represented in terms of voting power. In fact, Grenoble was by far the largest commune and, although it contributed 50 per cent of the investment finance, it was only entitled to express two votes like any other member of the syndicate.

Between 1965 and 1971, the municipality of Grenoble built three new wells which abstracted ground water from a reservoir already exploited. This solved the problem in terms of providing a sufficient supply for the city — the problem was rather the overcapacity of the plants. When the decision to introduce private sector operation, by delegating water supply under affermage contracts, was made in 1989, the infrastructure had been paid for almost entirely by consumers and taxpayers.

Plate 13. Welding a plastic sewer pipe in 2004 in Grenoble, France (Photo: Régie des Eaux de Grenoble)

Table 7. Key long-term decisions on Grenoble water and sewerage services

Year	Event	Reason	Outcome	Organisational change	Stakeholders
1882	Works	Need to tap adequate water sources and to manage demand	Tapping of abundant and pure ground water from nearby mountains		City councillors, city council, experts
1930	The adoption of metering became compulsory	Demand management	All buildings worth more than FF 1,500 and all fountains were equipped with taps		City councillors, city council, experts
1965 1971	Three new wells built to abstract ground water from a reservoir already exploited	Need of a sufficient supply for the city	The problem was solved		The municipality of Grenoble, SIERG
1985	Decision to award sanitation concession to Suez-Veolia joint venture SDA	Financial Ideology	Repeated renegotiation meant reduced private finance and increasing prices		
1989	Decision to award water supply concession to Suez	Bribery Fiscal inducement ("hidden taxation")	Price hikes with no sensible improvement in investment		
2000	Decision to remunicipalise water supply and partly remunicipalise sewerage operations	Excessive costs of private operations and lack of transparency	Improved service quality at relatively lower costs	Municipal enterprise set up in Grenoble, municipally-owned sewerage operations at inter-municipal level	Courts of justice, citizens' movements, political parties

It should be noted that from the late 19th century to 1971, decision making was dominated by technical considerations rather than ownership, the urban system remaining under municipal management until 1989. The possibility of creating an inter-municipal structure, always under public ownership but involving a plurality of municipalities, was entertained briefly due to the difficulties in creating a mutually satisfactory institutional framework. SIERG is still active to date, but Grenoble is not part of it.

In November 1989 the water supply and sanitation of Grenoble were delegated under affermage contracts to a subsidiary of Suez-Lyonnaise. The sanitation service in the region of greater Grenoble with a population of 372,500 was delegated earlier, in 1985, to a joint venture owned equally by Suez-Lyonnaise and Vivendi-GdE. Due to bribery and other problems, including inflated prices, less than transparent accounts and the dubious legality of past municipal decisions, the Grenoble city council finally decided in 2000 to terminate the private contracts and replace them (with one partial exception) by a municipal service through two new régies.

Although the Grenoble case might be unique, it exemplifies the problems that might be associated to private water operations. The case also shows the importance of the option of a public sector model, as a necessary condition for good decision-making in the public interest. In Grenoble, the legal and practical possibility of a municipal régie enabled the municipality after 10 years to choose a solution which was better than any negotiable with the multinational. The existence of alternatives is not, however, sufficient to guarantee that decisions are made in the public interest. This became apparent at the start of the sanitation concession in Grenoble, where a clearly advantageous public sector option was rejected in favour of a private concession. There also has to be a vigorous and transparent political process. When a decision to privatise was made in 1989, the infrastructure had already almost been paid for by consumers and taxpayers.

Germany

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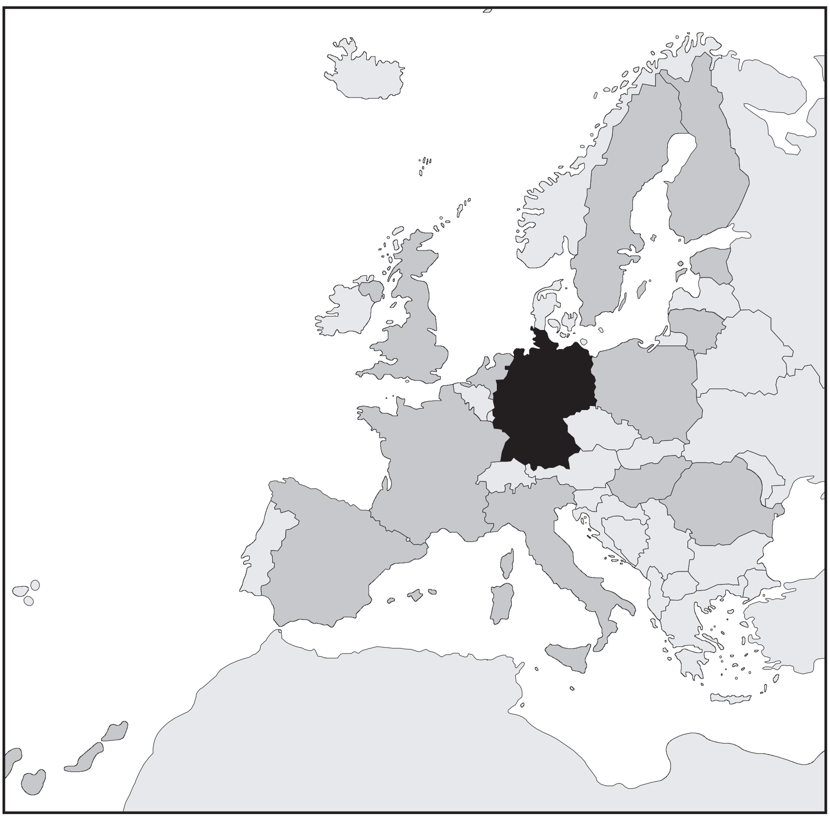


The history of urban water supply and wastewater collection and disposal systems in Germany reveals a variety of different development paths which are framed by the political and administrative history of the respective city. Generally, the higher the level of independent governance and administrative confidence of the city, the more concerted the planning and construction of centralised technical systems of water supply and disposal.

Until the second half of the 19th century, the necessity of a central system was not generally accepted. From the 1850s, however, cholera outbreaks in many German cities generated a general climate favourable to drastically improving water supply and sanitation. By about 1850, the majority of city dwellers in Germany relied on mostly shared dug wells close to their houses. Rivers were also an important source of drinking water in cities, but increasingly polluted. In low-lying cities with open canals such as Hamburg, people took water from these slow-flowing waterways or bought it from water vendors. Rich cities such as Nürnberg (Nuremberg) invested over the centuries into public fountains fed from peri-urban sources. People were allowed to fetch water from them although that was not the original rationale for constructing these ornamental fountains, but rather appearance and urban beautification. At the same time, virtually every city had separate water supply systems for the rich, the nobility and monasteries. They supplied a fair number of inhabitants with fresh water from outside the city, but were unaffordable to the general population.

The development of modern German water and wastewater services can be classified under four key periods:

(i) First concerted efforts to solve the urban drinking water crises;
(ii) Consolidation and extension from the 1880s to the 1930s;
(iii) Regional quality problems and river pollution (1950s onwards);
(iv) The 1990s and the discussion on liberalisation and privatisation.

The first period

Two main topics can be identified in the early discussions about urban water supply and sanitation: The choice of the best technical system and the problem of finance. Technical questions centred on two issues concerning wastewater disposal: a) should water closets (WCs) be allowed to be connected to sewers, and b) should wastewater be disposed of into rivers or sprinkled on fields. It was a heated debate which in some cities, such as Dresden and Munich, lasted for several decades. The lack of certainty about the cause of the repeated cholera outbreaks (which did not become clear until the 1890s) complicated the discussion considerably. In the end, all cities introduced WCs and connected them to the sewer system, while in terms of disposal, sprinkling remained in use until the end of the 20th century, especially where major rivers do not exist (e.g. Berlin, Braunschweig).

Finances were the other main issue because constructing a central supply and sewerage system was extremely expensive. However, most cities obviously never considered anything but taking on the task by themselves. In Hamburg there was a heated discussion on whether the system should be built and run by private companies or the city administration. A public system based on general taxes was strictly opposed by Hamburg's rich and influential merchants who were already well-supplied by their own private systems. The British engineer David Lindley, commissioned to devise the system for Hamburg, however, successfully argued for paramount public responsibility. The only city effectively entering into a private arrangement (temporarily) was Berlin.

The second period

In this period the development and extension of central water supply and wastewater systems was undertaken with what appears *remarkable foresight* and responsibility in the early 2000s. Master plans were devised for more than 50 years and followed through over the decades. Responsibility for drinking water and wastewater lay with the municipal administration, and planning, construction and operation were undertaken by civil servants. Cities with special water problems sometimes opted for cooperation with neighbouring municipalities. This is the origin for instance of Gelsenwasser, a co-operative of municipalities in North-Rhine–Westphalia, where local ground water is unavailable because of coal mining which had drastically lowered ground water levels. Gelsenwasser historically mainly organised joint construction of reservoirs in the nearby mountains.

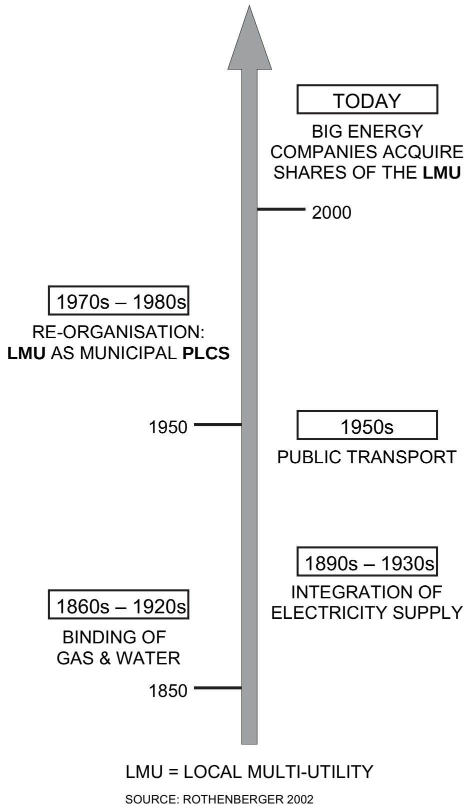
The third period

Once WSS systems were more or less completed by about 1950, the water resources of many cities were insufficient or of unreliable quality. A second wave of investment thus concentrated on improving the resource base. Many peri-urban wells were given up at that time and *long-distance* water transfers built, for instance, in most of Baden-Württemberg in the south. Other cities relied on ever deeper ground water wells, or on increased use of artificial infiltration (Hamburg, Berlin). It is probably the biggest failure of the otherwise very successful German water supply model that administrations and water companies, for at least two decades, failed to adequately protect water resources against industrial and agricultural pollution. It was not until the 1990s that the German Waterworks Association started supporting pollution prevention. Wastewater treatment plants were upgraded throughout the 1970s.

The fourth period

The discourse in the German water sector changed dramatically in the 1990s. While technical and quality issues had once prevailed, cost effectiveness and questions of private involvement dominated this period. Increasing focus on lowering the costs of water supply and wastewater disposal has the potential to endanger achieved service level and standards. In 2004 there were strong signs of under-investment in privately run water operations, but increasingly also in public enterprises. Quality control had been reduced to the legal minimum, investment in maintenance postponed, etc. At present, the German water sector is arguably experiencing its most dangerous technical, financial and strategic crisis since the beginning of central systems a century and a half ago.

Figure 10. Evolution of local multi-utility services in Germany (Rothenberger 2002)



The evolution of the Stadtwerke (local multi-utility, LMU) tradition of water supply, gas, electricity and district heating in Germany as seen by Rothenberger (2000) is shown in **Figure 10**. It also shows the development of drinking water operations in Germany from the beginning of centralised supply systems in the 19th century until 2002. Note that this LMU (Stadtwerke) approach was not adopted everywhere. Large supply areas such as Berlin and Hamburg and the region served by Gelsenwasser always ran drinking water supply as separate independent units. Note also that wastewater operations have not normally been integrated in LMUs.

Berlin

A private episode in the 19th century

Berlin is the most important example in Germany of early private involvement in the water sector (**Table 8**). In 1852, the city of Berlin awarded the British entrepreneurs and railway engineers Charles Fox and Thomas Russell Crampton the exclusive right to supply Berlin with water for 25 years until 1881. They founded the Berlin Water Works Company as a London based joint-stock company which undertook at its own cost the construction works until 1 July 1856. Water for flushing streets and fire fighting would have to be supplied to the city for free, but the investors were allowed to charge for private uses.

Plate 14. Fire-fighting in Berlin, Germany, illustration from 1727 (Photo: Bärthel 1997, p. 27; with the permission of Berlin Wasser)

Table 8. Key long-term decisions on Berlin water and sewerage services, 1835–2002

Year	Event	Reason	Outcome	Organisational change	Stakeholders
1852	Decision by Prussian government (police superintendent) to draw up a contract with English private company to supply water	Urgent need for water supply due to cholera outbreaks, yet no action by city administration	Waterworks facility goes into operation (1856)	London-based private company is set up (Berlin Waterworks Company)	Municipal government unwilling to invest in water infrastructure Prussian gov't, English entrepreneurs
1860	A municipal committee is set up to organise construction of a sewer system	Larger water quantities supplied to the city and use of WCs lead to overflowing gutters and heavy river pollution	Beginning of sewer construction (1873)	Part of municipal administration, private companies are rigorously excluded from construction works	Municipal administration Engineers Physicians
1873	City takes over water supply system from private company, several years before contract ended	Unsatisfactory water quantity and quality supplied by company, private company unwilling to build drainage system	High price paid for private system (double the investment), extension and operation of water system in public hands until 1999	From private management to management by public administration	Municipal gov't, German government (emperor) facilitating early cessation of contract
1874	Decision to spread waste-water on irrigation fields	The slow flowing rivers of Berlin did not allow direct discharge of waste-water (experience of a decade)	Purchase of extensive agricultural land and establishment of large irrigation fields (8,400 hectares in 1920)		Municipal administration Engineers Hygienists Physicians
1901	Decision to change water source from lakes to ground water	Pollution of lakes by waste-water disposal	Berlin drinking water almost entirely ground water (by 1910)		Municipal administration
1928	Decision to change from irrigation fields to waste-water treatment plants	Economic costs and surface area required made irrigation fields unfeasible	Two major treatment plants (activated sludge) had been completed by 1935		Municipal administration
1949	Decision to separate both water as well as waste-water operations in East and West Berlin	Separation of Germany and Berlin into two independent countries	Physical separation of drinking water supply completed in 1954; sewer system only partly separated		Municipal governments of East and West Berlin Allied (US, UK, F, SU) administrations

Year	Event	Reason	Outcome	Organisational change	Stakeholders
1988	Merger between water and waste-water branch in West Berlin	Synergies and joint responsibility for entire water cycle	New municipal utility with 3,250 employees (1990)	Combination of water and waste-water services	City council, Gas and waterworks,
1990	Decision to reunify water activities in East and West Berlin	Economic and political reasons	Joint municipal utility by 01.01.1992 (7,300 employees): BWB	Merger of two hitherto independent water and waste-water units in East and West	Municipal government (Senate)
1994	Change of legal form to public limited liability company (AdöR)	More operational independence to government, scope to enter international water business	Major investment in mostly unprofitable companies	Change of legal form	Municipal government (Senate) BWB management Berlin parliament
1999	Partial privatisation with RWE/Veolia as partners	City needed money for budget deficit, ideological reasons	Financially troubled water undertaking of doubtful water service performance	Full private management, sale of 49.9 per cent of assets	Municipal government Parliament MNCs Consultants

Source: Historical accounts from
Bärthel, Hilmar: Geklärt! 125 Jahre Berliner Stadtentwässerung. Berlin 2003.
Bärthel, Hilmar, Berliner Wasserbetriebe (Eds.): Wasser für Berlin. Berlin 1997.
Schramm, Engelbert: Private or public sponsorship of water infrastructure in the 19th century. Presentation at University of Graz, Austria, 2004. Http://www.ifz.tugraz.at/index_en.php/filemanager/download/318/Schramm_SA%202004.pdf

Earlier attempts to involve the city had failed. At the time, the mayor, while conceding that a central water supply may be a good idea, was unwilling to spend any money on such a plan. There was no consideration of the pros and cons of private involvement: if the city wanted a water supply system, regarded as indispensable for health reasons by the head of the administration, Polizeipräsident Hinckeldey, then it would have to involve private investors. Hinckeldey tried in vain to find German investors, but found several interested parties in England.

The water supply system that Fox and Crampton built was not intended in the first place to supply drinking water, but mainly for street cleaning and washing purposes. It distributed untreated water from the river Spree. The new water supply was not accepted by the inhabitants of Berlin, partly because of its doubtful quality, partly because many home-owners refused to pay for water. Not even the administration sought connections for public buildings. By 1857, one year after the inauguration of the supply, no more than 341 houses (314 private households) had been connected, and the Berlin Water Works Company failed to turn a profit. By 1862, still only 2,349 connections had been made. A few years later, the quality was improved by sand infiltration, and more households sought a connection. From about 1860, the administration and the mayor were unhappy with the services provided by the private company. Finally, after a chain of episodes, the city of Berlin acquired the Berlin Water Works Company in 1873, eight years before the intended end of the contract.

The case of West Berlin

A little known aspect of the water history of Berlin is the development after the separation of Berlin into three Western sectors (American, British and French making up West Berlin) and an Eastern, Russian sector (East Berlin) in 1949. The majority of the drinking water wells of Berlin were at that time located in the Russian sector, and 34.6 per cent of the water was 'exported' to the Western sectors. However, the Western water supply company was not willing to pay the price demanded for this water by the East Berlin authorities, and decided to disconnect the two pipe systems on Monday, 3 July 1950. For days on end, the population of West Berlin was cut off from a secure water supply, and several districts with several hundred thousand people were supplied from tankers located on squares. Even hospitals were left without water, and had to reactivate old wells nearby. Although warned by the East Berlin authorities about the potential problems of such a cut, the West Berlin waterworks believed they could supply West Berlin from their own wells.

Plate 15. Water main burst after an air raid on 3 January, 1945 in Berlin, Germany at the end of World War II
(Photo: Bärthel 1997, 188; with the permission of Berlin Wasser)

In the face of this catastrophic situation, negotiations were reopened immediately and an acceptable price soon found. Only three weeks later, on 25 July 1950, water supply from Eastern to Western sectors resumed. In the years to come, major infrastructure was installed in West Berlin to make the water supply independent of East Berlin waterworks, including a large ground water infiltration project at Lake Tegel. The main problem with this system is that Lake Tegel receives treated wastewater including hospital wastewater via a canal from the Northern districts of West Berlin. Due to its origins, this water contains highly mobile and soluble chemicals which cannot be completely removed from the drinking water.

After re-unification of Berlin in 1990, the two water supply and sewerage systems were re-connected, and the need to use the Lake Tegel infiltration plant ended. However, the plant is still running and supplying polluted drinking water due to financial reasons and a ground water-related levy.

Munich

Financing and organisation

It was only in 1883 that Munich started its own central water supply. There was apparently no discussion about private involvement. The city immediately created two new departments under the construction department, one responsible for 'supply', one for 'abstraction'. Much of the construction work was undertaken by the city itself.

In 1875, the city of Munich hired British engineer J. Gordon to devise a package solution for urban drainage and wastewater disposal using the Frankfurt model. The first 25 kilometres were built by 1885, with the Frankfurt-based construction firm Philipp Holzmann mainly responsible for the works. According to the contract, the construction firms were responsible for the sewers, including eventual damage during construction to buildings and existing underground infrastructure, e.g. drainage, water and gas pipes. Critical steps such as the mixing of cement and the watering of bricks for sewer construction were tasks reserved for municipal workers to maintain the highest building standards.

In 1885, the city decided, mainly on financial grounds, to drop Gordon. The magistrate (city parliament) felt that the city's public servants had by then acquired enough

Plate 16. Sammelstollen, one of the "well collecting chutes" driven in the slopes in Gotzing/Mangfalltal, built between 1902 and 1913 and serving Munich, Germany. From the slits in the walls the water gets in the chute, with the total length of 4.2 km (Photo: Courtesy of SWM, Munich)

knowledge to undertake sewer construction by themselves. Thus a new city depart 'urban drainage' was founded, and a public servant engineer given the responsibility for planning, construction, operation and maintenance of the sewer system (**Table 9**).

Most of the discussions concerning water and wastewater revolved around technical issues. In terms of drinking water, there was a lengthy debate in the 1880s about the best-quality and most reliable source. In terms of wastewater, the question of connection of WCs to the sewer system was debated heatedly for over 30 years (Baureferat der Landeshauptstadt 1985; Stadtwerke München, Wasserwerke 1983).

There are two major publications covering the historical periods from the beginning of the city to 1983, the year marking the 100th anniversary of water supply and municipal sanitation in Munich. However, these publications lack sufficient detail mainly on the question of financing. Ownership issues were never a topic until the 1990s.

The first mechanical treatment (rake and grit chamber) at the Munich Großlappen plant, with 2 million people treatment capacity in 2003, was completed in 1926. Soon thereafter, large fish ponds were added to provide 'biological' treatment. By 1926 more than 80 per cent of the population were connected to sewerage and the wastewater treatment plant. Some 60 per cent of the scheme was financed and owned by a related hydropower company, though the plant was taken over by the city in 1931. The ponds still exist, but now located in a migratory bird preserve. Yet, the Großlappen plant effluent is still used for the hydraulic supply of these ponds (Stegmayer 2005).

Plate 17. Aerial view of the sludge treatment at the wastewater treatment plant of "Gut Marienhof" constructed from 1986 to 1989 in Munich, Germany — foreground six covered sludge thickeners, in the background three anaerobic digesters, and on the right edge gas storage tank. The plant has one million people equivalent treatment capacity
(Photo: Munich Municipal Wastewater Works, 2003)

Table 9. Key long-term decisions on Munich water and sewerage services, 1835–2002

Year	Event	Reason	Outcome	Organisational change	Stakeholders
1855 (waste-water)	City ordered by regional government to organise a systematic drainage system	Cholera outbreak in 1854 with 2,936 dead, amongst them the wife of King Ludwig I of Bavaria			Regierung Oberbayern
1874 (water)	Decision by city magistrate to investigate a potential change of water supply to better quality and a more reliable water source	Unsatisfactory quality and low reliability of water supply in times of drought	Improved water supply from Mangfalltal (alpine region to the South) goes into operation (24.04.1883). Fierce opposition in Mangfalltal against ground water abstraction	Setting up of two distinct municipal authorities to organise water supply (infrastructure, pipes) and abstraction	Municipal government Physicians Scientists Engineers Mangfalltal property owners
1875 (waste-water)	British engineer J. Gordon commissioned to draw up plan for drainage system	Renewed cholera outbreak in 1874 with almost 1,500 killed	After fierce debate about whether WCs should be connected to sewers, first section of Gordon's system (incl. WC) is built (1881–1885)		Municipal government and administration Hygienists/doctors Gordon (engineer)
1883 (water)	Decision to set up unit for water meter maintenance	Siemens water meters had been introduced already in 1850/52	Water is charged by measured consumption		Municipal administration
1885 (waste-water)	Decision to establish an "urban drainage unit" in the municipal administration	Task to construct a city-wide system was considered to require concerted municipal supervision	City employs an engineer as first head of "urban drainage" (Stadtentwässerung) unit		Municipal government Municipal administration
1908 (water)	New Bavarian water law stipulates that water abstractions are subject to authorisation	More administrative control to prevent excessive ground water abstractions	Immediately, property owners in Mangfalltal use the new law to sue the city of Munich. Finally, courts decide that city may continue using the ground water		Mangfalltal property owners Municipal administration of Munich Bavarian government
1910 (water)	Decision to combine water supply and abstraction units into one common authority	Need to improve performance and to take responsibility for entire water cycle		One municipal water supply authority formed as unit of the works department	Municipal administration

Year	Event	Reason	Outcome	Organisational change	Stakeholders
1920s (waste-water)	Decision to install waste-water treatment	Severe pollution problems in river Isar whose quality is too bad for some industrial uses	Completion of first mechanical treatment plant with biological treatment in fish ponds (1926)		Municipal administration Water authorities of Bavaria
1937/38 (water)	Decision to remove utilities from direct municipal management		Water (and gas) supply units become municipal utilities, each a financially independent company		Municipal administration
1970s (waste-water)	Decision to construct stormwater retention basins	During rains, increased water flows caused sewers to overflow into rivers, leading to severe river pollution	Huge investments in the construction of underground stormwater basins in the 1970s and 1980s		Municipal administration Water authorities
1976 (water)	Major reorganisation of Munich water works	Preparatory step for incorporation of water supply company into Stadtwerke	The sub-units for abstraction and distribution are restructured, with two new sub-units for construction and operations/ maintenance (each responsible for the entire system).	Major shift of responsibilities: all non-technical units (finances, administration) were transferred from the water utility under a general directorate of municipal utilities	Municipal administration

Source: Historical accounts from
Stadtentwässerungswerke München (Eds.): 100 Jahre Stadtentwässerung München. München 1985.
Stadtwerke München (Eds.): Hundert Jahre Münchner Wasserversorgung. München 1983.
Website Stadtwerke München www.swm.de
Schramm, Engelbert: Private or public sponsorship of water infrastructure in the 19th century. Presentation at University of Graz, Austria, 2004. http://www.ifz.tugraz.at/index_en.php/filemanager/download/318/Schramm_SA%202004.pdf

The first activated sludge basins of the Großlappen plant were built in the late 1950s. Since then it has been continuously expanded, and the year 2008 will see the startup of a final sand-filter with simultaneous denitrification. In the late 1980s a second plant with 1,000,000 people treatment capacity was built at another site, which received a final sand-filter with simultaneous denitrification in the late 1990s and will start ultra violet disinfection in 2005. These two plants do not only treat all of Munich's waste water, but also the majority of the precipitation waters in the Munich area (Stegmayer 2005).

Hungary

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The key long-term phases of WSS development in Hungary[4] can be classified as follows:

(i) City-owned water and sewerage systems since the 1880s utilising foreign private sector services;
(ii) Nationalised water sector under the sole responsibility of the state, 1948–1990;
(iii) Municipalities in charge of water supply since 1990 and of sewerage since 2001.

The Romans brought the culture of water supply networks, canalisation (originally meaning drainage, later also often used for sewerage — editors' note) and baths to Hungary. In the 3rd century, water-based toilets were installed in a few public and upper class private houses. Sewage and rainfall were collected and led to the Danube. In the mid-1800s the 'English toilet' — water closet — was introduced. In 1885 the first water act was passed prohibiting the contamination of waters. It had provisions on the various obligations of landowners related to network developing including sewerage and water supply. It defined public and private waterworks. The act was the basis for several local ordinances. Network development was mainly left to municipalities. However, the assistance of the central government was needed in several instances, especially when local financial resources were not sufficient. At the time the local municipality set the price of water.

It was common that the city prepared tenders for planning and building water and sewage networks. Especially during the 19th century foreign engineers (mainly British) submitted and won tenders in Hungary, for instance, in Budapest. It was also common that canalisation was an urgent need and a tool to stop epidemics, while it meant collecting the sewage and then discharging it untreated into rivers.

In 1948 nationalisation of the water sector took place under the influence of the Soviet Union. Ownership of the systems was seized by the State, while municipalities continued to operate them. The new Water Act based on state ownership was passed in 1964. While before the war there was no significant difference in coverage between the water supply network and sewerage (22 per cent and 17 per cent, respectively), the development of the networks between 1950 and 1970 generated the so-called 'utility gap' where 55 per cent of the households were connected to water supply but only 28 per cent to the sewerage system.

After the collapse of the Soviet Union in 1991, the water utilities were handed over to municipalities. The Act on municipalities provided that it is the legal responsibility and a compulsory duty of the municipality to provide healthy drinking water, but not until 2001 did sanitation also become compulsory. In 1991 municipalities could gain ownership over the water system within their territory. Based on 1995 statistics, 98 per cent of the population and 90 per cent of the households were connected to a water supply network, while the figures for sewerage were only 57 per cent and 44 per cent, respectively, and only about 46 per cent of sewage was treated in some way. By 2002 the utility gap had narrowed: 56 per cent of the households were connected to the sewerage system, while 65 per cent of the sewage collected through the network was treated mechanically and 61 per cent biologically.

[4] Based on the information available from Emil Sali: Budapest közműrendszerei (www.epa.oszk.hu), reports of the State Audit Office (www.asz.hu) and the year books of the Central Statistical Office.
For the casematerial, thanks to all the anonym people who wrote the history of the utilities for the websites.

Budapest

Budapest[5] is the capital of Hungary which was established in December 22, 1872 by joining three settlements: the hilly Buda and Óbuda on the right bank, and the flat Pest on the left bank of the Danube. The population at that time was 300,000 people, while in the early 2000s there are about two million people living in Budapest. During the Roman Empire there were pipelines for water supply, canals and baths.

The need for healthy drinking water was pronounced in the 1800s (**Table 10**). That was also when geological investigations proved that the natural gravel layers along the banks of the Danube provided natural filtration for producing drinking water. Budapest has mainly two water sources: one on the northern and one on the southern bank of the Danube. Also, due to the high level of ground water, lack of sewage canals, rainfall and bad quality drinking water caused frequent epidemics, such as cholera and typhoid. The canalisation of Budapest started at the beginning of the 19th century on the Pest side. After the 1838 great flood of the Danube the works were accelerated, because despite flood control the canals led the water to the town through the underground system causing great damage. It happened later again, but only on the Buda side.

The first engineers and entrepreneurs who developed plans for the canalisation and water pipelines for the whole city were British (Sir Orton Peto and Bazalgette). The first water pipeline network was finished in Pest in 1868 based on the plans of William Lindley. The city council put the plans, and later also the works to tender, and the best bid won. In 1875 British, French and Hungarian engineers were participating in the 'competition'.

The first local ordinance on sewerage was passed in 1847. Legal rights were established in relation to public and private sewers, the costs of using the sewers, the legal obligation to connect to the sewer, etc. The city council supervised the works.

In Budapest both systems were developed continuously. The first permanent 'Waterworks-wells', were dug wells. Still in operation in the early 2000s, they were built on the Káposztásmegyer bank side, and later at the southern end of the Szentendre Island at the turn of the 20th century. In the first dug wells the water was collected by a perforated cast iron bell (up to 3 m or greater in diameter) submerged to the appropriate depth, and was then siphoned from one well to the other by a siphon pipe. Where the natural gravel layers were very thin, mainly on the western banks of the Szentendre Island, water was extracted through lines of drilled, vertical wells (about 300 mm in diameter). That was followed by the use of horizontal filtering wells in the 1940s. Horizontal filtering wells were built with reinforced steel concrete shafts of 5 m diameter, from which a 7 mm diameter filter pipe was drilled horizontally parallel to the river bank.

[5] Based on the information available on the website (www.fcsm.hu, www.vizmuvek.hu) and the reports of the Budapest Sewage Works, Budapest Waterworks, Emil Sali: Budapest közműrendszerei (www.epa.oszk.hu), reports of the State Audit Office (www.asz.hu) and the year books of the Central Statistical Office.

Table 10. Key long-term decisions on Budapest water and sewerage services, early 1800s–2004

Year	Event	Reason	Outcome	Organisational change	Stakeholders
Early 1800s	Geological investigation for water resources	Need for healthy drinking water	Natural gravel layers filtered good quality drinking water		City council, experts
1838/47	Canalisation accelerated	Great flood caused health hazard	New canalisation policy, first local ordinance on sewerage	Simultaneous public and private sewers	City council, landowners
1868	First water supply network planned for the whole city	Increasing demand for healthy drinking water at HHs.	First network finished and started operation	Municipal operation	City council, foreign engineers (British, French)
Turn of the 20th century	Network expansion, water and sewers	Increasing demand	First dug wells, then vertical drilled wells, then horizontal filtering wells		City council, companies, landowners, HHs
1949/50	Nationalisation and integration of the systems	Change in the political system, legislation	State ownership of the network, municipal operation, integration of district systems into one	State ownership of the network, municipal operation	State, city council, waterworks
1960s – 1990s	Use of surface water	Increasing demand for drinking water, new technologies	The use of surface water was abandoned by the 1990s due to high cost		City council, state financing, company, industry
1966, 1986	Sewage treatment	Untreated sewage represented environmental hazard to the Danube	Sewage treatment plants established, but with inadequate capacity, first with 20%, then about 50% of the sewage	Operation of the new facility	City council, company, state financing, landowners
1992/93	Ownership transfer from state to municipal and new legal status	Political change and legislation	State ownership becomes municipal	The companies became share-holding companies	City council, state, trade-unions, employees forum
1997	privatisation	Lack of financial resources	New organisational and operational structure, PPP, in ownership of the network and the operating company	Emergence of PPP	City council, MNC, trade-union, employees forum, political parties
1994 – 2004	Plans on sewage treatment and capacity increase	Inadequate sewage treatment, and capacity for it, environmental legislation	Concrete investment plans and future establishment of a modern WWTP	New facility shall be operated	City council, MNC, company

Plate 18. Water tower on Margaret Island in Budapest, Hungary, constructed in 1911 and designed by Szilárd Zielinski. (Photo: Zsigmond Vízy, Hungarian Museum of Water Administration, Archive and Library, 2003).

In 1946 the Budapest Canal Works was established for sewerage, and in 1950 the autonomous districts of Budapest were united and the Budapest Water Works took over all the establishments and created an integrated system of the water systems for water supply. Following the nationalisation of the water systems, the operation of the services in Budapest stayed in the hands of municipal companies.

The southern water sources were used from 1948. In the 1950s a new patent was obtained for the so-called "Dwarf" horizontal wells. In the 1960s surface water was introduced. However the high costs of artificial treatment and the still bad taste and odour led to abandoning its use in the 1990s.

The first sewage treatment plant started operation in 1966 serving the southern parts of Budapest, followed by the second in 1986 for the northern parts.

In 1992/1993 state ownership of the network was transferred to the municipality. It formed two share-holding companies and gave ownership of the entire water and sewage networks to the two separate companies: in January 1994 and in December 1993, respectively. In 1997 some 25 per cent of the shares plus one were bought by private investors, multinational companies under two different consortia. This introduced private ownership to the network and the operating company as well. However, the new trend in network development is municipal ownership, and therefore both kinds of networks are owned partly by private companies and partly by municipalities.

The so-called utility gap has never been pronounced in Budapest. For example, in 1990 the ratio of sewage network connections to water network connections was 86.7 per cent there, while it was less than 30 percent in most of the counties.

Based on 1995 statistics, 99 per cent of the households were connected to the water supply network, while the figure for sewerage was 90 per cent — and only about 20 percent was treated mechanically, the rest was discharged into the Danube untreated. By 2003 about 93 per cent of the sewage was collected, but the total treated volume was still around 40–45 per cent, while about 50 per cent of the sewage was discharged into the Danube untreated. Between 1997 and 2001 new facilities were established and modernisation of technology occurred in the southern sewage treatment plant. The Northern sewage treatment plant has been modernized. Sewage treatment will be solved by a new modern treatment plant. According to the plans it will start to operate by 2008 and 90 per cent of the sewage will be treated as a result of its operation.

Plate 19. Flooding in the city of Budapest, Hungary in August of 2002 (Photo: Simon Forstner, Hungarian Museum of Water Administration).

Debrecen

Debrecen[6] is one of the biggest cities in Hungary. It is situated in the northeastern part of the Great Plain with no surface water available in its vicinity. For hundreds of years the lack of good quality potable water represented health hazards to the population. There were two kinds of wells: the 'good wells' giving good quality water, and the 'bad wells' with bad quality water. Around 1820 debates and negotiations about solving the problem with drinking water started as well as about the need for canalisation of the city (**Table 11**). They were needed basically for three reasons: hygienic, fire fighting and lung-disease prevention. The lack of canalisation represented a real health hazard, without water for the extinction of fires the risk of fire damage was high, and without water to keep dust out of the air deaths from lung-related diseases were higher compared to other major cities. The work was done based on Hungarian engineers' plans.

In Debrecen the wastewater system preceded the establishment of the water supply network. The actual work was put to tender. By 1826 the city had a connected sewer system. The system was planned based on natural water flows. In 1911 the second phase of canalisation took place. The city ordinance on sewers was passed in 1914. It provided for the rights and obligations of the land owners, established provisions on connections and fees for using the system, etc.

By 1830s artesian wells were drilled (100–837 m) based on the plans and work of Vilmos Zsigmondy. By 1896 the number of artesian wells was 1,200. In 1893 the city council had decided to establish the central waterworks, while the actual operation of the waterworks did not start until 1913. A city ordinance of 1914 was passed establishing the rights and obligations of households related to water supply. People could take water free of charge from public wells, however, if they used the network then a price had to be paid based on metering.

The plan for the first sewage treatment plant was accepted in 1924 and it started operation in 1931 with a mechanical cleaning system. In 1934 the city council considered establishing a new modern treatment plant for biological treatment, as well. They studied the Hungarian modern treatment plants, as well as those of five German cities: Nürnberg, München, Strasbourg, Hattingen and Iserlohn. The last one was the size of Debrecen with similar demand and capacities. They compared operational costs and as it turned out that the costs in Debrecen would be much higher than in Iserlohn, the city gave up on the plans.

