

From a Few to All



Long-term Development of Water and
Environmental Services in Finland

Petri S. Juuti & Tapio S. Katko

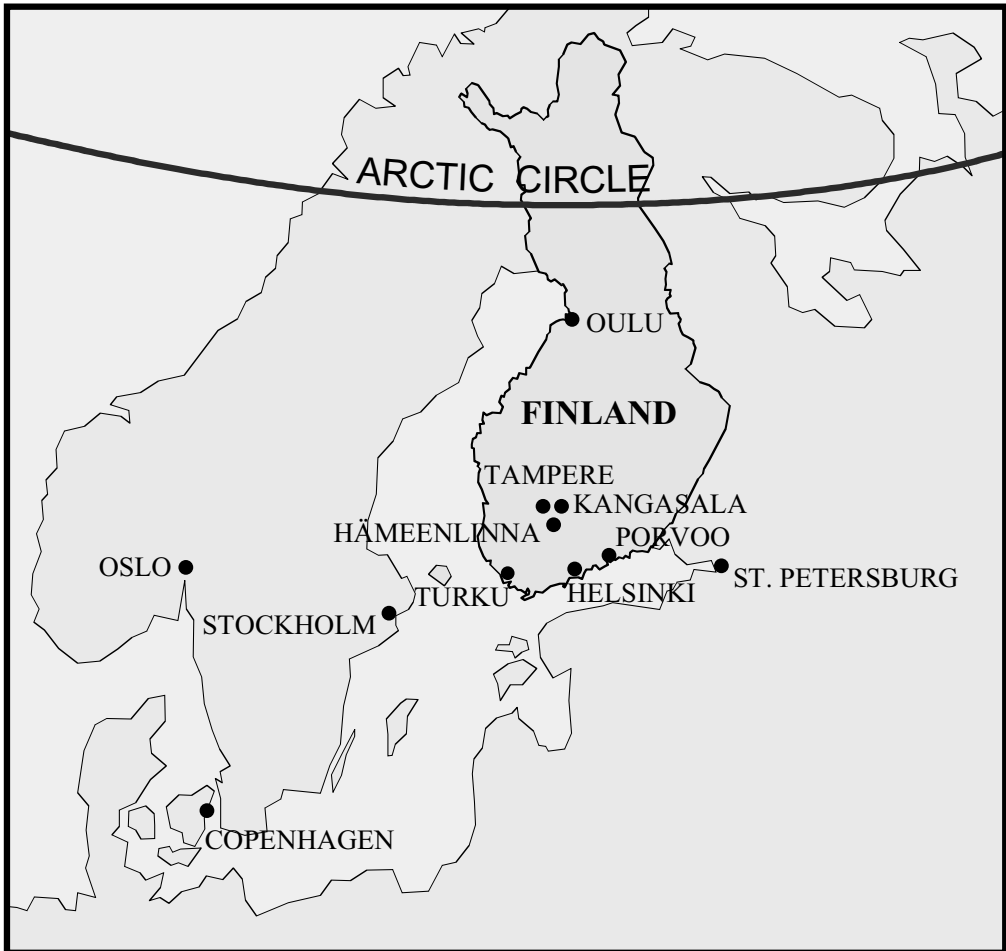


“This book is an important contribution to the history of water and environmental history of Finland in general. Hopefully, it will promote more work of value for eager readers.”

*Martín V. Melosi
University of Houston*



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The water tower of Maikkula in Oulu, completed in 1992

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Back cover: Viinikanlahti biological-chemical wastewater treatment plant in the 1990s.

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Petri S. Juuti ∞ Tapio S. Katko (eds.)

FROM A FEW TO ALL

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LONG-TERM DEVELOPMENT OF WATER AND ENVIRONMENTAL SERVICES IN FINLAND

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FOREWORD

Timo Myllyntaus



WRITING ON WATER

The importance of water has always been self-evident for human beings. Without water, there would be neither flora nor fauna, no life at all on the Earth. In about 450 BC, the Greek philosopher Empedocles attempted to crystallize this idea scientifically by proposing that all substances are made up of a combination of four elements – earth, air, fire, and water. That idea, later developed by Plato and Aristotle, persisted for more than 2,000 years. These two philosophers also elaborated on the contents of the concept *τεχνολογια*, technology.¹

The human being has used technology to govern water and bring it under his dominion. In the antiquity, technology related to water constituted a central part of craftsmanship. Entire civilizations were built up on the infrastructure of complicated irrigation systems. Shipbuilding was the basis of fishing fleets, merchant fleets and navies. Administrative centres and big cities, such as Knossos on Crete and Rome in Italy, flourished partly because of their advanced aqueducts and waterworks. From about 1000 BC, a new epochal era began when simple Greek or Norse watermills began to replace animate sources of power with inanimate energy. Around 300 BC more efficient waterwheels with horizontal axles were invented in the Middle East. In the following two centuries, they became known in Rome and started to spread from the Italian Peninsula to the rest of Europe.²

Water-born technology is generally vital for a societal infrastructure and its development is a fundamental part of the history of all civilizations. To use and control water has been one of the major tasks of societies. Water, a physical element, has not been a distant environmental background factor but a key element of life, welfare and power.

Like many other nations, the Finns have traditionally been primarily interested in four environmental themes: climate, forest, water resources, and landscape.³ The reason for this is fairly evident, because these are the four basic elements that have been confronted by the Finns, since they arrived at the country some thousand years after the last glaciers melted, i.e. some 6,000 to 8,000 years ago.

The history of water in Finnish society has many mainstreams and tributaries. The older traditions of Finnish water history are definitely anthropocentric; they describe and analyze, how the inhabitants of this country utilized their water resources. These resources have benefited Finns in a variety of ways, supplying nutrition, drinking water, fish and waterfowls, transportation routes, waterpower, liquid for various industrial processes and sinks for wastes, and providing the means for washing, irrigation, recreation and aesthetic experiences.

It is true that water history has not been studied thoroughly enough but it is an exaggeration to claim, like a Ph. D. candidate, that Finnish historians suffer from hydrophobia.⁴ Among natural phenomena, water history is no exception. All sectors of environmental history have been neglected in this country, because environmental history is a new discipline. Nonetheless, it does not necessarily mean that historians fear the environment. Furthermore in international comparisons, the Finnish case is not extraordinary; one might even claim that in relative terms, environmental history has a stronger position in Finland than in many other European countries.⁵

If we take a look at historical records, there are huge amounts of information on disputes on fishing rights, damming rights, building watermills, lowering lakes and polluting water. Even in the Middle Ages, the use of water had notable economic significance and rules were needed to regulate that use. Our legislation on water rights goes far back to the early times of the Swedish rule at the beginning of the second millennium A.D. Historians have not neglected that type of water history. Several Ph. D. theses and other studies on the themes connected to the economic utilization of water have been written. Many of these studies, however, lack a modern ecocentric approach. Can we blame previous generations on neglecting the ecocentric approach if the concept was developed only a few decades ago? Standard methodological textbooks warn historians not to judge history.

WATER MAKES HISTORY

To a great extent, water history has been the history of water under the service of humans, i.e., how humans have utilized water for their purposes. However, that is not the whole story. Water is a fascinating example of the research objects of environmental history with an interactive aspect. Water, as many other natural elements, has the ability to respond to human actions. “The natural environment is anything but passive.”⁶ If water is maltreated or mistreated, it may hit back. The most dramatic parts of water history are in fact composed of such natural backlashes as floods, droughts, erosion, salinization, pollution, and unexpected freezing. Those backlashes may lead to huge environmental catastrophes, such as the drying of Lake Aral between Kazakhstan and Uzbekistan in Central Asia.

In the northern hemisphere, we are accustomed to thinking that rains regularly bring new water to vitalize our environment. How renewable is water on the global scale? Compared with the huge total stock of water, the supply of fresh water is surprisingly limited. Global water resources consist of 1,386 million cubic kilometers, and only 2.5 per cent of them are fresh. The water of the highest quality, drinking water, accounts for even less, because much of the fresh water is undrinkable for some reason. In addition, not all fresh water is easily available: some 30 per cent of fresh water is stored as groundwater, which is not always a quickly renewable natural resource. Part of the groundwater is actually incredibly old. In various artesian groundwater basins, water may be older than 20,000 years. Hence, when Libya, for example, pumps water from its artesian groundwater basins, it is exploiting a natural resource that is practically non-renewable. In addition, rainwater, the only naturally renewable form of water, is

a finite natural resource. Yet, fresh water is indispensable to various plants and animals as well as humans. As a result, quality issues may override quantity issues concerning water in the foreseeable future.

A persistent water scarcity may become a major political and management issue. Transfers of population to areas with more abundant water resources will be only one solution. Technological remedies will probably prove the most practical and realistic solution in preventing the exhaustion of fresh water reserves. The production of artificial groundwater by filtering water through natural or man-made gravel ridges is already in operation. In contrast, the desalinization of water on a mass scale is still a challenge for modern technology.

WATER, HEALTH AND WELFARE

It is a Christian conception that the human being is the crown of all that the Lord has created. A biblical task of humans is to govern nature, and by governing nature they make history. However, the history of health and diseases shows us contrasting evidence. Actually, microbes govern the world and shape history more dominantly than humans. At least this has been the case for more than fifty millennia. Up to the 1870s, during practically every war, diseases killed more people than battles and other military actions. Armies, and especially their leaders, were more afraid of the spread of disease among their soldiers than they were of their enemies.

The maltreatment of water triggers natural backlashes, with microbes as nature's most dreadful weapons. Microbes have a much longer history than humans, and they are much more adaptive to change. They are also more comfortable in water than humans. Water is one of their homes, their habitats.

Many historical cases have proven that if the infrastructure of a society collapses and the drinking water becomes unusable, many other factors affecting health care become increasingly difficult. Over time, many events have underlined the fundamental role of water in public health and human diseases. To provide pure and healthy water for citizens was one of the major reasons for starting to build waterworks in European cities in the 19th century. The other reason was to meet the growing demand of water because wells often failed to provide enough water. The third major reason was to provide sufficient amounts of pressurized water in the case of fire, which was a constant hazard in the era of industrialization.