After World War I the management of the water supply system was handed over to the Lighting Company in 1923 due to a government order on reducing the number of employees. There had been some problems with the quality of water. It turned out that there was a limit to the exploitation of artesian wells. While the number of Debrecen's population had been continuously increasing, the supply of water was limited. New sources had to be found. The new dug wells had some quality problems. From 1916

[6] Based on the information available on the website (www.debreceni-vizmu.hu) and the reports of the Debrecen Waterworks, Gábor Gulyás: otthon Debrecenben 1998-2002, Debrecen 2002, reports of the State Audit Office (www.asz.hu) and the year books of the Central Statistical Office.

Table 11. Key long-term decisions on Debrecen water and sewerage services, 1826–2004

Year	Event	Reason	Outcome	Organisational change	Stakeholders
1826	Canalisation programme	Sewage represented health hazard	First sewers		City council, landowners
1820 – 1830s	Water resource research	Need for healthy drinking water (hygiene); lung disease resulting from uncovered roads, fire extinction	Artesian wells drilled		City council, land owners, engineers
1913	Metered water supply from network	Population growth and demand for healthy drinking water by HHs	Central waterworks established First local ordinance on supply	Network development in municipal hands	City council, HHs
1914/ 1931	Billed sewerage and further sewers development, also WWT	Mainly health reasons, the sewage had to be collected	First city ordinance on sewerage, and first treatment plan introduced		City council, landowners,
1916/ 1931	Increased demand for water supply	The demand for drinking water increased due to population growth	Investigation for further resources and quality improvement, introduction of new technologies	Management by lighting company in 1923	City council, HHs, waterworks, Berlin laboratory
1949	Nationalisation	Change in the political system, legislation	State ownership of the network, municipal operation		State, city council, waterworks
1960 – 1970	Use of surface water	Population growth, industry demand	Water supplied partly from the East-Main-Canal	State financed new facility	City council, HHs, industry, state
1981 – 1983	Sewage treatment plans	Need for increased sewage treatment capacity	Operation of new sewage treatment plans	Operation of the plants	City council, state, HHs, industry
1994/ 2004	Sewers development and WWT modernisation, capacity increase	So-called utility gap was large, environmental legislation	Significant increase in length of sewers, and number of connections	Operation of new facilities	City council, financial institutions, water company, landowners
1992/ 1995/ 2000	Ownership change	Legislation and economic rationalisation	In 1992 ownership transferred from state to municipality, municipality established the company as a share-holding company; a share holding company established to manage all municipal companies	Legal status and organisation of the company changed over the years	State, city council, trade unions and employees of the company, business sector, political parties

samples of water were sent to the laboratory in Berlin to find the best technology for meeting quality requirements — as a result a new Kurtz-type filter was introduced in 1931. The iron content of the water dropped drastically as a result.

During World War II the system was severely damaged and reconstruction was completed by 1947. The paving of the roads also caused problems as more than 90 per cent of the rainfall ended up in the sewers instead of the 20 per cent before paving. The new system operated till 1981. By the end of the 1990s a new sewage treatment plant was built. In the early 2000s a new modern sewage treatment plant is under construction by community funding.

After the nationalisation of the water systems in 1949, the Debrecen Water and Canal Works was established. In 1959 the well drilling department was hived off, and it became the legal predecessor of the County waterworks. In 1963 the operation of one of the new water towers was given to the Medical University. In 1967 new major industrial users connected to the sewerage system (mainly food processing industry).

Plate 20. Dobozi housing estate water tower in Debrecen, Hungary (Photo: Victor Pál, 2004)

The increasing demand for water in the 1960–70s resulted in the introduction of an additional water source: surface water from the East-Main Canal. In 1976 the surface water cleaning department was transferred under the regional waterworks of Tisza river-basin and the surface water coming from the East-Main Canal was cleaned based on a mutual agreement between the two companies.

In 1976 the water supply and sewerage company and the Bath operating company were merged into one single company. Sewage treatment was always important in Debrecen due to its geographical location. In 1981 and 1983 new sewage treatment plants started operation due to the increased amount of sewage. However, the so-called utility gap was still relatively high in Debrecen. Water supply network development gained priority over the sewer network, resulting in 91 per cent coverage of water supply within Debrecen by 1980. Based on the 1995 statistics, 98.5 per cent of the households were connected to the water supply network, while the figure for sewerage was only 69.7 per cent. And sewerage was treated for the most part only mechanically –only part of it biologically. For that reason, a plan for sewer development and treatment improvement was prepared and accepted by the municipality.

In 1992 state ownership of the network was transferred to the municipality, and in 1995 a share-holding company fully owned by the municipality was established and assumed ownership over the network and started operating the services. In 2000 the waterworks became a member of Debrecen Asset Managing Shareholding Company that was established by the municipality to manage all municipal companies.

Plate 21. Water intake plant (Balmazújvárosi str. 3) in Debrecen, Hungary (Photo: Victor Pál, 2004)

Szeged

Szeged[7] is one of the major Hungarian cities of the Great Plain at the meeting point of the Tisza and Maros Rivers. This is the lowest point in Hungary at 84 metres above sea level, and for that reason it had been flooded several times in the past. Probably due to the frequent floods it was very important to start canalisation early: the first sewers were laid in 1844 (**Table 12**).

At the beginning of the 19th century, the inhabitants of Szeged still got water from the river Tisza. Scoops — floats — were put in the river bed, and the water was carted away in wooden barrels on two-wheelers. In 1862 a private company (the Szegedi Kiviteli Gőzmalom Rt) established a small water network providing water to a few streets, still using surface water from the Tisza river. However, the pumps were soon blocked by mud and untreated water could run through the pipelines. The network was operated under a 25-year concession.

In 1879, after the great flood in Szeged, one-tenth of the currently used sewerage network was developed. The biggest recorded flood took place in March 1879 destroying almost the whole city — only 265 of the 5,458 houses remained. The city was rebuilt between 1880 and 1883. It was planned to fill up the site of the city above the 0 point of Tisza by 8.22 m in order to elevate the ground level, but the plans were not feasible.

In 1887, taking some geologists' advice, the authorities decided to ensure water production from deep artesian wells. In 1887 a deep artesian well was drilled (Zsigmondy Béla) which provided water of good quality untill 1920. In 1892 the municipality took over the network but the operation was still under a concession. Due to increasing demand by the households, a decision was made in 1894 by the local municipality to establish a water network providing water for the population with a capacity of 5,411 m^3/day.

Table 12. Key long-term decisions on Szeged water and sewerage services, 1844–2004

Year	Event	Reason	Outcome	Organisational change	Stakeholders
1844	Canalisation programme	Sewage represented health hazard	Laying first sewers and connections		City council, landowners
1862	Small water supply network development	Need for healthy drinking water	Surface water of Tisza was filtered and led to some HHs,	Water supply under concession agreement	City council, HHs, Private company,
1879 – 1904	Network development after the Great Flood	Almost the whole city was destroyed by the flood	Network development, one tenth of the currently used sewerage network was laid		City council, landowners

[7] Based on the information available on the website (www.szegedivizmu.hu) and the reports of the Szeged Waterworks, István Ágoston: Szeged város vízellátásának és csatornázásának krónikája, Szeged 2004; Ferenc Somorjai: Szeged, Panoráma 2002. Gábor Gulyás: otthon Debrecenben 1998–2002, Debrecen 2002, reports of the State Audit Office (www.asz.hu) and the year books of the Central Statistical Office.

Year	Event	Reason	Outcome	Organisational change	Stakeholders
1887	Artesian well drilled (Zsigmondy, Béla)	Need for healthy drinking water, to avoid epidemics	The first artesian well provided good quality water till 1920		City council, HHs
1892 – 1894 – 1904	Supply network in municipal ownership, capacity increase, operational change	inadequate operation, bad quality of surface water	Abandonment of the use of surface water, plans to increase capacity for daily consumption, municipality over-took operation of the system	First the network, then the operation was taken over by the municipality	City council, private company
1927	Hot artesian well drilled	Search for healthy drinking water	Water for the hot thermal bath is provided by the well since then		City council, engineers, bath
1949	Nationalisation	Change in the political system, legislation	State ownership over the network, municipal operation		State, city council, waterworks
1970 – 1973	Company and settlement integration	Organisational	The company operating WS and WWS merged with the bath operating company into a single company, also 5 settlements of the agglomeration joined Szeged	One municipally operated state-owned company, also took over the network operation for the 5 settlements	State, city council, companies, municipalities of the 5 settlements
1970	Industry breaks away	Shortage in water supply, HHs to have priority in network supply	Industrial companies drilled their own wells to supply themselves	Change in customers	City council, company, industry
1994	Privatisation	To improve services, lack of financing	Establishment of a new company with MNC involvement for the operation of the services	Network in municipal hands, operation by PPP	City council, MNC, political parties, trade unions, employee forums, HHs,
1998 – 2004	Sewage treatment	Environmental legislation	Mechanical sewage treatment started in 1998 (in 1994 a small percentage was treated), biological treatment expected by 2006	New facility to operate	City council, company, financial institutions, landowners, HHs

In the 19th century only a few cities had canalisation, but Szeged was among those mentioned by the technical registrar. Although sewage was collected, no treatment was introduced. In 1879–1904 the length of the underground network was 50 km.

At the end of the 19th century, there was real progress in water supply: five wells (depth: 220–275 m, diameter 150 mm, lined with wooden pipe) were bored around 1900, and water was led to the first water station (currently 88 Tisza Lajos Bld.) that was under construction. In the engine house the Worthington steam-pumps sent the water into two pipes of 225 mm diameter and on to the Szent István water tower of 1000 m^3. Artesian wells were connected to each other by 1904, and an integrated water supply network went into operation. From 1904 the water supply was under the control of the Engineering Office of the municipality.

The water tower is a beautifully designed historic-industrial building and the landmark of Szeged. With the water tower of Margit Island in Budapest, they are the first buildings constructed of reinforced concrete in the country. It was built between 1902 and 1904 according to the plans of Dr. Zielinszki Szilárd (1860–1924) who was the first Hungarian doctor of technical sciences and the introducer of reinforced concrete construction. Korb Flóris and Griergl Kálmán were his architects. Thanks to the builders, Feund Henrik and Sons, the water tower with a capacity of 1,000 m^3 was still working in 2005.

Plate 22. The water tower of Szent István Square of 1,000 m^3 in Szeged, Hungary, constructed between 1902 and 1904, still in operation in 2005
(Photo: Zoltán Laukó)

In 1930, due to over-consumption (140–180 l/capita/day), a shortage occurred in water supply, and the steam engine was replaced by pumps operated with electricity. In 1927 a hot artesian well was drilled that has been supplying hot water for the thermal bath ever since.

After World War II the boundary of Szeged was redrawn, and its territory shrank from 816 to 112 km^2, since it lost the surrounding farms. After the nationalisation of the water systems in 1949, the Szegedi Water and Sewage Company was established.

The need for sewer network development became urgent, and in 1957 a new sewer network plan was accepted based on Árpád Farkas's plans from 1911.

In 1970 the Water and Sewage Company (Szegedi Víz és Csatornaművek) and the baths operating company (Szegedi Fürdők és Hőforrás Vállalat) merged, while in 1973 the networks of settlements in the agglomeration of Szeged were joined (Algyő, Kiskundorozsma, Szőreg, Tápé, Gyálarét). Thereby Szeged's territory grew to 356 km^2.

In the 1970s big industrial users broke away from the network and created their own individual supply because the company's main duty was to supply water to the population.

In 1994 a sewage treatment plant was established in Algyő. This was the first time sewage was lead to the river after treatment. However, Algyő separated from Szeged again in 1997. Based on the 1995 statistics, 98.9 per cent of the households were connected to the water supply network, while the figure for sewage was only 66.3 per cent, and none was treated (except in Algyő).

In 1994 the municipality decided to privatise the operating company, and it dissolved into four companies, three with private investor (multinational companies) involvement according to the agreement between the municipality and a private investor consortium. In 2001 the general agreement of 1994 was renegotiated. In 2004, the services (water supply and sewerage) were provided by the company with private involvement — a joint venture (municipal–private).

Environmental legislation made sewage treatment compulsory, and in 1998 the new sewage treatment plant started operation (mechanical treatment). Biological treatment is expected by 2006.

Plate 23. Under Szeged, Hungary there lies a several-hundred-kilometre long pipesystem often running inside hundred-year-old brickwalls (Photo: Szeged Water Company).

Italy

By Emanuele Lobina, PSIRU, University of Greenwich <E.Lobina@gre.ac.uk>

The long-term development of WSS services in Italy can be categorised as follows:

(i) The prevalence of private sector participation, which often meant the involve ment of foreign firms, mostly English but also French, in installing the first water networks from the middle to the end of the 19th century (Barraqué 1995, 177);

(ii) The inception and consolidation of the municipalisation movement from the end of the 19th century to the mid-1950s when private operators accounted for 30 per cent of the Italian water industry;

(iii) Further strengthening of public sector dominance from the mid-1950s to the end of the 1980s. By the end of the 1980s, the share of the private sector had declined to 4 to 5 per cent;

(iv) Private water operators still accounted for 4 to 5 per cent of the water industry in the mid-1990s, but their share was to increase in the following decade. In 2005, it is not clear whether the diffusion of private sector participation is set to con tinue or not.

Historically, ownership and management of urban water operations have been characterised by trends similar to other European countries, induced by the prevailing socio-municipal policies around the end of the 19th century. Up to then, English and French private companies had installed the first water networks, often with limited service, to the centre of urban areas, lacking the necessary financial resources to extend coverage and even to ensure maintenance. It should be noted that English private companies were predominant in this period and that the same occurred in Germany.

Barraqué (1995, 177) pointed to the generally "mediocre" quality of service offered by private water operators as the cause leading Italian authorities to opt for the municipalisation of urban water services, and more broadly also of gas and public transport. The first Italian municipal enterprises (the so-called "aziende municipalizzate") were set up around 1880, but only in March 1903 was a law passed (l. n. 103/1903) (Legge 1903, 103) which supported the process of municipalisation by defining municipalities' legal status (Drusiani 2003b, 4; htpp://www.aemcremona.it/html/aem1915.htm). On that occasion, the Italian government vigorously followed the example of the UK that had pioneered the municipal management of local public services in Europe (Cispel-Confservizi 2002; Fazioli et al. 1999, 25).

However, the 1903 law merely allowed, it did not require, municipal authorities to resort to "aziende municipalizzate" to ensure the provision of public services. In other words, the 1903 law did not ban water privatisation, for example in the form of concession arrangements under which private companies predominantly operated. Also, the 1903 law provided for the compensation of the operator in case the city council decided to unilaterally terminate an ongoing concession (Fazioli et al. 1999, 25–34).

It should be noted that the law l. n. 103/1903 required an extremely elaborate process prior to setting up an "azienda municipalizzata", including a number of opinions and approvals by a range of public authorities as well as the necessary approval by the citizens concerned in the form of a popular referendum (ATAM SpA Arezzo). It was only in 1922, under the fascist regime, that the law TU n. 2578/1925 provided for a reduced number of preliminary opinions required for the approval of municipalisation proposals, through the abolition of an ad hoc Royal Commission, and eliminated the prior requirement for a popular referendum. Referenda on proposals for establishing any "azienda municipalizzata" would have had to be held only if at least a twentieth of the electorate, or a third of the city councillors, had expressed their disapproval of the plans (Fazioli et al. 1999, 35–41).

According to Barraqué (1995, 177), many municipal enterprises eventually encountered financial problems as they remained firmly under the direct control of local authorities. Italy's "aziende municipalizzate" were in fact characterised by lack of juridical personality and managerial autonomy, although their accounts were separate from the city council budget and municipal enterprises were subject to the same fiscal regime as private companies (Barraqué 1995, 172; Fazioli et al. 1999, 25). Fazioli et al. (1999, 34–35) identified the governmental decision to block tariffs, in order to fight hyperinflation caused by World War I, as the major determinant of the financial difficulties experienced by "aziende municipalizzate" from 1914 to 1922. In the mid-1950s, private operators accounted for 30 per cent of the industry. The share of the private sector declined to 4 or 5 per cent at the end of the 1980s as water tariffs were subject to anti-inflation policies which undermined profitability (Guffanti & Merelli 1997, 45).

History does not seem to have affected only patterns of ownership in water services provision but also the territorial distribution of water operators and their size, thus explaining the high fragmentation which is still characteristic of the Italian water industry. Interestingly, Barraqué (1995, 177) argued that the fragmentation of Italian water operations was due, partly to the importance of underground water as a source, partly to historical reasons such as the transfer of French administrative structures under Bourbon and Napoleonic domination, although such legal transfer was not accompanied by the assimilation of French juridical philosophy in matters of water resources. Drusiani (2003a, 2) explained the high fragmentation of Italian public utilities, with particular reference to water supply and sanitation operations, in the light of the following historical, geological and hydrological factors. As regards historical reasons, fragmentation had derived from a context of "strong political/administrative localism due also to the late formation (1861) of the national state, starting from situations with highly differentiated traditions, economic development and geographic organisation".

Arezzo

In 1870, water was supplied in Arezzo by a number of private and public wells as well as through a fountain connected to the aqueduct Vasariano built in 1603 with funding from the local charity Fraternita dei Laici. However, no water supply pipeline network existed. Studies aiming at providing the town and all its citizens with piped water from surface sources had been carried out since 1860, as the satisfaction of hygienic and industrial requirements became increasingly impellent under the pressure of urban growth. In fact, the population of Arezzo rose from 11,154 in 1871 to 34,302 in 1951.

In 1870, Fraternita dei Laici redirected water previously devoted to private usage in order to serve the hospital and other public buildings as well as individual citizens. In 1871, the charity started construction of the pipeline network in the old town, which in November 1872 served 46 users (**Table 13**). In 1886, both the Fraternita dei Laici and the municipal administration constructed a reservoir for the distribution of water by gravity. From 1871 to 1866, 11 public fountains had also been built but scarcity of water remained a problem, especially in periods of drought. Therefore, while the Fraternita concentrated its efforts on repairing the ancient aqueduct (whose restoration would be completed in 1923), the commune purchased the right to new water sources in 1891. However, this did not suffice to solve the problem of water scarcity so that the commune financed the construction of a subsidiary aqueduct, completed in 1908, to serve industrial users in the lower town (supply to households did not take place due to water quality concerns).

Plate 24. Medieval well in Arezzo, Italy
(Photo: Arezzo Tourist Agency, APT)

Table 13. Key long-term decisions on Arezzo water and sewerage services

Year	Event	Reason	Outcome	Organisational change	Stakeholders
1871	Construction of the pipeline network in the old town starts	Poor sanitary situation	Better quality of city life, in November 1872 served 46 users		The charity
1886	Reservoir for the distribution of water by gravity	Need to distribute water	Better distribution of water		Fraternita dei Laici and municipal administration
1891	Purchase of the right to new water sources	Economic resources available, need to supply the requested water solve problem of water scarcity	This did not suffice to solve the problem of water scarcity	Increased authority of the commune	City councillors, city council, experts
1908	Subsidiary aqueduct	To serve industrial users in the lower town	Water supplied to the lower town	The commune has an own aqueduct, named the Buon Riposo aqueduct, that supplied water from a number of wells tapping ground water deriving from the river Arno	Industrial users, city councillors
1930	Operation of the Vasariano aqueduct	The Fraternita could no longer afford running the ancient aqueduct	Payment of a fee for the lease of the land		City councillors, city council, experts
1952	Buon Riposo water treatment plant	Quality problems with surface water			City council, experts, water works, several municipalities, consumers
1980	Completion of the Casolino wastewater treatment plant	Quality problems with surface water	1st wastewater treatment plant in the city		Suez subsidiary Dégremont, City councillors, city council, experts
1999	In 1999, a 25-year water supply and sanitation concession was awarded to a public–private operator managed by a Suez-led consortium	Foreseen benefits, favourable conditions	A 25 year water supply concession	A public private operator control the water supply	Suez. , City councillors, city council, experts
2003	Renegotiation of business plan and concession agreement	Conflicts over efficiency and effectiveness with private operator	Private operator renegotiates favourable deal		Suez, communes, local regulator

In order to find a decisive solution to the necessities of the town in terms of quality and quantity of water supplied, the commune financed the construction of a new aqueduct, which was completed in 1929. The new aqueduct, named the Buon Riposo aqueduct, supplied water from a number of wells tapping ground water deriving from the river Arno, which was then artificially recharged drawing from the course itself. Even the Buon Riposo aqueduct was used exclusively when necessary to meet demand, even though its capacity exceeded overall requirements.

In 1930, the commune of Arezzo became responsible for operating the Vasariano aqueduct. The move originated from the fact that the Fraternita could no longer afford to run the ancient aqueduct. Furthermore, the decision aimed at ensuring the rationality of operations as the various components of the fragmented infrastructure system were brought under the sole management of the commune.

During post-war reconstruction, water treatment plants tapping surface water from the river Arno were built at the Buon Riposo aqueduct starting from 1952 (Stocchi, 1998; Comune di Arezzo, undated). Surface water from Buon Riposo would be eventually replaced only at the end of the 1990s with water from the Montedoglio dam. Wastewater treatment was first introduced in 1980 with completion of the Casolino wastewater treatment plant by Suez subsidiary Dégremont (Tafi, 1985).

A plan to organise a sewerage network connected to a modern wastewater treatment plant was devised in 1972 and was implemented by 1980. Sewers did exist prior to 1972 but discharged raw sewage into rivers.

Plate 25. Public fountain in Piazza Grande in Arezzo, Italy (Photo: Arezzo Tourist Agency, APT)

Bologna

In 1846, the commune of Bologna awarded a concession for street lighting to a private company (Source: Hera). French and English companies built the gasworks providing the energy for lighting (Officina del Gas) (Comunicato Stampa del Comune di Bologna 2004). As of 1851, the Bologna gasworks were operated by the private company Roux & Co., which had also operated the Milan gasworks since 1846 (Lapini). In April 1862, the municipality of Bologna decided to award a 40-year street lighting concession to Compagnia Ginevrina del Gas (Source: Hera 2004), a multinational (Melotti 2003) which undertook the task of building new gasworks as the old ones lacked the capacity to extend the service to the whole city (Dal Cero 1999). In 1900, the commune of Bologna terminated the concession with Compagnia Ginevrina del Gas, 12 years before its expiry, and set up the municipally-owned undertaking Azienda Municipalizzata del Gas (**Table 14**). This took place 3 years before the enactment of the national law envisaging the possibility for communes to set up "aziende municipalizzate" (Source: Hera 2004).

In 1871, SNAG (Società Nazionale Gasometri ed Acquedotti) started construction of the Setta aqueduct (Acquedotto del Setta), providing Bologna with water from the Setta river. The work was completed in 1881, and SNAG started operating the aqueduct (Source: Hera). More precisely, SNAG did not build the Setta aqueduct from scratch but renovated the ancient Roman aqueduct, which had been constructed around 2,000 years earlier. To date, the Setta aqueduct supplies nearly one fifth of the water distributed in the city of Bologna ("L'acquedotto romano"). In 1903, the commune of Bologna started construction of a new aqueduct — the Borgo Panigale aqueduct (Melotti 2003). The construction of the Borgo Panigale aqueduct was completed in 1913, and operations were temporarily awarded to Azienda Municipalizzata del Gas. As of 1913, water supply operations in the city of Bologna were therefore conducted by two enterprises — SNAG operated the Setta aqueduct and Azienda Municipalizzata del Gas operated the Borgo Panigale aqueduct (Source: Hera).

Table 14. Key long-term decisions on Bologna water and sewerage services

Year	Event	Reason	Outcome	Organisational change	Stakeholders
1871	Construction of the Setta aqueduct (Acquedotto del Setta) started	Need for water	Provides Bologna with water from the Setta river, the Setta aqueduct supplies nearly one fifth of water distributed		SNAG (Società Nazionale Gasometri ed Acquedotti)
1900	The municipally-owned Azienda Municipalizzata del Gas is set up	National law envisaging the possibility for communes to set up aziende municipalizate	Terminates the concession to Compagnia Ginevrina del Gas	Azienda Municipalizzata del gas	City council, experts, water works, several municipalities, consumers
1903	Construction of a new aqueduct – the Borgo Panigale aqueduct	Need for water		Operations were temporarily awarded to Azienda Municipalizzata del Gas	City council, experts, water works, several municipalities, consumers, SNAG

Year	Event	Reason	Outcome	Organisational change	Stakeholders
1926	Redeemed the investments made by SNAG for the renovation of the Setta aqueduct			Concession for the operation of both the Setta and Borgo Panigale aqueducts to SNAG	City council, experts, water works, several municipalities, consumers, SNAG
1948	Terminated contractual relationship with SNAG			The municipally-owned Azienda Municipalizzata del Gas entrusted with water supply operations	City council, experts, water works, several municipalities, consumers, SNAG
1976	The municipalities of the Province of Bologna established the public consortium CAR "Consorzio Acque Reno"	The construction of the Reno river aqueduct.		Public consortium CAR	City council, experts
1984	The Province of Bologna established the public consortium Co.Se.R. – Consorzio Servizi Reno	Need for merging CAR with a number of other public undertakings	Transformation of CAR into a multi-utility active at provincial level	Municipally-owned water supply and gas distribution "azienda municipalizzata" AMGA Bologna was transformed into an "azienda speciale" and became the operator of all services for which the public consortium Co.Se.R. was responsible	City council, experts, CAR, Co.Se.R.
1989	A.Co.Se.R. extended its operations to wastewater treatment			A.Co.Se.R identified its areas of activity as energy and the environment	
1994	City council decided to merge A.Co.Se.R. with AMIU	Need of a multi-utility active in the water supply and sanitation, gas and waste management sectors	Became the 100% municipally-owned SEABO		City council, experts
2002	Creation of the multi-utility PLC Hera SpA.	Seabo merged with 11 public undertakings in the neighbouring Romagna region			City council, experts
26th June 2003	Hera was listed on the stock exchange		Hera is currently 55.5 % owned by local authorities and 44. 5 % by other institutional and private investors	Semi-privatisation of Hera	City council, experts, Hera SpA.

Source: Meris Melotti (2003)

In 1926, the commune of Bologna redeemed the investments made by SNAG for the renovation of the Setta aqueduct and awarded a concession for the operation of both the Setta and Borgo Panigale aqueducts to SNAG. The unified water supply concession was renewed a number of times, but not without controversy. It was in 1948 that the commune of Bologna terminated its contractual relationship with SNAG and entrusted the municipally-owned Azienda Municipalizzata del Gas with water supply operations. In 1953, Azienda Municipalizzata del Gas was renamed AMGA (Azienda Municipalizzata Gas e Acqua) to emphasise the importance of its water supply operations. It should be noted that up to 1962, with the organisational unification of gas and water operations, water and gas had remained as two distinct divisions of AMGA, described as two different enterprises by the Azienda Municipalizzata itself (Source:Hera).

Modern wastewater treatment in Bologna started in 1990. Since June 2003, when it was listed on the stock exchange, Hera was 55.5 per cent owned by local authorities and 44.5 per cent by a number of institutional and other private investors.

Plate 26. Construction of sewers in Bologna, Italy in the 1930s–1940s (Photo: Hera)

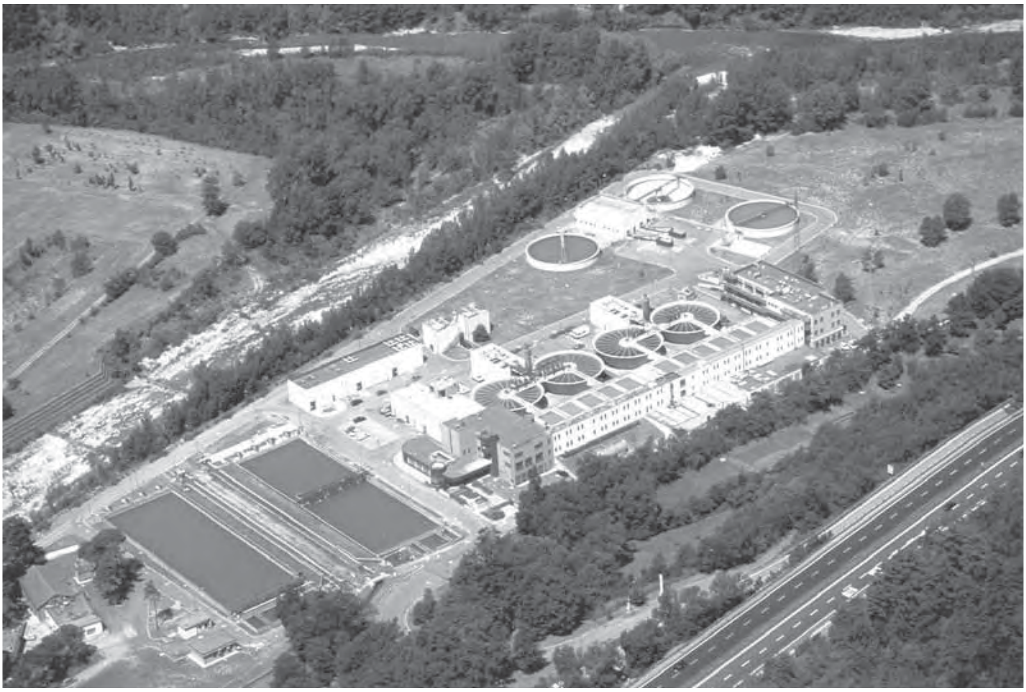

Plate 27. Water treatment plant in Val di Setta – Sasso Marconi, serving Bologna area, Italy
(Photo: Hera)

Milan

In the last decades of the 19th century, more than 600 epidemics broke out throughout Europe, about 70 per cent of them involving water-borne diseases. This led Milan's public opinion to call for the construction of an aqueduct to serve the city. As a result, the city council appointed a special commission in October 1887 in order to evaluate the various options and report to the city council (**Table 15**). The commission eventually decided to accept the proposal of the technical office of the commune of Milan — that is to say, to dig wells and supply ground water. The first wells were constructed in the second half of 1888. The decision to use ground water as a source since the beginning of aqueduct's operation might be regarded as technical path dependency. In fact, to date ground water remains the only source of drinking water supplied to the city of Milan (Venegoni 2000, 20–22).

The first project for the construction of a sewerage network, although limited to the city centre, dates back to 1868. Between 1868 and 1878, 3,584 m of sewers were built with a total capacity of 8,304 m^3. In 1890, a comprehensive project for the city's sewerage network was completed by the technical office of the commune of Milan (Venegoni 2000, 22–26).

Plate 28. Water tower from around 1500 in Milano Maritima, coastal city south-east of Milano (Photo: Vadim Akselrod).

It should be noted that the water supply service was set up as a department of the technical office of the commune of Milan in April 1887 (Venegoni 2000, 26). Despite being the second largest city in Italy, Milan has had its water supply and sewerage services provided under direct municipal management until 2003. Although the city administration is committed to the privatisation of local public services for ideological and fiscal considerations, water supply and sanitation services were awarded to a 100 per cent municipally-owned PLC, as a way of avoiding having to put the concession out to tender. Yet, the water operator might be privatised at a later stage.

Modern wastewater treatment was not introduced in Milan until September 2004 which is remarkably late compared by any criteria on Italian or European scale.

Table 15. Key long-term decisions on Milan water and sewerage services

Year	Event	Reason	Outcome	Organisational change	Stakeholders
1868	First project for a sewerage network	Poor sanitary conditions	Better quality of city life, although limited to the city centre		City councillors, city council, experts
1887	A special commission evaluates the various options for the construction of an aqueduct to serve the city.	More than 600 epidemics broke out throughout Europe, about 70% of those due to water-borne diseases	The commission eventually decided to accept the proposal		City councillors, city council, experts
1868 – 1878	Construction of a sewerage network	Milan's public opinion call for the construction of an aqueduct to serve the city.	3,584 m of sewers were built with a total capacity of 8,304 m^3		City councillors, city council, experts, inhabitants
1887	The water supply service was set up as a department			Department of the technical office of the commune of Milan	City councillors, city council, experts
1888	First wells	To use ground water as a source for aqueduct's operation	Dug wells and supply ofground water		City councillors, city council, experts
2003	A short term concession for the water services	National law limits choice	Concession awarded to municipally-owned PLC	Awarded to the municipally-owned PLC Metropolitana Milanese	City councillors, city council, experts

Plate 29. Construction of sewage collector ("collettore") in the Nosedo area, Milan, Italy, in early 1900s
(Photo: Gentile & al. 2003, p. 112; with the permission of Commune of Milan)

Plate 30. Assembling so-called "vetroresina", sort of glass-fibre, sewer pipes in Milan, Italy
(Photo: Gentile & al. 2003, p. 157; with the permission of Commune of Milan)

Rome

Rome with its ancient aqueducts and sewers is a unique case. During renaissance, the popes decided to renew and beautify the city that had been abandoned for a long time by promoting splendid works such as bridges and the restoration of the ancient aqueducts and the creation of public fountains (Rausa & Viggiani 2004).

In 1865, Pope Pius IX (Pope in 1846–1878, born in 1782) who then ruled in Rome awarded a 99-year concession for the renovation and operation of the ancient Acqua Marcia aqueduct to the majority English-owned private company Società dell'Acqua Pia Antica Marcia (also known as Anglo Roman Water Company), also including Belgian and local partners (**Table 16**). In 1870, the year of the unification of Italy as a nation state, the Acqua Marcia aqueduct was inaugurated under Pope Pius IX (Ristori 2004a).

At the beginning of the 20th century, Rome was supplied water via four aqueducts. In 1909, the municipality of Rome established AEM (Azienda Elettrica Municipale) in order to provide electricity for public (e.g. street) and private (e.g. household) lighting (http://www.aceaspa.it).

Plate 31. Cloaca Maxima, the first main sewer of Rome built originally for land drainage around 600 BC
(Photo: T. Katko, 2005)

Table 16. Key long-term decisions on Rome water and sewerage services

Year	Event	Reason	Outcome	Organisational change	Stakeholders
1865	The Pope awarded a 99-year concession for the renovation and operation of the ancient Acqua Marcia aqueduct	Acqua Marcia aquedut was ancient	Better service and a better distribution of water	Anglo Roman Water Company	The Pope, the majority English-owned private company, Anglo Roman Water Company, Belgian and local partners
1937	Municipally-owned AGEA entrusted with the construction and operation of aqueducts and water supply pipeline networks for the city of Rome	Control of both water service and energy	Works started for the construction of the Peschiera aqueduct	Municipally-owned "azienda municipalizzata"	Governor of Rome, city council, AGEA
1938	Commune of Rome transferred the operation of the Vergine, Felice and Paolo aqueducts to AGEA		AGEA control almost all the water services of Rome		Governor of Rome, city council, AGEA
1964	ACEA acquired the operation of the Acqua Marcio aqueduct.	Concession to Società Acqua Pia Antica Marcia (SAPAM) expired	ACEA become the only provider of water supply to the city of Rome.	End of PSP in water supply	Governor of Rome, city council, ACEA
1975	Extension of sewerage service coverage to the "borgate", illegal settlements in peri-urban areas	Acea served that area by tank, it was an inadequate service	An important contribution to the city's sustainable development	Acea was entrusted	ROME commune, ACEA
1985	Acea undertook management of the wastewater treatment	Rationalisation of water supply and sanitation operations	Acea become the sole manager of water treatment in Rome	End of direct municipal direct of sanitation operations	Rome Commune, ACEA
1992	Transformation of Acea into azienda speciale	More efficient services to Rome Commune	Delibera 325/92	Acea becomes wholly municipally owned	Rome Commune, ACEA
1998	Transformation of Acea into PLC and listing on stock exchange	Greater strategic flexibility for the Acea and Commune of Rome, fiscal reasons		Semi-privatisation of ACEA	Rome Commune, ACEA
2003	ACEA ATO 2 begins operations	Implementation of Galli Law	Acea 96 % owned subsidiary operates water supply and sanitation services at Provincial level under 30 year concession		Rome Commune, 111 communes of ATO 2, ACEA

Source: www.aceaspa.it

In 1937, under fascist rule, the Governor for Rome entrusted AEM with the construction and operation of aqueducts and water supply pipeline networks for the city of Rome. In the same year, AEM was renamed AGEA (Azienda Governatoriale Elettricità e Acque, i.e. Gubernatorial Enterprise for Electricity and Water) and the works started the construction of the Peschiera aqueduct (http://www.aceaspa.it)

In 1938, the commune of Rome transferred the operation of three aqueducts to AGEA (Ristori b), while one remained under the private concessionaire. In 1945, with the end of the fascist rule and WWII, AGEA was renamed ACEA (Municipal Enterprise for Electricity and Water) (http://ww.aceaspa.it).

In 1964, as the concession to Società Acqua Pia Antica Marcia (SAPAM) expired, ACEA acquired the operation of the Acqua Marcio aqueduct. This allowed ACEA to become the only provider of water supply to the city of Rome (www.aceaspa.it).

Plate 32. Remains of the Aqua Claudia, having been constructed by Dominiti Ninus
(Photo: T. Katko, 2005)

Rome's municipally-owned companies have very different origins, and operate in very different sectors. On the one hand, there are those that traditionally operate in the local public service sector, like transport, energy and water supply and waste collection. These are companies with an old and rooted history, in the municipal tradition. But they have been recently subject to change, notably undergoing corporatisation. Acea was quoted on the stock exchange in 1999.

According to the web-site, Acea manages the water distribution cycle in 111 municipal districts for over 3.6 million inhabitants and also for some international companies (Acea 2005).