After painful experiences, European urban dwellers learned to be afraid of contaminated water, an invisible killer. The fatal cholera pandemic that struck Europe in the 1830s is one example of the power of microbes. The cholera bacillus arrived in Russia from South Asia in 1829, and within a few months it reached the Baltic Sea region and for the first time spread widely over the Continent through trade and military operations. At the same time, a similar epidemic of *cholera Asiatica* occurred in Holland, where more than 10,000 people died of cholera during a two-year period. It is estimated that as many as 140,000 people died of cholera in Britain in a single year, 1832.⁷ In relative terms, the cholera epidemic was then the most severe in some major cities around the Baltic Sea: In St. Petersburg there were 40 cholera deaths per 1,000 inhabitants in

1832 and two years later the cholera mortality rate was in Stockholm as high as 43 per mil. The epidemic also arrived in Finland in 1831 but only 1258 cholera cases were reported and of them more than half died.⁸

Cholera returned to Western Europe in two big waves between 1844 and 1874. In Finland, the climax of this disease took place during the Crimean War, when roughly 7,000 died of it including nearly 1,700 Russian soldiers and more than one thousand men of the French-British army occupying Ahvenanmaa, the Åland Island, at the time.⁹ The epidemic of the early 1870s hit the most devastatingly the eastern part of the Austro-Hungarian Empire: 500,000 Hungarians then died of cholera, and the toll caused a drop of 2 per cent in the total population of the country.¹⁰

In 1892 Russian immigrants on their way to the Americas brought *cholera Asiatica* again to Western Europe. However, that time a major epidemic broke out only in Hamburg where the number of cholera cases soared from 2 to 1024 within twelve hot days, on 16–26 August. The disease was spread throughout the city by means of polluted tap water. The city council knew that its water supply network was contaminated with the bacillus but did not warn the population on time because the authorities were afraid to assume responsibility for what had happened. In consequence, 8,600 citizens died of cholera within two months. Fishermen were the worst hits by the epidemic. The Hamburg waterworks pumped untreated water from the river Elbe into its network, while the neighboring town, Altona, which had used sand filtering from 1859, and practically avoided the cholera epidemic.¹¹ Globally, water quality problems have for centuries caused outbreaks of intestinal diseases, such as cholera, typhoid fever and dysentery.

Despite the great success of medical science during the past two hundred years, we have still not conquered cholera. We can read about new cholera epidemics daily in the newspapers. Some time ago, in the province of KwaZulu-Natal in South Africa about 100,000 people contracted cholera and more than 200 died within a few days.¹²

In the 19th century, science and scientists were accused of being asleep when they were unable to respond to the challenge of intestinal diseases. It was not until in the 1960s that a simple but effective cure was found against cholera. Using a mixture of salts and sugar, it became possible to reduce the mortality rate from fifty per cent to less than one per cent.¹³

Nonetheless, it is worth noting that microbes are capable of changing quickly. Some of recent super microbes are immune to common medicines, such as antibiotics. Several epidemiologists are afraid that we can only temporarily attain the upper hand over microbes. A severe panepidemic comparable to the Black Death of the 14th century, the cholera of the 19th century or the Spanish fever of the 20th century is still possible – despite modern medical science.¹⁴

RELATIONSHIP BETWEEN THE ENVIRONMENT AND TECHNOLOGY

Some years ago, the World Bank published a development report analyzing the greatest problems of the developing world. The report claimed that the poorest people

lack two very vital things: one billion people live without pure water and two billion are without electricity. The fact that the shortage of pure water is ranked the most urgent problem in the developing countries, and as much as one sixth of the humanity is deprived of it clearly indicate, the importance of a functioning and safe water supply.¹⁵

Human tragedies caused by dirty water have been a permanent feature in environmental history. Contaminated water has threatened the health of humans for millennia and continues to be a serious hazard even today. Microbes living in water are a risk for people; as basic components of nature, they belong to our environment and are research objects of environmental history providing one example why water history overlaps environmental history in many ways.

Not all water pollution is caused by humans, but a great many of the problems are human-induced. How water is supplied and used, and how it is treated before and after use are also technological questions whose past is included in the sphere of the history of technology. One might claim that, on the one hand, several aquatic problems are caused by technology or the lack of it. However, technology has no autonomous power; it is dependent on human decisions and actions.

On the other hand, science, technology, and political decisions can help to 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. Cleaning of wastewater is a good example of its application. Technology increases the assortment of opportunities available for policy makers, business life and the public to cope with environmental hazards and damage.¹⁶ However, the “technology fix” syndrome may be exaggerated; it is no omnipotent factor that can solve all environmental problems.¹⁷ In any case, finding solutions often takes a lot of time, effort and political determination.¹⁸

Environmental problems related to water illustrate the close connection between environmental history and the history of technology. In a way, they are two sides of the same coin. Thus, if we want to treat a coin as an entity, we must take both sides of it. Environmental history and the history of technology are different but still – willingly or not – “married to each other.” Combining both fields of study is nowadays considered an expression of sound multidisciplinary – no longer – a violation of the academic status quo.

FINLAND – A CASE IN POINT

Some time ago, a British research team investigated water resources of 147 countries evaluating the quality and quantities of available water, the number, spread and accessibility of these resources. The result was that the team ranked Finland first.¹⁹ Consequently, that country should suffer less from water-related problems than many other countries. In Finland, annual rainfall is reasonable and an evaporation rate is low. It also has significant water resources spread over the country’s thousands rivers and 188,000 lakes. The following articles by a group of eight contributors, however, show that the Finns have some times had to work hard to sort out their water problems.

The multitude of lakes is far from an excellent indicator on the abundance of the water resources. Finnish lakes are shallow and two thirds of them are small: less than

two hundred metres long. In addition, they are frozen several months a year. Due to geographical and climatic reasons, Finnish watercourses are rather sensitive ecological systems. They can be polluted easily. Environmental problems also tend to be accumulative. Because watercourses are often very long, even hundreds of kilometres, those living downstream have to use water that includes wastewater of those living upstream.

In the agrarian period, wells were the main source of drinking water. Especially in towns, the closest wells could not always provide high quality water in sufficient quantities a year round. Particularly in wintertime, wells frequently dried and dirt from yards easily polluted them. Alternatives were needed and wooden water pipes provided an option. According to the article by Tapio Katko, the transition to pipebound technology started in Finland from the countryside – not from big cities. In general, water supply technology was not diffused from the main urban centres to the periphery. In contrast, exchange with technological know-how between different areas was typical for Finland of the 19th century.

Helsinki, the capital, constructed the first proper waterworks in 1876 and other cities gradually followed. By the outbreak of World War I, all major Finnish cities were supplied by tap water. One of the early water issues was whether to use surface water or groundwater. Petri Juuti and Tapio Katko claim in their article *From Polluted to Swimmable Waters* that abandoning its groundwater project and instead choosing surface water of a nearby lake, the City of Tampere gave an unsustainable model to many other cities. The authors find the reliance on surface water as unfavourable path dependence because dozens of lakes cannot provide high quality drinking water for various cities and towns. Sometimes their problems have been lethal. For example in 1916–1917, contaminated surface waters caused an environmental catastrophe that demanded the lives of about 300 citizens in Tampere. Like eight years earlier, a typhoid epidemic spread through tap water around the third biggest city of the country.

It was only in the late 20th century when Finnish water supply utilities again became interested in natural and artificial groundwater. That was an epochal turn, because research in that field had been neglected for decades.

Jari Kaivo-oja, Tapio Katko and Osmo Seppälä give in their article *Seeking for Convergence between History and Future's Research* an example of good path dependence in the Finnish water supply sector. Despite the abundance of water, investments in the first urban water supply utilities were found high, and a fair method was needed to distribute high costs among subscribers. The authors consider that it was a farsighted decision to adopt water metres from the very beginning. That helped to solve many later problems.

Supply utilities were only a partial solution to water related issues. Wastewater was another major field and there the development has been much slower and more uneven. The construction of sewerage systems began in some cities in the late 19th century. In Helsinki building dozens of sewers carrying wastewater from households and the rising industry to bays surrounding the city caused severe pollution problems. In summertime, wind brought an awful smell to the city centre, while authorities prohibited swimming and washing cloths and carpets near the outlets of sewers. A turn to

better took place in 1910 when Helsinki built the first wastewater treatment plant in the country. In the same year, Lahti followed suit and its plant was the very first in the Nordic countries constructed for an entire city.

Although some Finnish cities were path breakers in wastewater treatment technology internationally, differences between urban areas were huge. A big wave in treating wastewater started only fifty years after the first plants were opened. The rapid development began only after the new Water Act became in force in 1962. During the following twenty years, the number of urban wastewater treatment plants increased by the factor of ten, from about 10 to roughly 110. This dramatic change was attributed also to accelerating urbanisation and environmental hazards. Petri Juuti and Tapio Katko illuminate this kind of situation in their article on Kangasala, authorities of which decided to pump the sewage of 4,000 inhabitants to quite small Lake Kirkkojärvi in the late 1950s. Within the next few months, oxygen was depleted and fish began to die every part of the lake. An environmental catastrophe broke out. The town council was forced to make a quick decision to build a mechanical treatment plant first and later to pump their wastewaters to the neighbouring City of Tampere that first had a plant with chemical and later with biological-chemical treatment.

A common argument for the team of the contributors is that modern water pollution control began in Finland because of pragmatic reasons and under the social and political pressures. Their surprising finding is that the biggest polluters were not trailblazers in treating their wastewater. Efficient municipal wastewater treatment was first adopted by small towns and only later by big cities. Furthermore pulp and paper mills, notorious polluters, introduced a serious control of their wastewater only ten or fifteen years later than urban sewerage utilities. That took place in the 1970s and 1980s when pressures from the public sector and foreign customers became compelling.

During the last two decades of the 20th century, water pollution substantially decreased and the quality of tap water improved. At present, tap water is among the nine dearest national products for the Finns; a good taste in international comparison is the simple reason for that.²⁰ This remarkable development did not, however, nullify all former negligence. Large quantities of residential and industrial wastes have been piled in the bottom sediments of lakes and rivers, as described in the article *Water Pollution Control and Strategies in Finnish Forest Industries in the 20th Century* by Tapio Katko, Antero Luonsi and Petri Juuti. A disturbance of those sediments may pollute water again. Therefore, present, fairly efficient treatment plants are not an omnipotent solution to water pollution.

In their article, Jari Kaivo-oja, Tapio Katko and Osmo Seppälä claim that discontinuities between the past, the present and the future have caused problems for the Finnish water supply and water protection. Infrastructure investments are long-term strategic decisions that should be based on the ample knowledge on the past experience, present possibilities and future predictions. Despite the significant development of the 20th century, challenges of the future will be demanding, as well. A lesson provided by the contributors is that those challenges can only be coped with multidisciplinary co-operation and joint efforts of both public and private stakeholders.