Plate 33. Fountain of Fontano di Trevi in Rome, Italy, designed by Nicola Salvi and completed in 1762 at the end of Aqua Virgo, built originally in 19 BC (Photo: T. Katko, 2005)

Lithuania

By Pekka E. Pietilä, TUT <pekka.e.pietila@tut.fi>

The development of public water and sewerage services in Lithuania can be divided into four phases:

(i) Private initiatives to build and operate water distribution systems but not sewerage, roughly 1890–1920;
(ii) Municipal water utilities, 1920–1940;
(iii) State water companies, 1940–1990;
(iv) Municipal water companies, from 1990 onwards.

Private initiatives

In addition to private wells there were some attempts of simple water supply systems until late 1800s. Towards the end of the 1800s, private wells became increasingly contaminated while the increasing water scarcity in the growing cities caused epidemics and thus a need to improve water supply systems. At this stage the cities were willing to take actions to ease the situation. On the other hand, there were private entrepreneurs and investors who saw an opportunity for business. In the largest cities in Lithuania there were several examples during the last decade of the 1800s, and the first decades of the 1900s, of private initiatives to build and operate water supply systems. A common feature of these proposals was that the private operator wanted to get a monopoly for the water business for a number of years as well as to get a guaranteed minimum annual income regardless of water sales. Yet, none of these proposals were accepted by the city administration.

Municipal utilities

In the 1910s and 1920s the cities started more actively searching for solutions to improve both water supply and sewerage services. Private companies were employed to carry out ground water surveys, make plans for water distribution and sewerage systems. Local experts were sent abroad to learn about the solutions of other cities. Funding of these new developments was a problem; concessions were considered and loans were sought from abroad. The administrative structure for water and wastewater services in the cities was developed — departments for water and sewerage were established in the city administration. Thus, in the 1920s and 1930s water and wastewater services were expanded and developed by municipal utilities.

State companies

During the Soviet occupation (1940–1990) municipal water utilities were nationalised. The responsibility of public water supply was transferred to a state water and wastewater company which had 14 regional subsidiaries. Local municipal administration had a very minor role to play.

Municipal companies

Since Lithuania regained independence in 1990, the responsibility for public water supply and sewerage was transferred back to the municipalities. Of the earlier 14 regional companies, 45 municipal water companies were formed. Basically there was one water and wastewater company for each municipality (there were altogether 56 municipalities in Lithuania in the early 1990s; some companies also took care of the water services of a neighbouring municipality). In some municipalities water services are the responsibility of a multi-utility company operating also district heating and solid waste services.

Kaunas

In the middle of the 16th century three public wells were built in Kaunas. Some wooden pipes were also built to bring water to the town hall square and some houses, but these structures were destroyed later during wars and fires. By the end of the 1800s many private wells were contaminated, and to help the situation the city administration built six public wells. The first proposal to build a centralised water supply system was made in 1891 by an engineer from Berlin. He wanted a monopoly for 75 years and a guaranteed minimum annual income. Later, similar proposals — a monopoly for a certain period plus a guaranteed minimum income — were made by private entrepreneurs or companies in 1893, 1894 and 1899 (**Table 17**).

In 1912 the city invited a specialist to draw plans for centralised water supply, and a geohydrological survey was done. World War I stopped all development plans. In 1922 the city made a deal with a German company to plan and build centralised water supply and sewerage, but the company failed to produce the plan in time and the agreement was cancelled. In 1923 a German expert was invited to make a plan for water supply. The source of water in these proposals had been river water or ground water or sometimes a combination of the two.

Plate 34. Laying of a submersible plastic sewer for Kaunas, Lithuania (Photo: P. Pietilä 1998)

Table 17. Key long-term decisions on Kaunas water and sewerage services

Year	Event	Reason	Outcome	Organisational change	Stakeholders
1895	Agreement with private entrepreneur to build water supply	Water in individual wells was polluted	Project was never realised		City administration & private entrepreneur
1912	City invited a specialist to make a plan for centralised water supply	Water in individual wells was polluted	Three wells and geo-hydrological investigation made, but the war halted the project		City administration and private entrepreneur and specialists
1921	Water supply commission established	City wanted to get centralised water supply built	Surveys and plans made	First permanent unit for development of water services	City administration
1922	BOOT contract with a private company	City did not have the expertise	Private contractor failed to implement		City administration and private company
1924	Department of water supply and sewerage established	City wanted to have a stronger touch on the development of water and sewerage services	A formal unit established in city administration	City strengthened water sector administration	City administration
1924	Loan from the Bank of Lithuania	Funding needed for implementation	Construction of sewerage started		City and Bank of Lithuania
1928	Construction of centralised water supply started		Operation of water supply started in 1929		City and local and foreign companies
1945	Municipal water company was nationalised	Lithuania came under Soviet rule		From municipal to state company	City and Soviet State of Lithuania
1990	Responsibility for water and wastewater services was transferred to the city	Decentralisation of administration	City inherited the assets and staff of state company	From state to municipality	Independent state of Lithuania
1990	Decision to build a WWTP	The only major population centre in Lithuania without WWTP	Planning process started		City Council
1995	Joint-stock company established	To formalise municipal operation		Municipal company	City Council

The construction of centralised water supply started in 1928 and water started to flow next year. The source of water was ground water — and has been ever since. Several wells/boreholes were drilled in the vicinity of a river, and partial recharge of ground water occurred from the river. In 1959–1964 canals were built from the river to bring water closer to the wells and increase recharge. The first artificial ground water infiltration basin was built in 1963.

In 2002 the average water supply was 60 000 m^3/day, and the number of persons connected to centralised water supply was 339,000 (324,000 residents had a connection to centralised sewerage); thus per capita consumption was 178 l/capita/day. The population of the city is 375,000 people. The length of the water distribution network in 2002 was 1,100 km.

Sewerage

In 1871 a topographical survey of the city was done and a city plan issued showing the location of streets and buildings. Some surveys on sewerage were made, but no proper planning was started. In 1914 an English specialist was hired to make a sewerage plan, but the work was halted by World War I. In 1922 an agreement was made with a German company to plan and build centralised water supply and sewerage but the process failed (see above).

A serious problem hindering the construction of sewerage was the city's lack of capital. Interested concessionaires were looked for, credits from abroad were sought — the mayor travelled for instance to London to get a loan, but the conditions for the loan were too complicated. In 1924 the Bank of Lithuania granted a loan for one year, and the construction of a sewerage network started on 26 September 1924. A wastewater treatment plant consisting of two vertical precipitators and a bio-filter was constructed, but when the sewerage network was expanded the treatment plant soon became overloaded and stopped functioning.

Plate 35. Wastewater treatment plant of Kaunas, Lithuania, taken into use in 1999 (Photo: P. Pietilä 2002)

Until the 1990s Kaunas had no wastewater treatment plant while the city had become one of largest polluters in the Baltic Sea area. In 1995 a comprehensive "Kaunas Environmental Project" was set up with financing from different sources. The most important part of this project was the construction of a wastewater treatment plant. The first phase, consisting of primary sedimentation and sludge treatment, was taken into use in 1999. Construction of the second phase — biological treatment — was expected to start in 2004. The design capacity of the wastewater treatment plant is 232,000 m^3/day, and in 2002 the average flow was 62,000 m^3/day. The length of the sewerage network in Kaunas is 940 km.

Organisational form

In 1923 the City of Kaunas established a technical commission for water and sewerage development, and in 1924 this commission was reorganised into a Department of Water Supply and Sewerage. During the Soviet occupation, water and wastewater services were the responsibility of a state company, which had 14 regional subsidiaries. Kaunas regional water company did not cover only the city, but also the surrounding area. In 1975 the responsibility for stormwater sewerage was transferred from the water company to the city's street administration.

After Lithuania regained independence in 1990, the responsibility for water and wastewater services was transferred to municipalities. Kaunas Water Company became one of the 45 municipal water companies established on the basis of earlier 14 regional state companies. The formal status of Kaunas Water Company was changed from special purpose joint-stock company to an ordinary joint-stock company in 2003/2004.

Vilnius

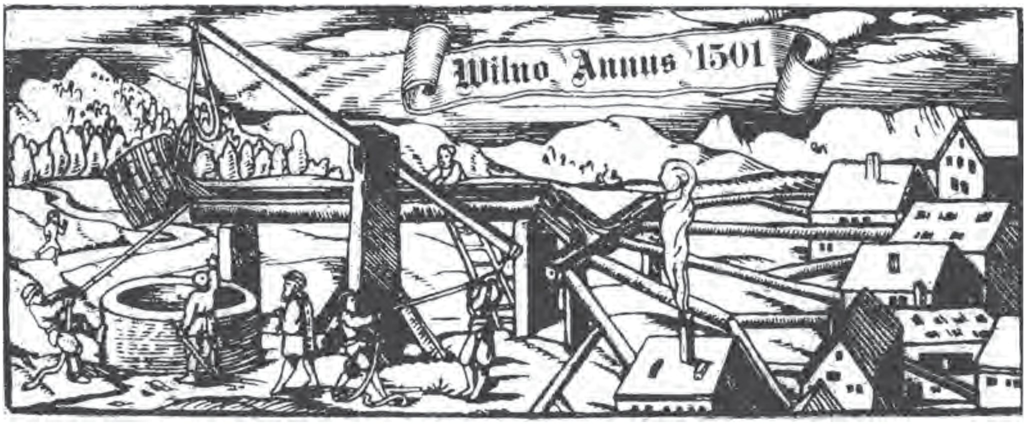

Plate 36. Old graph showing well construction for Vilnius in the Middle Ages (Source: Vilniaus Vandenys 2001, 3)

Water supply

Historical documents show that there was some water supply in Vilnius already in the 15th century, but officially public water supply in Vilnius started in 1501 when Grand Duke Aleksandras gave the Blackfriars the right to use the wells in Vingriai and supply water to the population. Ground water has been the source of water in Vilnius ever since. During the next centuries wooden pipes were installed, and water flowed by gravity from the springs to public ponds and some houses.

In 1864, in connection with the construction of gas lighting for streets, metal pipes were also used for water supply. Towards the end of the 1800s, the city had grown and the yield of the wells was insufficient resulting in a lack of clean water which led to typhus outbreaks. At that time people (obviously only the rich ones), started to drill their own artesian wells. The quality of water in the wells was good.

In 1893 the city established a commission to develop public water supply system (**Table 18**). The commission hired also experts from abroad (Warsaw, St Petersburg). The proposal was to take water from the River Neris and some lakes.

The first ground water surveys were carried out around 1902 by a German expert. In 1907 the City Council approved the plan for centralised water supply which was based on the use of ground water. The first ground water pumping station started to operate in 1914. Since then the water supply of Vilnius has remained in principle quite similar. The biggest problems have remained the same: first, rather high iron content of ground water and consequently the need for iron removal, and second, how to avoid clogging of borehole filters.

During Lithuania's independence in the 1920s and the 1930s Vilnius and the surrounding area were not part of Lithuania but were annexed to Poland. After World War II Vilnius regained its status as the capital of the country, and the city started to grow fast. After the war new well fields were taken into use without proper ground water investigations, and some of the schemes failed.

In 2002 Vilnius Water Company supplied, on average, 97,000 m^3/day water to 553,000 people; per capita consumption being 175 l/capita/day. The length of the water distribution network was 1,340 km. **Figure 11** shows the specific water consumption in Vilnius from 1950 to 1997. The decline was particularly noticeable in total per capita consumption but also in domestic consumption in the 1990s. The quite dramatic change is an example of what a transition economy underwent after the collapse of Soviet Union — due to the adoption of a more efficient economic system while industrial activity declined. Yet, slight increase in total water consumption is probably an indication of economic recovery.

In 2003 Vilnius Water Company supplied, on average, 102,000 m^3/day water to 553,000 people; per capita consumption was 187 l/capita/day. The length of the water distribution network was 1,340 km.

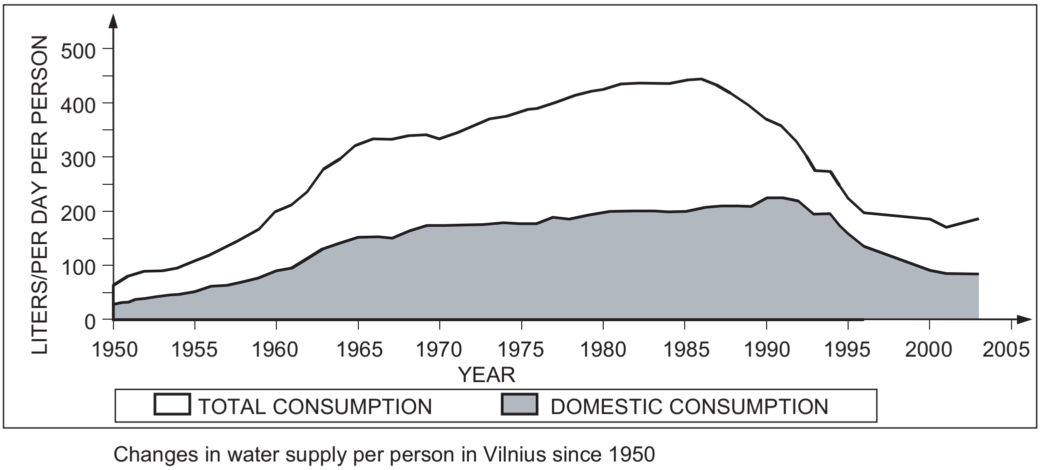

Figure 11. Specific water consumption in Vilnius, 1950–2002

Sewerage

The sewerage system of Vilnius started to evolve from drainage canals built along the streets to lead wastewater to the rivers. During the 1800s several canals were built in the central area of the city. They were built of wood, stones or brick. Open canals were also covered.

Since the early 1900s a modern sewerage network was being constructed for the city but wastewater was discharged into the River Neris via several outlets without treatment. To improve the quality of the water in the river in Vilnius, a collector sewer was constructed and all wastewater from the city has been discharged into the river 17 km downstream from the city centre since 1979.

A mechanical wastewater treatment plant, capacity 600,000 m^3/day, was taken into use in 1986. This plant was extended and in 1996 an activated sludge treatment plant, capacity 420,000 m^3/day, was taken into use. Since then the plant has been thoroughly upgraded and the present capacity is 225,000 m³/day. In 2003 the volume of wastewater treated was, on average, 106,000 m³/day and the length of the sewerage network 866 km.

Table 18. Key long-term decisions on Vilnius water and sewerage services

Year	Event	Reason	Outcome	Organisational change	Stakeholders
1893	Commission for water supply established	Lack of water	Experts invited in 1894 to study the situation		City Council
1902–	Discussions on whether river or surface water should be used		Discussion continued for several years, finally ground water was selected		City Council
1907	Water supply project accepted		Ground water to be used, planning started		City Council
1909	Loan	Money needed to start building water supply	City Council took a loan		City Council, bank
1914	First ground water pumping station in operation		Centralised water supply started		
1945	Municipal water company was nationalised	Lithuania came under Soviet rule		From municipal to state company	City and Soviet State of Lithuania
1965	Wastewater treatment plant planning started	To reduce pollution in the river	Construction started in 1975, the plant started operation in 1986		City
1979	Wastewaters discharged via a collector sewer away from the city centre	To make river water cleaner within the city area			
1990	Responsibility for water and wastewater services was transferred to the city	Decentralisation of administration	City inherited the assets and staff of state company	From state to municipality	Independent state of Lithuania, City of Vilnius
1995	Joint-stock company established	To formalise municipal operation		Municipal company	City Council, Water Company

Organisational form

In the middle of the 1800s springs passed to the ownership of the city. Since the late 1800s, and during the early 1900s until World War II, the city administration was the initiator and implementer of water supply and sewerage development.

During the Soviet occupation Vilnius Water Company was one of the 14 state water companies and the municipality had only a marginal role. Since independence in 1990, water and wastewater services have been the responsibility of municipalities. By area the present municipal water company covers the same area as the earlier state company.

Plate 37. Headquarters of Vilnius water company
(Photo: Vilniaus Vandenys, 2003)

Netherlands

By Robin de la Motte, PSIRU, University of Greenwich <R.DeLaMotte@gre.ac.uk>

In the Netherlands, there has for historical reasons existed a structural separation between the provision of flood defence and water quantity management (by water boards); the provision of public water supply (largely by private and municipal companies and municipal works); the provision of sewerage services (largely by municipal works); and the provision of wastewater treatment (largely by specialised water boards). At the beginning of the 21st century some of these distinctions are eroding or subject to some discussion on revision; in particular, water board mergers (reducing the number of boards from 2,500 in 1950 to 37 in 2004) mean that the distinction between 'water quality' (i.e. wastewater treatment) and 'water quantity' boards is increasingly disappearing, as merged boards increasingly carry out both responsibilities. There is also some pressure from government for wastewater treatment and even sewerage responsibilities to be transferred to the water companies, although there is considerable resistance to such ideas from water boards and municipalities.

Water Boards

The Dutch have a long and unique tradition of managing environmental aspects of water at the local level through water boards (in 1850 there were 3,500 water boards), which form the basis of the Dutch tradition of consensus politics. **Table 19** shows a summary of the long-term development of the Dutch water sector starting from the water boards in the 12th century. The origins of the water boards lie in farmers in the Middle Ages organising themselves to provide local flood defences, which developed into a self-financing system of boards where stakeholders made financial contributions based on the size of their land holdings. This was later extended to allow greater involvement of urban landowners, and most recently (1995) to include taxation and representation of households (Uijterlinde et al. 2003). Although regulated by government, the water boards have never had a formal place within the national/regional/local government structure, since they were sectorally-based, self-financing non-governmental organisations.

Water Supply

The water boards have not, however, been involved in public water supply. This developed in the Netherlands in the mid-19th century, with private companies and municipalities responding to various public health crises. Three distinct periods can be identified:

(i) 1854–1920, when the majority of water companies were under direct private management and provision, particularly early on, supply was largely limited to larger, wealthier urban areas;
(ii) 1920–1975, when water supply was predominantly under direct municipal management and provision, it was expanded into rural areas. Expansion, reaching 100 per cent coverage by 1970, was particularly associated with developing system of the regional water supply companies operating as public water PLCs;
(iii) From 1975 to present, when the public water PLC has come to dominate and other forms have almost disappeared.

Table 19. Key events of Dutch water history, 1100–2000

1100–1300	Water boards first set up, playing a key role in limiting the encroachment of the sea, protecting against river flooding, and land reclamation
1798	Rijkswaterstaat set up to oversee management of surface waters, as well as general supervision of the water sector
1854–1920	Urban water supply takes off. Private water companies, initially predominant, are increasingly municipalised
1900–1950	Sewerage networks are developed by municipalities in the first half of the twentieth century, typically through their municipal works
1930s on	Wastewater treatment works are increasingly provided from the 1930s on by water boards specialising in wastewater treatment
1950s on	Water board mergers (the number of boards fell from 2,500 in 1950 to 37 in 2004) mean that the distinction between 'water quality' (i.e. wastewater treatment) and 'water quantity' boards increasingly disappears, as merged boards increasingly carry out both responsibilities
1954	Waterschapsbank set up by the water boards, specialising in providing finance for the expansion and upgrading of flood defence, wastewater treatment and other water sector needs
1957	Water Supply Act grants provincial authorities the power to induce changes in the organisation of the water supply industry
1957–1975	Number of water companies and types of water supply organisation declines as companies and municipal works increasingly merge into regional PLCs
1969	Surface Water Act makes wastewater treatment the responsibility of water boards, and gives them powers to impose a pollution levy to pay for it
1975	Water Supply Act amendments come into force, providing a series of effective instruments to the Provinces to enforce reorganisation, and the right for national government itself to intervene if Provinces fail to act
1992	Water Authorities Act standardises water board governance
2004	Water Supply (Ownership) Act requires water companies to be publicly owned

Municipalisation of private companies frequently occurred when private owners did not want to engage in risky expansions into rural areas, preferring instead to sell out to municipalities. The later change from direct municipal management to public water PLCs was driven by rising demand (water demand almost quadrupled between 1945 and 1970 (Blokland et al. 1999, 37), rising pollution, and government demands to increase economies of scale (**Figure 12**).

Concern over an excessive number of water companies (a peak of 229 in 1938) lead to the 1957 Water Supply Act. It was intended to grant provincial authorities the power to induce changes in the organisation of the water supply industry as they thought necessary, but it failed to provide effective instruments. By the 1970s there were still 109 companies, of which only 14 had more than 100,000 connections. In 1971 the Dutch government amended the Water Supply Act (changes taking effect 1975), providing a series of effective instruments to the Provinces to enforce reorganisation, and the right to do so itself if Provinces failed to act. By 2001, the number of companies had been reduced to 22. The Act also had a strong technical focus, requiring various actors in the water system to draw up plans regarding future infrastructure requirements.

Following several decades of consolidation of the water supply companies through a series of mergers, the number of companies was down to 10 in 2004, from 52 in 1991 and 185 in 1965 (Blokland & al. 1999, 38).

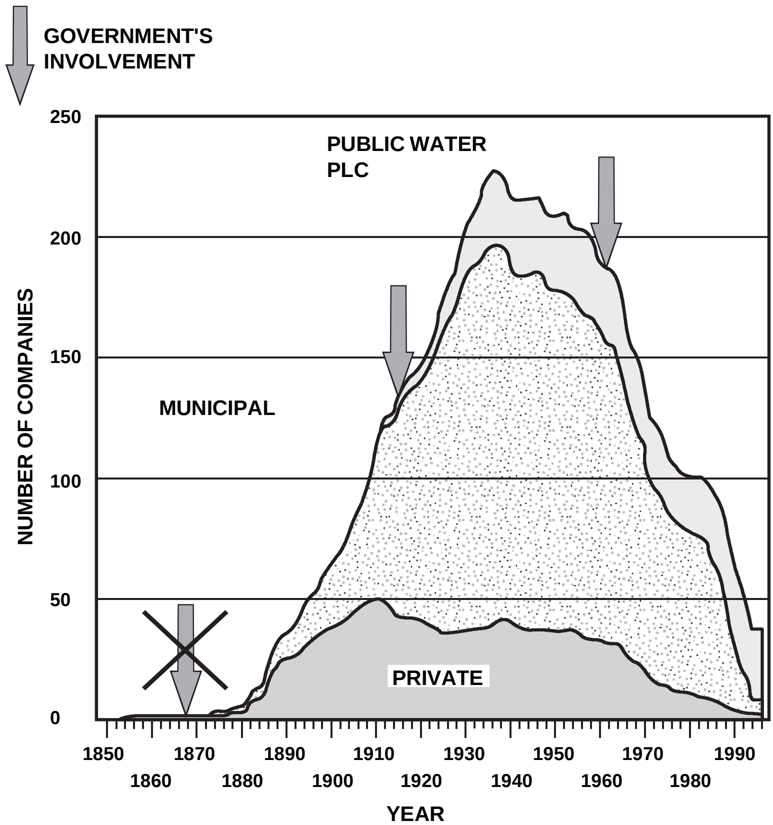

Figure 12. Evolution of Dutch water undertakings with major government´s involvement, 1854–2000 (Blokland et al. 1999, 38)

Sewerage and WWT

Although modern sewerage systems were developed in the nineteenth century in some cases (such as Rotterdam and Maastricht), the widespread development of sewerage systems in the Netherlands did not take place until around 1930. This period also saw the initial development of wastewater treatment systems (often by municipalities and provinces, with plants transferred to water boards after the 1969 Surface Water Act gave the responsibility to the water boards), although this took some decades to develop. In 1950 public wastewater treatment capacity (excluding industrial plants for own use) was just one million population equivalent (mpe); and in 1960, just two million. Thereafter wastewater treatment capacity grew more rapidly, reaching 8 mpe by 1970, and, boosted by the 1969 Surface Water Act, 20 mpe by 1980. In 2004, it is around 27 mpe, in around 400 plants (Nederland Leeft Met Water 2004, 51).

Rotterdam

Background

In 1860 Rotterdam was a 500-year old city of 100,000 people, and had inherited a peculiarly Dutch water system. The city consisted of three zones: the *binnenstad* (the oldest part, situated behind the original Schiedamsche Hooge Zeedijk which had enabled the city to be built); the *Waterstad* (the next oldest part, situated between the dike and the Maas river; and the *polderstad*, situated further away from the river, behind the binnenstad.[8] Each of these faced different challenges from the rapid development that would take place in the latter half of the century, as Rotterdam industrialised and grew to 300,000 people.

The Waterstad was relatively well off in terms of its water system; the Maas provided drinking water of acceptable quality by 19th century standards, and its ebb and flow ensured that the city's canals — which functioned as open sewers, as the prohibition on disposing of human waste in them was widely ignored — were regularly flushed. The binnenstad and polderstad, on the other hand, were cut off from the cleansing power of the Maas by the dike — which was under the control of the Hoogheemraadschap van Schieland (HvS), not the city. Whilst the HvS had since the Middle Ages occasionally permitted the dike sluices to be opened to flush the city's canals, its primary concern was to ensure that the canals were used to ensure sufficient drainage for the polder hinterland. This meant that in winter, and in summer when there was heavy rain, the canals were insufficiently flushed and as a result stank. As the same canals were also these districts' main source of drinking water, the result was a considerable public health problem (van den Noort & Blauw 2000, 13). For example, in 1848/49, nearly 2,100 people of 90,000 died of cholera, and a further 1,200 of 115,000 people in 1866 (Dijkstra 1974, 14).

Developments in the 1850s

As a result of the ongoing health issues, a series of projects were conceived to improve the city's system of canals, beginning with the 1854 Water Project (**Table 20**), designed jointly by the technical director of HvS and the Rotterdam city architect (W.N. Rose), based on plans by Rose going back as far as 1842 (van den Noort 1990, 23). This aimed at improving the water and sanitation situation of the polderstad by developing the two major canals that flanked the city, to be used as store of fresh Maas water; and by building parallel open sewers (*singels*) to collect wastewater from the city, making use of the gradient from the centre of town. From the singels two pumping stations returned the wastewater to the Maas. Although an improvement, this system was still not flushed regularly enough by Maas water to prevent a foul odour from emanating from the sewers (van den Noort & Blauw 2000, 13–15).

[8] All of these are on the north bank — areas on the southern bank were incorporated into the municipality of Rotterdam around the turn of the century.

Table 20. Key long-term decisions on Rotterdam water and sewerage services

Year	Event	Factor	Outcome	Organisational change	Stakeholders
1854	First attempt to improve open sewer system	Public health problems	Some improvement		Citizens, City/Mayor
1858	New plan, to build reservoir upstream and flush sewers properly	Continuing public health problems and smell			Head of municipal works
1862	First draft proposal presented to Mayor by municipal committee	Delays caused partly by opposition of city architect, Rose, who had a financial stake in maintaining status quo	Draft plan		City architect, Mayor, Council
1864	Tender proposal finalised; none of the offers meet council terms	How much should sewer-flushing be cross-subsidised by private connections	Mayor authorised to negotiate at own discretion		Mayor, Council, private business
1866	Provisional concession agreement with JF Metzelaar collapses without replacement	Metzelaar unable to raise financial capital; alternative offers involve unacceptable terms		Provisional concession 1865 (lapsed 1866)	Mayor, Council, private business
1867	First plan for munici-pal water system de-veloped, and amend-ments requested	Negotiations with private parties ongoing			Head of municipal works, city architect, Mayor
1868	Revised plan for mu-nicipal system com-pleted, and shelved	Negotiations with private parties ongoing			Council/Mayor
1869	Revised plan for municipal system presented to council, and passed	Negotiations with private parties clearly leading nowhere		DWL created	Council/Mayor
1874	Municipal water supply system comes online				
early 1880s	Experimental sewerage system fails	Population density too low (advice of DWL Director ignored)			Council/Mayor, DWL Director
1883	Plan for modern sewerage system launched				Head of municipal works
1903	Municipal health board investigation of typhoid outbreak reveals lack of independence of DWL from municipal works			DWL becomes fully independent (1907)	City
1985 – 1994	Merger of DWL with 9 other companies into Waterbedrijf Europoort (WBE)			WBE created	Province of Zuid-Holland
2004	WBE merges with Delta Water	Economies of scale, especially in industrial water market		Evides created	

By 1858 a new plan had been drawn up by the head of the municipal works (*Gemeentewerken*, created 1855; van den Noort 1990, 19), W.A. Scholten. The plan was built on the Water Project, and foresaw the construction of a reservoir upstream along the Maas, with water being brought to the city to ensure sufficient flushing of the city's sewers, which would then be explicitly used for blackwater (human waste). Rose opposed the blackwater approach, preferring the continuation of the existing system of sludge collection, where sludge was sold for agricultural purposes. His financial participation in the profitable sludge collection concession may have been a factor, especially as the concessionaire was not averse to dumping in the canals excess sludge that could not be sold.[9] Scholten wrote a report on his visit to assess the blackwater system in Hamburg as well as described his experiences in other cities, including London, Berlin and Milan. That his proposed system would also enable drinking water to be supplied through a network was an incidental by-product of the plan; and one of less interest to Scholten than the improved fire-fighting capacity he discovered in Hamburg (van den Noort & Blauw 2000, 13–15). Shortly after presenting his plan, Scholten died of typhus (1861), one of the main diseases his water system was designed to combat. His successor, C.B. van der Tak, continued his plan, and the council decided to put the system out to tender.

Plate 38. Draining water from the polder close to Rotterdam, the Netherlands (Photo: K. Wallenius, 2004)

[9] The concession was held by councillor I Thooft and his heirs from 1847 to 1873; in 1887 the service was integrated into the municipal waste management works, established in 1876 (van den Noort 1990, 30 & 46).

From private concession attempts to municipal works

In 1862 the municipality decided to put the construction and operation of Scholten's system out to tender, with the initial draft proposal presented to the Mayor by the municipal Committee on Local Works on 27 October 1862 (Dijkstra 1974, 27). Although the primary purpose of the plan was to supply water to flush sewers with — a purpose the municipality would have to pay for — concern about the financial burden led the municipality to declare that it would pay little or nothing to a private operator for this purpose, who would be expected to cross-subsidise this function from the profits gained from private connections for drinking water. A major problem with this approach was that the private operator would be competing in large parts of Rotterdam with acceptable quality water which could be abstracted at no cost from the Maas. Recognising the potential problems, the Committee on Local Works noted that if no private contractor could be found, the municipality would have to undertake the task itself.

Nonetheless, even prior to the council's completion of its deliberations, offers from private parties were being submitted to the council. This had significant consequences, as it led the council to conclude that the concession was rather valuable, and led to or, at least strengthened, the idea of a cross-subsidy from household connections. One councillor sounded a note of caution, pointing out that any gains the council made in this way would effectively constitute a tax on drinking water. Another councillor made a proposal (not accepted by the council) that to keep prices low, a uniform price should be required in the binnenstad and the Waterstad, whereby the competition in the Waterstad based on free Maas water would keep the price low for both districts. Finally, on 3 March 1864 the council finalised the tender, proposing — to give the concessionaire sufficient room to manoeuvre — that the sewer-flushing concession would run for sixty years, and that for the first twenty it would have a city-wide monopoly on drinking water supply (van den Noort & Blauw 2000, 18).

The reaction, however, was underwhelming, and even after a two-month extension of the deadline, only four offers had been received, none of them meeting the council's terms. The council rejected all four and authorised the mayor to continue at his own discretion. He reached an agreement with one of the four contenders, a local businessman named J.F. Metzelaar, and on 8 August 1865 the council approved the new concession terms. Metzelaar, however, had severe difficulty in raising the capital required, with potential links in Liverpool and London falling through; appeals to the population of Rotterdam (to become shareholders and sign three-year water consumption contracts) did not raise enough funds either, (Dijkstra 1974, 30) and in 1866 Metzelaar's concession ran out without replacement. The water company of Liège[10] let the council know, through Metzelaar, that it would be prepared to take over the concession in return for an income guarantee from the municipality;[11] but the council refused, and subsequent negotiations between the company and the Mayor led the Mayor to report to the council on 21 January 1867 that the need to ensure a return on capital would make prices unaffordable for most, suggesting the city might take the matter in its own hands (Dijkstra 1974, 31).

[10] Compagnie Generale des Conduites d'Eau of Liège/Luik.

[11] Among other conditions, the company also wanted the wording of the concession terms changed so that drinking water quality would be evaluated only in biological terms, excluding chemical criteria (Dijkstra 1974, 31).

The first plan for a municipal water system was presented in 1867. Using different estimates of expected water consumption than private partners had so far, the estimated costs of the system were considerably higher than Metzelaar's; the Mayor requested the water capacity be doubled, to 4600 m^3/day (or 15,000 ft^3/day) (Dijkstra 1974, 32). On 21 November 1867 one councillor proposed that it was time for the city to take care of the matter itself, but found no support. The City Treasurer pointed out that negotiations with private parties were still ongoing and might yet lead to a successful outcome (van den Noort & Blauw 2000, 19). The secrecy surrounding the negotiations was criticised by another councillor, sarcastically comparing it to foreign diplomacy. Rose and van der Tak's revised plan was finished on 18 July 1868. As negotiations with private partners were still ongoing, the plan was shelved for another year, until it finally became clear that no agreement would be reached. Rose and van der Tak's plan was presented to the council on 15 September 1869 and accepted on 13 November 1869, with one councillor (of 35) opposed (Dijkstra 1974, 32). The lack of results from the long negotiations with various private parties meant that the private option was not feasible. The water system first began operations on 30 July 1874, and was officially opened on 1 October.

The advantage of a municipal operation was that it allowed the city to promote public health by flushing the sewers by collecting a cross-subsidy from wealthy households (initially, only wealthy households could afford a connection, and connection rates increased dramatically in the last decades of the nineteenth century). Although it seems strange that drinking water was initially an incidental by-product for the Drinkwaterleiding Rotterdam, the mid-nineteenth century public health insights of Englishmen like John Snow — that dirty water was the source of diseases like cholera, not 'miasma' — took another fifty years to reach the Netherlands. Hence the priority was flushing the stinking sewers, not providing clean drinking water.

Nonetheless, the importance of the latter was well-enough recognised so that in the 1860s and 1970s the city distributed water in buckets, especially during epidemics. That the new system did have an impact can be seen in the fall in annual mortality from 32 per thousand in 1870 to 17 in 1900 (van den Noort 1990, 123).

A modern sewerage system — again building on the previous systems, but this time using closed, underground sewers — can be dated to a plan presented by *Gemeentewerken* Director de Jongh on 27 June 1883 (van den Noort 1990, 2). A different type of sewerage system (Lienur's pneumatic system) had been tested (unsuccessfully) in Feijenoord in the early 1880s; DWL director Cramer had warned that the area had too low a population density for it to be efficient (van den Noort 1990, 52).

Water consumption

By 1894 water consumption reached 205 l/head/day. City action to reduce and then ban the use of tap water for street washing reduced this to 163 l by 1898, rising again to 185 l by 1904, before falling again to 161 l in 1907. The decision that year to charge the city for water used in public buildings reduced consumption to 142 l in 1908. A 1908 council decision to make toilet cisterns compulsory reduced consumption to 98 l in 1910 (Dijkstra 1974, 57).

Other issues in the 19th and early 20th century

In 1868 a state commission (set up following the 1866 cholera epidemic) issued a report emphasising the importance of clean drinking water for public health. The following year, during Rotterdam's debate over creating a municipal water works, the provincial health inspector sent letters to the council declaring that chemical treatment of water from the Maas was an absolute necessity. The municipal health board supported the inspector's opinion, but remained divided about the consequences to be drawn. The commission appealed for a dune water source to be used; the two doctors on the commission even said that the water supply idea should be abandoned for the time being if this was not possible. In 1873 the council set up an expert commission to look into the necessity of chemical treatment, which finally reported a year and a half later that it was not. The water system first began operations on 30 July 1874, and was officially opened on 1 October.

Although the DWL was largely given free rein by the city authorities, its organisational linkage with the Gemeentewerken, together with the subordination of the DWL's director to the Gemeentewerken director, meant its independence was somewhat limited. The DWL finally became a clearly separate organisation in 1907 (Dijkstra 1974, 48). This followed an outbreak of typhoid in 1903, the cause of which was investigated by the municipal health board, which along with the physical cause discovered that the director of the DWL had relatively little control, and that much of the blame actually lay at the door of the Gemeentewerken.

Although the water concession never got off the ground in Rotterdam, the water companies of several neighbouring municipalities, which would later be merged with Rotterdam's to form Waterbedrijf Europoort, were originally private concessions. For example, the NV Vlaardingsche Waterleiding-Maatschappij originated as a private concessionaire in 1885; it was municipalised in 1911 (van den Noort & Blauw 2000, 64). In Maasluis drinking water was originally provided by a private company, which was municipalised in 1922 amid strong concerns about water quality because of the use of polluted surface water as a source. Less than 2 months after municipalisation, chlorine treatment of drinking water was introduced; Maasluis was one of the first Dutch municipalities to use it.

Some neighbouring municipalities (some of which later merged into Rotterdam) received bulk water from DWL; eg Schiedam, Vlaardingen. A factor leading to this was the creation of the Nieuwe Waterweg that shortened the distance between Rotterdam and the sea, which particularly after its deepening allowed saltwater to increasingly intrude into the ground water. This led Maasluis, for example, to eventually import drinking water by ship.

Between 1870 and 1895 Rotterdam expanded several times, as neighbouring municipalities (or parts of them) were merged into the city. In the space of 25 years, the area of the city increased 8-fold, and the annexations contributed to a rise in population from 120,000 to 300,000 (van den Noort 1990, 122–3). In 1923 Rotterdam expanded again, taking over parts of Schiedam, including its water towers. In anticipation of the rest of Schiedam merging into Rotterdam soon, a "perpetual" agreement was reached in which Rotterdam agreed to supply Schiedam with bulk water at the fixed price of 4.2 cents/litre. By 1973 — with no merger having taken place — this arrangement was costing Rotterdam 2 million gulders per year, and it reached an agreement with Schiedam to buy its way out of the contract for a lump sum of 14 million gulders (Dijkstra 1974, 74).

In 1901 a *Gezondheitswet* was passed to regulate state supervision of public health, including drinking water supply. A requirement was introduced for municipal health commissions, supervised by a regional inspector, to be set up in towns of more than 18,000 people. By the turn of the century, there was a 70 per cent connection rate for drinking water supply in South Holland (80 per cent by 1914), but connections were heavily concentrated in towns and cities: less than a quarter of the surface area had access to drinking water networks as rural areas were left behind (van den Noort & Blauw 2000, 112) In 1912 a state-owned water supply system for rural areas was considered, but progress was very slow, and it was eventually pre-empted by the creation in 1920 of the Provincial water company PWN, covering much of the state company's planned territory (van den Noort & Blauw 2000, 112). **Table 21** summarises the agglomeration of water utilities in the province of South Holland over the years.

Table 21. Number of water companies in the Province of South Holland

Year	1900	1910	1929	1938	1971	1994	2004
No	17	35	70	80	35	3	3

Sources: 1900–1938: van den Noort & Blauw 2000, 116; 1971: Dane & Warner 1999, 51.

According to van den Noort (2003, 2005), Rotterdam's wastewaters were hardly treated until the 1980s. Then three biological treatment plants were opened for Rotterdam and its neighbours (West: Vlaardingen in 1982; East: Kralingseveer in 1986; South: Dokhaven in 1986).

In 2002 the first PPP contract in the Dutch water industry was concluded, concerning the construction and operation of the Harnaschpolder wastewater treatment plant, one of the largest in Europe, to serve The Hague and parts of Rotterdam.

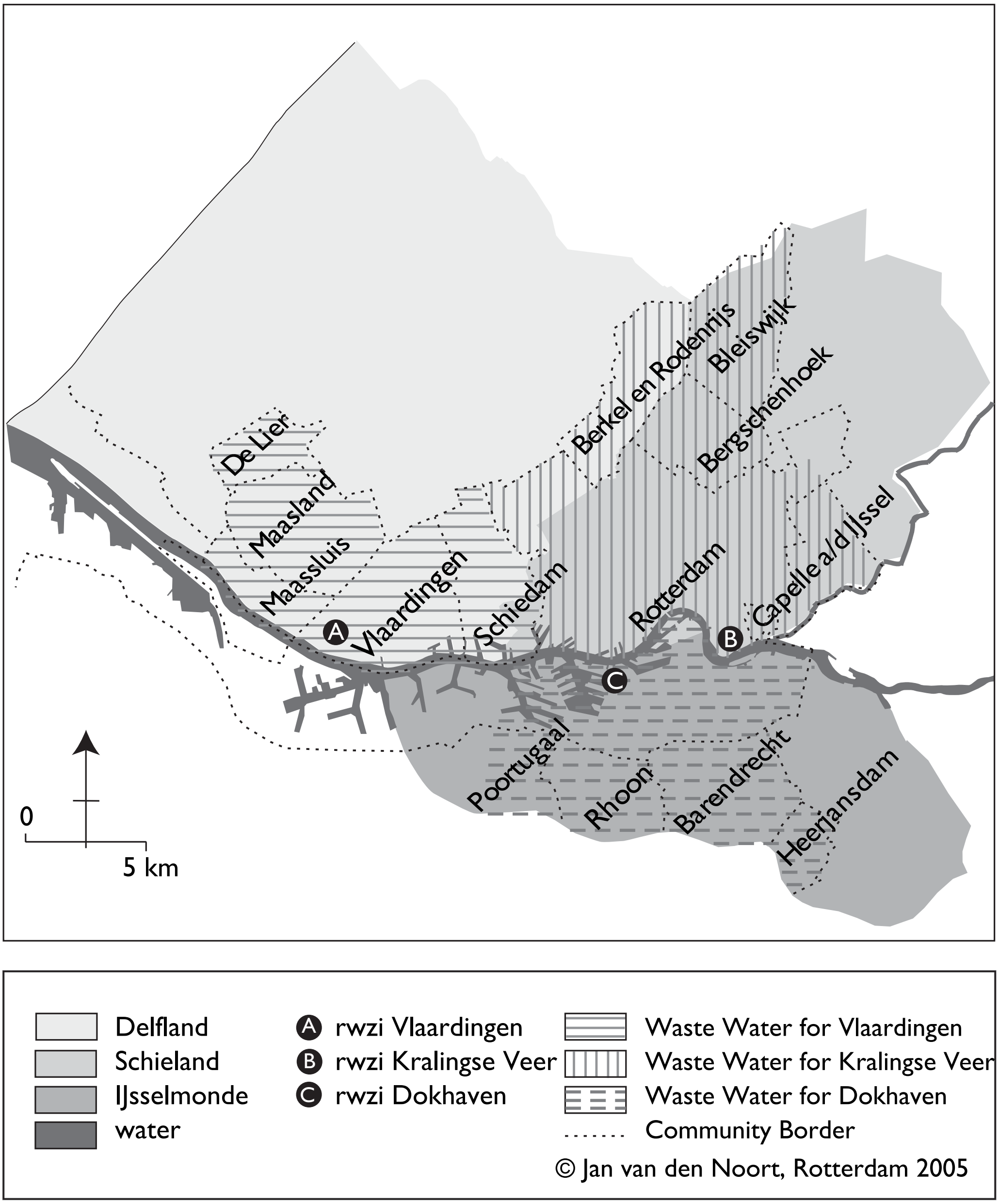

Plate 39. Sewerage system plan with three wastewater treatment plants near Rotterdam from 1975. The map shows overlapping spheres of influence among the fourteen municipalities in the region and the three Water Boards (Delfland, Schieland and IJsselmonde). In 1974 the responsibility for wastewater treatment was transferred from the municipalities to the Water Boards. In the 1980s, after heated debates, three wastewater treatment plants (rwzi) were built (Graph: Jan van de Noort, 2005)

Poland

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Poland's water system history can be categorised as:

(i) 19th century, and early 20th century: heavy reliance on wells, occasional examples (eg. Gdańsk) of municipal development of water and sewage systems;
(ii) 1920–1950: beginning of (municipal) water system construction in some cities, but slow progress due to politically chaotic interwar years and WWII;
(iii) 1950–1990: water utilities nationalised, and networks and treatment sys tems expanded, though not enough to cope with demand, creating water quality problems (for drinking water and for the environment);
(iv) 1990 onwards: remunicipalisation. Under increasing pressure from EU standards as well as catch-up needs, large-scale investment (relative to previous period, less to needs) using national funds, foreign funds, and municipal/enter prise funds. Some privatisation, but utilities remain overwhelmingly municipal.

Ground water is unusually accessible in Poland compared to most other European countries: "usable aquifers may be found beneath almost 80 per cent of the country's surface" (Inspection for Environmental Protection 2003, 159). As a result, water mains in many cities were a relatively late development, and public and private wells are still important sources of water even in urban areas. Water networks were not seriously developed in most urban areas until after WWII. Gdańsk, however, (then part of Prussia) was an exception, as its reliance on surface water from its increasingly polluted river (a branch of the Vistula) caused large-scale health problems. The city developed a sewerage system, including a wastewater treatment plant, in the late 1860s, several years before Berlin did, as well as developing ground water sources around the same time.

Gdańsk

Poland's largest city until around 1770, Gdańsk is still its 6th largest. Its population has increased relatively little since 1975 when it had a population of 420,000. Together with several other urban areas Gdańsk forms an agglomeration known as the Tri-City (Trójmiasto) with more than 800,000 inhabitants.

Table 22. Key long-term decisions on Gdańsk water and sewerage services

Year	Event	Factor	Outcome	Organisational change	Stakeholders
1865	Water and sewerage system construction begins	Sanitary conditions in Gdańsk			Citizens, City/Mayor
1872	WWTP begins operations				
1932	More modern WWTP ("Zaspa") begins operations				
c. 1950	Municipal company taken over by voivodship	Most municipal services nationalised post-1945 under communist system		Nationalisation	Voivodship
1976	Construction of modern WWTP ("Wschod")	Widespread environmental pollution from Gdańsk wastewater	Wschod completed, though only with mechanical treatment		Voivodship
1985	Capacity of Wschod doubled to 180,000 m^3				Voivodship
1992	Utility transformed from voivodship company by giving 30-year contract to SAUR joint venture with city (SNG)	Various	Saur Neptun Gdańsk (SNG) created	Municipalisation and privatisation by 30-year lease contract	City/Mayor, national government
1990 – 2000	50% decline in water consumption	Declining industry and increased industrial efficiency; meters and higher prices reduced household demand			Industry, consumers, company
1993	Chemical treatment added to Wschod	Finance provided by city, company and Ecofund			City/Mayor, Ecofund
1995	15% decline in household water consumption	Prices, meters	Income falls so much that SNG made a loss that year	Contract renegotiated to provide fixed return on capital	Consumers, SNG, city/mayor

In the 19th century Gdańsk (Danzig) was an important military harbour of the Kingdom of Prussia. In 1875 it had 98,000 inhabitants. Gdańsk suffered from the typical 19th century health problems associated with using the same water source for water supply and for (untreated) wastewater disposal. The first ground water intake ("Pregowo", still in use in 2003) was constructed in 1869.

The sewerage system of Gdańsk, including a sewage treatment plant, a pumping station and collecting sewers, was designed by the German engineer Friedrich Wiebe in 1865 (**Table 22**). The design addressed the problems of collecting, transporting and treating wastewater simultaneously; from the very beginning the stormwater system and the sewerage system were separate. The first treatment plant "Stogi," using filtration fields, was built in 1872, and it fulfilled its role efficiently for almost 120 years before it was closed in 1991 (Swinarski 1999). According to Kowalik & Suligowski (2001), the 1872 system was the first comprehensive water supply and sewerage system on the European continent.

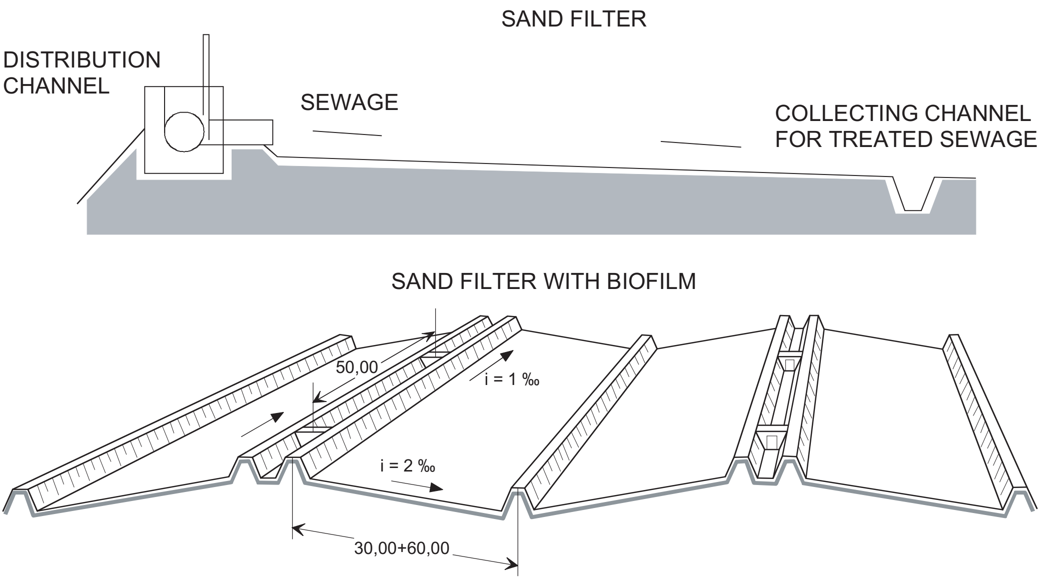

Plate 40. Wastewater filtration fields built in Gdansk, Poland in 1872 (Graphs: Above: Swinarski 1999, p. 72; redrawn; Below: Kowalik & Suligowski 2001, reproduced with the permission of Ambio).

In 1932 an activated sludge plant, "Zaspa", was built to replace two smaller local plants using filtration fields and bio-filters, and it remained in use in 2003, although there were plans to close it down. Until 1970 the sewerage system of Gdańsk, built before World War II, remained mostly in its original form; the existing system was modernised only to enlarge its capacity. Later developments of the sewerage system aimed at centralisation. The central mechanical treatment plant "Wschod" was constructed in 1976 with a total flow of 94,000 m^3/day (expanded to 180,000 m^3/day in 1985). For financial reasons treatment plants were however not substantially modernised in the 1970s and 1980s, despite urgent needs and significant deterioration of treatment results and consequent environmental outcomes. Most of the increasing amounts of sewage collected in Gdańsk were treated only mechanically, which caused increasing pollution of Gdansk Bay, leading to the closing of many beaches (Swinarski 1999).

In the 1990s the modernisation and development of the sewerage system in Gdańsk recommenced, motivated both by general environmental concerns and the specific desire to make Gdańsk more attractive for tourism. Chemical treatment to remove pollutants more effectively was introduced in 1993, following the commencement of a 30-year lease contract with Saur Neptun Gdańsk, a joint venture between the city and French multinational SAUR. However, the incomplete and long-neglected system had needs which greatly exceeded the financial resources of the city. In 1997 loan finance from the National Environment Fund made it possible to begin modernisation and further development of the treatment plant "Wschod", which would contribute greatly both to the improvement of the sanitary condition of the Gdańsk coast and to sea water pollution control. By the middle of 1999 the plant was to use the modified UCT2 system for biological nutrient removal (Swinarski 1999).

Plate 41. A covered ground water well in Gdańsk, Poland
(Photo: Agata Depka, 2004)

ŁÓDŹ

The City of Łódź is one of the largest cities in Poland with approximately 850,000 inhabitants. Łódź's history is closely linked with the textile industry, which developed in the 19th century in part because of the area's excellent ground water resources, with a favourable chemical composition. Most factories had their own wells, so there was not a direct industrial demand for a water system. However, the expansion of industry drove a massive population expansion in the late 19th century, nearly trebling to 320,000 in the 15 years to 1901 (**Table 23**). In 1840 Łódź had only 13,000 inhabitants, while by 1913 it had around 500,000. Just before World War I, Łódź was one of the most densely populated industrial cities in the world, with 13,280 people/km^2, yet still had no water and sewerage system (City of Łódź 2004).

At the beginning of the twentieth century, pressure from citizens for a water and sewerage system continued to grow, as sanitary conditions became increasingly critical (Czarzasty, 2004b.) With its huge working class population, Łódź saw a strong socialist movement develop, which in 1892 paralysed the city with strikes. Later hundreds of workers were killed by Russia's Tsarist police (City of Łódź 2004). The socialist movement helped organise public pressure, which eventually became so great that the Mayor of Łódź invited British engineer William Heerlein Lindley, already overseeing Warsaw's water system, to design a system for Łódź. After an 8-year study the proposed system was, however, so expensive that the authorities shelved the project for some years.

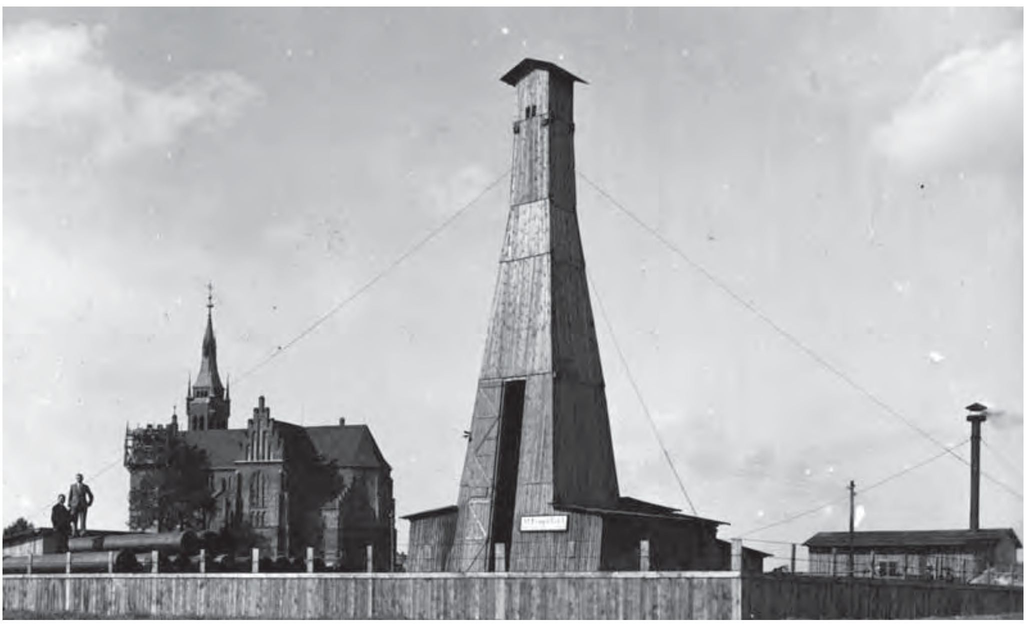

Plate 42. Drilling of a deep well in 1934 in Łódź, Poland
(Photo: Company of Water Supply and Sewage Systems in Łódź, ZWiK)

Table 23. Key long-term decisions on Łódź water and sewerage services

Year	Event	Factor	Outcome	Organisational change	Stakeholders
1876	First requests to city for a WaSN	Growing population (50,000)	Requests denied – no WaSN		Citizens, City/Mayor
1885	Engineers Słowikowski and Bronikowski offer Mayor Pieńkowski to design WaSN	Growing population (108,000)	Offer ignored – no WaSN		Engineers, Mayor
1901	Strong public pressure for a WaSN	Growing population (320,000); sanitary conditions becoming critical; other major Polish cities developing WaSNs	Mayor invites William H Lindley to design Łódź WaSN		Public, Mayor, Engineer
1909	Lindley presents report proposing gravity network using sources 50km away	Lack of suitable water resources near Łódź; Łódź's topography	Proposed WaSN design		Engineer
1909	City drops WaSN project	Cost	No WaSN		City/Mayor
1918 – 1925	Project plans are re-examined and set in motion	Public pressure; new political environment (Polish independence)	WaSN construction begins 1925	Municipal WaS unit set up	
c. 1950	Municipal company taken over by voivodship	Most municipal services nationalised post-1945 under communist system		Nationalisation	Voivodship
1952	New 50km surface water supply line commissioned	Dramatic water shortages in Łódź (rationing since 1950)	New supply line (following original Lindley concept) completed 1955		Voivodship
1968 – 1977	17 km artificial lake developed	To increase supply and ensure year-round supply	Supply increased and secured		Voivodship
1976	Construction of WWTP begins	Widespread environmental pollution from Łódź wastewater	Financial constraints do not allow completion by 1990		Voivodship
1991	Utility transformed from voivodship company to city of Łódź MBE			Municipalisation	State, city/Mayor
1990 – 2000	50% decline in water consumption	75% fall in industrial demand (declining industry, increased efficiency); 35% fall in household demand (meters, higher prices)	Less water needed; use of surface water reduced; treatment costs reduced		Industry, consumers, company

Year	Event	Factor	Outcome	Organisational change	Stakeholders
1994	Phase I WWTP completed	Finance provided by city, company and National Environment Fund (NEF)			City/Mayor, NEF
2000	Operations of WWTP hived off			WWTP operated by separate municipal co.	City/Mayor
2001	ZWiK incorporated	Various		ZWiK becomes a commercial law company	City/Mayor, national government
2004	Contract for completion of final phase of WWTP	Continuing pollution issues; EU directive (UWWT); EU finance	WWTP to be completed to EU standards by 2006		City/Mayor

By 1918 Łódź was the last city in Europe of its size (450,000) without a water and sewerage network. Construction started in 1925, using Lindley's designs. The first (mechanical) water treatment plant at Lublinek began operations in 1932. The intervention of the Second World War meant that relatively little progress was made, and at the end of the war the total lengths of sewage and water networks were 192 km and 86 km, with 227,000 and 56,000 people served, respectively (ZWiK 1998, 12).

The construction of a water mains network in Łódź (by the municipality) started only in 1934 (Trzupek 2004, 8). The intervention of WWII meant relatively little progress was made, and at the beginning of 1952 only 1,336 properties were connected to the water and sewerage network then being constructed. Łódź at the time had 750,000 people, mostly served by wells (Poralla 1952). By 1996 Łódź had the highest proportion among Polish cities of inhabitants using water from the water mains network — 99.1 per cent (Trzupek 2004, 8).

With the sewerage network expanding to 65 per cent coverage by 1965 (ZWiK 1998, 12), the quantities of effluent pouring into the Ner River, a tributary of the Warta which flows into the Odra, were leading to serious pollution of the river downstream from the city. As a result, a wastewater treatment plant was designed and planned, with construction beginning in 1976 (Czarzasty, 2004b). At the time the construction project was under the direction of the voivodship, the regional administration which then owned the water and sewerage company, ZWiK; ZWiK was responsible for the implementation of the project. With state budgets always under stress, even a project considered of national importance found finance hard to come by, and there were repeated delays; by the early 1990s, only 25 per cent of the 450,000 m^3 plant had been constructed (FT Energy Newsletters 1993). After 1990, and the transfer of ZWiK into municipal hands in December 1991, the project was entitled to support from voivodship funds, but the state's means continued to be limited (Solidarity 2004). (**Table 24**)

Table 24. Coverage of water and sewerage in Łódź, 1945–1997

Year	Water				Sewerage		
	network (km)	population served (000s)	coverage (%)*	household consumption (l/p/d)	network (km)	population served (000s)	coverage (%)
1945	86	55.7	11.3	62.3	192	226.7	45.1
1965	627	447.5	80.2	93.4	512	485.0	65.2
1980	1173	784.1	93.8	234	1019	690.8	82.4
1997	1814	807.6	99.1	155.1 (2000)	1408	742.2	93.7

*The city population implied by the coverage figures for water and sewerage is not always the same (notably for 1965) — it is not clear why.
Sources: ZWiK (1998:12), Januszkiewicz et al (2004)

The city's wastewater is discharged largely to the Ner River, a tributary of the Warta which flows into the Odra, leading at present to serious pollution of the river downstream from the city. The city has substantial requirements for investment in drinking water supply and improved and extended wastewater treatment. About 91 per cent of the population of Łódź is connected to the sewerage system.

Plate 43. Inner view of the potable water tank of Łódź, Poland during conservation before filling with water, constructed originally in 1937 (Photo: Company of Water Supply and Sewage Systems in Łódź, ZWiK, 2002)

Warsaw

At the end of the 19th century Warsaw's sewage still flowed straight into the Vistula River through open gutters or covered drains, causing the usual health problems. In 1876 the city of Warsaw (under acting mayor General Sokrates Starynkiewicz, appointed by the Tsar) commissioned the English engineer William Lindley to design a water and sewerage system, above all because of the city's poor sanitary conditions. (**Table 25**) Lindley had already designed and constructed systems in Hamburg, Frankfurt and across Europe from Budapest to Moscow (Wierecky 2003). The blueprint was completed in May 1878.

The plans were readily accepted by the Russian government in St Petersburg due to Lindley's reputation and the fact that epidemics were breaking out in Russia. In 1881 an agreement was signed with William Lindley and his son William Heerlein Lindley for a detailed project of a water supply and sewage disposal system as well as for taking over the management of the works (Wrobel 1999). Construction began the same year with Lindley's son, William Heerlein Lindley, as chief engineer. The basic sewer arrangement remains to this day. The water treatment plant began operations in July 1886. It remained the only one in Warsaw until the 1950s, and "Central" as it is now called, is still Warsaw's main plant (Drogosz 2004).

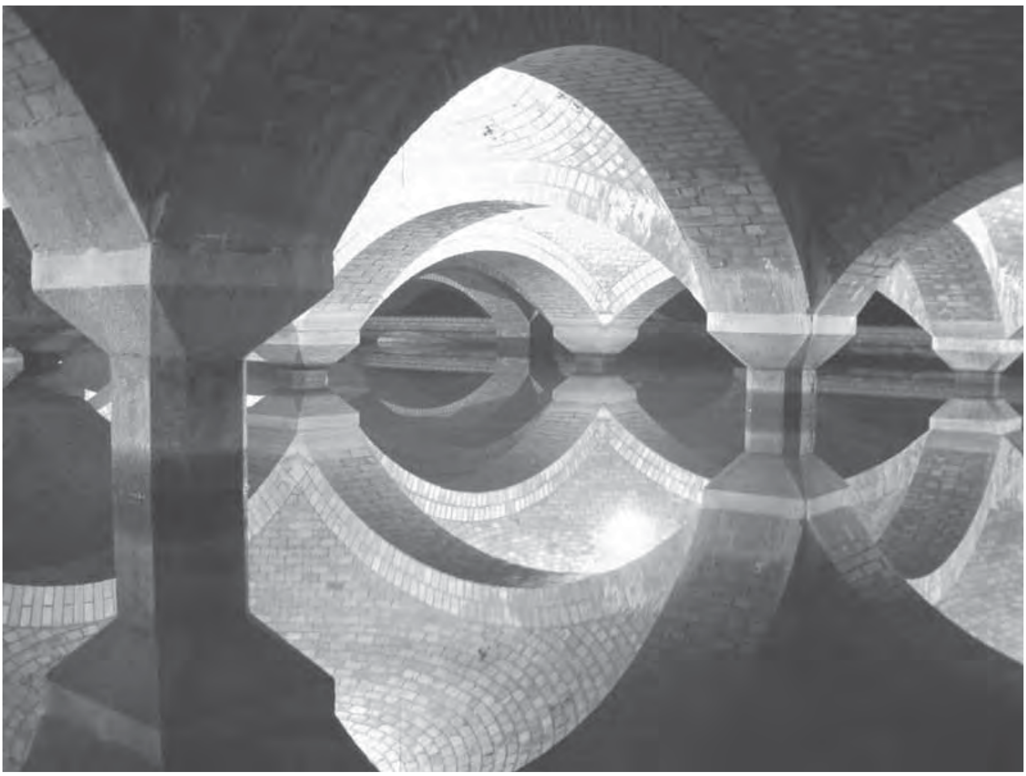

Plate 44. Underground slow sand filters in Warsaw, Poland — originally constructed in 1886
(Photo: Municipal Water Supply and Wastewater Company in Warsaw City, 2004)

The first wastewater treatment plant for Warsaw[12] ("Czajka") was designed in 1970–1973, and construction began in 1974. Operations began in January 1991. For historical reasons it is situated on the right bank of Warsaw, where most of the industry used to be. At the time, industry accounted for 30 per cent of wastewater, including the most heavily polluted; while it was 8 percent in 2004. The projected capacity in 1974 was to be 400,000 m^3, to be expanded to 600,000. In 2004 it was 240,000 m^3, and was sufficient for the right bank's needs together with some neighbouring municipalities ("Czajka" 2004).

Construction of a second plant ("Południe"), situated south of the left bank, began in 2000 and is due to begin operations in 2006. However, treatment of all of Warsaw's wastewater will have to wait for Czajka to be expanded (to around 500,000 m^3) and connected to the left bank by 2010.

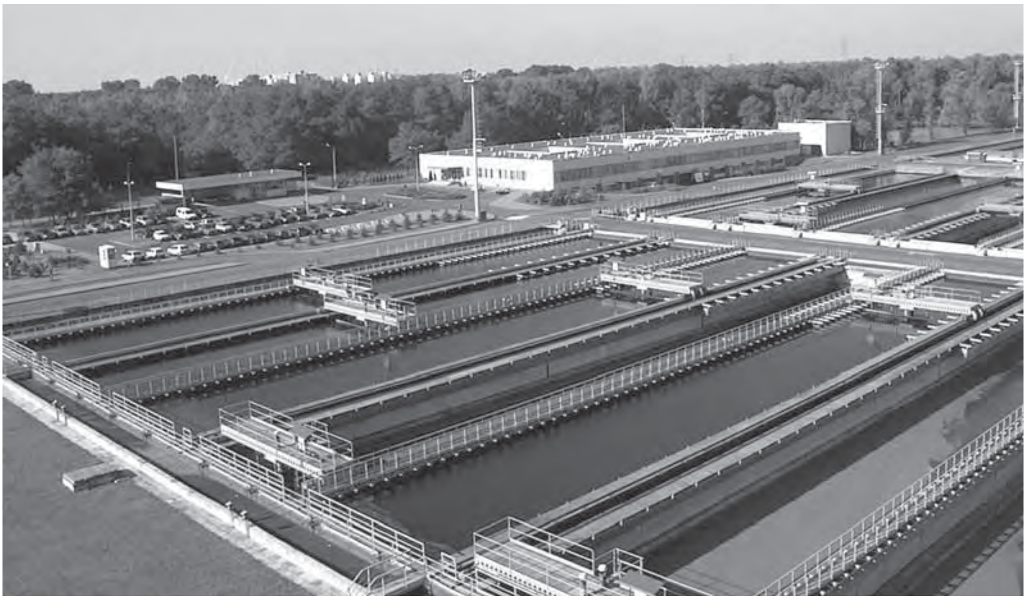

Plate 45. Wastewater Treatment Plant "Czajka" in Warsaw, Poland constructed in 1990
(Photo: Municipal Water Supply and Wastewater Company in Warsaw City, 2004)

[12] The neighbouring municipality of Pruszków has had a small WWTP since the 1970s. It also treats some wastewater from one of Warsaw's districts (Ursus). Its capacity was expanded to 50,000 m^3 in 1999–2003.

Table 25. Key long-term decisions on Warsaw water and sewerage services

Year	Event	Factor	Outcome	Organisational change	Stakeholders
1881	Water and sewerage system construction begins	Sanitary conditions in Warsaw		Warsaw MBE	Citizens, City/Mayor
1886	Water treatment plant begins operations				
1974	Construction of WWTP ("Czajka") begins on right bank	Widespread environmental pollution from Warsaw waste-water; most industry (30% of WW) is on right bank	Financial constraints prevent completion by 1990		Voivodship
1991	"Czajka" begins operations				Voivodship
1991	Utility transformed from voivodship company to Warsaw MBE	Various	ZWiK municipalised	Warsaw MBE	City/Mayor, national government
1990 – 2000	Decline in water consumption and wastewater output	Fall in industrial demand (declining industry, increased efficiency) and in household demand (meters, higher prices). Industry fell from 30% to 8% of wastewater	Czajka's planned capacity no longer needed		Industry, consumers, company
Early 1990s	"Czajka" modernised and capacity reduced from 400,000 m^3 to 240,000 m^3.	Decline of industry means capacity not needed on right bank; need to modernise to improve environmental standards			City/Mayor, company
1999	Decision to connect "Czajka" to left bank and expand to provide necessary capacity	Most of Warsaw's wastewater still untreated; impending EU requirements (UWWT); finance available			City/Mayor, company, consultants
2000	Construction of "Południe" WWTP begins	Most of Warsaw's wastewater still untreated; finance provided by city, company and National Environment Fund			City/Mayor, NEF
2003	MPWIK incorporated	Various		MPWIK becomes a commercial law company	City/Mayor
2004	MPWIK solely responsible for investment				City/Mayor

Romania

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The key phases of long-term WSS development in Romania can be divided roughly as follows:

(i) Early systems before the mid-1800s;
(ii) Start of modern WSS systems from the mid-1800s;
(iii) Expansion of systems mainly based on municipal systems, including also some early wastewater treatment;
(iv) The post-war period influenced by the Soviet Union and the central role of the state;
(v) Since the early 1990s the start of modernisation of systems including water pollution control and some private operation contracts, like in Bucharest, where a multinational company won a contract in 2000.

Bucharest

The first fountains and water pumps were built under Under Prince Gheorghe Dimitri Bibescu's rule. Until then, the city dwellers drew their drinking water directly from the Dambovita River. Those situated far from the river used dug wells or springs. In 1847 the first mechanical water supply system in Bucharest was put into operation: Bucharest had direct water intake from Dambovita River, a treatment procedure (wool filters), water pumping and a distribution network (cast iron pipes). In 1848–1866 the first hydrants were mounted and the first water tariffs applied. Alexandru Ioan Cuza developed then the first regulations concerning the tax procedure for the water distributed by public water pumps to private consumers (**Table 26**).

In the early 1870s, the development of the city and the restricted area served by the so-called "fountain settlements"[13] together with the low efficiency of the settlement forced the municipality to seek solutions for increasing the water supply to the city in order to satisfy the increasing demand. Other problems besides water supply also emerged such as those related to sewerage, Dambovita River regulation, etc.

In 1876, the then Municipal Mayor, General Manu, organised an auction for project drawing regarding the Bucharest water supply, and the winner was the French engineer Guilloux, the Director of the Romanian Railway, who proposed, among other things, the following actions: An intake in Dambovita 27.5 km upstream from the city, a river diversion on a filtering culvert parallel with the river 0.5 km long and 9 m wide, water clarification before introduction into the pipe, an aqueduct 900 mm in diameter, built of concrete for the first 7 km and then of cast iron, and two brickwork water reservoirs: one on the Spirii Hill (8,000 m^3) and the other on the Avenue. Works started, but were halted due to the War of Independence.

Three years later, in 1879, the Mayor asked two engineers from Zurich (Cullman and Burkli-Ziegler) to rebuild the project on a larger scale; the investigations began at the end of the same year. During the period 1882–1888, the first compartment (10,000 m^3) of a reservoir was built at Cotroceni, as stipulated in the original project of Cullman and Burkli-Ziegler. At the same time, the German engineer Lindley completed the initial project designed by Cullman and Burkli-Ziegler in 1882 including the pumping station of Grozavesti and a water castle (The Fire Water Tower). Finally, in 1889 the Grozavesti Water Plant with a capacity of 90,000 m^3/day was put into operation.

In 1888, the activity of the "fountain settlements", which lasted 41 years, came to an end, and the 15.5 km long Arcuda-Bucharest aqueduct I of the water supply system, taking water from slow filters, was put into operation. In 1892, a water castle (tower) was completed to regulate the pressure within the network (the Fire Water Tower Foisorul de Foc), completing the initial project designed by Cullman and Burkli-Ziegler in 1882. Many years after the tower was finished, it was used only as a fire observation tower because the water pressure hardly allowed filling the reservoir in 1924.

[13] Settlements grown in the neighbourhood of the fountains.

Plate 46a (left) and **46b** (below). Modernising of the water system of Bucharest, Romania; old and new water flow measurement systems (Photo: Apa Nova Bucharest – a Veolia Water company)

Since the water production of the Arcuda Treatment Plant was very low at the beginning — during winter the situation was the worst due to frost and there were many problems in summer also as the flow used to decrease — the engineer Elie Radu presented in 1892 a procedure of using the underground water upstream of Bragadiru-Cornetu communes. The Bragadiru source was chosen for political-military reasons, because it is situated inside a fortress which would have prevented potential enemies of Bucharest from damaging its aqueduct.

In 1923 the Municipality of Bucharest decided to unite all communal services under direct administration in a "regia" called "Uzinele Comunale Bucuresti" (UCB – Bucharest Communal Works, approved by a law called "Administrarea si Exploatarea Uzinelor Comunale Bucuresti" (Administration and operation of the Bucharest Communal

Works). In 1949 the Bucharest Communal Works became the Sewage-Water-Sanitation Utility. In 1955 the Sewage-Water-Sanitation Utility became the Bucharest Sewage-Water Utility. In 1990 the General Water Company of Bucharest (RGAB) was set up by the Municipality of Bucharest, and three years later some modifications were made within the RGAB in order to simplify and modernise the company's activities: introduction of several computer programs regarding personnel, salaries, relationship with customers, the investment programme, evaluation of production, etc.