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PART I
OVERALL DEVELOPMENT

"When the well is dry, we know the worth of water."

Benjamin Franklin

LONG-TERM DEVELOPMENT OF WATER AND SEWAGE SERVICES IN FINLAND

TAPIO S. KATKO

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ABSTRACT

This article describes the evolution of urban and rural water supply and sanitation in Finland over the past 150 years. In addition to technology development, it explores various institutional issues related to the water sector such as legislation, utility management, human resources development, research and development, professional associations, sector enterprises such as consulting companies and contractors, and exporting activities. Though utilities in Finland are mostly publicly owned, they today adhere to commercial principles. Planning, construction, operation, and maintenance services are often bought from the private sector. The services have been, and still are, covered by direct consumer payments, whereas governmental subsidies have been small. Rural water supply is organized through consumer-managed water cooperatives. Water supply and sanitation systems and services have expanded gradually. Sometimes old treatment methods have been reintroduced. In the future, there will be more focus in the sector on increasing customer orientation, intermunicipal cooperation of utilities, and international cooperation. The gained long-term experience will be a cornerstone of future water policy and strategy development.

INTRODUCTION TO FINNISH WATER RESOURCES AND SOCIOECONOMIC DEVELOPMENT

Finland is a country with abundant water resources. There are some 56,000 lakes with a minimum diameter of 200 meters (650 feet), and the landscape is largely dominated by lakes, especially in the central and eastern parts of the country. However, these lakes are shallow, and thus their total volume small. As for groundwater, the best deposits are found in alluvial deposits formed during the ice age. Surface waters are typically rich in humus, especially in the western part of the country. The groundwater is generally speaking of better quality for water services, but particularly in the coastal areas, those once under the Baltic Sea, groundwater may contain excess iron, manganese, or sulphur (National Board of Waters and the Environment, 1993). In the 1990s the lowest quality surfacewaters have been improving, whereas the quality of the best surface waters is slowly declining in spite of extensive water pollution control activities since the 1960s.

The total area of Finland is 338,000 square kilometers (130,000 square miles). The majority of the population, which recently reached 5 million, lives in the southern and western parts of the country. Two thirds of the land area is covered by forests; lakes and rivers take up 9.9% of the surface area. Economic growth in Finland was the result of a structural change from the traditional primary sector production (agriculture and forestry) to increased production in the secondary (manufacturing and construction) and service sectors. Compared to other industrialized Western countries, the structural

Compared to other industrialized Western countries, the structural change in Finland came late.

change in Finland came late (Myllyntaus, 1991). The share of employment in agriculture and forestry was still about 70% in the 1920s, declining to about 50% in 1945 and only 9% in 1993. In Finland, the secondary and service sectors have grown together, except for the past 30 years when service sector growth has been faster (Heikkerö, 1987).

From 1860 to 1985, the growth in per capita gross domestic product (GDP) was faster in Finland than in Sweden, the United Kingdom, or the United States. In 1860, the Finnish GDP figure was half that of Sweden and one third that of the United States (Hjerppe, 1989). By 1990 Finland was among the first 15 nations in the per capita GDP ranking. Throughout this century, the leading principle of agrarian reforms has been to create a farm system based on private ownership. Accordingly, today some 70% of the forest areas are owned by private people. Finland was among the first countries to allow women to vote and also to stand as candidates in parliamentary elections. Since the preindependence days before 1917 the country has had a multiparty system, and except for a few instances it has always had a coalition cabinet.

There are some 450 municipalities in Finland and 102 of them are called cities, though the word *town* might be more appropriate. Although about 1 million people live in the Helsinki metropolitan area, only 12 of the country's cities have a population of over 50,000 (The Association of Finnish Local Authorities, 1996). Urbanization accelerated

after World War II, but began to decline after the oil crisis in the early 1970s. By European standards, building density is low and communities tend to be scattered. The major part of the infrastructure has been built after World War II, and the early 21st century will see a great need for basic renovation.

The history of local government or municipal administration in Finland dates back to the mid-1860s. Already at that time local authorities, either towns or rural municipalities, were given the right to tax residents. After independence, local councils were elected directly. Furthermore, local self-government was guaranteed in the national constitution. The Local Government Act of 1995 took into account the differences between individual local authorities and left it up to each municipality to arrange its own internal administration and operations as it sees fit (The Association of Finnish Local Authorities, 1996).

The most important services provided by local authorities are education, social services, and health care, and the maintenance of the technical infrastructure. Except for the smallest systems, local authorities and municipalities have played the key role in Finnish water supply and sanitation. In cities, towns, and rural centers, municipalities have at least indirectly acted either as service providers or facilitators through municipality-owned water and sewage utilities of various forms.

OBJECTIVES AND METHODS

The objective of this article is to describe the key issues of the evolution of urban and rural water supply and sanitation in Finland during the past 150 years. The article is based on the author's book (Katko, 1996) and on the respective summarized English version (Katko, 1997a). In 1998 the Abel Wolman Award was given to the latter book by the Public Works Historical Society of APWA.

The original research was based on an intensive literature review and semistructured theme interviews of some 160 senior sector professionals in the country. Before compiling the two books, several substudies were made on water treatment (Tanhuala, 1994), wastewater treatment (Lehtonen, 1994), consumer-managed water cooperatives (Juhola, 1990; Katko, 1992), and the development of water sector enterprises in Finland (Lehtonen & Katko, 1995). The emphasis of the study is on community water and sanitation services; industrial water pollution issues are also dealt with. The article also includes some key findings of the recent case study on Tampere City Water Works and its development since 1835 (Juuti & Katko, 1998).

DEVELOPMENT OF RURAL WATER SUPPLY

The oldest examples of water services are from the countryside, whereas similar rural technologies were also used in earlier urban centers. Wells were traditionally sited by so-called witchers. It was believed (and some people still believe) that these local experts can locate water veins by the help of a forked willow branch. In 1949 to 1950, some 40 of the most famous well witchers were invited to locate the water

veins in the botanical garden of Helsinki University. The eyes of the witchers were covered, and the result was as many different maps on water veins as there were witchers (see Figure 1). Yet a considerable number of the citizens still seem to rely on these witching methods. In reality, well witchers are practical geologists who are able to locate the most potential sites simply through vegetation, other signs in nature, and their earlier experience. Besides, small amounts of groundwater can be found in Finnish conditions almost everywhere.

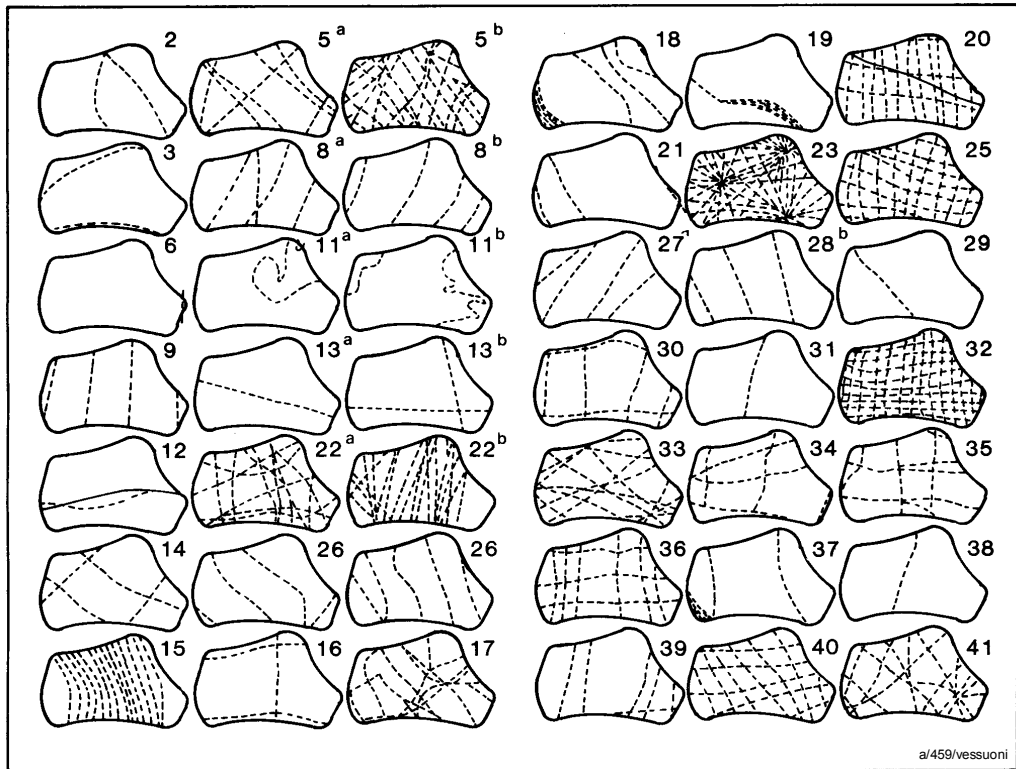


Figure 1

Water veins and radiation lines located in the same area by witchers in a study run in 1949 and 1950 in Helsinki.

SOURCE: Wäre (1953).

Traditional wooden well structures were considerably improved once concrete rings came into the market in the 1930s. The traditional counterpoise lift and winches, and later also hand pumps, were introduced. The latter were manufactured from wood before the factory-made models out of cast iron came to the market. After World War II, the Work Efficiency Institute of Finland introduced a developed model of the women's double yoke with padding for the shoulders. The need for this new model was quite real, because in 1951 it was estimated that the Finnish women walked daily the distance from the earth to the moon and back while carrying water from wells to the cow shed and house (Wäre, 1952).

The earliest written proposal for constructing common piped water supply appeared in the *Wasa Newspaper* in 1863 (“Pseudonym Hn,” 1863). It was suggested that a pipeline be built to carry water by gravity from a natural spring. The first documented case of such common piped water supply with several users was constructed in Ilmajoki in Ostrobothnia in 1872. This was soon followed by other small systems in the same area. These water pipes were constructed out of wooden pipes that were drilled manually from pine trees. A skilled driller could produce some 40 to 50 meters (130 to 160 feet) of pipe in a day. In the early 1930s, a special machine was developed for drilling wooden pipes. It is difficult to know the origin of wooden pipes use, but according to one professional article (Mäkelä, 1945), the idea might have come to Ostrobothnia from the United States along with returning emigrants. However, the earliest single wooden water pipe has been found in Turku, dating back to the mid-1600s (M. Stenroos, personal communication, 1998). Wooden pipes were also largely used in the European continent, and many of the structural and civil engineering codes and practices in Finland were borrowed from Germany (Katko, 1997b).