Table 26. Key long-term decisions on Bucharest water and sewerage services

Year	Event	Reason	Outcome	Organisational change	Stakeholders
1846	Construction of fountains and water pumps	Until then the drinking water was abstracted from Dambovita River, dug wells or springs	Bucharest had direct water intake from Dambovita River, a treatment procedure (wool filters), water pumping and a distribution network (cast iron pipes) which constitute a system		The French hydro-technician Jean Marsillon, appointed for the work, Town Council, Prince Gheorghe Dimitri Bibescu
1872	The French engineer Charlier appointed to design a project on water supply	Increasing demand	Charlier's project was not realised		French engineer Charlier, Municipality of Bucharest
	Municipal Mayor, Cretulescu, asked engineer Lindley from Frankfurt, to review Bucharest water supply		Lindley proposed a program from which an auction was organised. Tenders were not accepted		Municipality of Bucharest , Engineer Lindley
1882	The Mayor adjudged the works for intake, treatment and distribution to the city boundary, proposed by Cullman and Burkli – Ziegler; later the works were continued by Burkli - Ziegler	Engineer Cullman died	Burkli –Ziegler project stipulated: Dambovita water intake at Brezoaiele, Dambovita channelling between Brezoaiele and Arcuda, 3 clarification basins at Arcuda, two SSFs, 1 km each, an aqueduct of 15 km from Arcuda to Cotroceni, a reservoir of 10.000 m3 at Bucharest (Cotroceni), a distribution network supplied by water gravityf		Municipality Romanian engineers Matac, Simion and Giupescu, supervising and coordinating the works; Brisquerin firm (contractor)

Year	Event	Reason	Outcome	Organisational change	Stakeholders
1885 – 1888	Works at the Grozavesti Plant	Lindley completed initial project by Cullman and Burkli – Ziegler in 1882 by buiding the pumping station of Grozavesti and a water castle (The Fire Water Tower)	In 1889 the Grozavesti Water Plant started to operate, capacity of 90.000 m3/day - The activity of the "Fountain Settlements" (lasted 41 years) ceased – the Arcuda water supply system started operating – Bucharest (Sept, 1888), using slow sand filters	Communal Council decided to sell all the old water pumping equipment and buildings in Mihai Voda, since with new system these were not needed	German eng. Lindley, The firm "Echer-Wiss" from Zurich. A Belgian firm from Liege, in charge of water network, The Communal Council
1906	Lindley presented the project for the Ulmi underground front, and a general study concerning the water supply of Bucharest	Increased flow of the Arcuda Treatment Plant	The Communal Council approved Lindley's Ulmi project and the development of the distribution network; a contract was signed	Contract signed with Lindley not approved by the Ministry of Public Works and Mayor Vintila Bratescu cancelled it. Works executed by Romanian engineers led by D. Ghermani, Lindley as consultant	Communal Council, Engineer Lindley , Technical Superior Council of Ministry of Public Works, Mayor Vintila Bratescu, Romanian engineers led by D. Ghermani
1956	The first chlorination process at the Arcuda Plant	Need to disinfect the water			
1960	South Pumping Station				
	Creation of the neutralisation station at the Arcuda Plant, situated in the old chlorination station	After disinfection with chlorine, phenols to be neutralised with ammonia to avoid medicine smelling water			
1990	Creation of the General Water Company of Bucharest (RGAB) by Decision of Municipality of Bucharest		Organizing and functioning regulation of RGAB approved	6 Directions	Municipality of Bucharest
2000	Veolia Water won the tender to privatise Bucharest municipal water services	The lowest tariff applicable during the whole concession period	Veolia Water became the concessionaire of water and sewer services in Bucharest	RGAB became a commercial society	Veolia Water, International Water Ltd, Suez Lyonnaise des Eaux, Municipality of Bucharest, RGAB

In 1925 the Administrative Board of Bucharest Communal Works (UCB) decided to increase the flow of the Arcuda Treatment Plant. The works were completed in 1927, and the flow of the Arcuda Plant reached 60,000 m^3/day. This action allowed the creation in 1931 of a reservoir of 6,500 m^3 at Cotroceni and another one of 4,500 m^3 at Bragadiru. A year later, another reservoir of 8,100 m^3 was built at Cotroceni.

Huge deposits in the upstream part of the predecantor forced building a second barrage at the Arcuda Plant between 1934 and 1935 in order to elevate the water level and eliminate floating elements. On the other hand, the need of industrial water, besides increased drinking water demand, forced building of the Crivina barrage and the Arges-Rosu channel during 1939. The works stopped for the war and began again in 1947.

In November 1949 the Bucharest Communal Works became the Sewage-Water-Sanitation Utility. During the two following years, Aqueduct I was covered internally with a 5 cm concrete layer to avoid the huge detected water losses. In the period 1951-1953, works were executed in order to increase water production at the Arcuda Treatment Plant by raising the filtering speed: fast filters were created by the experimental transformation of pre-filters, and water production grew from 60,000-70,000 m^3/day to 140,000-150,000 m^3/day.

Since water production at the Arcuda Treatment Plant was not sufficient, a Technical-Economical Study concerning the water supply of the city for the following 20 years was carried out. Between 1954 and 1959 the Arcuda Treatment Plant was developed by creating a coagulant station, decanting basins made of concrete, fast filters, a chlorination station, a thermal central, aqueducts and a transformation station.

In 1955 the Sewage-Water-Sanitation Utility became the Bucharest Sewage-Water Utility and one year later, due to the need to disinfect the water, the first chlorination process was developed for the Arcuda Plant.

The flow of raw water in the Dambovita River was not sufficient, and in 1957–1959 some actions were taken in order to assure water supply: creation of the Crivina I Pumping Station on the Arges River, with a capacity of 135,000 m^3/day, and completion of Aqueduct III, (L=16.8 km; Dn=1.5 m; Q=200,000 m^3/day).

In 1960 a neutralisation station was built in the old chlorination station of the Arcuda Plant, since phenols have to be neutralised with ammonia after disinfection with chlorine in order to avoid medicine smelling water.

In order to meet again the need to increase the flow of the Dambovita River, the Crivina II Pumping Station, with a capacity of 90,000 m^3/day, was built in the period 1960–1965 on the Arges River. After some consecutive extensions of the flow of the Arcuda Treatment Plant, the plan concerning the development of the Arcuda Treatment Plant was finally approved in 1981 by Decree no. 199/1981, which stipulated, among other things, the size of the fast filters, by introducing another two filters with a surface of 120 m^2 each one. Thus, the production of the plant grew from 485,000 m^3/day to 745,000 m^3/day.

In 1983, vertical breaks appeared on the vault of the Ulmi-Arcuda aqueduct, generating huge water losses, which determined the need to build a new one.

Plate 47. A new water treatment plant under construction in Bucharest, Romania in 2004
(Photo: Apa Nova Bucharest)

In the period 1987–1990 the regulation of the Mihailesti Lake on the Arges River affected some wells of the Bragadiru front. As compensation, a decree concerning the regulation of the Dambovita River, included, among other things, the development of the Ulmi underground front: a series of wells (35), which composed the Ulmi-Vest front, were put into operation, increasing the production of the Ulmi front from some 40,000 m^3/day to 55,000 m^3/day.

In 1994 the National Committee of the Water Producers and Distributors of Romania (C.N.P.D.A.R.) was created with the aim of representing and defending the interests of the water autonomous regias of the country. In 1997 the Wastewater Treatment Station equipment was blocked due to an ecological accident (heavy pollution with petroleum products), and in order to dispose of these products, four electrical sump pumps and a Flygt mixer from Sweden were acquired. At that time, the Grozavesti Plant stopped its activity and became a museum, being substituted later by a new modern pumping station.

In 1998 the International Finance Corporation (IFC) became the main adviser on the incorporation, restructuring and privatisation of the RGAB. Finally, in March 2000, Vivendi won the tender to privatise the Bucharest municipal water services and RGAB became a commercial enterprise.

Timișoara

During the siege of the city in 1849 by General Bem's troops, the pipe used to supply water to the fortress was cut, and from that moment on, the citadel started to use the dug fountains (**Table 27**). Large-scale use of only water extracted from the fountains makes the quality of the water improve considerably in the long run. The frenetic digging of more than 300 public and artesian fountains began in 1888. When epidemics started to occur, the first international bidding, organised with a view to the creation of a sewerage system for the city, was organised. Ten bids were submitted of which three were rewarded, but none of them materialised.

In 1904 the engineer Vidrighin started to prepare the general wastewater treatment project as well as the water supply project for the city. Since 1907, he coordinated the elaboration of the projects and the construction of the sewerage network (32.6 km) and the wastewater treatment station. Work on the north and south collectors and the wastewater treatment plant started in 1909, and three years later the plant was put into operation. Finally, in 1912 the Wastewater Treatment Plant begins to work, having a capacity of 570 l/s. Some of these structures exist today. In 2004, the WWTP comprises mechanical and biological treatment. The biological step has been in operation since 1981. There are also facilities for sludge treatment and storm water discharge (Ladislau 2005).

In the period 1912–1914 the first and second water towers were built due to the need to supply water in case of system shortages. Since 1914 the Water Factory No. 1 began to operate as well as a series of fountains with a flow of 62 l/s. In 1976, Surface Water Factory No.2 began operation.

In the period 1912–1914 the two first water towers were built due to the need to supply water when the system fails. The water towers were used to accumulate water from the network during the night, when use was low, in order to contribute to the higher consumption registered during the day; each water tower had a capacity of 500 m^3.

In 1914 Water Factory No. 1 started to operate: it consisted of a series of fountains with a flow of 62 l/s, a distribution network 87.4 km long and two equilizing towers of 500 m^3 each. Two years later, the Industrial Water Factory went on-line with a capacity of 150 l/s and its own distribution network of 15.8 km.

Between 1925 and 1957 Water Factory No. 1 was developed until it reached a capacity of 208 l/s and had a distribution network of 155 km while the industrial water network was extended to 36.5 km in the period 1935–1965. Moreover, in 1939 the sewerage network reached 100 km. In 1958 navigation on the Bega River stopped. During the following 17 years, until 1976, Surface Water Factory No.2 was in operation, and its capacity developed from 115.7 l/s to 1,380 l/s, and the distribution network extended from 158 km to 318.8 km.

In 1968 the Wastewater Treatment Plant reached a capacity of 1,200 l/s. In the late 1970s, the economic development and expansion of the neighborhoods required increasing wastewater flow and enlargement of the sewerage network. In the period

Plate 48. The superstructure of the first well used for water supply in Timișoara, Romania, completed in 1914 (Photo: Aquatim – Water and Sewerage Company of Timișoara).

1979–1981 work was started to develop the mechanical stage of the purification process, which increased the treated volume to 800 l/s; biological purification (2,000 l/s) was launched along with Surface Water Factory No.4, which had a capacity of 900 l/s, while the network extended to 421.9 km.

Since 1993 Water Factory No. 1 began to operate under new conditions: it used a new network (20 km long) for catching the water, 40 wells and managed a total volume of 600 l/s. In the same year, the work on Water Factory No. 5 (with a volume of 34 l/s and plans to expand it up to 250 l/s) was finished.

In 1995 the EBRD programme (Municipal Utilities Development Programme) concerning the development of the water and sewerage services of Timișoara was launched. It allowed modernising the mechanical stage of the wastewater treatment station and setting up an industrial water laboratory. Throughout 1996 the municipality financed the digging of several public fountains in the heavily populated sections of the city to ensure an alternative water resource.

In 1997 more than 16,800 water meters had already been installed, as well as some main pipes of ductile cast iron; the centralised supervision, co-ordination and regulation of the drinking water pressure in the network was also organised. During the following two years, the system for monitoring the water pressure, at the level of the whole city of Timișoara, was implemented with EBRD's contribution.

Table 27. Key long-term decisions on Timişoara water and sewerage services

Year	Event	Reason	Outcome	Organisational change	Stakeholders
1849	Pipe to the fortress cut, since then the citadel relied on dug fountains	The city is besieged by General Bem's troops	Subsequent large-scale use of water only from the fountains makes water quality improve in the long run		Local community
1894	1st international bidding, organised for creating a sewerage system for the city	Occurrence of epidemics	10 bids submitted, only 3 rewarded, none of materialised		Municipality of Timişoara
1912	Wastewater Treatment Plant starts to operate, mechanical stage				
1916	The Industrial Water Factory begins operation, 150 l/s and own network of 15.8 km				
1979 – 1981	Improving mechanical WWT, treated volume increased by 800 l/s; Biological WWT (2000 l/s) starts, Surface Water Factory No.4 with 900 l/s, and network reaches 421.9 km	Economic growth and the extension of neighbourhoods increase wastewater flow and enlarge sewerage system			
1995	Start of EBRD-MUDP- programme on development of water and sewerage services		Modernisation of mechanical WWT and creation of an industrial water laboratory		
1997 – 1998	With EBRD's support a pressure monitoring system is developed for the whole city		Computer-based monitoring by radio, not telephone, like with water castles		
2002	Frequency converter on pump of the Water Factory no. 2-4, financed by Aquatim and EBRD		Permits continuous pumping, leading to energy savings, keeps uniform pressure in the network		RA Aquatim

Year	Event	Reason	Outcome	Organisational change	Stakeholders
2003	Loan contract between Aquatim and EBRD. 48,080,000 Euros, 71 % as EU-ISPA grant. Part of loan syndicated to Bank Austria Creditanstalt, the 1st long-term commercial financing for a municipal utility in Romania. RA Aquatim contributed its own funds	The Conference that took place in Mar del Plata in 1977, which stressed the importance of protecting water resources from pollution	The 15-year loan, guaranteed by the city; rehabilitation and upgrading of WWT plant and sewage network, technical assistance for management and supervision, enabling the city to meet EU directives for WWT		RA Aquatim

MUDP = Municipal Utilities Development Programme

In 1999 the new Water Pumping Plant for Water Factory no. 2–4 began to operate thanks to the help of the EBRD, and in March 2002 a frequency converter on a pump of Water Factory no. 2–4, financed by AQUATIM and EBRD, was installed. The new system allows regulating the energy supply of the pump according to the water needed at each moment in the network, which saves electrical power and, indirectly, money; it also maintains uniform pressure in the water network of the city.

In December 2003 the loan contract between AQUATIM and EBRD was signed. The loan is being provided under the Municipal Environmental Loan Facility, set up in 2000 to provide co-financing with the ISPA programme for wastewater-related projects in Romania. AQUATIM benefits from a 48,080,000 euros project, of which the EU, through its ISPA programme, pays 71 per cent, or 34,136,800 euros, in grant funds to support the project. A portion of the loan is being syndicated to Bank Austria Creditanstalt, making the project the first long-term project financing for a municipal utility in Romania with commercial bank participation. RA AQUATIM also contributes its own funds. The 15-year loan, guaranteed by the municipality of Timișoara, will help rehabilitate and upgrade the local wastewater treatment plant and sewage network, and will ensure technical assistance in the management and supervision of the works, enabling the city to meet European Union directives for wastewater treatment (Directive 91/271/EEC). The capacity of the wastewater treatment plant will be developed for an average flow of 2,400 l/s and a population of 440,000 inhabitants. The investment will be completed by 2009.

Plate 49. One of the buildings of the 1912 wastewater treatment plant in Timișoara, Romania, completed in 1914 (Photo: Aquatim – Water and Sewerage Company of Timișoara)

Spain

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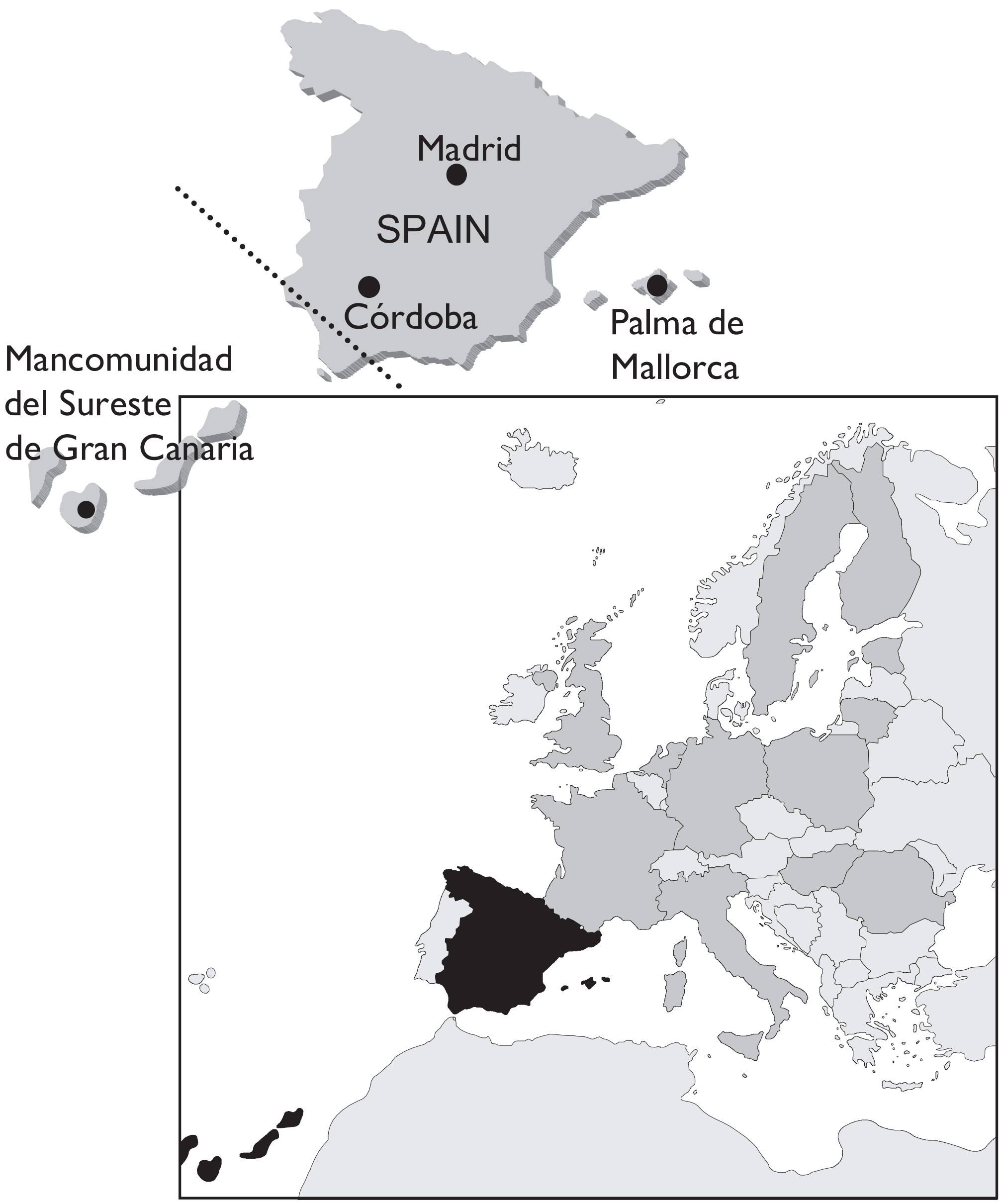


In Spain, over the years, various private and public systems and combinations of them have been used. While in some cities very long concessions existed until the early 2000s, the majority of the works have been managed as municipality-owned utilities and companies.

The key long-term development phases could, therefore, be classified as follows:

(i) Early phase based on public fountains and single pipe systems till the mid-1800s;
(ii) From the mid-1800s the start of modern WSS systems in Madrid and other cities;
(iii) Expansion of WSS systems based mainly on municipal systems;
(iv) Increasing pressure towards taking into use new water resources, particularly from tourism in the islands and the southern part of Spain since the 1950s and 1960s, incorporation of municipal systems;
(v) More recently the start of modern wastewater pollution control and more demand-based water management.

In 2001 the Spanish Parliament approved the National Hydrological Plan Act that has, however, become quite controversial. This plan proposed massive transfer of water from the Ebro River in the Pyrenees down to the southern parts of the country — a distance of over 900 km (Biswas & Tortajada 2003). The plan was evaluated independently by international experts who concluded that it is not necessary if proper demand management practices are formulated and implemented (Biswas & Embid 2003). In 2004 the plan was, at least in its original form, postponed by the new government. The plan promoted the birth of the so-called "European Declaration of New Water Culture" that tries to promote the modern principles of water management within a wider economic, environmental and social context (http://moncayo.unizar.es/fnca/europeandeclaration.nsf).

Córdoba

In Córdoba the municipal company, EMACSA, continues the municipal service which has been provided by a body of the City Council for a hundred years. Although this municipal body assumed its present organisational form due to reasons of administrative performance, the only owner and responsible party for the water service is the municipality, as stipulated in Spanish Law on services provided to the citizens by municipalities.

For many years, before the construction of a complete water supply service, the population used fountains and springs as their only water supply system. Pipes and canals had been laid in the city to bring water from the springs, while most of the population used the public fountains to obtain water or bought it from water carriers — men who delivered water carried by a beast of burden against a stipulated price or some food. Some of these old springs are still used in the city of Córdoba and supply good quality water.

In 1882 the city's water supply was discussed for the first time by political parties and social groups (**Table 28**). In 1891 the company Aguas Potables de Córdoba was founded, and the first water supply project was implemented. But it was not until 1930 that a significant change took place, when the construction of the main water resource for Córdoba, Guadalmellato reservoir, was finished. In 1938 the council of Córdoba acquired Aguas Potables de Córdoba, and as a result the water supply became a municipal service. The name of the new company was Servecio Municipal de Aguas Potables de Córdoba.

Plate 50. Plant based on anaerobic UASB process in Córdoba, Spain for combined treatment of municipal and yeast factory wastewaters. Purge and net of gas in front
(Photo: EMACSA)

Table 28. Key long-term decisions on Córdoba water and sewerage services

Year	Event	Reason	Outcome	Organisational change	Stakeholders
1882	1st meeting of political and social groups on water supply service	People used fountains and springs as water sources			
1891	Initiation of the 1st water supply project	Need for clean water			Aguas Potables de Córdoba Company
1938	The council of Córdoba acquires Aguas Potable de Cordoba			Water supply became a municipal service	Servicio Municipal de Aguas Potables de Córdoba
1955	Construction of the Water Treatment Plant, Villa Azul	The inadequate water supply limits city development	People had a water service with enough flow and quality	Start of new period of social & economic development	City Council
1969	Creation of the EMACSA (Empresa Municipal de Aguas de Cordoba). The Servicio Municipal de Aguas ceases to exist	Lack of legal status	The company gets autonomy to plan and manage water service and control water resources	The company that was only a council service became a municipal public corporation	Servicio Municipal de Aguas, EMACSA
1980	Design of the future wastewater plant "La Golondrina"	Introduction of integral water cycle in Córdoba			EMACSA
1981	Presenting a Comprehensive Sewerage Plan, programme for WWT		Implementation of city water cycle		EMACSA
1982	The sewerage system of the city becomes also a responsibility of EMACSA	Several studies on the whole water cycle in the city elaborated		EMACSA, a company in charge of the whole water cycle	EMACSA
1984	Construction of the peripheral sewers and wastewater plant	Need for connecting future waste water plants and users			EMACSA
1988	Initiation of the construction of the waste water plant La Golondrina	Solution to medium and long-term Cordoba sewage treatment	100% sewage treatment		River Basin Institution, Ministry of Public Works, EU EMACSA
1988 - 1990	Enlargement and modernisation of the Villa Azul plant	Increasing water treatment capacity	Capacity rises to 150,000 m^3/day		
1990	Operation of the ozone and fluoridation plant in Villa Azul starts	To improve water quality			

Year	Event	Reason	Outcome	Organisational change	Stakeholders
1991	Launch of the new La Golondrina wastewater plant, EDAR		Plant treats over 90% of city WW		
1996	EMACSA assumes responsibility for water services in Cardeña and Santa Cruz districts		Sanitation improves in Córdoba city		
1996	Installation of a new control system in all EMACSA facilities	To improve efficiency and effectiveness and service	Better system management		EMACSA
1996	Integration of the treatment of the industrial wastewater from yeast production plant in WWT plant La Golondrina	Necessity of treating polluted water from the yeast plant	Anaerobic UASB reactor, financed by the yeast plant		Yeast Company, citizens, unions EMACSA, City Council
1999	EMACSA, implemented Quality Management System and Environmental Management System		Management system based on ISO 9002		
2000	Construction of a new water control laboratory	To meet EU Directive 98/83/CE on the control of water properties	Water control in compliance with EU requirements		
2001	Installation of a biogas system inside the wastewater plant		Bad smell problem solved and energy gained from biogas		

The inadequacies of the water supply service were still evident, and they were seen as a limiting factor for city development. The water troughs and fountains managed by the City Council were insufficient, and there were numerous water wells supplying water for all kinds of uses, even for drinking. On the other hand, thousands of septic holes were contaminating the water wells and transmitting diseases.

It was not until 1955 that the situation started to change significantly, when Córdoba started a new period of social and economic development as important things happened, like the construction of the water treatment plant of Villa Azul, which supplied 88 litres per person per day. It was only then that Cordoba had a water service with enough flow and quality. The enlargement of the Guadalmellato reservoir took place shortly thereafter, in 1960, its connection to the Villa Azul treatment plant later on, in 1964, while the construction of the Cola water tanks started in 1967.

In 1969 EMACSA (Empresa Municipal de Aguas de Córdoba) was created replacing the old Servicio Municipal de Aguas. The company, which was a Council service, with no legal status, became a municipal public corporation, having the autonomy to plan and manage the water service and to control water resources. EMACSA's achievements are important, like the construction and operation of a new water pipe from Guadalmellato reservoir to Villa Azul plant in 1978. Since then, several studies concerning the whole water cycle[14] in the city were launced, and the wastewater treatment programme, Plan Integral de Saneamiento, was presented. It was just then that the idea of the future wastewater plant, La Golondrina, was conceived. And little after, in 1982, the sewage system of the city, formerly managed by the municipality, also became a responsibility of EMACSA, making the company responsible for the whole water cycle in Córdoba.

The peripheral sewers and the outlets conducting water to the future plant were constructed in 1984, while construction of the plant itself started in 1988. From 1988 to 1990, the Villa Azul plant was expanded and modernised, so that its capacity reached 150,000 m3/day. The La Golondrina plant finally started to operate in 1991, and just a year later, the ozone and fluoridation plant in Villa Azul also went operational. Later on, EMACSA was put also in charge of the water services for Cardeña and Santa Cruz districts. In 1996, a control system was installed in all EMACSA facilities which enabled better management of the whole system.

One of the latest important events happened in 1996, when EMACSA agreed to integrate the treatment of the industrial wastewaters of a yeast production plant into its depuration plant La Golondrina. This is why a year later a special anaerobic unit called UASB, financed by the yeast production company, was constructed, aimed at treating all the wastewater from the yeast plant. EMACSA have implemented since 1999 a quality management system based on ISO 9000, and they also have an environmental management system.

In 2000, a new quality control laboratory was built to allow making the necessary water analyses. This is important to control water properties, especially as regards the European directive 98/83/CE related to water quality requirements of water supply systems. One of the most recent important events regarding the water supply service in Córdoba was the construction in 2001 of a system to make use of the biogas produced in the plant. Presently, the biogas produces energy and the problems with bad smells have been resolved.

[14] Water and wastewater systems.

Plate 51. General air view of wastewater treatment plant, treating wastewaters from the city and the yeast factory in Córdoba, Spain
(Photo: EMACSA)

Madrid

In Madrid, which has been the capital of Spain for ages, the state has been involved more in promoting water supply than in other cities where it has been more of a municipal responsibility. In fact, the Ministry of Public Works took part in the decision to set up Canal de Isabel II (CYII), which has never been owned by the municipality. In 1977 CYII was given a new legal status widening its operational autonomy by the Autonomous State Bodies Law (Ley de Entidades Estatales Autónomas) of December 1958. Finally, state ownership of CYII ended when the Autonomous Community of Madrid incorporated this body and its service infrastructures into its public capital, just after the Statute of Autonomy for the Community of Madrid was passed in 1983.

Ever since King Felipe II of Spain (1527–1598), the monarch who installed the court in Madrid, the city has been on a constant search for drinking water supplies. Before that, the traditional supply system consisted of wells and, later on, nearby springs. Due to population growth, the excavation of underground galleries, the so-called *waterways*, was needed to lead water from the springs to the city wells. Until the mid-18th century, water supply to private residences was carried out by the people themselves or their servants. Only a few palaces and monasteries had fountains or wells within their walls. As population increased, a new profession emerged, that of the *water carriers*, men who provided home delivery of water for a stipulated price. After the creation of Canal de Isabel II, very few water carriers remained — they were required just to carry the water to the upper floors of the dwellings in high areas, where system pressure was insufficient (**Table 29**). The launch of the pumping station, with its high pressure water network, finally ended the need for water carriers in 1912.

The excavation of underground galleries, so-called waterways, became gradually necessary to lead the resource from the springs to the city wells as the population grew moderately. They were basically 1.90 x 0.70 m cross section filtering, collecting and piping galleries dug in the ground. Water from other similar galleries also flowed into these and gathered near the city limits, in a chest from which a clay or lead pipe branched out to distribute water to the fountains. Madrid had a total of 11 galleries which supplied an average volume of 3,600 m^3 a day, as long as they were in good condition. These waterways were used until the mid-19th century, though they were considered insufficient and, eventually, caused serious problems for the citizens.

Until the middle of the 18th century water supply to private residences was carried out by the people themselves or their servants. Only a few palaces and monasteries had fountains or wells within their walls. As population increased, a new profession emerged, that of the water carriers, men who provided home delivery of water for a stipulated price. The job of the water carrier as such derived from the 17th century.

The use of fountains by vendors and private citizens was shared. Some bylaws were established to govern the licensed vending and adapt it to the use of residents who also had the right to use the taps. Both groups had their own taps to avoid conflicts. The different districts around the city had their own appointed water carriers who had a permanent clientele. They took the water up to the houses by means of traditional barrels, and besides carrying and selling water, they also worked as messengers, firemen and citizen assistants and were appreciated for their industriousness and loyalty.

After the creation of Canal de Isabel II, very few water carriers remained; they were needed just to take water up to residences in high-lying suburbs, where system pressure was insufficient. The launching of the pumping station, with its high-pressure water network, made water carriers obsolete in 1912.

In the middle of the 19th century, Madrid had 77 public fountains on which 128 taps were installed, to fill up the barrels of the 950 water carriers who delivered 66,350 "reales fontaneros" – measure of that time – equivalent to 2.15 m^3. Installation of public fountains in Madrid started in 1618. The first one was set up in Puerta del Sol, and its opening was an event filled with expectation. In the times of Felipe IV, the "Castellana" and "Arroyo Vanigral" fountains came into use. Around that time, Prado de San Jerónimo already had 23 fountains. Madrid also had, from time immemorial, several fountains called "holy" as they were supposed to have curative powers. The most popular ones were those of San Isidro, Santo Domingo and Santa Polonia.

Despite several projects to supply water to the capital city since the mid-18th century, it was not until 1848 that the proposal for a provisional supply plan for Madrid, with water from Lozoya river, was approved. This forward-looking project was planned for more than double the population of that time. Currently, some of the original facilities are still in operation. In 1851, Isabel II (1830–1904), Queen of Spain issued a Royal Decree which encouraged realising the supply by means of a canal diverting water from the Lozoya. The conduit was named Canal de Isabel II, in honour of the Queen, the true sponsor of the project.

Water resources

The Tajo river basin contains the Autonomous Community of Madrid (CAM) territory, from a hydrological point of view. Seventy kilometres of this river, and its tributaries Jarama (161 km), Guadarrama (145 km) and Alberche, each of them with their own tributaries, comprise the CAM hydrographical network. In the 1960s Madrid grew rapidly and demand increased out of control. The former plan and predictions of 1947 surpassed all expectations. A modified working plan to extend water supply in Madrid was finally approved in July 1963. However, the 1984 drought worsened the situation, and the population of Madrid again had reason to be discontent with their water supply system: continuous breakdowns and low water pressure which did not bring water to the highest floors together with a nearly doubling of the price of water. The situation was even worse in the new neighbourhoods, where water was usually muddy and of bad quality, due in part to the need to exploit the reservoirs to the maximum and the pollution of rivers by the spills from the nearby towns and industries.

Table 29. Key long-term decisions on Madrid water and sewerage services

Year	Event	Reason	Outcome	Organisational change	Stakeholders
1867	Dissolution of the Board of Directors by Royal Decree	Difficulties in building and finance	On 20 March the Board of Directors meets for the last time	CYII loses its status as a company, depends since then on Ministry of Public Works	Ministry of Public Works
1899	General department of Public Works takes actions to guarantee summer supply	1896 was a rather dry year. New period of drought in 1899	It was necessary to reduce consumption by 18% until autumn rains	Water use reduction failed due to lack of citizens´ cooperation. Ichaurrandieta showed the need to raise fares and introduce metering, proposal in Oct 1902	Citizens
1905	A Royal Decree sets up a Commission to analyse the reorganisation of CYII	Trifling budget, sale of water not enough; need to increase capacity and improve network	Commission divided: technical sub-commission accepts Inchaurrandieta's proposals; managerial sub-commission proposes organisational modification	Act and Regulations of February 1907 that reorganise CYII: management reports to a special committee, similar to the old Board of Directors	CYII
1939	CYII recovers its original name and is managed by a Military Junta of Supplies	To control consumption, increase income and cut expenses		New departments: reservoirs, pipelines, tanks, allocation, irrigation ditches and new arteries, Laboratory, and East Channel	
1946	Decree by the Ministry of Public Works: CYII to present a new Plan to improve the system in 25 years	A very dry year in 1944. Implementation of a plan to cut off supply several times. Drought in 1945	Plan of Works to improve the water supply to Madrid and surrounding towns		Ministry of Public Works
1963	Approval of the "Plan to Enlarge the Supply of Water to Madrid		Agreement to build with State funds El Atazar Reservoir. Plan for Incorporation of Water treatment plants in Torrelaguna, Santillana, and Colmenar. Improvement of channels of Hidráulica Santillana for using Manzanares river		

Year	Event	Reason	Outcome	Organisational change	Stakeholders
1964	Dissatisfaction of the people: continuous breakdowns, lack of pressure, doubling of the price of water	Problem of collection.	Several proposals for improvements, also the incorporation of the Manzanares. Decision to use water from the Manzanares River for industrial activities, irrigation of parks and big gardens, and refrigeration		Citizens
1980 – 1984	Drawing up of a comprehensive sewage treatment system (PSIM) for the City of Madrid	Environmental decay and lack of WWT infrastructures	New infrastructures, recovery of the Manzanares River for exploitation	Creation of new departments in City Council Water Department	Central and local governments Madrid citizens
1984	CYII is attached, to the Autonomous Region of Madrid as a Public Sector Company			Autonomous Region in 1983 –transfer of responsibilities from the State to the CAM. Financial balance achieved by subsidy received from the Central Administration	CYII Autonomous Region of Madrid, CAM

CAM = Autonomous Community of Madrid

After several researches, an updating programme for the water network's pipes was proposed as well as the construction of the El Vellon dam in the Guadalix River. Although a 1963 decree kept water from the Manzanares River supplying the city of Madrid, some undertakings required to increase transport capacity from the Santillana reservoir, owned by Hidráulica Santillana, to Madrid were proposed, too. Finally, Hidráulica Santillana listed its shares on the stock exchange, and CYII bought most of them, since it was authorised by a 1963 decree to buy shares in Hidráulica Santillana. Since water supply was only a duty assumed from the former owners, Hidráulica Santillana, whose core business was selling and supplying energy, could not meet the good quality of CYII. Thus, it was decided to use water from the Manzanares River to irrigate gardens, refrigerate and in industry. The final investment was about 500 million pesetas (about 40 million euros in 2005) to achieve an additional capacity of two m^3/s, which proved to be of crucial importance during the dry years of 1965 and 1966.

Plate 52. The historic Sifon de Guadalix constructed for water supply in Madrid in 1858
(Photo: Canal de Isabel II)

A 1976 decree authorised the Government to reorganise certain bodies in order to reduce public expenditures and to make services management more effective. One of these bodies was CYII, which by a 1977 decree became a public firm under the Ministry of Public Works, with a legal status making it independent from the State, its own capital, autonomous management. Although the internal structure did not change, the company remained under control of the Board of Directors, a new economic policy was designed to make the public body CYII function as a real company. A bank loan from Banco de Crédito a la Construcción (Building Credit Bank) was given to CYII while other loans negotiated with Cajas de Ahorro (Saving Banks) were rejected. Then

CYII was forced to go to the external market to get financing and finally got a bank loan in December 1977. The new Government's representative, and President of the CYII Board of Directors, defended the idea that the final service user must defray costs, and he proposed a tariff increase to cover the deficit.

The numerous hydraulic infrastructures created by Canal de Isabel II in the autonomous region of Madrid allowed this enterprise to become an important public sector company in 1977. Currently, Canal de Isabel II is a public sector water company — under the government of the autonomous region of Madrid since 1984. Its more than 1,700 permanent employees comply with the goal of carrying out all the tasks involved in the water cycle with maximum efficiency, besides maintaining the high quality and security of the supply to the around five million inhabitants of the region.

Wastewaters

Madrid has one of the greatest traditions among European cities in wastewater treatment, dating back to the construction of the first treatment plant of La China in 1932, with the capacity to treat most of the wastewater of that period. The Madrid sewerage system serves about 3,700,000 inhabitants, including some important municipalities of the Madrid metropolitan area with more than 630,000 people until they build their own treatment plants (Getafe, Parla, Fuenlabrada, Pinto, Humanes, Leganés, etc). The major boost in this field was the development of the First Sewerage Plan for the City of Madrid during the period 1978–1984, when the sewerage system infrastructures were updated and a financial mechanism to support the construction, maintenance and exploitation of the treatment plants was established.

When the Sewerage Plan for the City of Madrid was designed and discussed between CYII and the City Council in the late 1970s, CYII representatives insisted on the need to make the citizens pay the true cost of the supply and sewerage services against the municipal representatives' view of charging a more politically acceptable price. Although the relations with the City Council were still quite tense, the development of the plan required close partnership between CYII and the municipality, which was successful thanks to the good offices of Mayor Tierno Galván.

Since the 1979 decree, the competencies of CYII increased. Two new tasks were added to the previous management of Madrid drinking water supply: treatment and the construction, improvement and extension of the sewerage infrastructures of the municipalities when requested by the city councils in question. This was why an information programme was established to continue the previous studies on sewerage infrastructure improvement — with little success: CYII already supplied water to 32 municipalities in the Madrid region, and of the 77 towns consulted this time only nine answered the CYII proposal.

Plate 53. ETAP de Torrelaguna, water treatment plant of Madrid, Spain, completed in 1967
(Photo: M. Angel Gómez, Canal de Isabel II).