On the whole, the common rural water pipelines developed gradually from small to larger systems (see Figure 2). These systems evolved especially in the Ostrobothnia region, based on the needs of cattle farming and rural house-holds. Water was taken from natural springs, located often at higher elevation than the service areas and led by gravity. The settlements were concentrated along the riverbanks, and there was also a long tradition of joint efforts in the region. It is believed that this tradition of constructing joint water pipes by consumers themselves originates partly from the lake drainage associations that were very common in the 18th and 19th century (Anttila, 1967).

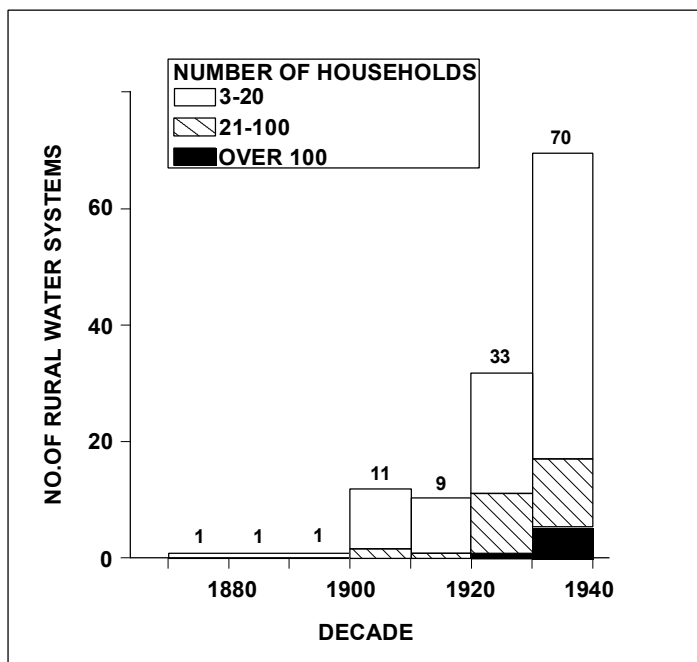


Figure 2
The establishment of common rural water supply systems 1870 to 1940.

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The evolution of rural water supply is largely based on cattle farming. At first, electricity was introduced to farmhouses. Second, a water pipe was constructed to the cow shed, followed by a sewer constructed from the house. Finally, a water pipe was drawn to the house as shown in Figure 3. The Finnish government started to support rural water supply through the first financial support act in 1951. This was preceded by the work of the Parliamentary Committee for Rationalizing of Households, having only female members and thus pointing out the role of women in daily household matters like water supply (Kotitalouden Rationalisoimiskomitea, 1950).

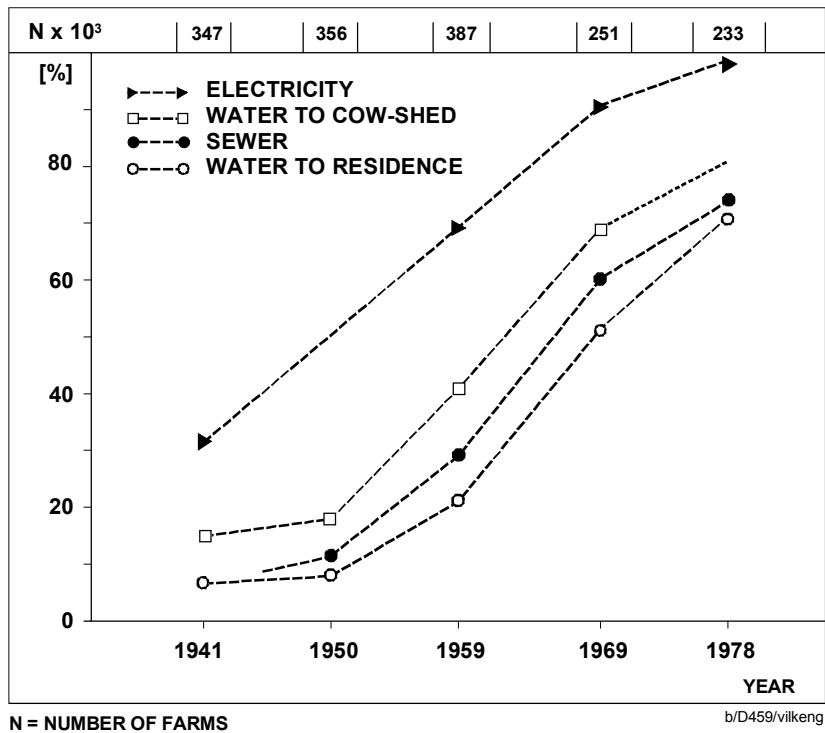


Figure 3

The diffusion of piped water, sewers, and electricity to Finnish farmhouses in 1941–1978
SOURCE: Census of Agriculture (1941–1978).

DEVELOPMENT OF URBAN WATER SUPPLY AND SEWER SYSTEMS

In the mid-1800s, urban water supply was still largely based on systems similar to those in the countryside: private and public wells. The first wells and latrines were introduced to Middle Age castles, from which they spread gradually to other areas. The first attempt to organize common water supply in urban areas took place in Tampere in 1835, when a German-made pump was tested. Though the pump was used for some time, it took almost 50 years to implement a reliable gravity water pipeline from a lake to the central square (Juuti & Katko, 1998). This first low-pressure water system

from 1882 was constructed under the control of the city, but it was preceded by rejected proposals made by a private concessionaire and a private contractor. The first as suggested in 1865 would have meant considerable risks for the city, whereas less to the private entrepreneur. The latter contractor came from the countryside with experience of various types of wooden structures.

The first urban water supply system was completed in Helsinki in 1876, constructed originally by a private company but soon acquired by the city. Water was needed in urban areas, especially for fire fighting purposes. The cities full of wooden houses at that time were like old pine and spruce forests that in the natural state used to catch fire every 100 years, if not more often. While cities grew little by little, the water in the wells started to become inadequate and deteriorated. In fact, the evolution of urban water supply and sanitation in Finnish cities can shortly be described by four key words: fire, thirst, health, and hygiene.

The water supply systems in Helsinki and Tampere were followed by systems in Vyborg in 1892, Oulu in 1902, and Turku in 1903. The water supply system in Vyborg, Karelia was the first groundwater system in the country. The city was given a special award in St. Petersburg for this achievement during the annual public health fair held the following year. On the whole, the establishment of water supply and sewers started in bigger cities and gradually dispersed to smaller ones, as shown in Figure 4. On the other hand, the formal establishment of city water supply and sewage works was often preceded by more informal construction of private water pipes and particularly sewers without the involvement of the city.

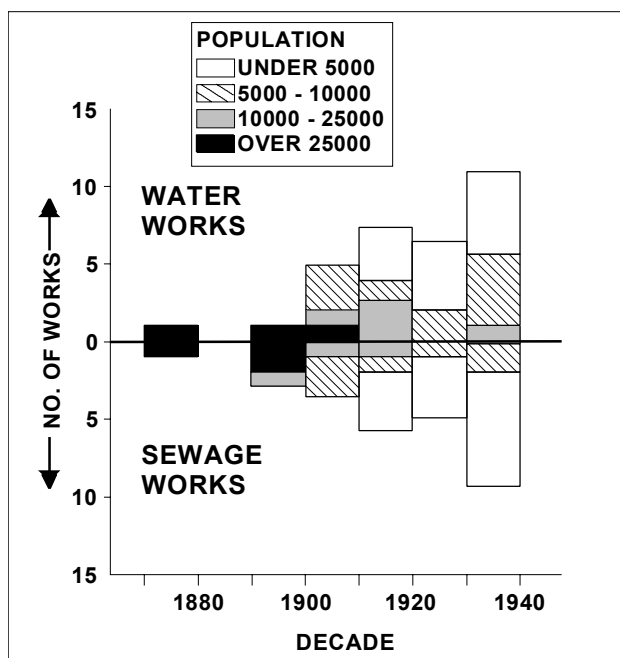


Figure 4
The establishment of water supply and sewer systems in Finnish cities according to their size.
SOURCE: Lehtonen (1994).

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Based on the experiences from groundwater use in Vyborg and Turku (Åbo), a lively debate on the feasibility of groundwater use was held in the 1910s (Gagneur, 1910, 1915; Sederholm, 1911). The geological bird's perspective and the method based on soil conductivity were considered as contradictory alternatives. The latter gave too optimistic estimates on water yields, and thus many of the cities decided to turn to the use of surface water. Yet by combining both, it could have been possible to develop groundwater use already at that stage. After the shift to surface waters by the year 1920, it took almost 50 years before large-scale use of groundwater restarted.

Helsinki and other bigger cities had direct connections abroad, especially to Sweden and Germany – civil servants went on study tours, and foreign experts were also invited to Finland (Hietala, 1987). Especially on the western coast people had direct connections abroad, but knowledge and experience was also gained from the capital, Helsinki. The water works of Vyborg assisted the establishment and expansion of water works in many cities and townships in eastern and central Finland. Yet the overall development does not seem to be as capitalcentered as stated in several other studies. However, in the diffusion of water services to households, the capital was undoubtedly the forerunner.

The oldest water towers were ground-based reservoirs, constructed of stone and brick and buried partly underground, like those in Helsinki, Vyborg, Tampere, and Turku. (The third one is still in use, reminding us of the potentially very long lifetime of water systems.) Occasionally, wooden towers were used as well. The first elevated water reservoir or water tower was constructed in Hanko (St. Michel), on the southwestern coast (the eastern part) of the country, in 1910–1911. In Vaasa, on the western coast, a water tower was constructed in 1914. Like many others later on, it was selected on the basis of an architectural competition with many various proposals. Later, various types of shell and core structures of reinforced concrete were introduced, often on tailor-design principle (Nagler, 1966). Indeed, tailor design seems to be a unique feature in Finnish and Nordic elevated water reservoirs.

The first waste water treatment plants in Finland were constructed in Lahti and Helsinki in 1910. The plant in Lahti was the very first one in the Nordic countries built for a whole city. The first plants comprised a septic tank and a trickling filter of natural gravel. The filters in the Lahti plant had some 450 cubic meters (16,000 cubic feet) of heart cinder and pieces of burned brick. The first activated sludge plant in Finland and Scandinavia was constructed in Kyläsaari, Helsinki in 1932. This was followed by the plants in Rajasaari, Helsinki in 1936 and in Pietarsaari (on the western coast) in 1938.

In the 1920s and 1930s, water supply and sewer systems also spread to smaller townships. During World War II, few of the urban water utilities experienced some damage due to air bombing, but generally they were able to operate reasonably well. After World War II one could (at least in smaller townships) still find private wells and latrines, indicating that the modernization of society did not happen overnight. In addition to public and private latrines, cast iron pissoirs were common in larger cities. The pissoirs, as well as public latrines, have largely vanished during the past few decades. It is yet obvious that the need to urinate has not vanished anywhere.

EXPANSION OF WATER SUPPLY AND SANITATION FROM THE 1960S TO 1980S

The largest expansion of water supply and sanitation services in Finland took place from the late 1950s to the 1980s. During this period, total water consumption increased, while the networks were expanded. It was generally believed (especially in the 1960s) that cities would grow quickly, but it could not be foreseen that almost half a million consumers would move away from the country during the decade. The design of water supply and sewers networks was largely based on this estimated growth.

After the oil crisis of 1973 and the introduction of the so-called Sewage Surcharge Act in 1974, specific water consumption (liters per person per day) started to decrease in Finland (see Figure 5). The decrease can be explained by the introduction of proper leakage control by utilities, better pipe materials, better water fixtures, and consumers' improved awareness of water wastage and saving. Even total water consumption started to decrease in some cities in the 1990s. This is a new challenge for the utilities in terms of water quality in the networks that, due to overdimensioned pipelines and extended detention time, tends to deteriorate. It will also require tariff adjustments. The flow in sewers may also become too low for flushing.

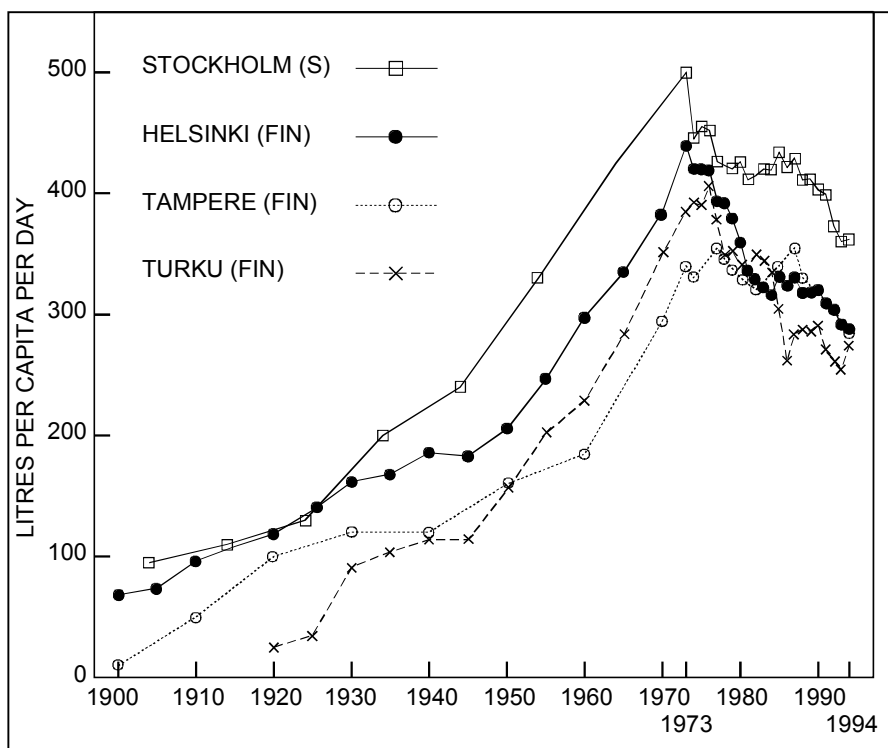


Figure 5

Specific water consumption of three Finnish and one Swedish water utility in the 20th century.

SOURCE: Katko (1997a).

Water treatment was also improved, and artificial recharge in groundwater use was introduced. The first such modern version was constructed in Lappeenranta in 1970 (Kivimäki, 1992). In surface water abstraction, slow sand filtration was reintroduced in the 1990s, whereas it was used in Helsinki as early as the 1880s (Tanhuala, 1994).

The Water Act of 1962 introduced officially the concept of water pollution control. In the 1950s the key element of watercourse protection was still the self-purification of water bodies. The construction of municipal waste water treatment plants increased rapidly in the 1960s, and by the 1980s practically all communities had wastewater treatment plants (see Figure 6). As for nutrients, the removal of phosphorus started in the early 1970s. In most lakewaters of the country, phosphorus is the minimum factor. Typically, so-called simultaneous precipitation (in which the precipitating chemical is introduced simultaneously to the aeration tanks) has been used. Ferrosulphate has been the key precipitating chemical, and it is very cheap because it is a by-product of titanium oxide production. Encouraged by the Swedish experiences, some utilities on the western coast of Finland started to use so-called postprecipitation, where separate sedimentation tanks are constructed after the aeration base. There was a heated debate concerning these methods, but simultaneous precipitation has finally proven to be as efficient as the Swedish practice (Lehtonen, 1994).

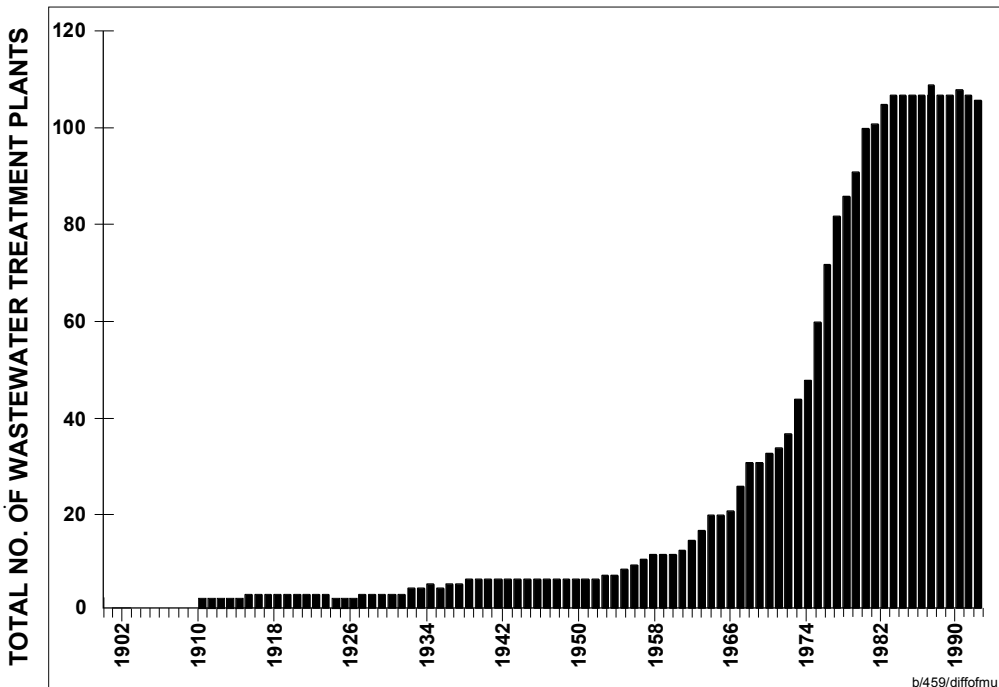


Figure 6

Urban waste water treatment plants in Finland, 1910 to 1992.

SOURCE: Lehtonen (1994).

Simultaneous precipitation was used overwhelmingly and is still in use, whereas the development of other alternative methods has lagged. In the 1990s, some treatment plants along river bodies (especially on the coastal areas) have been obligated to remove also nitrogen. In 1967, the first wastewater treatment plant constructed in the bedrock was completed. Thereafter, such underground structures have been introduced in (for instance) the cities of Lahti and Helsinki. These have several advantages from the point of view of land use, especially because rock tunneling technology is at a very high level in Finland (Tamrock, 1988). However, such structures are fairly expensive.

As for industries, water pollution control started first in the food and tanning industries. The first waste water treatment plants were constructed in the 1950s, whereas biological-chemical treatment was introduced in the 1960s and 1970s. Mechanical and chemical forest industries emerged in Finland at the end of the 19th century. Most of these plants were established along inland waterways, which was practical considering the location of forest resources, transportation based on timber floating, and the water needed for processes. But at the same time, the water bodies started unavoidably to deteriorate little by little. For instance, the water pollution caused by the sulphite pulp mill of Mänttä, some 250 kilometers (175 miles) north of Helsinki, was already being discussed in the 1930s.

Water pollution loads from forest industries started to decrease in the 1970s, whereas biological-chemical treatment, similar to municipal waste water treatment, was not implemented before the mid-1980s. On the whole, the water pollution loading from forest industries has decreased continuously since 1970, although total production has increased (see Figure 7). Another key objective has been to reduce the use of chlorine compounds in pulp bleaching. In spite of these positive developments, forest industries in Finland are still discharging considerable amounts of organic and nutrient loads into water bodies.

Forest industries started to treat their waste waters with biological and chemical methods some 15 to 20 years later than municipalities. Some small townships and rural centers constructed their waste water treatment plants earlier than bigger cities. As regards protection of water bodies and water pollution control, this order looks irrational. The order probably implies the fact that forest industries (which are very important to the economy of the country) and bigger cities are better able to advance their interests in policy and political decision making: They have a louder voice and less difficult exit (Paul, 1990). Although the traditional way of thinking “out of sight, out of mind” is not necessarily applicable to the industry, the saying “it stinks of money” more or less is.

THE INSTITUTIONAL FRAMEWORK OF DEVELOPMENT

This section of the article covers the development of (a) water and environmental administration, (b) water and sewage utilities, (c) professional associations, (d) water pollution control associations, (e) human resources, (f) research, (g) intermunicipal cooperation, (h) sector enterprises, and (i) international activities.