The present high level of treatment in the CAM has been achieved through great efforts of the different Governments of the CAM since 1985, when the Madrid Water Plan (Plan Integral de Aguas de Madrid PIAM) was approved for the period 1985-1994. The first act was to the treat wastewaters from urban centres spilling into supplying reservoirs, from the main industrial areas and the region of Sierra de Guadarrama, with a very large seasonal population. The Madrid Water Plan investment proposals were accepted by the Regional Government and the local bodies and the Central Government. From the point of view of the CAM, considering the experience and management capacity of CYII, the Madrid Water Plan represented an investment chance and an opportunity to organise the region with the participation of the municipalities. At the end of this period, a Madrid Sewerage Plan was drawn for the period 1995 to 2005. This plan, still in force, tries to extend wastewater treatment coverage to 100 per cent of the municipalities in the region of Madrid.

Mancomunidad del Sureste de Gran Canaria

Initially, the municipalities of Agüimes, Ingenio and Santa Lucía were under the same inter-island council, Cabildo Eclesial de Agüimes, until 1814 when the municipality of Santa Lucía got its own territorial status followed by the municipality of Ingenio in 1815. Historically, these municipalities have been characterised by a small population and economic development based on agriculture and ranching. Since the 15th century, the role played by Gran Canaria as an area colonised by Castilla has led to socio-political arrangements that work even nowadays. In consequence, some basic resources, such as water, have been used, exploited and commercialised as private propriety.

The origin of a water management was the so-called Heredades de Agua, a legal entity set up in the 16th century to provide water to irrigators and citizens, to determine land and water distribution in places where there was not enough water to irrigate all the arable land due to scarce water flow. The first Heredades (short of irrigation association — groups of private owners of water resources which oversee the common interest of the municipality, assure proper water distribution and resolve every possible disagreement among irrigators regarding water uses) were set up around 1503 by Reyes Católicos. Subsequently, the job of Alcalde de Aguas (Water Mayor) was created to oversee the common interest of the municipality, to assure proper water distribution and to resolve every possible disagreement among irrigators. Before this, water was managed by a few private owners. This body functioned until the early 19th century, when it was replaced by a kind of Board of Directors. Nowadays, these bodies are still functioning although their importance in the new institutional framework has declined. All Heredades are set up with private capital contributions and frequently a limited number of people; they usually transfer from one generation to another if they are not sold or the rights rented. Nowadays, most of these bodies, like Heredades del Agua, exist only in the Islands.

Hard natural conditions (low rainfall, high evaporation level, etc.) made farming impossible near the coast without artificial irrigation. The first water collection in the area, called Acequia de los Negros, dates back to the 17th century. On the other hand, taking water from the rugged mountains to the coast required much work, undertaken by private companies, in building irrigation channels and networks that still work.

Sugar cane and corn plantations in the region demanded larger volumes of water from the 16th to the 18th century. That is why the first water mines were built in 1740 resulting in high collection and distribution costs, which forced the Heredades to establish a consumption fee to be charged to everyone wishing to make use of the resource (**Table 30**) in the region and which led to a borehole campaign starting in 1903. These wells were built by Heredades or big private investors who initially bore all costs and then use them for their own land or sold them to irrigators and private users.

Nowadays, there are 115 wells operating just in the Santa Lucía area with an overall length of more than 17 km. From the beginning the water from the wells has been mixed with water from karstic mines or water from mountains due to the high salinity of well water.

Until 1958 there was not a public water tank on the whole island, and till the second half of the 20th century no public wells were built. However, the municipalities of Ingenio and Agüimes had no water tanks to supply water to the majority of the population until 1971, when the water tanks of La Goleta, Arinaga and Montaña Francisco were built. The shortage of water for domestic uses has been a constant problem and is a cause of conflict between agricultural and urban users. In the summers of the 1970s and 1980s water supply was cut to some municipalities due to serious shortages. The need to meet water demand led to a reservoir and dam building campaign: in 1966 the first dam was built in Barranco de Tirajana, in Santa Lucía municipality.

The development of tourism, which started in the 1960s, gathered speed over the next years, at the same time as tomato exports increased in the coastal areas of Ingenio, Agüimes and Santa Lucía. All this economic development got a boost in the 1970s from the Ingenio airport extension, the industrial development of Agüimes and the commercial maturity of Santa Lucía. Thereafter the urban water supply problem got worse. The origin of this situation could be found in the persistent refusal of the municipal councils to provide the municipalities with their own water sources: no municipal wells were ever built nor any share was bought of any other already working, except in Agüimes, where only a small percentage of its water needs is supplied from municipality owned sources. In addition, it must be taken into account that in some cases owners and water suppliers held municipal political offices and that there was much corruption related to water supply.

Plate 54. Since 1960s the increasing tourism has set its special demands for water use in the Canary Islands
(Photo: S. Kaaria, 2005)

Table 30. Key long-term decisions on Gran Canaria water and sewerage

Year	Event	Reason	Outcome	Organisational change	Stakeholders
1740	Building of first water galleries or water mines	The incipient export agriculture of corn & sugar demands more water	Bigger water supplies facilitate agriculture development through subsoil exploitation	Development of specific infrastructures for water transport & distribution	
1903	Boreholing of water wells	Resource shortage in agriculture & domestic water supply			
1942	Water taxes in Santa Lucía considerably increased	Julianno Bonny's widow cancels free water transfer & starts charging for it	Citizens must pay for water		SF1-WU1 & SF2-WU2 Town Hall
1940 – 1950	Public protests due to high prices	People´s low ability to pay	Water scarcity affects citizens´ quality of life because of high prices of private water supply		
1958	First water tank constructed by public funds, therefore public property	a) Population increase; b) Water demand clearly higher than supply; c) Social protests	A minimum water reserve for consumption guaranteed	1st relevant public service appears to solve water problems. Provision & collection still in private hands	Town Hall, Civil Government & Cabildo de Gran Canaria.
1966	First reservoir construction	Lack of irrigation water for coastal area. High salinity of well water			
1970 – 1977	Water consumption is restricted further	Incapacity to meet water demand due to: a) population increase; b) export agriculture; c) limited rain, etc.	a) Higher water prices charged by suppliers from towns and by towns from citizens; b) Protests by citizens, etc.	Control of use a priority for 3 municipalities – more interested in reducing water losses than others	Santa Lucia Town Hall & Agüimes & Ingenio Town Hall
1978	Mayor Manuel Sánchez (Sta. Lucía) demands that Lorenzo Olarte & the Spanish president promote construction of ‑hydraulic infrastructures	Social protests & general mobilisation demanded improved water supply. It was claimed that the municipality be declared an emergency area	The municipality of Santa Lucía & Agüimes ‑declared a "special area" by the Central Government in 1983		SCMs, Santa Lucia Town Hall, Cabildo de Gran Canaria & Central Government
1979	Introduction of water infrastructures into the municipal political agenda of Agüimes & Santa Lucía	1st democratic elections brought citizens movements into the government, which acts through political parties	Budget packages created, aimed at channelling & building the sewerage system	Public participation mechanisms introduced to solve some problems of the municipal political agenda	Political Parties & Town Hall

Year	Event	Reason	Outcome	Organisational change	Stakeholders
1982	Creation of the Neighbourhood Meeting attended by all the citizens' associations of Santa Lucía; decides municipal management issues of binding importance	Municipal initiative closely related to citizens' movements & high participation rate sought. Also the neighbours binding decision about the municipal government.	Creation of sector commissions chaired by citizens, including one on water. Territorial Court cancels the Meeting, due to the lost of competences, regarding the corporation & Town Hall	Santa Lucía municipality adopts a citizens' participation system, where citizens suggest things & are consulted on municipal problems like water	Workers' Brotherhood of Catholic Action, directed by D. José Suárez Sánchez. (HOAC) Association of Families from Vecindario Association of Neighbours
1982	Santa Lucía's Town Hall presents a water supply plan at the Central Government Ministers Council	To solve problems concerning the lack of water	Ministers Council did not consider the water supply plan. Restricting water for public consumption would have left agriculture in ruins		Town Hall of Santa Lucia & Central Government
1985	Installation of a desalination plant powered by solar energy	It was installed in Arinaga industrial area	It failed due to problems in technical performance		Agüimes Town Hall & Centre of Energy Studies for the Canary Islands
1991	Private initiative to build a desalination plant	Agricultural water supply a problem: aquifers exhaustion, high salinity, water shortage	First studies on desalination plant to be built in the area of Santa Lucía		Agricultural export cooperatives and other minor cooperatives
1991	The Ingenio, Agüimes & Santa Lucía Town Halls decide to build a public desalination plant	a) Domestic & industrial water demands; b) water insufficiency; c) water resource price increase; d) agricultural economy of the area in danger	Plant completed in 1993. Agreements with private agricultural producers to build a private desalination plant. Commitments to provide them with irrigation water	Through public initiative of 3 Town Halls, an autonomous organisation created to manage the construction: desalination, wastewater treatment, distribution	Towns Hall of Agüimes, Ingenio & Santa Lucia, Canary Reg., MSGC, Local & Central Government
1991	Creation of the Southeast Gran Canaria Community	The three municipalities had the intention to solve a common problem in an optimal way. The problem is water scarcity & high price	An autonomous, independent organ created with its own resources	Community assumes task of water provision to the three municipalities	Towns Hall of Agüimes, Ingenio & Santa Lucia.
1999	Creation of the Wastewater treatment plant & the Spilling Control Unit	Concerns about water quality improvement & reuse process for irrigation & agricultural uses	Concession from the Community to PRIDESA to manage the whole construction & post management project	Community assumes a new role: whole water cycle management transferred to an external company	Government of the Canary Islands Mancomunidad del Sureste European Union Pridesa

Year	Event	Reason	Outcome	Organisational change	Stakeholders
2001	Adoption & signing of Agenda 21 (Aalborg Charter)	Concerns of 3 mayors & Community managers about introducing sustainability patterns affecting the Community & municipalities' management	First studies & analysis to identify social demands, priorities, etc.	The MSGC launched actions to develop it	MSGC & Town Halls of Ingenio, Agüimes & Santa Lucia
2003	An administrative concession to manage the whole water cycle in the Ingenio municipality given for 25 years	The PSOE party in Ingenio approves an annual contract deferment after 8 consecutive years	Aqualia (FCC) pays Ingenio Town 6.16 million euros & assumes responsibility for the whole management process	Entire urban water cycle in Ingenio to be managed by Aqualia for the next 25 years	Ingenio Town Hall & Aqualia

In the late 1980s, due to a water shortage, even the export farmers were in a bad situation: they faced an expensive resource of low quality and insufficient quantity. Throughout the 1980s the democratic municipalities looked for solutions and found a favourable framework: the central government and the regional government agreed on a hydraulic policy based on desalination to supply urban water, treated water reuse to satisfy the agricultural water demand, and the control and restriction on aquifer use to avoid their salinisation.

The municipalities of Agüimes, Ingenio and Santa Lucía got financing from the ministries of Public Works, Transports and Environment and from the regional government for up to 75 per cent of the total and 12.5 per cent from the seawater desalination plant of Sureste works. The remaining 12.5 percent was contributed by the three municipalities together. In 1990 Mancomunidad Intermunicipal del Sureste de Gran Canaria was set up to manage the seawater desalination plant, drinking water supply and wastewater treatment including water reuse. In 1993 the desalination plant went operational and supplies nowadays 33,000 m^3/day of water for urban and industrial uses.

As for wastewaters, the wastewater treatment plant and the Spilling Control Unit were established in 1999 and a concession was agreed with PRIDESA on managing the whole construction and the post-management project.

Plate 55. Surrounded by the sea, the Canary Islands relies also on desalinated water (Photo: S. Kaaria, 2005)

Palma de Mallorca

Palma de Mallorca is the capital of the Balearic Islands. The municipal district covers an area of 21,356 hectares and it comprises the Cabrera subarchipelago. Palma had a population of 367,300 at the beginning of 2003. In the recent history of the Balearics it is important to point out the beginning of large-scale tourism at around 1950. The Palma has an average annual rainfall of 450 mm. As concerns water resources, Mallorca has been mainly supplied by underground water, due to the high land permeability, which makes underground water the most abundant water resource. The island's development, the population increase and increased tourism led to an actual water deficit, which could only be balanced by unconventional methods like seawater desalination or wastewater reuse. On the other hand, the continuous degradation of ground water quality due to seawater intrusion has promoted use of these techniques in the last decades, which nowadays characterise water management in Mallorca and, specifically, in the city of Palma.

In the late 19th century, the water distribution and the wastewater collection systems were highly inadequate. The water reaching households was not pressured, it was supplied only 64 h/week and the flow was different depending on the season. The water losses were also considerable, and the networks of pipes and channels in the city were chaotic, both those for drinkable water and ones for wastewater collection.

The history of water management in the city of Palma de Mallorca involves mainly search for new water resources. The physical and natural characteristics, together with the strong economic development and population growth experienced since the fifties, shows that water really is a limited natural resource. As ground water has always been Mallorca's main water resource, it is heavily dependent on rainfall and the soil's infiltration capacity.

Before 1940 the city of Palma de Mallorca received potable water mainly from the La Villa Spring. In winter time they also received water from the Na Bastera spring. The water reached the city of Palma and was distributed through an archaic system dating back to the Middle Ages. The supply water from the La Villa spring had to be shared with farmers, thus causing problems and confrontations between farmers and the City. The first proposal for a proper water supply and sewerage system was made during the second half of the 19th century. In 1912 the city water supply project for Estada was proposed, and in 1915 the one for Garau, while the water works did not really start operating until 1934. In 1934–1950 the basic construction of the water supply and sewerage system was carried out (**Table 31**).

The municipal water company, EMAYA, was created in 1943 to provide also sewerage service. Since then, the management of the whole urban water cycle has been centralised under a single organ, the City Council, with no private participation: all projects concerning water management were monopolised under one municipal body. Before this, there were both municipal and private actors.

Table 31. Key long-term decisions on Palma de Mallorca water and sewerage services

Year	Event	Reason	Outcome	Organisational change	Stakeholders
1300 – 1950	Palma mainly supplied from the La Villa fountain, water shared with farmers	No surface water streams			Palma citizens, farmers
1848	Creation of the Palma Garden Irrigations Union	Improvement of the institution in charge of water distribution	Union in charge of water distribution and the channel maintenance	Institution in charge of the La Villa fountain system to be reformed	City Council, and farmers
1854	Underground gallery, started 1821, was finished (Bouby), drawing La Villa fountain water	The fountain water was wasted during high flow periods	Water from La Villa fountain better exploited		
1867	1st important water distribution project by Bouby, for the Palma City Council	Water system inherited from the Middle Ages needed reform	This project was the basis of the reform		Palma City Council
1867	1st water works (Bouby) whose users to be charged a corresponding tax		Water users have to pay for the 1st time		
1879	Drilling of the 1st important well by the City Council at Pont d'Inca	After 3 years' drought, people began thinking about alternative sources			
1912	Estada project for Palma water and sewage system reform (based on Bouby project)	Water supply and sewage system in Palma still needed reform	This project launched the expropriation of La Vila fountain		
1913	Expropriation of the La Vila fountain for urban water supply only	Urban water demand increase due to population growth and city expansion	La Vila Fountain only used as water supply resource for Palma		City Council
1915	Garau project for the Palma water supply and sewage system reform	System needed important reform	This project was finally executed, but only after 20 years		
1934 – 1936	Execution of a General Plan for water supply and sewerage system inside the city started	The republican City Council in Palma promoted these works	Development of an adequate water supply and sewerage system inside the city started	Pressured water for most of the citizens in Palma as well as a sewerage system	City Council, building contractors
1943	Creation of the municipal water service (SMAYA), a special organisation in charge of all Palma water management	To improve the water management in the city	Municipalisation of the whole urban water cycle centralised into one unit, under City Council, and no private participation	All projects concerning water management, placed under one municipal body	City Council, City Council technicians

Year	Event	Reason	Outcome	Organisational change	Stakeholders
1969 – 1974	The so called Supply Water System Enlargement Plan carried out, utilising water resources of northern mountains	Increased demand and aquifer overexploitation related salinity problems	1st time surface water was used. Palma's role in island's water management decisive	Palma's system is more varied and decentralised, expanded outside the municipality	City Council, Central Government
1970 – 1973	Balearic Islands Water Treatment and Sewerage Plan, and consequent construction and wastewater reuse	Coastal region polluted, its influence on tourism	Coastal region pollution control Wastewater reuse		City Council, Central Government
1995	Transfer of all responsibilities for water resources management in the islands from the State to Autonomous Government	Decentralisation: Autonomous Regions in Spain to acquire more responsibilities	EMAYA to deal more with the Autonomous Government in water resources management		State, Balearic Islands Government, City Council
1995 – 1999	Son Tugores brackish water desalination plant, and Bahía de Palma sea water desalination plant started operating	Water scarcity and salination problems	The start of high cost, non-conventional methods for water resources use		Central State, Balearic Government, City Council
1994 – 2001	Palma reduces drinkable water consumption by 20 % thanks to Urban Reuse Water Plan	Water scarcity, Promotion of more sustainable development	Palma has a secondary reusable water system for uses requiring lower quality		City Council

During the 1940s the City Council acquired several private wells for the city water supply. These wells became the Virgen de Monserrat Water Supply Center. Some years later the first Pont D'Inca water wells were bored and connected by a network of water pipes (Palma plain area). These aquifers became one of the main water resources for Palma. Two drillings were made at Na Burgesa aquifer in the Son Serra area. At the end of the 1960s, this was the water supply situation, complemented by some water acquired from private wells in the area of Son Verí and, mainly, Na Burgesa (Son Serra).

After the extraordinary development due to tourism, water demand increased strongly in 1950–1973. This together with the progressive ground water degradation led to two important projects aimed at finding new water resources.

In the early 1970s the sewerage system was completed with the construction of the two wastewater treatment plants, Palma 1 and Palma 2. A drought was experienced in the early 1980s. The third drilling was made by EMAYA in the Son Serra area in 1981, and they acquired an already existing drilling in Son Roqueta in 1982. Two years later in 1984, three new drillings were made in La Vileta.

Plate 56. Cave of Cuevas Dels Hams, karstic formation including underground gorges in Palma de Mallorca, Spain
(Photo: Cuevas Dels Hams)

Apart from S'estremera, all the wells were made in the municipal area of Palma, but a point was reached where new drillings had to be made outside the municipal area. This involved the Alaró wells: first two drillings at Son Perot Fiol, later in 1989 a new drilling in C'an Negret and in 1991 in Borneta. At this point a major drop in water level was observed at the Sierra Norte de Tramuntana (Tramuntana North Mountains) drillings, and high levels of salt were detected. Half of the water supplied in Palma and Calviá municipalities was of poor quality (high salinity), which was to be mixed half and half with water of good quality resulting in water of average salinity (4,000 mg/l of chloride). This resulted from the construction of the brackish water desalination plant of Son Tugores, put out to tender by the City Council through EMAYA and the Autonomous Government. The plant started service in 1995, providing a good quality water flow of 30,000 m^3/day.

At the same time, the Autonomous Government started running some wells which were drilled by the Instituto de Reforma y Desarrollo Agrario, IRYDA (Agrarian Reform and Development Institute), in the Llubí region, and a pipe to link with the one coming from the dams was constructed in 1994. EMAYA also undertook other actions to reduce water losses.

The drought, at the beginning of the 1990s, and the continuous increase in water demand led to the Ebro water transfer, organised by agreement between the Palma and Calviá City Councils and the Autonomous Government with the Central Government. This water was transferred by boat. An effort was also made to reuse wastewater for green area irrigation and other urban uses.

In August 1999 the seawater desalination plant of Bahía de Palma started service, with a total capacity of 42,000 m^3/day, and served drinkable water to Palma and Calviá as well. One year later both plants, the Lloseta treatment plant and the Son Tugores plant, were optimised. The first one increased its capacity by 5,000 m^3/day, and the second one reached production of 43,000 m^3/day. Finally in 2002, the Na Bastera spring pipe was improved, reaching a total of 1 million m^3/year.

Two important projects, which will improve the water management system, are under construction:

(i) A new wastewater treatment plant, designed with tertiary treatment to reuse wastewater. This new plant will substitute the old Palma 1, and will feed the already existing net for reusable water;

(ii) A transfer pipe to exploit the Sa Costera spring, which is the only spring on the island which has not being exploited yet due to technical difficulties. The spring naturally discharges 40,000 m^3/day directly into the sea preventing its exploita tion. This project will reduce dependence on seawater desalination.

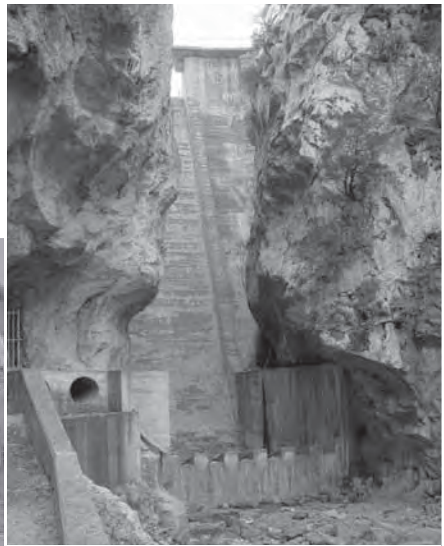
As concerns wastewater treatment, there are two plants whose operation is highly seasonal due to tourism. The first one treated 3.4 million m^3 in 2001 and the second one 23.6 million m^3. The treated water has been used for irrigation since 1970. Due to the insufficient capacity and age of the installations, it has been necessary to build a new water treatment plant in Palma. It should be noted that since the late 1990s there has been a regenerated water network supplying treated wastewater for activities which do not need high quality water.

All in all, several changes in water resources management have led to major water resource savings in Palma De Mallorca. They are all part of a global reform process related to the water management policies of the islands. In the beginning of the seventies, the wastewaters of Palma started to be reused after conventional treatment for irrigation in the area of Pla de Sant Jordi and after 1990, it has reached an annual reuse volume of 12 million m^3.

In 1994, EMAYA, the municipal company in charge of the water supply and sewerage services in Palma launched an Urban Wastewater Reuse Plan. This plan, which was in compliance with the water conservation and management optimisation policies, aims at reusing wastewater for cleaning streets and irrigating gardens, etc. The plan included extra treatment of the wastewater following the conventional secondary treatment to guarantee that its quality meets a series of sanitary requirements. It also implied the construction of a secondary renovated water network.

In the early 1990s Spain went through a severe drought, which in Palma de Mallorca led to the idea of constructing a seawater desalination plant to satisfy the increasing potable water demand. On the other hand, the increasing demand for more sustainable water management policies, which could protect the natural main water resources, the aquifers, reinforced the decision in Palma to go for the desalination technology. This led to the construction of the Bahía de Palma desalination plant which in 2001 supplied 30 per cent of Palma's potable water.

Plate 57. Embalses raw water reservoir of 4.8 million m^3 capacity for water supply of Palma (above), and the reservoir of Gorg Blau of 6.4 million m^3 on the back (Photo: EMAYA)



Sweden

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The long-term development of WSS services in Sweden can be divided into the following key phases:

(i) Some early concessions simultaneously with city managed undertakings from 1850–1880;
(ii) Establishment and expansion of water and sewerage services in 1890–1930 as municipal departments and works;
(iii) Expansion of systems including water pollution control, 1950 to 1980;
(iv) Increasing autonomy, inter-municipal cooperation and outsourcing of non-core operations, 1980–2000, with few private contracts.

Compared to Finland, the development of water and sanitation services started somewhat earlier. The innovations and ideas were derived from the pioneering European countries, and many Finnish cities also utilised the Swedish experiences. The key strategic long-term decisions in Sweden and Finland (**Table 4**) are largely similar reflecting the Nordic "family" and tradition of WSS services.

The main reason for constructing sewers was drainage. A town must be drained to protect the buildings. Stormwater was initially conveyed in gutters together with the small amounts of sanitary sewage and solid waste that were produced. Already in the mid 16th Century king Gustav Wasa demanded that all property owners must keep a barrel containing 200 litres of water close to the street.

Until the mid- and late 19th century, the primary use of water supply in Sweden in urban areas was to combat fires. During the middle of that century some bad outbreaks of cholera in Stockholm and Gothenburg killed a large number of inhabitants. This prompted the construction of networks of water mains conveying good quality water to the consumers for health reasons. The use of water in the urban areas increased then almost continuously until 1970. From then on, the demand has been constant or has even decreased.

Stockholm

Table 32 presents a summary of selected key strategic issues in Stockholm. Since 1851 the city assumed the major responsibility for WSS services. In 1909 the use of WCs was accepted, in 1925 compulsory metering was introduced, and in 1932 wastewater treatment started. The waterworks was earlier organisationally connected to the gas works. From the 1920s to the1950s the waterworks was under the Technical Bureau together with gas and electricity. However, since 1974 water and sewage have been taken care of by the same company, which has gained increasing autonomy, especially after its incorporation in 1990.

In 1851, the state's representative in the city of Stockholm (*Överståthållaren*) requested a proposal from a local expert, Fredrik W. Lejonancker. Lejonancker's proposal was completed in 1853 after several study trips to Europe. Lejonancker argued that water and wastewater services would decrease water-borne diseases, would help fight fires, and provide enough water for street cleansing. It would also allow poor people to wash themselves. A committee established for water supply and sewerage approved Lejonancker's proposal in 1854. The City Council decided in 1858 to build a water intake facility by Årsta Bay. In 1861 the Årsta Bay Waterworks was taken into use. The burghers were against the water supply system because they thought that it was no business of the city to get involved in such matters. The proponents argued for the benefits: hygiene, fight against diseases and fire and the social aspects. One way to fight pollution and diseases was to build a sewerage system (Cronström 1986).

From 1861 to municipal reform (communal law) waterworks were managed by local authorities (*sockenstämmonämnd*). The 1861 order (*förordning*) by His Majesty, the King of Sweden led to the establishment of a city council in Stockholm in 1864. The City Council replaced the former local authorities (sockenstämmonämnd) and in 1868 passed a municipal ordinance (*ordningstagda*) which played a role in preventing surface water pollution and initiated pollution prevention actions. In 1874 the National Health Law (*Hälsovårdstadga*) made the Board of Health responsible for the purity of source water. The board was also responsible for tap water purity. Tap water was to be inspected regularly. The National Health Law meant the beginning of regular water inspections (Cronström 1986).

In 1880 a debate about installing and connecting water closets to water and sewerage systems began. In 1883 when permission was granted to install WCs, some unofficial installations already existed. Finally, in 1904, a general permission for flush toilets using piped water was given, and in 1909 it was allowed to connect water closets to the municipal sewerage system (Jakobsson 1999).

By the end of the 19th century it seemed obvious that the City had to find another place for its waterworks for two main reasons: the increasing demand for water and the pollution of Årsta Bay. It was proposed that Bornsjön was a suitable place for the new waterworks because there it was possible to use both surface and ground water. As a result of the proposal, the Norsborg waterworks was taken into operation in 1904. The system operated at full capacity from 1920 on. The Norsborg waterworks replaced Eriksdal and Årstavik waterworks, which were closed soon after (Adolfsson 2003).

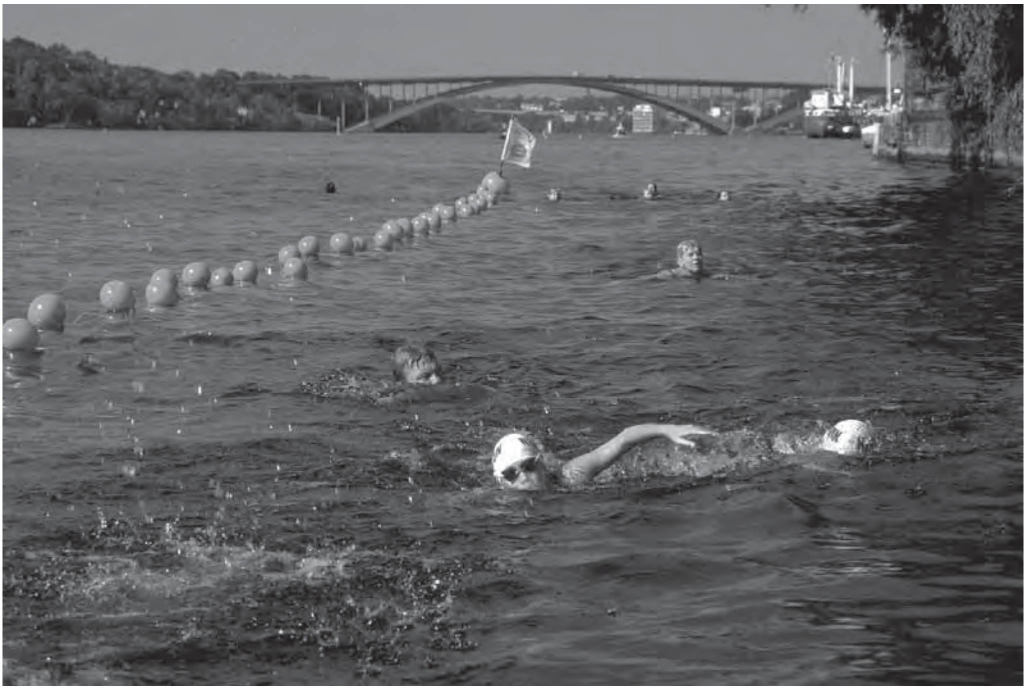

Plate 58. The Riddarfjärden Swimming Contest in the center of Stockholm, Sweden started in 1976. The annual event takes place in August and is open for anyone prepared to swim 3,200 m in open water from the Smedsuddsbadet to the City Hall
(Photo: Thomas Henrikson, Orange AV-Produktion)

In 1925 it was made obligatory to meter the consumption of each service connection. A change was introduced because a significant share of produced water could not be charged. After obligatory metering, the income grew significantly (Cronström 1986).

In 1939 the Lovö waterworks started operations. The Lovö plant used a "new" technique: chemical purification with aluminium sulphate, rapid filtration and chlorination. At same time, the first treatment plant for Stockholm was under planning. The problem was that after the connection of WCs to the water and sewerage systems was allowed, the number of WCs increased rapidly. So did also the amount of excreta in discharge areas. In 1934 the first treatment plant in Ålsten was taken into operation and remained in use until 1965. Another treatment plant was built in 1939 and was in use until 1964 (Cronström 1986).

In 1941 the act on water supply, lakes and other water areas was enacted. At the same time, His Majesty gave an order that owners of waterworks had to engage in physical-chemical study of water. The Ministry of Fisheries was made responsible for overseeing it, assisted by the Water Court and the Provincial Administrative Board (länsstyrelse). In 1941 the Henriksdal treatment plant was completed. The treatment plant inaugurated the next year, the Ekhagen plant, treated sewage waters until 1964 (Cronström 1986).

Table 32. Key long-term decisions on Stockholm water and sewerage services

Year	Event	Reason	Outcome	Organisational change	Stakeholders
1857	Decision to construct waterworks	Planner´s proposal approved "Hygienic must" instead of "gas "luxury"	Waterworks facility goes into operation (1861)	Board of works	Various groups among local councillors
1864	Decision to construct sewage system	Poor sanitary situation, part of "pipeline project"	Short term improvement of life, health aspects, pollution of surface waters		Various groups among local councillors
1883	Permission to install WCs	Demand and supply of flush toilet technology	Increased number of WCs, increased pollution of surface waters, acceptance of connection of WCs to sewers (1909)		Various groups among local councillors, health officers, consumers
1904	Decision to build new waterworks	Pollution of surface source; increased water consumption	Closing of first works, secure water supply for next 100 years		Various groups among local councillors, consumers
1925	Compulsory metering	Need to control and charge for water consumption, waterworks demand for metering of new connections	98 % of water goes through meters		Technical bureau, consumers
1932	Decision to try mechanical purification of sewage	Pollution problems (quality, smell of surface water)	Mechanical treatment since 1934		Experts, local councillors, water works, consumers
1954	Organisational change	New set-up	Gas and waterworks merged	Gas and waterworks	City council, gas and waterworks
1968	New method for pricing tap water	New balance sheet procedure	Water rate increase of 50 %		Water works, consumers
1974	Water works and sewage works merged	Rationalisation	Sewerage charge doubled	Water and sewage works	City council, water works
1990	Incorporation	Overcharging	Foundation of water company, raising of profile	Stockholm water co.	City council, Stockholm Stadshus Co

Once the problems of fire fighting and water supply had been solved, an environmental problem emerged. The introduction of bathrooms and WCs severely deteriorated the receiving waters through oxygen depletion, odours and health risks. In the late 1930s, the popular swimming contest held in downtown Stockholm had to be discontinued due to health risks to the contestants leading to the introduction of sewage treatment plants.

Wastewater treatment

A large mechanical wastewater treatment plant was completed in 1950. After discussions in newspapers, the City made a general plan for a sewerage system in 1954. The Water Court approved the plan on condition that biological treatment and a separate sewer system are built (Cronström 1986).

The first wastewater treatment plant in Stockholm, the Ålsten plant, provided mechanical treatment of wastewater for 5,000 people from 1934 to 1965. The first phase of the Åkeshov plant was also completed in 1934. It was initially built for 15,000 people, but was extended in the 1940s and 1950s. It operated as a pilot biological treatment plant. This plant is still in operation in 2005 known now as the Bromma plant.

In 1939 the small Bergvik plant became operational. It consisted of an Emscher tank for 3,000 people and remained in use until 1964. The Henriksdal plant, which was completed in 1941, provided mechanical treatment of wastewater for 500,000 people. In 1942 the Ekhagen plant was taken into operation, treating the wastewater of 1,000 people until 1964. In 1950 a large mechanical treatment plant, Loudden, was completed. The capacity of this plant was estimated to be sufficient to treat the wastewater of 50,000 people. In the 1960s the plant was modernised with the addition of biological treatment processes. The first activated sludge plant in Stockholm, it is still in operation.

The second biological plant, the Eolshäll plant, was completed in 1961 and operated until 1984. The first attempts to remove phosphorous were made there in 1966–1967. In 1968 three plants had biological treatment, while since 1970 the city's wastewater has been treated both chemically and biologically. Efficient nitrogen removal was introduced in the 1990s. In 2004 wastewater was treated in three plants, Henriksdal, Bromma and Loudden. Since 1989 no wastewater has been discharged into Lake Mälaren, only into Saltsjön (sea). About 400,000 m^3 of wastewater is treated daily in the plants (Johansson & Wallström 2001).

After adopting a new accounting method in 1964, Stockholm Waterworks encountered a serious challenge: a housing association sued it for overcharging. The court proceedings took a long time passing through all instances in Sweden. The Supreme Court gave its decision in 1988 which meant that Stockholm Waterworks had to pay back to consumers overcharged water tariffs. Soon after the decision, the City council decided that Stockholm waterworks should be incorporated to prevent the same from happening again. In 1989 the City decided to establish Stockholm Water Company, and the company began to operate the next year (Cronström 1986).

Plate 59. Entrance of the Henriksdal wastewater treatment plant located underground in Stockholm, Sweden. The plant has 700,000 people equivalent treatment capacity
(Photo: Thomas Henrikson, Orange AV-Produktion)

Since the 1970s Stockholm has used "water" as the brand of the City. This was followed by the introduction of the annual Stockholm Water Prize and Stockholm Water Symposium in the early 1990s in connection with the incorporation of the Stockholm Water Company.

At the same time, supra-municipal cooperation has increased both in water supply and sewage collection and treatment.

United Kingdom

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In the UK the development of water and sanitation services since the 1970s has been quite different in England and Wales compared to the other parts of the United Kingdom (Scotland and Northern Ireland), following the transformation of a large number of municipal providers into ten Regional Water Authorities in 1973, which were privatised by stock market flotation in 1989. Scotland's water system remained on a municipal basis until 1996, when it was regionalised, and in 2002 the three regions were merged into one state-owned water company (Scottish Water). Northern Ireland has one government agency, which is to be transformed into a state-owned company.

The evolution of water and sanitation systems and services in England and Wales are briefly as follows (adapted from Hassan 1985):

(i) Before 1800: a mixture of unauthorised water undertakings, privately owned works, and public works authorised by charter or Act of Parliament;

(ii) 1800–1840: effort by joint-stock companies, authorised by Act of Parliament, to improve urban water supplies;

(iii) 1840–1900: municipalisation of most urban water supplies;

(iv) 1900–1974: municipal development of water and sewerage systems, with the exception of the 20 per cent of the population with water supply provided by non-municipalised private water companies ('statutory water companies'), heavily regulated;

(v) 1974–1989: largely regional structure based on river basins, with 10 Regional Water Authorities (RWAs) responsible for water and sewerage (some re sponsibilities operationally delegated to municipalities and the statutory water companies);

(vi) 1989 onwards: RWAs privatised; statutory water companies ('water-only companies') freed from previous regulatory restraint; consolidation of these companies by horizontal merger and through takeover by the large water-and-sewerage companies.

Table 33 summarises the key long-term strategic decisions on WSS services in UK. In relation to public health history, the UK played a pioneering role. After Edwin Chadwick's classical study "General Report on the Sanitary Condition of the Labouring Population of Great Britain", the Public Health Act of 1848 gave local authorities powers to improve water supply quality though this was not mandatory in all cases. It was compulsory to establish a Local Board of Health when mortality exceeded 23 per thousand (Millward 2000).

According to Millward (1986), centres with rapidly growing populations and industries faced more urgent public health concerns. Evidence suggests that such towns turned to publicly owned supplies while there were also some exceptions. In any case, on the eve of WWI publicly owned water undertakings represented 80 per cent of the total, while some decades earlier private ones held the same share.