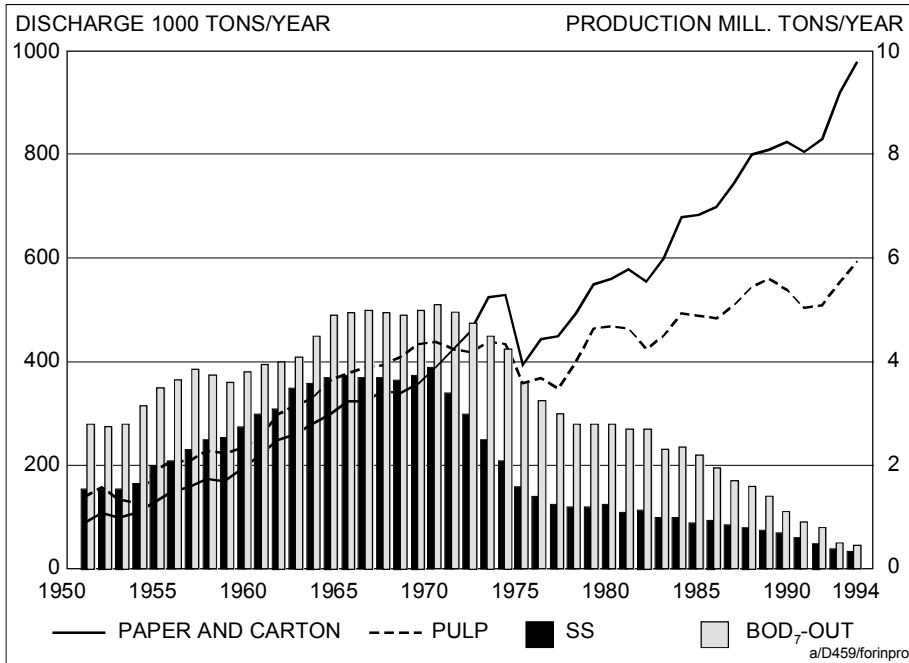


Figure 7

Total production and waste water loading from forest industries, 1950-1994.

SOURCE: Finnish Forest Industries Federation (1995).

Finnish environmental administration has its roots in the agricultural engineering districts. The first such districts were established in Vaasa and Oulu regions in 1889. New districts were gradually established, and their boundaries largely reflected the development of the regional administration in the country. The water districts were established in 1970 as part of the Water Administration, and in the 1990s the regional environmental centers were formed on this basis.

In 1912 the role of municipal technical services in general and water supply and sewage utilities in particular were debated during the first annual national seminar of cities. Mr. B. Vuolle, the head of electricity works in Helsinki, gave a presentation in which he discussed the operational principles and objectives of these utilities based on foreign examples. Vuolle stated that when establishing water supply works, the main emphasis should not be on making a profit; nor, he maintained, was it feasible to set such a requirement. Instead, Vuolle asserted that the emphasis of water supply works should be on health aspects and other indirect benefits. In 1866, Mr. W. von Nottbeck, an entrepreneur, proposed that he could construct and maintain a water supply system for the city of Tampere. His 10 detailed requirements can be summarized by the following idea: He would take the money and the city would carry the risks (Juuti & Katko, 1998). Such ideas should be repeated in the 1990s, when privatization of water utilities is demanded and largely promoted in international forums.

Finnish waterworks have managed to survive thanks to their water charges, whereas sewage services used to be financed through municipal taxes. One of the key points is that central governmental support to the sector has always been minor, and that this support has mainly been directed to intermunicipal projects, groundwater investigations, and similar promotional and support activities.

Water and sewage utilities in cities and townships have traditionally been part of municipal administration, whereas small private water associations present a unique Finnish solution.

Water and sewage utilities in cities and townships have traditionally been part of municipal administration, whereas small private water associations present a unique Finnish solution (Katko, 1992). These associations can be partnerships, water cooperatives, or joint-stock companies. Some water cooperatives have become merged into larger systems, whereas at the same time new ones have been established especially in dispersed rural areas. Since the 1970s, joint-stock wholesale companies have been formed, particularly for intermunicipal systems. The first intermunicipal wholesale water works were created along river valleys on the western coast of Finland, and these systems were largely based on the plans presented already in the 1960s. In the early 1970s,

the Helsinki metropolitan area water company built a 110 kilometers (70 miles) long bedrock tunnel taking water from Lake Päijänne. At that time the tunnel was among the largest and longest ones of its kind in the world.

The water supply and sanitation sector has several professional associations that have contributed to the development of sector education and that have also promoted the general policy development. During the first decade of the century, the Union of Civil Engineering Technicians developed the Finnish sector terminology mainly on the basis of Swedish terminology. Other professional associations include municipal central associations, the Finnish Municipal Engineering Association, the Agricultural Engineering Association, and later the Finnish Civil Engineering Association. The Finnish Water and Waste Water Works Association (FIWA) started its activities in the 1950s by representing mainly the interests of small waterworks, but later it expanded to represent all the water and sewage utilities. In addition to overall professional and human resources development, professional associations have also contributed to public relations and public education.

The Water Association, Finland was established in 1969, and it has for its part promoted water sector research, especially water pollution control issues. The association has mainly personal members who cover almost the whole water sector and are experts in several disciplines. The association has organized an annual research seminar. The topic of the first seminar in 1970 was eutrophication, which is still one of the unsolved problems of Finnish water bodies (Timonen, 1994).

Those water pollution control associations whose operations largely focus on a certain river basin represent voluntary activities. The oldest such nongovernmental organization was established for the Kokemäki river basin in 1961. It is also the largest one in terms

of its activities. A considerable share of the activities of these associations consists of laboratory services (Anon, 1977).

Compared to the evolution of water supply and sanitation services, specialized training (particularly at the university level) started late. Yet the curricula of agricultural engineers in the early part of the century were quite multidisciplinary, including both engineering and agricultural subjects. In a way, they can be regarded as the first environmental engineers of the country. The first chair in water supply and sanitary engineering was not established at Helsinki University of Technology until 1967. This was followed by an associate professorship at Oulu University in 1969 and a chair at Tampere University of Technology in 1973. Since the 1960s, the continuing education in the sector and later also international education in the sector have been remarkable.

The first research activities in the sector took place at Helsinki water works in the late 19th century. The research projects dealt with health impacts of lead pipes and chemical treatment of surface waters.

The first research activities in the sector took place at Helsinki water works in the late 19th century. The research projects dealt with health impacts of lead pipes and chemical treatment of surface waters. Based on this research, the use of lead as the main water pipe material was forbidden (Lillja, 1938), which we now know was a very good decision. The authorities started research activities in relation to water supply and sanitation in the 1950s. These studies dealt with water use, water supply pipe materials, water quality in wells, and even water veins.

In the 1960s groundwater explorations were begun, especially in relation to intermunicipal water supply. The first studies related to waste waters dealt with the use of marshland and stabilization ponds. In addition to authorities and industries, research has also been conducted by universities. Unfortunately, research has often been conducted after practical applications. This was true in the 1970s with municipal waste water treatment, and the same was repeated in relation to forest industry water pollution control in the 1980s.

One of the key sector persons was R. Huber, who originally came to implement the first construction works of Helsinki waterworks and who later established his own company in Helsinki. Huber also prepared practical instructions on how to use the flush-toilet (Lehtonen & Katko, 1995).

In 1912, the Swedish company *Almänna Ingeniörsbyrå* established a subsidiary in Finland with the aim of getting involved, especially in Russian railway construction. This gave later birth to the key water sector company, YIT Ltd. Other contractors and consulting companies were established after World War II. Many of these companies were in one way or another connected to YIT. The first actual consulting company in the country, Soil and Water Ltd., was established in 1949. The Association of Rural Municipalities established a company that later became Plancenter Ltd. Originally, the first consulting companies were established especially to serve rural water supply and sanitation (Lehtonen & Katko, 1995).

Finnish export activities in the sector started in the late 1950s, when YIT carried out the planning of the sewerage system of Reykjavik, Iceland and constructed the Karpala water works in Iraq. Export activities expanded gradually to other Arab countries and to the former Soviet Union. Later in the 1990s, export activities were expanded to China and to countries close to Finland (Lehtonen & Katko, 1995).

Water supply and sanitation has traditionally been one of the key sectors in bilateral development cooperation funded by the Finnish government. The first bilateral development cooperation project was started in Tanzania in the early 1970s, lasting until the early 1990s. Other water and sanitation projects have been supported in Sri Lanka, Kenya, Vietnam, Egypt, Mozambique, Nepal, Namibia, and Ethiopia.

The experience gained from development cooperation by enterprises and individual experts has also prepared ground for cooperation in the Baltic region. Water pollution control and management is the key issue in improving the so-called 132 pollution “hot spots” identified within the Baltic Sea Protection Programme (Anon, 1993). These references have been also important in various activities supported by the European Union. Thus, it can be said that it has really been worth exploring new horizons (or visiting the areas behind the mountains, to use a Finnish phrase), as was done in the sector already 100 years ago. In the 1990s, water and sewage utilities are gradually also becoming involved in international activities through twinning and related arrangements (Juuti & Katko, 1998).

On the whole, the institutional development of the water supply and sanitation sector is based on the cooperation of several parties. As for legislation, the special water courts are independent of the environmental administration, and they operate as autonomous courts with both jurists and water professionals as members. The courts were established in connection with the Water Act of 1962, emphasizing water pollution control. The various parties such as industries, water and sewage utilities, professional associations, and sector personnel have all played their remarkable roles. In short, the evolution of water supply and sanitation services has been a national civilization project, and it remains so today.

CONCLUSIONS AND SUGGESTIONS

As the development of water supply in rural and urban areas of Finland has proceeded along different paths due to different demands, the country’s water systems have gradually become closer to each other in terms of their technology, economics, and management.

The overall development path of the Finnish water supply and sanitation sector can be divided into seven development phases. After the first initiatives that in some cases took several decades to mature, the first systems were constructed. After independence in 1917, water supply and sewage services spread to other cities and townships and rural centers, but this development was practically stopped during World War II. The postwar reconstruction period in Finland was followed by the greatest expansion of these services ever in the 1960s and 1970s. Thereafter, the sector reached a plateau,

although new challenges have continuously arisen (see Figure 8). At the same time, international activities and intermunicipal cooperation have increased remarkably.

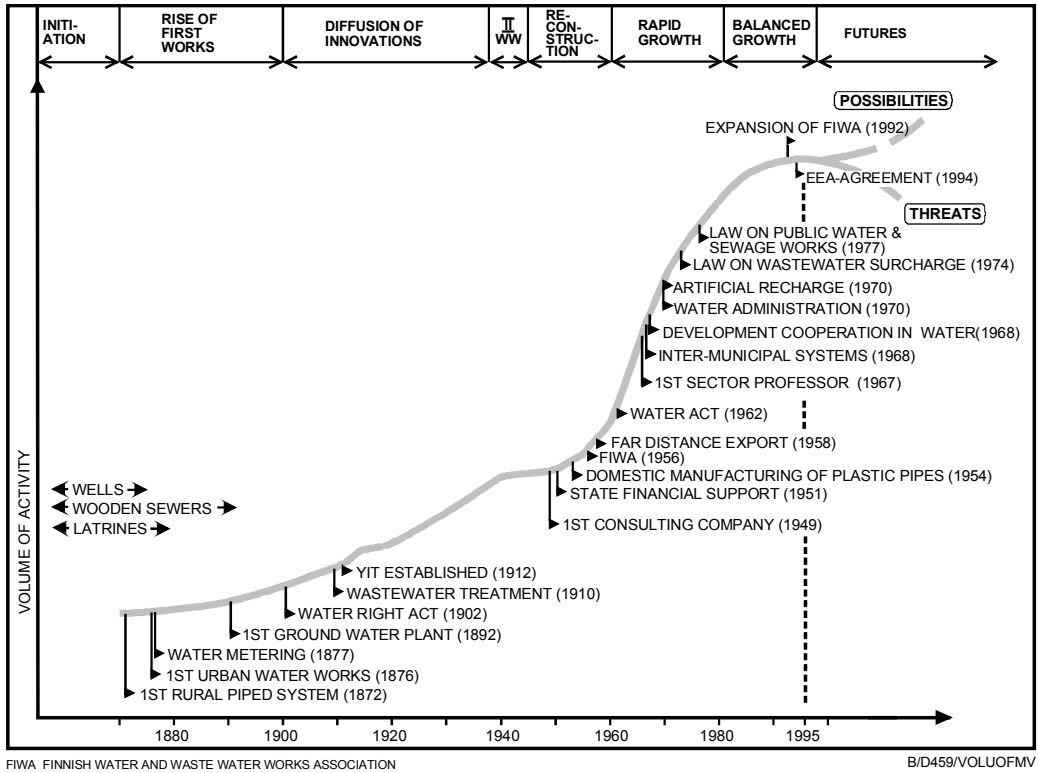


Figure 8

The development of water supply and sanitation in Finland with selected key phenomena. SOURCE: Katko (1997a).

In international comparison, the level of Finnish water supply and sanitation services is very high. For instance, equally efficient and extensive waste water treatment can probably be found only in a few countries other than Finland. The Finnish model of implementing water supply and sanitation services is largely based on the cooperation of the public and private sectors; the services are provided by publicly owned utilities that operate on a nonprofit basis but still adhere to commercial principles. Any possible profit benefits the public owner, the utility, and, in the end, the consumers. The other major principle is that the services have been and still are covered by direct consumer payments, and governmental subsidies have always been very minor. The third key principle has been to organize rural water supply through consumermanaged water cooperatives. Other best practices and management principles typical of Finland include the autonomous water courts.

Water supply and sewer systems have expanded gradually, whereas technological development has been quite rapid in areas such as plastic pipes, wastewater pumping, and water chemicals. The 130 years of development show that even in this sector there are no shortcuts to success.

The decisions made by several cities around 1920 of not using groundwater had long-term effects on the sector – the interest toward groundwater use, artificial recharge, and groundwater protection did not come back before the 1960s. Such decisions related to the theory of path dependence may thus have long-term effects.

The study (of documentary nature) implies several needs for further research. From the author’s point of view, the areas with the most potential are the following:

- development of and projections on water demand, and the overall effects of the foreseeable decline in demand on the management of the services;
- various forms for public-private partnership in water and sewage services;
- institutional development and the roles of the sector stakeholders;
- in-depth synthesis of the interaction between water, sanitation, solid wastes, and other environmental services and their future policy implications; and
- future strategies for national and international environmental services.

A comparative study on the evolution of water services in selected countries should also be made to improve the understanding of the key requirements for viable services. This effort could also contribute to international cooperation in the sector. If we are seriously interested in the future, we have to know where we are and where are we coming from.

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AN EARLY ATTEMPT TO PRIVATIZE – ANY LESSONS LEARNT?

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INTRODUCTION

Water supply and sanitation has been subject to policy changes over the last decades. In the 1960s interest was focused merely on technology, and in the 1970s on so-called “appropriate or low-cost technology”. In the 1980s social issues were emphasized and by the end of the International Drinking Water Supply and Sanitation Decade (IDWSSD), it was gradually accepted that the services must be paid for. In the 1990s environmental concerns have been brought up, as well as the acute need for institutional development (ID). One of the latest ideas is to promote privatization of water services (Hukka and Katko 1999). Through a historical case the paper presents a critical view of particularly the privatization efforts in urban water services.

The subject of the case study is the city of Tampere and the evolution of its water-works from 1835 to 1998 (Juuti 2001, Juuti and Katko 1998). Nowadays, Tampere is the largest inland city in the Nordic countries and the third largest city in Finland with a population of nearly 200,000 people. The city was established in 1779 along the rapids between two lakes, with an elevation difference of 18 metres. The city used to be the major industrial centre of the country in the 19th century. In Finnish the city is often called “Manse” referring to her big sister and industrial centre, Manchester, in England. After being a part of Sweden for some 600 to 700 years, in 1809 Finland became a Grand Duchy of Russia while reached her independence in 1917. The time of the case study 1860–1880s presents a period of awakening Finnish national spirit, start of industrialization, construction of basic infrastructure as well as development of municipal administration.

The first known attempt to organize urban water supply in Finland was made in Tampere in 1835.

The first known attempt to organize urban water supply in Finland was made in Tampere in 1835. The system used a German-made iron pump and a wooden gravity pipe from the upper lake to the downtown area. Yet, the amount of water produced was insufficient and had a questionable taste and odour. Thereafter, several proposals were made to build a water system, particularly due to the risk of severe fires.

Traditionally houses and buildings in Finland, contrary to the bigger cities in the European continent, were made of wood. For instance, three fourths of the former capital of Turku was burnt down in 1827, whereafter the University had to be moved to Helsinki.

ENTREPRENEUR'S PROPOSAL

The construction of a water supply system in Tampere was forgotten until a fire again raised the issue in 1865. Then, the industrialist William von Nottbeck, originally from St. Petersburg, offered to build a water pipe at the request of the City Board. He suggested that a wooden pipe be constructed from the upper lake to the marketplace at a cost of 7,500 silver rubles – Finland being an autonomous Grand Duchy of Russia at the time. An alternative proposal was to supply the entire City at a cost of 28,000 rubles. The City Board decided to continue dealing with the matter in its Nov. 22 meeting. It was suggested that von Nottbeck would submit a written statement of the

conditions under which he would undertake the project. And why did the city ask for help and a plan from von Nottbeck? The city councillors were well aware of that the von Nottbeck-owned Finlayson industrial area, among others, had the first sprinkler system as early as in 1837. In addition, the industrial area, next to the city centre and the rapids between the two lakes, had a drinking water system and large water canals which lead water to powerwheel by gravity. It is evident that in such a situation the views of the industrial entrepreneurs like those of von Nottbeck concerning water supply for the city were listened to.

The major demand for improved water supply was due to the need for fire-fighting water. The water intake was to be located at the previously planned site; the suggested layout was also the same as earlier. Yet, von Nottbeck's proposal started to raise serious doubts among the members of the City Board. Why? In its meetings on Nov. 22 and Dec. 11, the Board discussed von Nottbeck's conditions for constructing the water system. A conspicuous feature of the 10-point list of conditions was, for instance, that the industrialist proposed to build the system at his own expense; thereafter it would become his property. The conditions were also skillfully formulated in von Nottbeck's favour (Box 1).



Figure 1
William von Nottbeck (1816-1890).
(Archives of Tampere City Museums)

BINDING CONDITIONS

It can be seen from the conditions that von Nottbeck planned to turn the water supply system into a project where the actual risks would be covered by the City Board. The acceptance of his offer would have given him a private water monopoly in Tampere. The market fees, of which von Nottbeck wanted a share, were a good source of income for the City. In 1863–66, the average annual income from market fees amounted to some 2,700 marks while the City's total revenues were slightly over 50,000 marks. Although the amount of collected market fees had been decreasing, it is understandable that the City Board did not want to share this source of revenue with von Nottbeck. After all, he insisted on being paid 40 pennies per head for a total of at least 2,500 marketgoers which would have meant a minimum loss of 1,000 marks to the City:

a 37 per cent cut in market fees. Had market fee income plummeted, the City would have been liable for a sum equivalent to 2,500 market fees. Something like this may have entered the minds of Board members since the number of marketgoers had decreased for some time.

1. Arrangements must be made to allow piping water initially from Mältinranta (upstream) or Mustalahti through the City to Kauppatori (marketplace) so that pipes of practical size can be used.
2. Permission to lay water mains in the middle of streets must be granted so that the owners of the houses along the streets can be supplied the necessary water at a reasonable price.
3. The conveying of water is to be considered the property of myself or my heirs and I shall therefore be entitled to use the water for my own needs. The City Board agrees not to allow the building of any other water supply system within the City without my permission as long as I maintain the water supply system in proper condition and gradually expand it to other parts of the City.
4. Should I decide to sell the facility, I agree to offer it first to the City Board at the offered price.
5. Should an act of God render the water supply inoperable for a period of time, I agree to repair it, but will not pay compensation for any resulting damages.
6. The City Board agrees to impose a large enough fine to prevent acts of vandalism against the system or any part of it.
7. The City Treasury shall pay me annually 200 Finnish marks for the use of the water system by the City Hall, the upper elementary school and the hospital, even if said institutions do not use it.
8. As the water system contributes to public safety and, among other things, benefits the City dwellers in the form of lower insurance premiums on their properties, I consider cheap a charge of 40 pennis for each one sixteenth (market fee) charged by the City Board which entitles people to use water free during fairs and regular market days.
9. I agree to set as reasonable a price as possible on the water consumed in the marketplace and from fire plugs installed in certain locations.
10. In the future, should the income from the one sixteenths fall below 2,500 marks, the City Board agrees to make up the difference.

Box 1

Von Nottbeck's terms for establishing a private waterworks for the city of Tampere in 1866. (Juuti & Katko 1998)

In accordance with the conditions, the city was to pay for three institutional water users even if they would not use water. Finally, the entrepreneur promised to make the price “as reasonable as possible”.