Regionalisation on river basin principles was discussed in the UK from the 1920s on. River Authorities were created in 1963 to coordinate some environmental aspects of water, but it was only in 1974 that the industry's aspirations were achieved in England and Wales, when the ten river-basin-based Regional Water Authorities were founded, taking over the work previously carried out by 157 water undertakings, 29 River Authorities and 1393 Sanitary Authorities (Hassan 1998, 127). The RWAs took over not only the work, but also the assets, including the water and sewage works and associated land and buildings, and the liabilities. No compensation was paid to the local authorities, but their objections were partially overcome by the government assurance that local government would control the RWAs by always having a majority of members on their boards. Municipal representation was gradually reduced, and then abolished in 1983, and in 1989 the RWAs were floated on the stock market. As Bakker (2003), among others, points out, "The 'British model' of water privatisation is unique: no other country has entirely privatised its water supply and sewerage systems". In the process, the government effectively expropriated the previously-municipal water systems.

Table 33. Key long-term events in water and sewerage services in UK

1832	National cholera epidemic
1842	Edwin Chadwick, "General Report on the Sanitary Condition of the Labouring Population of Great Britain"
1847	General election replaces Conservative government unsupportive of public health reform with a Liberal one
1848	Public Health Act establishes power for inspection and supervision of water, sanitation, and waste disposal
1849	National cholera outbreak kills 33,000 in 3 months
1858	Great Stink in London (House of Commons affected by stinking River Thames)
1858–1865	Intercepting sewers built in London to carry (untreated) waste downstream
1861–1881	Key period of municipalisation: proportion of towns municipally supplied with water rises from 40.8 to 80.2% (Hassan 1998, 18)
1875	Public Health Act facilitates municipalisation (but does not require it)
1955–1970	Mergers reduce number of water providers (public and private) from c. 1,000 to c. 200
1963	Act creating River [basin] Authorities
1973	Act merging River Authorities, municipal water companies, and sewerage boards into 10 Regional Water Authorities
1989	Privatisation of Regional Water Authorities, creation of initial regulatory structure (Ofwat, National Rivers Authority)
1995	National River Authority merged into newly-created environmental regulator covering air, water, and solid waste management (Environment Agency)
1999–	Financial restructuring including mutualisation attempts, securitisation, increased reliance on debt finance
2003	Water Act providing an independent consumer body (formerly WaterVoice) and reforming the economic regulator (Ofwat)

Leeds (England)

Leeds was one of the first towns in Britain to have a water supply piped to individual houses. Designed by the engineers George Sorocold and Henry Gilbert, it began operating in 1694, serving the wealthy parts of Leeds, then a town of 7,000. A water wheel built near Leeds Bridge, Lower Briggate, pumped water from the River Aire through 2.5 kilometres of 75 mm diameter lead pipes to a storage reservoir, from where the water entered the local distribution system.

By the early nineteenth century, Leeds Waterworks Company supplied around 2,000 houses with water. Most of Leeds continued to rely on wells, boreholes, water carriers and the River Aire. By 1830, however, pollution from wastewater had caused the Aire to become completely unsafe for drinking, and the death rate in Leeds rose from 20.7 per thousand in 1831 to 27.2 per thousand in 1841. At this point Leeds Waterworks Company finally stopped using the Aire as a source of drinking water. As Leeds' population continued to expand, the number of connected houses rose from 3,000 in 1842 to 22,732 in 1852, when the Company was municipalised, being bought by the Leeds Corporation for 250,000 pounds (Sellers 1997, 4-5).

Plate 60. Plant for crushing and screening filtering media showing "saggars" before crushing for wastewater treatment plant in Leeds around 1900–1905 (Photo: Raikes, 1908)

Sewerage

During the 1832 national cholera epidemic, 700 people died in Leeds over a 6 month period. A reference to a report by Robert Baker stated, "There was shown to be a clear link between the disease and poor drainage. The report was sent to the Home Secretary in London, but appears to have been promptly shelved." (Sellers 1997, 2)

"Impelled by a growing movement for Improvement, the newly formed Borough Council promoted a series of local Acts of Parliament… [including] the Leeds Improvement Act, 1842," (Sellers 1997, 6) which, among other things, empowered the Council to build a sewerage system. One of three rival sewerage schemes was approved by the Council in June 1846. Some delays arose from the need to gain permission from landowners. Further delays arose because the 1842 Act also imposed a borrowing limit of 100,000 pounds, and the Council had already borrowed 50,000 pounds for other projects. The financial difficulties (including increasing opposition to a sewerage tax, due to an economic downturn) were only overcome after a further outbreak of cholera in October 1849, in which 2,000 died in Leeds. The first contracts for construction work were authorised in 1850, and the sewerage system was completed by 1855, at a total cost of 137,000 pounds (Sellers 1997, 6–7).

Between 1856 and 1865 average daily water consumption rose from 7,280 m^3 to 20,000 m^3, all of which returned to the River Aire without any form of treatment. In 1875 the Council's Streets Committee began work on the city's first wastewater treatment plant, using an experimental system designed to produce high-quality sludge for agricultural use. The market for this failed to materialise, and the system was changed to a more traditional one.

Table 34. Key long-term decisions on Leeds water and sewerage services

Year	Event	Factor	Outcome	Organisational change	Stakeholders
1694	First piped water supply				
1800	Around 2,000 houses supplied; most still rely on wells, boreholes and river water (River Aire)				
1832	Cholera outbreak in which 700 die	Lack of sewerage/ clean water			
1832	Report on outbreak by Robert Baker is sent to Home Secretary	Shows clear link between disease and poor drainage	Report shelved	None	Robert Baker, Home Secretary
1832	Reform Bill grants Leeds two MPs			Two Leeds MPs	City
1835	The Municipal Reform Act allows the first elected council to take office			First elected council	City/MPs
1841	Leeds Waterworks Company discontinues use of Aire for drinking water	Pollution of the Aire			
1842	Leeds Improvement Act		Power to build sewerage scheme; £100,000 city debt limit		
1846 – 1849	Council decision to adopt sewerage scheme	Public health	Scheme delayed (debt limit prevents financing)		City
1849	National cholera outbreak in which 2,000 die in Leeds	Lack of sewerage/ clean water			
1850	Sewerage system initiated		Sewerage system completed 1855		City

Year	Event	Factor	Outcome	Organisational change	Stakeholders
1852	Leeds Waterworks Company bought by Leeds Corporation (for ¼ million pounds)	Failure to expand water system sufficiently; need to develop sewerage		Municipalisation	City
1899	Compulsory for dwellings to be connected to sewers	Public health			City
1974	Responsibility for water and sewerage transferred to new Yorkshire Water Authority; agency agreement made with Leeds Council to run sewerage operations	Economies of scale; more effective integration through river-basin management		Nationalisation (and large merger)	National government, Yorkshire Water Authority, City
1983	Removal of Leeds Council representation on Yorkshire Water Authority			Removal of Leeds Council representation on Yorkshire Water Authority	National government
1989	Privatisation of Yorkshire Water	Conservative ideology; investment needs from EU directives		Stock market flotation of Yorkshire Water	National government
1997	Termination by Yorkshire Water of agency arrangement with Leeds Council for sewerage operations				Yorkshire Water
2000	Mutualisation proposal (rejected)	Various			Yorkshire Water, consumers/NGOs, Ofwat, government

Sources:
http://www.leeds-uk.com/history.htm
http://www.leeds365.co.uk/briefhistory1.htm

Recent history

A new, more modern wastewater treatment plant was constructed at Knostrop between 1910 and 1936. The late seventies saw investment in sewage treatment decline rapidly, and thus by 1983 Knostrop was in a state of disrepair with many sections of the plant deteriorating and effluent quality suffering. To bring it up to date a 24 million pounds upgrade was completed in November 2001. Since then Knostrop has met the effluent requirement of 20 mg/l BOD and 5 mg/l ammonia (Horan 2005).

In 1974 the one and a quarter century period of municipal ownership of the city's sewerage came to an end. Simultaneously with the implementation of Local Government Reorganisation, which created the Leeds Metropolitan District, the sewerage, sewage treatment and water supply functions were handed over, with all related assets, to the newly formed Yorkshire Water Authority (YWA). The Water Act, 1973, provided for the Leeds City Council to maintain the sewerage system and design new works on the Water Authority's behalf, i.e. as an Agent of the YWA. This gave City Councillors some sort of influence on sewerage policy, but the strategic priorities were set by the YWA Board, on which Leeds Councillors had only indirect representation. In the early 1980s the Conservative Government completely reorganised the ruling bodies of the Regional Water Authorities and, removing all local authority representation, thus completed the severance of sewerage from municipal control. (Sellers 1997, 24)

On 31 December 1997 Yorkshire Water terminated sewerage outsourcing arrangements with all its sewerage agents, including Leeds City Council. Operational responsibilities for the sewerage system were taken 'in-house', with City Council staff engaged in this work transferred to Yorkshire Water. The Council was given the option of acting as consultants for designing new investment in sewerage, which it took up. (Sellers 1997, 27)

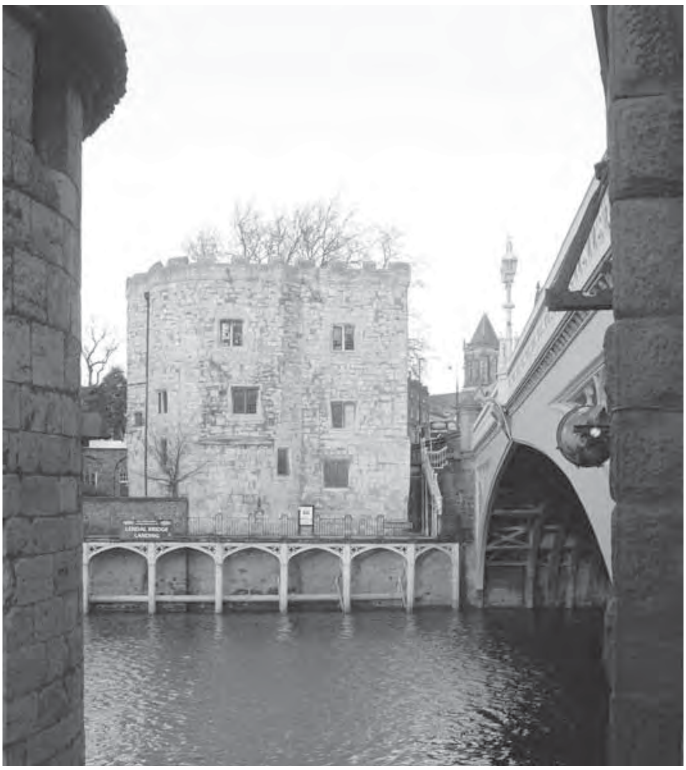


Plate 61. Lendel water tower in Leeds, England, dating back to the 14th century, in more recent years used as the headquarters of York Waterworks, purchased by Yorkshire Water in 1999 (Photo: Yorkshire Water)

Cardiff (Wales)

Cardiff, in southeast Wales, grew at a phenomenal pace in the nineteenth century, becoming a major port especially for coal and iron, particularly after the railway reached Cardiff in the mid-19th century. In 1801 the population of Cardiff was less than 1,900; by 1851 it was over 18,000, reaching nearly 60,000 in 1871, and 160,000 by 1900. (Lambert 2004). A summary of the key long-term strategic decisions on the water services of Cardiff is presented in **Table 35**.

Plate 62. Sewage pumping station circa 1880 in Cardiff, Wales, pumping sewage to a tank sewer discharging to the sea on the outgoing tide. Nowadays used as an Antique & Craft Centre
(Photo: Dwr Cymru Welsh Water)

By the mid-19th century, population growth was causing sanitary conditions in Cardiff to worsen, and there were outbreaks of cholera in 1842 and 1849, as there were elsewhere in Britain. As a result of the 1849 outbreak in which 396 people died (Penrhyn Jones 1958), a petition was presented to the General Board of Health, which carried out an inquiry that year into water and sanitation. The report noted that many people were taking drinking water from the River Taff and the Glamorganshire Canal, sources which were contaminated with sewage, and that as a result "cholera was raging in Cardiff". As a result, on 19 December 1849 local businessmen set up the Cardiff Waterworks Company to supply drinking water from clean sources through a network (Edwards 2003) and in 1850 won passage of the Cardiff Waterworks Act to give them the powers to do so. This was supplemented by further Acts in 1853 and 1860 to enable investment in further supply including a reservoir.

In 1875, "after much political and financial negotiation" (The Fourth Arch Online Magazine. http://www.richardmayer.co.uk/fourtharch/localhistory/localhist4.htm) the city of Cardiff won statutory authority to municipalise the Cardiff waterworks, in part because of the need to finance construction of a new reservoir (Edwards 2003). Construction of a modern sewerage system also followed.

Table 35. Key long-term decisions on Cardiff water and sewerage services

Year	Event	Factor	Outcome	Organisational change	Stakeholders
1842	Outbreak of cholera				
1849	Cholera outbreak in which 396 die	Lack of sewerage/ clean water			
1849	Board of Health report		Concludes lack of sewerage/clean water is the problem	Cardiff Waterworks Company established as a private company, 19 Dec 1849	Board of Health, Businessmen
1854, 1866	Further cholera outbreaks (225, 76 dead)				
1875	Public Health Act 1875 clarifies responsibilities of councils				National government
1875	Municipalisation	Need for more water; need for sewerage		City takes over Cardiff Waterworks	City
1974	Nationalisation (and large merger)	Economies of scale; more effective integration through river-basin management Economies of scale; more effective integration of organisation to river-basin principles		Responsibility for water and sewerage transferred to new Welsh Water Authority; agency agreement made with Cardiff City Council to run sewerage operations	National government, Welsh Water Authority, City
1983	1983 Water Act			Removal of Cardiff Council representation on Welsh Water Authority	National government
1989	Privatisation of Welsh Water	Conservative ideology; investment needs from EU directives		Stock market flotation of Welsh Water	National government
1996	Welsh Water takes over Swalec, becoming Hyder			Creation of multi-utility Hyder	Welsh Water
2001	Welsh Water becomes a Company Limited by Guarantee	Financial difficulties from Swalec takeover, etc.		Dismantling of Hyder; Welsh Water becomes non-profit company	Glas Cymru, Ofwat, Welsh Assembly

Cardiff has had its water and sewerage services provided by Welsh Water since 1989, and earlier by the Welsh Water Authority between 1974 and 1989. Most recently, in 2001, Welsh Water was mutualised, i.e. taken over by a company limited by guarantee (Glas Cymru). It is the only utility company in England and Wales in 2004 that is not owned by shareholders. All Glas Cymru's financial surpluses are retained for the benefit of Welsh Water's customers.

Plate 63. New wastewater treatment plant in Cardiff East, Wales (Photo: Dwr Cymru Welsh Water)

Edinburgh (Scotland)

In 1621 the Scottish Parliament passed an Act for a gravity supply in Edinburgh that was introduced in 1676 with a supply of 274 m^3/day. By 1760, various springs were added and augmented the supply to 909 m^3/day. The next expansion was undertaken by the Corporation of Edinburgh in 1819 when the Edinburgh Water Company was formed. It constructed a reservoir using cast iron pipes for the main trunk to Edinburgh. With the Crawley and Glencrose Schemes, Edinburgh in 1821 had a daily supply of 11,365 m^3. Public wells were provided all the while, and household supply was introduced around that time also. Increasing demand in the 19th century led to more resource schemes (British Waterworks Association 1934; Tetlaw 1982, 15–16).

In 1862, an Act "gave local authorities the power to require landlords to introduce water into houses, at this time houses in slums were still totally devoid of water" (**Table 36**) (Tetlaw 1982, 15). In 1870, the Edinburgh and District Water Trust, a corporate body consisting of representatives of the Town Councils of Edinburgh, Leith and Portobello, took over responsibility for providing water supply (British Waterworks Association 1934; Tetlaw 1982, 15). The supply of water "remained in the hands of the Trust until 1920 when it was transferred to Edinburgh Corporation" (Tetlaw 1982, 15). "Responsibility for the supply of water remained in the hands of Edinburgh Corporation from 1920 until 1968 when the South East of Scotland Water Board was created. It survived until 15 May 1975 when the present Authority, Lothian Regional Council, was created" (Tetlaw 1982, 16).

Edinburgh experienced considerable urban growth from a population of 160,511 in 1851 to 316,837 in 1901. Urban growth led to increased pollution of the Water of Leigh. An Act in 1864 resulted in the construction of a sewer extending to the sea after intercepting several drains and sewers that previously discharged into the Water of Leigh. The expansion of the sewerage network continued incessantly until 1960 (Department of Water and Drainage, undated; Tetlaw 1982, 17–20).

Table 36. Key long-term decisions on Edinburgh water and sewerage services

Year	Event	Reason	Outcome	Organisational change	Stakeholders
1862	An Act "gave local authorities the power to require landlords to introduce water into houses	Houses in slums were still totally devoid of water	Water into houses		The King, City councillors, city council, experts
1864	An Act resulted in the construction of a sewer extending to the sea after intercepting several drains and sewers that previously discharged into the Water of Leigh	Poor sanitary situation	Better quality of city life		The King, City councillors, city council, experts

Year	Event	Reason	Outcome	Organisational change	Stakeholders
1870	The Edinburgh and District Water Trust took over responsibility for providing water supply	Need for better management of the water service	Institution of the District Water Trust, a corporate body consisting of representatives of the Town Councils of Edinburgh, Leith and Portobello	Institution of the District Water Trust, a corporate body consisting of representatives of the Town Councils of Edinburgh, Leith and Portobello	The King, City councillors, city council, experts
1920	Institution of the Edinburgh corporation		Responsibility for the supply of water went to Edinburgh Corporation	Edinburgh Corporation	City councillors, city council, experts
1920 – 1968	The South East of Scotland Water Boaird was created		Responsibility for the supply of water went to SESWB	SESWB	City councillors, city council, experts
15 May 1975	The present Authority, Lothian Regional Council, was created				
1978	Wastewater treatment was introduced	Health and environmental aspects	Completion of the Seafield treatment plant that benefited from a European Investment Bank Sewage underwent primary treatment before being discharged into the sea, 2.8 kilometres off the shore. Sludge from the treatment works was disposed of at sea by a sludge disposal vessel		City councillors, city council, experts, the Bank
1996	Creation of East of Scotland Water				
1st Jan 1999	Upgraded Siefield plant	Need for better water treatment	Sewage received secondary treatment before being disposed of in a landfill site		City councillors, city council, experts, the Bank
April 2002	Creation of Scotland Water	North of Scotland Water operations economically unsustainable	All Scottish water operations merged	From 3 public corporations to one public corporation	Scottish Executive, WIC (regulator), 3 Public Water Authorities

Plate 64. Steam excavator used for Talla Reservoir construction 1895–1905, South of Broughton / Peebles for water supply of Edinburgh, Scotland
(Photo: Scottish Water)

Plate 65. Digestors and gas holders of Sealand wastewater treatment plant in Edinburgh, Scotland, refurbishment completed in 2003
(Photo: Scottish Water)

Wastewater treatment was first introduced in April 1978 with completion of the Seafield treatment plant that benefited from a European Investment Bank "substantial loan at preferential rate of interest". Sewage underwent primary treatment before being discharged into the sea, 2.8 kilometres off the shore. Sludge from the treatment works was disposed of at sea by a sludge disposal vessel. By 1982, 92 per cent of Edinburgh's sewage was treated at Seafield and the overall cost of the scheme had reached 52 million pounds (Department of Water and Drainage, undated; Tetlaw 1982, 22).

Sludge disposal vessel Gardyloo ceased its activity in December 1998 as the EU Urban Waste Water Directive banned sludge disposal at sea. From 1st January 1999, sewage received secondary treatment at the upgraded Siefield plant before being disposed of in a landfill site (Cairns 1998, 20).

Edinburgh is the capital city of Scotland that has experienced a number of reforms introduced by Westminster (the UK Parliament) since 1975. Prior to that date, water supply and sewerage operations were provided by a large number of undertakings. This was reduced considerably through concentration and mergers, from a few hundred to just 12 regional authorities. They remained responsible to local government, and privatisation on the model of England and Wales did not take place, mainly as a result of a massive campaign which saw the involvement of many sections of Scottish society. In 1996, in the context of devolution of power from Westminster to a newly founded Scottish Parliament with its own Executive, whose responsibilities included water, further restructuring led to the creation of three public water supply and sewerage authorities. Despite rejection of English-style outright privatisation, a different form of private sector involvement has been introduced where BOT (build–operate–transfer) contracts are awarded for the construction of new treatment plants. Finally, in 2002 the three water authorities were merged into Scottish Water, a public corporation responsible for the provision of water services to the whole of Scotland.

Comparative analysis and discussion

"Irrigation of the land with seawater desalinated by fusion power is ancient. It's called 'rain'"

Michael McClary

Comparative analysis

Most of the available documents and sources on the long-term development of water services and utilities are of descriptive nature, often based on a deterministic conception of technological development and concentrating on technical evolution of the systems rather than bifurcation points, alternative development paths and path dependencies. Therefore, surveys focusing on the key strategic decisions, the decision-making processes and the number of potential alternatives considered are quite difficult and very challenging in terms of the period of City in Time. Yet, for general comparison of the evolution of WSS services in the case countries and cities we have selected some of the key indicators that either are available or can be roughly estimated. The purpose of these comparisons is not to do fashionable comparative bench-marking but rather to present the key phenomena, changes, and decisions made over the City in Time period.

In the early establishment phase of the WSS systems several alternatives were debated and discussed often for several decades, if not a century. After the systems were established, the focus was on continuous expansion of the systems together with urban population growth, while less attention was paid to alternatives. This was in harmony with the modernisation doctrine of society.

Factors creating demand

The demand for improved water and sewerage services was created by several factors (motives) based on local conditions in all case countries. **Figure 13** is a compilation of such factors: the WSS business itself, fire protection, lack of water, poor quality of water, environmental protection, public health, industrial use, regional focus, tourism, other reasons or various combinations of them. It is obvious that these demands were and also are of contradictory nature. In many cases the improvement of services was directly linked to WSS sector legislation as such, while in some cases societal changes in other sectors influenced also WSS services like regionalisation in the UK and later in the Netherlands.

The need for fire-fighting water was one of the earliest drivers for water supply and is therefore discussed here in more detail. After the great Fire of London in 1666, the city organised fire protection companies and required certain amounts of equipment to be on hand by all residents for use in combating fires. Another spin off of the Great London Fire was the advent of the first fire insurance companies in England. These companies has three basic duties; they posted fire marks to identify insured and protected properties, trained fire-fighters and salvage men who protected insured premises only, and they responded to actual calls for fire to the protected properties.

These insurance company fire-fighters became England's first organised fire brigades. Gradually the brigades began competing to attend any fire for the honour of having reached the fire first. Modern traditions of fast response stem from these beginnings over 200 years ago. The traditional idea of being ready to fight all fires was also born among members of these early insurance company brigades (www.georgetowncityfire.org/admin/history.html).

The first fire insurance company in Germany and the world to insure public buildings, the "Hamburger Feuerkasse", was founded in 1676 in Hamburg. Insurers soon realised that it was in their interest to hire men to put out fires in buildings they had insured. In order to identify their policyholders' houses, each insurance company had its own metal badge, or fire mark, which was attached to the facade of the insured house. When a fire broke out, it was not unusual for more than one brigade to arrive at the scene.

Fire insurance companies also played a role in financing the first piped water supplies, at least in the Nordic countries. According to Barraqué (2005), the access or non-access to cheap public funding explains where and how water services developed in France. According to Lantz (2005), technical and organisational questions rather than financial considerations seem to have been important in the early phase of water supply and sanitation in Berlin in the 19th century. Considering also other cases, there seem to have been various driving forces and their combinations, or at least emphases, in various conditions.

Figure 14 presents a summary of the key development phases of WSS services in the case countries. In almost all cases private concessions were introduced or considered in the first phase, but by 1900 almost all of the systems were taken over by municipalities that started to develop, manage and provide the services. Naturally WWI and II undermined the development of WSS services, but reconstruction and expansion of the systems followed both. After WWII, until the collapse of the Soviet Union in the early 1990s, East European water and sanitation services were managed by State Water Companies although municipalities were sometimes in charge of operation. The major policy constraints of that time were the low prices of energy and water, which undermined the possibilities for proper management of services. In most of the case countries modern water pollution control did not start until the 1960s or 1970s. In the 1990s, and in France in the 1970s, private operators and in some cases private ownership was re-introduced. At the same time, and even earlier, municipality-owned systems had gained operational autonomy and developed various forms of inter-municipal cooperation.

The establishment of "modern" water supply, sewerage and wastewater treatment over time in the case cities is summarised in **Figure 15**. In many cases water supply was introduced first, followed, or in several cases combined with the establishment of sewerage systems. In some cases sewerage was introduced first, if deemed necessary.

In a number of cases the first "modern" water supply systems had low-pressure or very simple systems for water treatment as in Tampere and Tallinn. Alternatively, the coverage was remarkably low. Sewerage was often preceded by drainage, and in such instances the available data are only indicative. For instance, it is even possible that some form of sewerage or drainage has existed since the Renaissance period. In practice, introduction of separate systems for sewerage made it feasible to start wastewater treatment.

Plate 66. Example of technology used for 2,000 years: an abandoned large-size archimedes screw pump in Tampere, Finland used now as a statue. Similar pumps are still commonly used worldwide for pumping raw sewage and sludge (Photo: T. Katko, 2005)

Plate 67. Example of late wastewater pollution control recognition: sludge-carrying vessel M.V. Gardyloo in Edinburgh, Scotland, taking sludge to the sea as late as 1998 based on the assumption of unlimited carrying capacity of the sea (Photo: Edinburgh sewage disposal scheme, 1978)

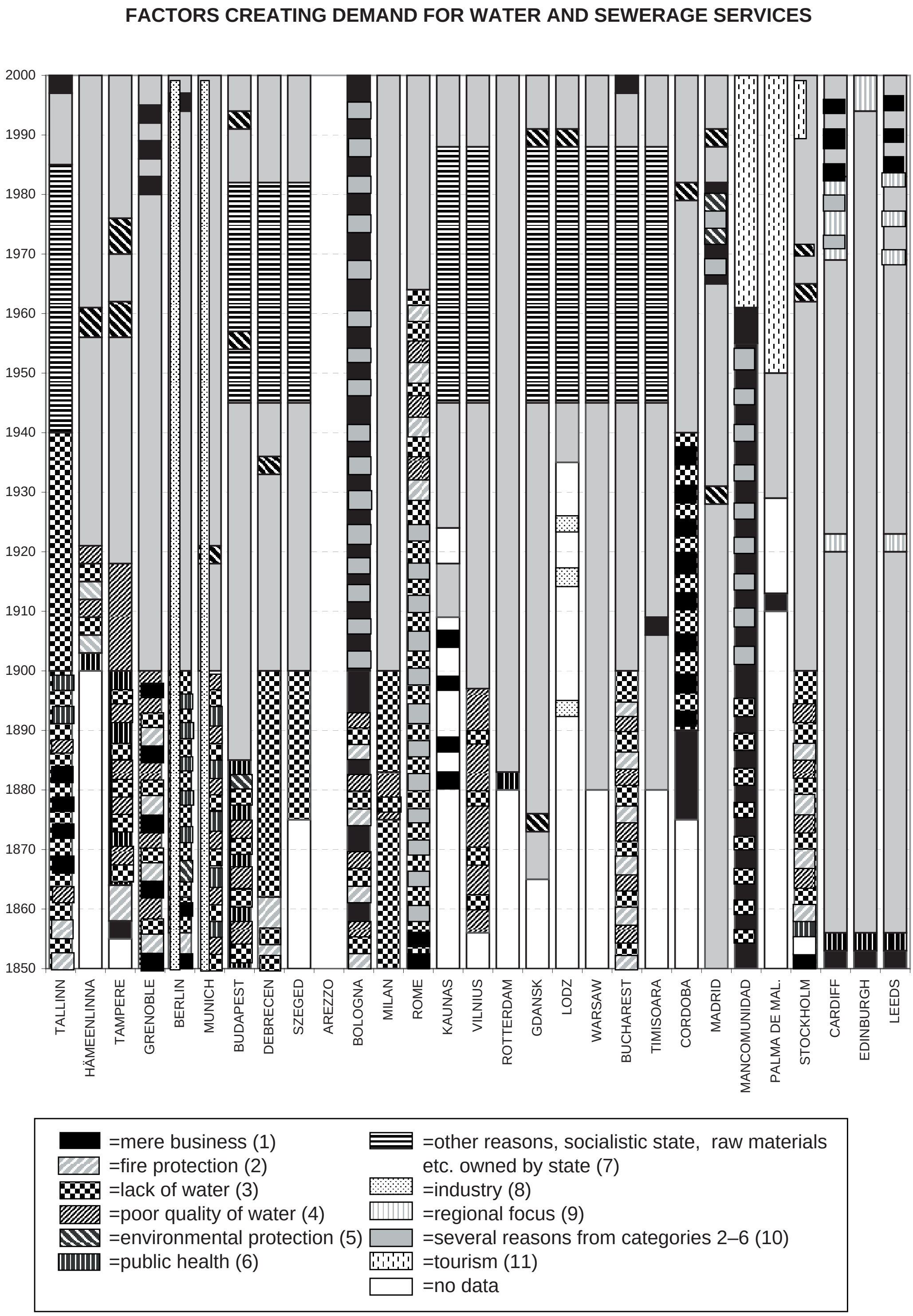
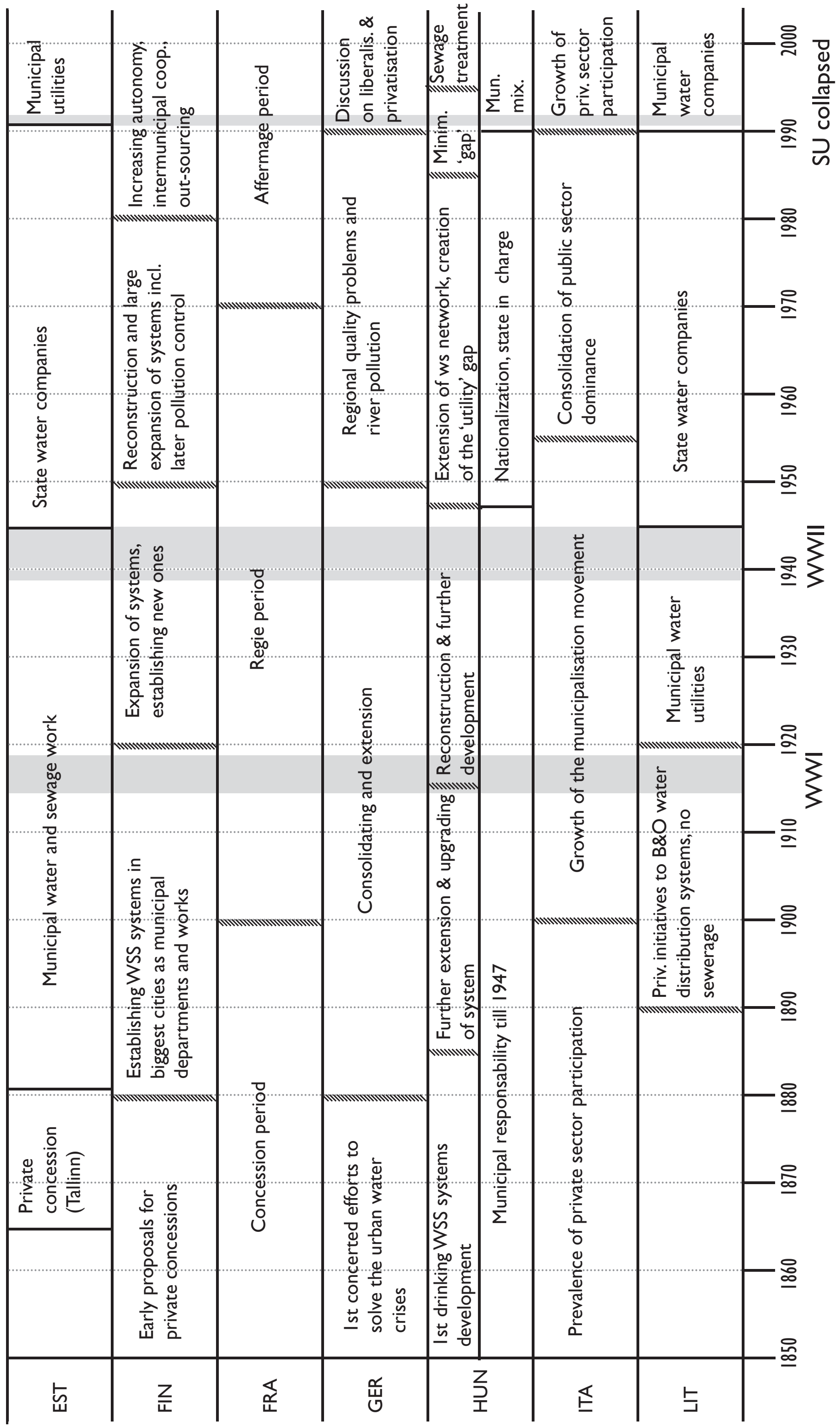


Figure 13. Factors creating demand for improved WSS services in the case cities over time

KEY DEVELOPMENT PHASES IN THE CASE CITIES, MID-1800s TO 2002



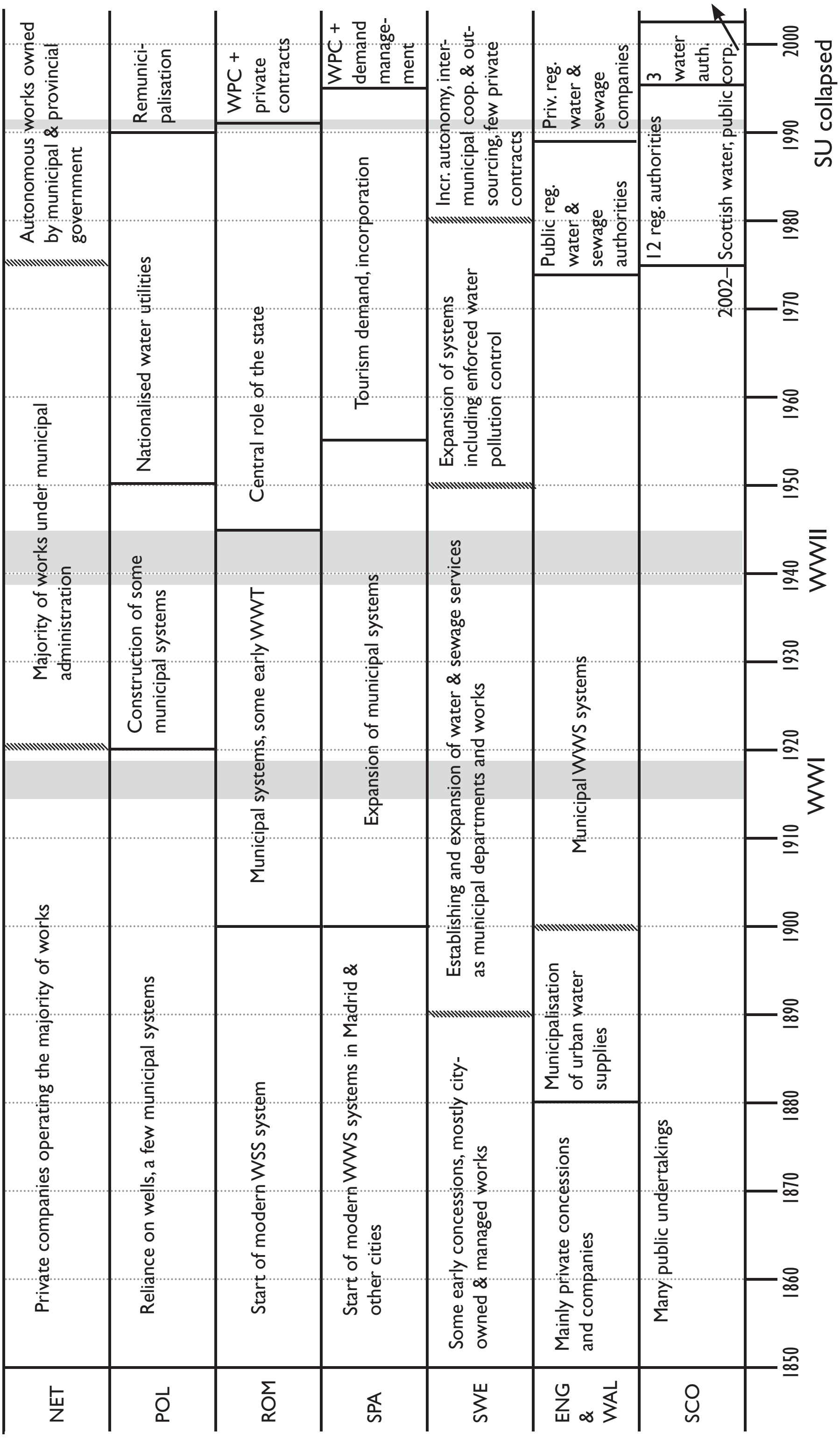


Figure 14. Key development phases of WSS services, from mid-1800s to 2000 (papers by partners; Hassan 1985)

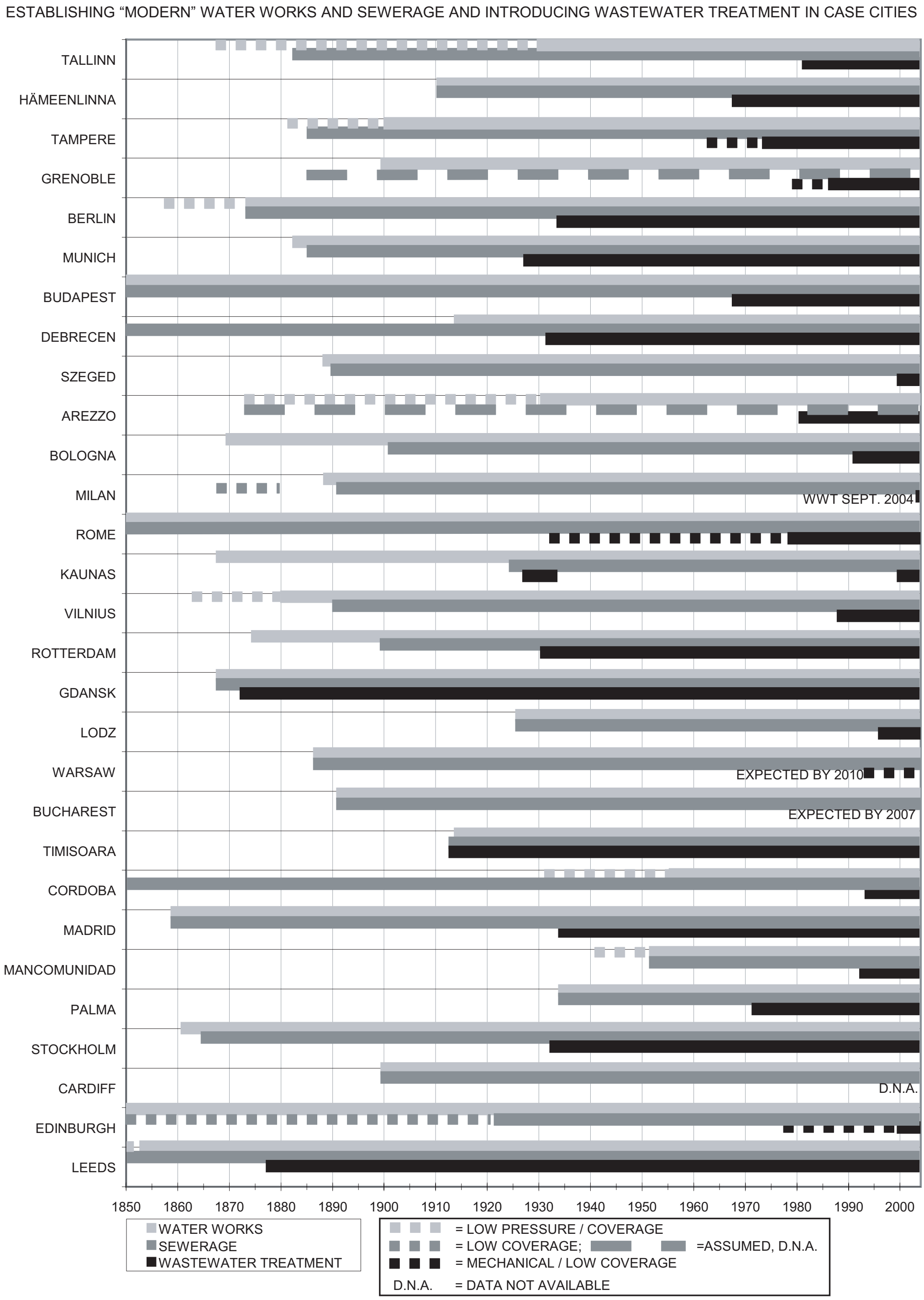


Figure 15. Establishment of modern WSS and introduction of wastewater treatment in the case cities

In some cities wastewater treatment was introduced remarkably early although at first based on mechanical or other fairly simple methods. However, the case of Gdańsk with land filtration, Leeds with trickling filters as well as Berlin and Munich with fish lagoons present early examples of "modern" wastewater treatment. Most of the cities introduced "modern" methods, chemical and biological treatment are here considered such, as are combinations of them in the 1960s and 1970s. In most cases the relative level of treatment has progressed while in some cases like Gdańsk, Kaunas and Leeds it has declined with time.

There are also cities that did not start to treat their wastewaters until the 1990s or 2000s. Besides, wastewaters are not even now in 2005 treated with the best available technology in all cities. Another question is the coverage of services. For instance, in Budapest the coverage of sewerage is quite high but only one half of the wastewaters were treated in 2004.

Especially in water pollution control, legislation and enforcement have played a major role. Natural conditions, like the possibility of discharging wastewaters into the sea, also explain the fairly late introduction of water pollution control in some case cities. In such cases combined sewers with mere screening were used until by 2000. And sewage sludge was dumped in the sea. Economic capacity or welfare of the regions, often considered a major factor, do not seem to correlate with water pollution control activities — sometimes the opposite is true.

In some cases early water pollution control was voluntary although based on "felt need" while in other cases the situation did not improve before EU requirements and legislation.

The various forms of public–private cooperation practiced over time in the case cities are shown in **Figure 16**. In one third of the case cities, particularly the first water systems, were implemented as private concessions. In several other cases concessions were proposed but municipal systems were selected instead. By 1900 most of the case cities had taken over the systems and started to develop utilities under local government. Yet, it is very important to note that in many cases these public utilities bought services, equipment and goods from the private sector already at this stage. Besides, these utilities took loans from private banks.

After WWII state water companies assumed the responsibility for WSS services in Eastern Europe. Obviously water pollution control was largely neglected in those days when low-priced or free services were provided and fuel was cheap — thus leading to inefficient use and high leakages of water systems. Some norms existed for water pollution control, but they were not properly enforced.

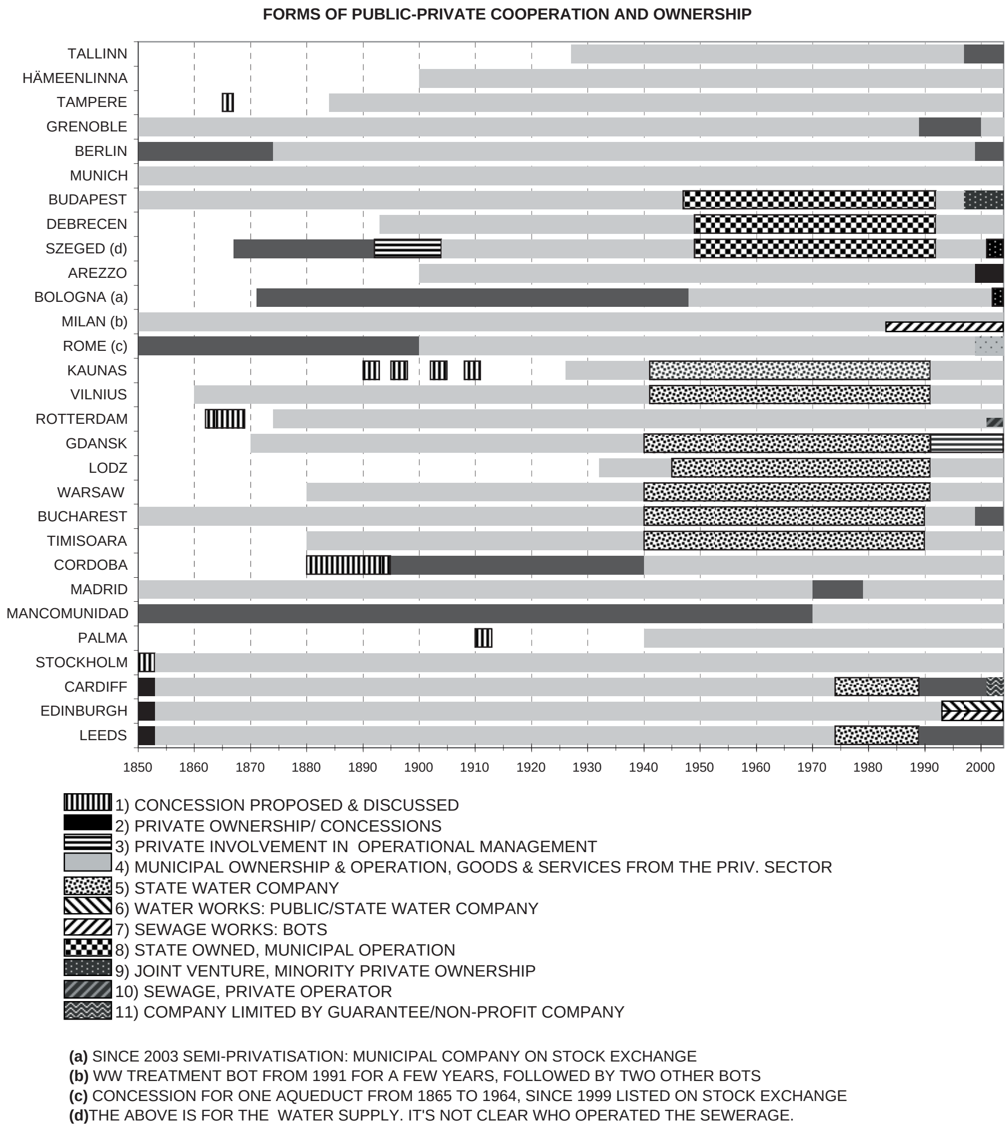


Figure 16. Forms of public-private cooperation and ownership, data compiled for City in Time

In the 1980s and 1990s, in connection with the so-called "Washington Consensus" and the introduction of neo-liberal ideologies, private concessions and operational contracts were introduced. The paradox of this so-called consensus was that it applied to a fairly small group of stakeholders or their representatives; no wider acceptance existed. The full privatisation in England and Wales in 1989 and partial privatisation in Tallinn in 2001 are the most dramatic changes of the period. However, the share of private companies and operation contracts is still small among the case cities. In addition to Tallinn, some private operation contacts and concessions were awarded also in Eastern European cities, but many of them have started to develop autonomous city-owned companies that largely aim at operating on commercial principles. In some cases private companies have been awarded BOTs or minority shares.

Sustainability of the use of water as a natural resource can be estimated by the so-called specific water consumption, SWC. In principle, SWC is calculated as the total amount of water pumped to the network divided by the number of people connected.

Figure 17 shows the available SWC data for the case cities. Most figures represent total consumption divided by the total number of people in the city and are thus probably smaller than the actual values. In some cases special water users, like industries, may be connected to the public systems, which explains the higher SWC rates. The figure also shows some data on total consumption. It is also possible that some utilities have lower average pressures which also means lower leakage rates. In addition to natural conditions, cultural and social factors and habits may also explain the variations. **Figure 18** presents specific domestic or billed water consumption in the case cities, and a few case countries. Some utilities take into account only water that is billed, while some only record domestic consumption.

In most, if not all, cases the available data show that SWC has declined or is starting to decline. **Figures 17** and **18** show that most of the cities seem to have passed the peak in SWC. The highest identified values were those in Munich after WWII and in Stockholm around 1975. Yet, some country statistics for Italy (not shown in the figures) also show high consumption rates. The general decline or balanced per capita consumption shows that through various means the utilities have been able to lower consumption rates or avoid unnecessary wastage of water.

The decline in SWC can be explained by various factors and actions by utilities, consumers, manufacturers, water pricing, etc. In several cases special fees for sewage treatment were also introduced in the 1970s when the energy crisis occurred. These were probably the two primary factors that created the demand for improving water use efficiency (Katko et al. 1998). As a consequence, the declined SWC has made utilities reconsider their tariff structures, especially if they are largely based on consumption fees. After the collapse of the Soviet Union, the Baltic countries — Poland, Hungary and Romania — experienced dramatic structural changes. Declined consumption rates can be explained by reduced industrial use and more efficient management including the introduction of meters.

Although the data are to be viewed only as indicative, they in any case show the general declining trend in specific water consumption. In the long-term this is probably appropriate from the natural resources management point of view, while in the short-term utilities will face challenges in balancing the need for increasing their income with declining volumes sold. Falling rates have also caused quality problems since the detention time of treated water in the over-sized networks is too long.

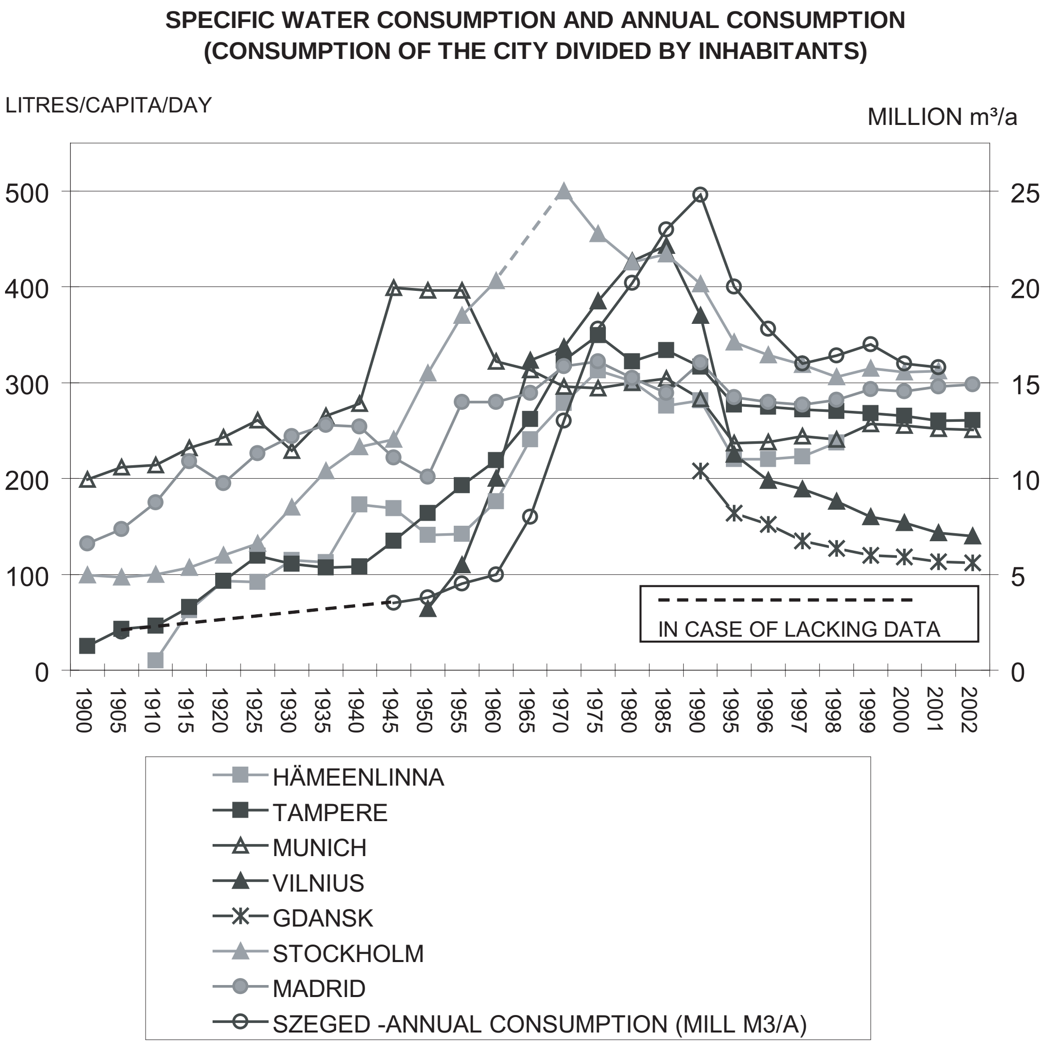


Figure 17. Specific water consumption in relation to time in the case cities (Note: Most of the data are calculated by dividing the total water use by the number of people, while some show only the consumption of those connected)

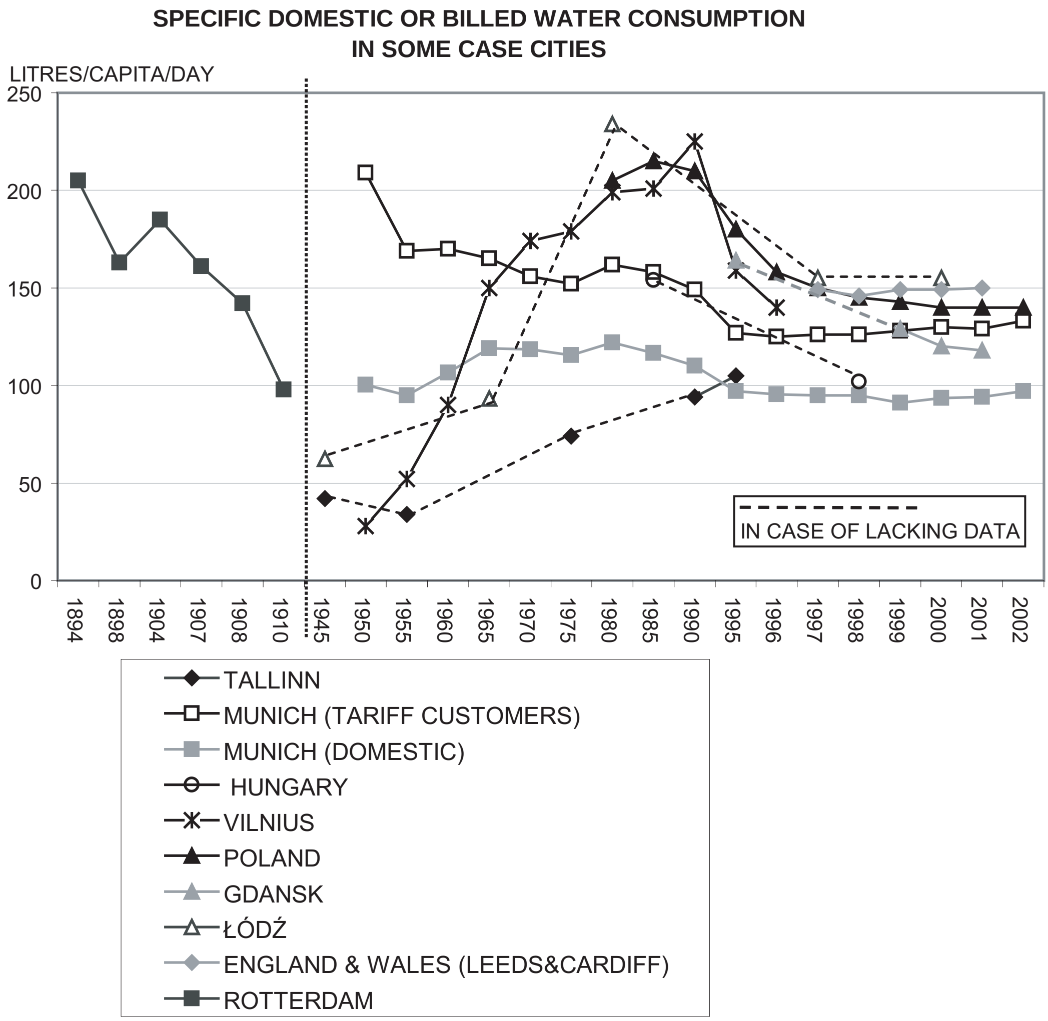


Figure 18. Specific domestic or billed water consumption in relation to time in the case cities and countries (Note: most of the data are based on city data, while in some cases country data are used)

One interesting historical exception in the United Kingdom compared to other countries was, and still largely is, the introduction of municipal operation of water services involving the finance of water services to households by rates, a tax on ratable values. Through such a levy councils were automatically able to enroll all ratepayers in the water undertaking's books. To our knowledge, at least in most developed countries, the metering-based fee system was introduced at a very early stage. Another example is Norway with abundant water resources and less need for conservation. Interestingly enough, in the late 1980s consumption was not always measured in Denmark, the Netherlands, Hungary and Spain (Stadtfeld & Schlaweck 1988) but was most probably done already in the early 2000s.

Decisions and path dependence

The importance of some of the key decisions was recognised when they were made, while the value of others may have been doubted but has perhaps later proved to be of strategic importance. As for raw water sources, the debate between surface and ground water has been relevant in many cases. Yet, from today's perspective, we could argue that the systems should probably be operated so as to allow us to utilise several raw water sources also in the future. The estimation of water demand as a function of population growth or decline has been, and still is, quite challenging and difficult even in areas with relatively rich water resources.

Decisions can also be classified according to their level of path dependence; whether they were very binding or caused less long-term dependence. In some cases the decisions were postponed, some of them limited available options, and some of them limited the number of paths available. Postponed decisions involved in many cases the introduction of wastewater treatment that started sometimes remarkably early, while in most cases in the 1960s, 1970s or as late as the 1990s. In many cases such arising problems had been discussed even a century earlier.

The selection of private concessions has sometimes left only a single path to follow, or at least limited the options for a considerable time. The selection of non-metering or lead pipes, or abandoning them, as well as water-based toilets, seems to have had a long-term impact resulting in path dependence. For instance, in the UK lead pipes were used to connect houses to the water main until the late 1970s, and many older houses also used lead internally. Thus, in the UK, in 2004 some 40 per cent of houses have lead pipes (Hayes 2004). Indeed, outside the Nordic countries, lead pipes are a good example of the technical path dependence or trajectory related to strategic decisions. In Nordic countries, on the contrary, abandoning of lead pipes in the early phase proved later to be a good decision.

As for wastewaters, the decision to introduce separate sewers instead of combined systems made it feasible to start wastewater treatment with methods better than mere mechanical ones. Let alone the impact of the selection of water closets. It obviously did not only pave the way to water-borne sewerage, but probably also meant that the development of non-water based sanitation was largely reduced or abandoned for long.

The post-war period of nationalised state water companies in Eastern Europe was largely based on the business-as-usual approach without paying proper attention to such key issues as demand management, adequate cost recovery and proper wastewater treatment and management. In practise, this meant that the necessary investments in modern water supply and sanitation systems and institutional development of these services were largely postponed to the post-Soviet period. This "postponing path dependence" will probably affect the East European countries for decades as regards the need for new investments and major rehabilitation.

While path dependence often seems to have led to less successful selections of technology or wider institutional principles, certain decisions have later proved to have a strong positive impact despite path dependence.

Discussion

To begin with, we will discuss the major findings of City in Time in relation to original research questions. Thereafter, the diversity of water management culture in Europe will be discussed, including a classification of water-service families in the case of the countries of WaterTime. This will be followed by a proposal for a long-term typology of management paradigms for water and sewerage services on the basis of our study as well as other key issues identified. Thereafter, the approach and implementation of the study will be shortly assessed.

What were the strategic decisions that mostly affected the development?

Some far-sighted selections were made like the decision not to use lead pipes in house connections in the Nordic countries, as the selection of this material became a great burden for Continental Europe in the early 2000s. It shows how sometimes the followers or later-comers can avoid the mistakes made by the forerunners. One of the most controversial issues was the debate over whether to accept flush toilets or not.

Some short-sighted decisions have been made by accepting innovations without critique and proper consideration like "lemmings". These include, for example, the copying of technical solutions originally introduced and tested in completely different climatic conditions. The same may also apply to institutional arrangements if social and cultural conditions are ignored.

Some of the past decisions or actions may have contained a strong forecasting element. This is the case with the German 50-year water master plans of the early 1900s, or respective plans, for instance in the Nordic countries, in the 1960s. It is another question whether the drafters considered many alternative possible, plausible and preferable options to make the plans strategic by nature, or whether they were just deterministic plans based on routine expansion or "business-as-usual" approaches. There are recent signs of the latter, too.

Who and what factors define and create demand for services?

The demand for improved water and sewerage services was created by several factors based on different local conditions. Such factors could include just the needs of WSS business, fire protection, water quantity and quality problems, public health and later environmental protection, other purposes such as industrial or tourism water use, regional focus, or various combinations of these. The business motive was the cornerstone of the first private proposal in the mid-1800s as well as some 130 to 140 years later. Fire protection was particularly relevant in areas with wooden houses. Although in many cases public health requirements were the major driver, water quality and quantity also had an impact. In some cases productive use rather than community needs has been the major driver. It is also possible that demands are contradictory.

In many cases the improvement of services was the result of WSS legislation as such. In some cases other external factors and changes had major impacts, such as the early promotion of regionalisation in the UK and later in the Netherlands.

How does the historical context constrain potential best practices for the future?

It seems that each of the developed water management cultures tends to continue along a "naturally taken path" while other options are not necessarily always considered. Among the most binding constraints seem to be "eternal concessions" that are still valid in some cities although not necessarily in the case cities of this study. Such a "historical burden" may seriously undermine use of available options and good governance principles such as openness and transparency. Although such approaches may provide continuity, they can be highly questionable from the viewpoint of the basic aims of modern WSS services. As for transparency, the study by Transparency International shows (www.icgg.org/corruption.cpi_2004_data.html) that countries which have selected public ownership and the municipal approach for their water services seem to have the least corruption.

In some cases dramatic changes have taken place in terms of ownership. Instead of any historical or other evidence of their applicability, let alone superiority, they rather seem to reflect sudden ideological changes in the societies — in the east and the west.

What limits do technical choices of the past impose on decision-making?

The vast majority of the assets of WSS systems, some 70 to 80 per cent, are tied to networks. Water treatment, wastewater purification and water quality control represent a minor part of the annual money flows although as such are certainly of very high importance. Changes in network structures are costly, especially if the selected pipe materials prove to be less durable. This is the case currently in countries that introduced lead pipes for house water connections, the replacement of which is not realistic in the short term. Technical systems should be designed and renovated bearing in mind flexibility, vulnerability and future needs.

In sewerage systems the key choice has been to introduce separate instead of combined systems which makes modern wastewater treatment feasible. Interestingly, this happened at very different times at different places.

On what basis have selected strategies been formulated and decided upon during different time periods?

An important question is to what extent were the various options of technological and institutional solutions and improvements considered at different times. According to the documents available for this study, it seems that alternative technological solutions were explored, tested and experiences gained particularly when these systems were first built-up. Yet, there are also opposite examples of where solutions were transferred to other conditions without considering a crucial factor like climatic conditions.

As concerns institutional alternatives and options, it is obvious that the TINA (There Is No Alternative) approach has unfortunately been applied too often. All institutional approaches were, and still are, not necessarily actively looked into, but decisions rather involve just saying "yes or no" to proposals that may even come from outside the sector.

This has been highly conspicuous particularly in connection with more recent cases. It is more difficult to assess whether this is true also in the historical context, although it seems likely.

After the introduction phase of WSS services in the 1800s and the early 1900s, solutions and knowledge were typically sought from several, best available sources. Thus, the assumption that capital cities would automatically be the forerunners and the only sources of knowledge is certainly incorrect or biased. More recent research (e.g. Juuti 2001, Manninen 2002, Nygård 2004a) has revealed that there is a diversity of social and knowledge networks among experts and others.

How has the role of public-private partnership (PPP) changed over the years, and how is it likely to change in the future?

Recently, the concept of public-private partnership (PPP) has been widely introduced to international water policy discussions. Unfortunately, PPP has been understood in a very narrow sense, taken merely to apply to private operators, concessions, or the like, while at least in practise ignoring the most commonly used type of private involvement — consultants, contractors, manufacturers, etc. selling their goods, equipment and services to public utilities based on continuous competition. By this definition, the concept of public-private cooperation includes all possible forms. Besides, current EU legislation on public procurements requires that such services be subjected to competition in projects exceeding certain cost limits — in the case of both public and private operators.

In fact, many public utilities have bought such services, equipment and goods from the private sector since the establishment of modern systems, and even before that. Data from one country, Finland shows that over the last 150 years probably more than a half of the annual cash flow from utilities has gone to the private sector as payment for such services and goods. A clearly larger share has been used for investments than annual operating costs. The situation is likely highly similar in countries with market economies, which all the case counties had in 2004, at least in principle.

As concerns private concessionaires, they played a remarkable role in the mid-1800s in establishing the systems. In several cases the concessions were bought back by the city before the contract expired. The full privatisation in England and Wales in 1989 was a dramatic change although a result of longer-term purposeful policy. In the 1990s only a few concessions and a few additional operation contracts were awarded, and this seems to be the most recent trend in PPPs. Yet, the argument that the private sector would make additional investments in the sector is largely false, or at least exaggerated in the historical as well as the more recent context.

Importance of water management culture and diversity

Considering the cultures and traditions of urban planning, typologies of water resources management, legal and administrative families, cultures and organisations, and the variation in the roles of local governments in the European context, we obviously also face a diversity of options for water services management. **Figure 19** presents a rough classification for the WaterTime case countries as they are in 2004. It implies that there is probably even more variety in water services management than, for instance, in the traditions of urban planning. Once water services are managed at the local level, the role of local governments in each society also largely explains how water services are managed.

Figure 19. Rough classification of water services families in the case countries of WaterTime around 2004
(designed by Juuti & Katko 2004)

In the early 2000s water and sewerage services have been managed by a single utility in most of the case countries and cities (Baltic region, Hungary, Nordic countries, and Spain). Germany has a long tradition of multi-infrastructure companies, "Stadtwerke", which manage water and gas and some other infrastructure services except for sewerage. Completely private water and wastewater companies exist in England, Wales and Tallinn, Estonia while a few concessions and private operators exist as well. Regionalisation has taken place in England, Wales and the Netherlands, while inter-municipal cooperation of utilities has taken place in many other countries and cities.

As Hall et al. (2004; D7) point out, primarily the utilities of German-speaking countries and Scandinavia (Nordic countries) regard water as a natural resource which should ideally be supplied unpolluted and untreated, when possible. Yet, others (e.g. in France or the UK) tend to see tap water as a 'manufactured good' which regularly needs treatment before consumption.

According to Hall et al. (2004), the 'natural water' philosophy is obviously closer to publicly-run water companies who try to avoid the cost of the treatment technology they have to acquire externally. Large multinational companies, however, with their own water treatment subsidiaries think differently since building and operating treatment facilities is part of their business and contributes to their turnover (Hall et al. 2004). On the other hand, at least in the Nordic countries, the publicly owned utilities acquire the best technology available even though they have their own staff to operate their plants. Besides, there are cases where public water and sewage utilities clearly exceed the required water and wastewater treatment requirements whereas the business-based approach would understandably just meet set requirements.

Proposal for a long-term typology of management paradigms for water and sewerage services:

Based on the City in Time study, a typology of water services management paradigms over time is presented below:

1. Early trials in biggest urban centres with private concessions from the early 1800s to the late 1800s;
2. Municipalities assume responsibility between the mid-1800s and early 1900s. Somewhat later in France concessions were replaced by management contracts or affermage;
3. Technical expansion and development of the established systems, from the early 1900s to the 1980s (except for WWI and II) — from narrow to wide coverage and improved water and wastewater treatment technologies together with stricter requirements. Municipal or inter-municipal systems were the major option, while regionalisation and river basin became the basis for water services in UK. In France private operators have largely occupied the market;
4. The collapse of Soviet Union and the reconstruction of the water and sewerage system in many Central and Eastern European countries that followed.

5. Reinvention of privatisation and private operational contracts in the 1990s in some countries and cities while the vast majority of municipal-owned systems improve their performance and continue buying services, equipment and goods from the private sector;
6. New diverse culture of water management in the 21st century in terms of size, roles, technological solutions, alternative options within the wider EU framework while recognising the need of local traditions and conditions.

Other key issues

One of the EU's key principles is *subsidiarity* — in terms of water, having the services managed at the lowest appropriate level. It is based on the fact that local solutions and locally made decisions are more effective, and thus more sustainable, than "top-down" ones. This is perhaps one of the key issues in managing water and sewerage services even though overall planning and water resources management have a wider regional impact.

The question can be raised whether the *special features* of water and sanitation as a service of general interest are always remembered, or whether there is a wish to lump together all infrastructure services. There are clear signs of such a wish, for instance, on the part of electricity companies which argue in favour of possible synergy benefits. Yet, water is largely connected to land use, community and public needs, the environment, etc, and as a "food" is certainly different from "more neutral tradable goods" such as electricity or energy. Besides, the scale of operations has a limit: the traditional paradigm of "routine expansion of WSS systems" should be rethought.

Participation

In terms of this study the issue of participation started to emerge in connection with town and regional planning in the 1970s, and indirectly also in water services, while more serious participation is probably a recent objective. In earlier times, participation occurred through democratically elected political representatives in local governments (authorities) in the case of public utilities. It is obvious that the need of more active participation is considered relatively more important when private operators or owners run the services than when countries have strong democratically elected local governments providing the services — in the latter case the need for additional or external public participation is not considered equally important.

In terms of sustainability, the use of water has become more efficient as shown by the general decline in specific water consumption. Yet, in areas with less water resources and growing demand due to population growth, needs for tourism, etc., it will be a real future challenge. Reuse, desalination and other options have to be examined as alternative sources.

In principle, it would be more sustainable to reduce the amount of treatment chemicals which would favour the use of ground water, assuming that it is managed in a sustainable way.

Integrated Water Resources Management
(IWRM) is appropriate as such for overall water allocation and planning purposes. However, managing of water and sewerage services is a different issue although it is closely connected to IWRM.

Role of local government
It is a historical fact that the vast majority of WSS systems in the western world have been developed under *local government ownership* while also utilising the services and goods of the private sector, if available. One key policy question is whether the same chance should be given to developing and transition economies. Some of them may be at the early stages of development which may require temporarily more extensive private involvement. In any case, capacity building by local governments and utilities as well as the local private sector should be the long-term objective.

Assessment of the study
As pointed out in the rationale in the first chapter, the original objectives and accessible material and sources of the City in Time study had to be modified, and focus be laid relatively more on the historical evolution of water and sewerage services in their wider institutional context rather than on strategic decisions as such. While we recognise the need of not binding ourselves too tightly to the past in current and future management of water services, we also argue that pasts, presents and futures all have to be balanced and considered if we seriously intend to achieve sustainability.

During the study it proved that either access to, or availability of, basic information and data concerning long-term development and trends was highly limited on non-existent in several cases. It is fair to accept these limitations as well as the resources that could be used for this study. One constraint of the study was that it was not possible to formulate in advance the exact data requirements for it, but these needs only became apparent as the study proceeded. Due to the diversity of the material available, the cases could not always be presented, compared and analysed in a systematic enough way. In spite of these drawbacks, the authors wish that this study will be useful also for wider use. As always the views expressed in the reports are solely those of the editors and contributing authors.

Conclusions – History matters for the futures

"Those who cannot remember the past are condemned to repeat it"

George Santayana (1863–1952)

Conclusions and recommendations

The following key conclusions on the City in Time can be drawn in terms of the historical context and experiences:

(i) In the historical perspective water management, both services and resources, is substantially a *local issue*. In the development of water services provision and production the *local government* has played an important role in many countries, though not everywhere. This is in harmony with the *subsidiarity* principle;

(ii) Some of the strategic decisions have proved to have a long-term positive or negative impact and thus strong *path dependence*. As for technology, selection of metering, adopting or abandoning of lead pipes, and acceptance of water closets in the early phase, have had very long-term impacts. As for institutional arrangements, private concessions have sometimes become very extended which might be the case also with the recent full privatisation of utilities;

(iii) Fundamental strategic changes have been decided upon often without any evidence of their potential superiority. In several cases decisions have been made in an *a historical context* or vacuum, while ignoring the past and even more recent experiences elsewhere;

(iv) It is possible that in the early phases of establishing the systems, *options and alternative ways* were discussed and considered relatively more than later on when the established systems were expanded;

(v) It is obvious that *institutional changes* are needed, but they should not be done for the mere sake of change — like the idea of reinventing private concessions or operators in a completely ahistorical context: not recognising the earlier models, let alone the experiences gained;

(vi) Some interesting and different *traditions* exist like the "Stadtwerke" in Germany, which operate both water and gas, but not sewerage systems. This diversity of options should be noticed and encouraged, if found feasible;

(vii) *Integration of water supply* and sewerage would be logical based on experiences from the Nordic and several other case countries. In any case, ensuring adequate cooperation between water and sewerage services could be a first natural step in terms of Integrated Water Resources Management;

(viii) Instead of assuming the business-as-usual scenario also for the futures, we should consider all possible means for more rational use of water, treating and managing wastewater as well as recycling water especially in areas with scarcity. Particularly, we should apply various types of *demand-based management tools* of whose performance we already have historical evidence;

(ix) In the historical context, we have evidence that water services cannot be considered merely managing an economic good. Instead, all the *requirements of water* based on political, economic, socio-cultural, technological, environmental and legislative dimensions have to be taken into account in a *balanced way*. History is full of warning examples of the so-called "opening up" of markets to international operators in the case of WSS services, or failed one-fits-all solutions;

(x) Access to, and availability of, basic information and knowledge seem to be bottlenecks that should be removed. This could be argued, for instance, on the basis of the recent Århus convention on access to information, participation in decision making and access to justice in environmental matters.

It is clear that we have a *diversity of options* for managing and producing water services bearing in mind all the political, economic, social, technological, ecological and legislative aspects. This is true among the old EU members, and particularly among the newer and future ones.

For further research proper indices on evaluating sustainability and operational efficiency and efficacy could be developed — if they cannot cover a century and a half, perhaps at least a few decades. Although this study has concentrated on urban areas, it is good to remember that many European countries have a large rural population and free-time housing with their own piped or on-site systems. Another key question will probably be to what extent is it sensible to expand current water and sewerage systems considering all the political, economic, social, technological, environmental and legislative (PESTEL) dimensions and limitations.

Based on all this and earlier experiences and studies, we claim that *history matters for futures* — as concerns the evolution of urban water and sewerage services in Europe. The approach of the study can hopefully be expanded and tested or otherwise utilised in a wider international context in the future.

"I would feel more optimistic about a bright future for man if he spent less time proving that he can outwit Nature and more time tasting her sweetness and respecting her seniority"

E. B. White (1899–1985)

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