The 7,500 silver ruble investment required by the smaller water system was equivalent to some 30,000 Finnish marks. Although participation in the system could have been a quite heavy financial burden to the City, it should be remembered that for von Nottbeck, an immensely rich aristocrat, the income from the water system would have constituted only a minor revenue: his dividend income alone was in the six figures at the time. It is probable that even if the City had lost a sizable portion of its revenues, von Nottbeck would have nevertheless considered himself a benefactor. The incomes of this business magnate and the average inhabitant of Tampere were worlds apart. At least a third of the City residents were at the time employed by von Nottbeck. Although the industrialist was a friend of the Czar family, he was devoted to and interested in the City of Tampere and its administration. The water supply system is a prime example of that.

REJECTION OF THE PROPOSAL

The City decided in favour of a municipal works against a private one. In its meeting on Dec. 11, 1865 the City Board concluded that the City could not accept the guarantees required by von Nottbeck. After the rejection of von Nottbeck’s proposal the merchant Hilden suggested that the City should commission a suitable person to survey the ground and make a proposal on how to build a water system for the City. If the project could be implemented with the City’s own revenues supplemented by a loan from the state, the City would build the system itself. Those present seconded the motion.

DISCUSSION AND POLICY IMPLICATIONS

Considering the “fad” of privatization promoted around 2000, one may ask whether we have learned from the past. In most European and Western countries water and sanitation services were started by private companies but relatively soon they were taken over by the cities and local governments. Yet, in France though private companies were born since 1835 (Goubert 1986) and since those days they have survived and expanded. Recently private operator contracts have increased instead of direct municipal management. In any case of harm the mayor are personally liable, and thus by delegating authority to a private firm, the mayor can eliminate his personal liability. Besides, the delegation decision is basically irreversible, and there is no effective competition (Clarke and Mondello 1999).

In the United States waterworks was the first important public utility and the first municipal service that demonstrated a city’s commitment to growth. In 1830 some 20 per cent of the 45 waterworks were publicly and 80 per cent privately-owned in USA. The share of public waterworks increased gradually, being about 50 per cent in 1880 and 70 per cent in 1924 (Melosi 2000, p. 74, 119–120).

In Finland, the Helsinki city waterworks was established in 1876 through a concession contract while in 1882 the city reassumed the ownership and the overall management of the works. Thereafter urban water supply and sewerage have been public-owned in Finland. Yet, in rural townships and villages there is a long tradition of private-owned small water associations and cooperatives. The latter ones are often cost minimizers sometimes with the risk of service quality, instead of profit makers (Katko 1992).

Based on Swiss experiences, Kilchmann (1997) points out that commercialization of water services is in principle a positive matter. Yet, due to their nature it is difficult to introduce commercial principles. He stresses the need for giving wider autonomy to water utilities, which can thus introduce commercial principles without the negative impacts of privatization. As Kraemer (1998) points out, the bulk of water supplies are managed by public-owned utilities in Germany as well as many other western countries. According to Hames (2000) the relatively small divisions, into which water management is broken down in Germany, have several advantages. It is obvious that we are dealing with a broader issue than mere economies of scale.

In England and Wales in 1904 local authorities had the responsibility of 80 per cent of water supply undertakers. The role of local authorities remained high till the 1960s. In 1973 regional water authorities were established. They took over the former 157 water undertakings, twenty-nine River Authorities and 1400 Sanitary Authorities, and operated on river catchment basis. In 1989 public-owned authorities were completely privatized. According to Hassan (1998) the patterns of commercial success and environmental investment which occurred in the water industry after 1989 proved to be very controversial. He also points out that it is not evident, whether the benefits

Gradually the negative or questionable sides of privatization experiences are also becoming visible.

and costs are fairly distributed among all the stakeholders. Gradually the negative or questionable sides of privatization experiences are also becoming visible. Okun (1994) points out that the privatization of public water utilities in 1989 was preceded by intentional government policy that since 1980 strongly restricted the borrowing by the public utilities. Indeed, the financial needs were one of the major arguments for privatization in 1989.

Considering the international debate on privatization and public-private partnerships, it is important to note that, in many respects, France as well as England and Wales are exceptions in terms of municipal administration. France has some 36,000 municipalities. As the number is so large, it is natural that other types of systems have developed instead of conventional municipal utilities. According to Johansson (1997), the role of local administration in Britain has continuously declined over the last few decades. This is contrary to the tradition of decentralization and local government, in, for example, Nordic countries. Thus, we are faced with a bigger problem than just the ownership of water utilities.

One may ask, why such exceptions have been taken as models or cases of best management practices while there are also several other institutional options available.

The answer to this may come more from political scientists than water sector professionals. But should the latter just close their eyes related to the policy change?

According to the Nobel-laureate economist Milton Friedman (cited by Williamson 1987,

...in the case of technical monopoly, we cannot find any good solution. We have to choose from three evils: private unregulated monopoly, private government-regulated monopoly, and public monopoly.

p. 33) in the case of technical monopoly, we cannot find any good solution. We have to choose from three evils: private unregulated monopoly, private government-regulated monopoly, and public monopoly. The fresh Nobel-laureate Joseph F. Stiglitz (1998, p. 23) points out that it has proved difficult to prevent corruption and other problems in privatizing monopolies. He stresses that trade liberalization and privatization are the key parts of sound macro-economic policies, but not ends in themselves. They must be complemented by effective regulation. It is obvious that many developing countries have not capacity, tradition nor skills for the latter. Thus, the public sector should not leave the consumers at the mercy of private entrepreneurs, but should

instead protect the public interest and the well-being of the whole society. The transfer of a natural monopoly like water supply to private ownership would present a double risk as shown in the proposal presented.

The case, although a single one, implies several needs for future research. One such a research question is, why did municipalities and local governments actually take over the private water utilities in most of the western countries in the late 1800s. In Tampere, the City Board represented largely the various parts of the city that time although the equal right to vote was not introduced in cities before 1917. Thus, in a way the City Board of the 1860s represented rather higher and middle classes than the whole community. Besides, in some cases the municipal leaders were largely the same persons who owned the private companies (Tarr 2001).

If the overtake of waterworks by municipalities was considered a natural part of democratic development of societies, should this not be valid in any circumstances? Now western countries are arguing for democratic development, transparency and openness in transition and developing economies, and at the same time many of them are promoting privatization of water services or various types of private operator contracts, as prerequisite for development cooperation or financial aid (Hukka and Katko 2000). The history of their own development would largely imply the opposite, especially because privatization seemingly increases the power of transnational conglomerates beyond any democratic control, corruption, secret contracts and agreements (e.g. Hall 2001). In any case, the option of a public sector water undertaking is historically the most common model and the one that is mostly used also today. International agencies largely favour private company contracts and thus, the main competitor to any of the private companies is being excluded (Hall 2001).

Indeed, privatization, public-private partnership or cooperation of various forms is not a new issue. Although overall responsibility and ownership was assumed by municipalities in most cases, public-private cooperation, in terms of public ownership

and private services, has been practiced, for instance, in Finland since the late 1800s. Sometimes the issue of public-private partnership is promoted as strict 50/50 financial sharing. Perhaps it would be more relevant to speak about public-private cooperation where each partners and players assume the most appropriate roles for themselves.

CONCLUSIONS

Considering the presented case, and the spreading “fad” of privatization, it is concluded that instead of private ownership, various forms of public/private cooperation and commercialization should be favoured as has historically been the case in many today’s developed countries. Competition should be introduced for various production activities, not for natural monopolies. Agreements, where the public sector bears all risks and the private sector reaps all profits, should not be made.

On the whole, it is difficult to foresee that the private sector would like to invest heavily in the water and sewerage services, since they are capital-intensive and require long-term investments. The burden of such investments and rate of return would be paid anyway by the consumers. Therefore, the commercialisation and/or public-private cooperation should be favoured.

Finally, the key question may be, whether a municipality or nation is patient enough to build its own capacity and manage the core operations of water utilities, and possibly leaving the non-core operations to the private sector. Time will eventually tell, whether the drastic change in favour of privatization by international support agencies will become another unsuccessful attempt to create a shortcut to progress, instead of long-term capacity building and institutional development of the water sector and services.

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VIEWS ON THE HISTORY OF WATER, WASTEWATER AND SOLID WASTE SERVICES

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HIDDEN STRUCTURES

From a historical point of view the city can be seen as a static backdrop to a drama that takes place in another dimension. In reality – in the minds of people – a city is a place of meeting, noises, smells and changing light effects. For an ordinary person the city probably includes only the experienced and visible part. Yet, what makes a modern city work is largely hidden behind curtains. We could also – of course – assert that people see only what they learn to see.

From the standpoint of infrastructure management, a city forms a network of streets and streetcar tracks, cables, and water and wastewater pipes. Some historians have named these systems “the hidden city” or “the city below the ground”. What makes

What makes the hidden city interesting – from the viewpoint of historical interpretation – is that it also seems to be hidden from historians.

the hidden city interesting – from the viewpoint of historical interpretation – is that it also seems to be hidden from historians. It is a research area from which a lot could be learned. Why did we get such a city? Which were the actual forces behind this evolution, behind the visible and invisible drama that shaped the modern city?

In the field of futures research the following question is also relevant: to what degree are we dependant on earlier choices and structures already built? Do we at all have a board and men that can be moved freely? A trustworthy sketch of the future must be based on historical analyses. We have to learn how earlier choices block possible, probable and preferable development paths. One of the recent theories that historians have used to understand the complex forces behind the evolution of the technical networks of the industrial city is the path dependence theory. It is also a good tool for futures research and strategic planning. The path dependence theory is also one of the cornerstones of this paper.

This article does not try to directly answer the above mentioned important questions. On the contrary, it focuses on questions and thoughts that came to the fore during the process of answering these questions. The study was conducted as part of the research project financed in 1997–99 by the Academy of Finland and the Ministry for the Environment, called “Long-term development of water, wastewater and sanitation services and their future implications”.

This paper concentrates on the Finnish case. It is important to realize that due to its relatively late industrialization and urbanization, the country is – in a sense – a special case. Thus, all general statements about European cities in early industrialized countries are not relevant for Finland. One example is the mortality in cities (which was one of the main motives for action) compared to the countryside. In Sweden and the rest of Europe, mortality in cities was higher than in rural areas in the 19th century. This was due to miserable sanitary conditions in the early modern cities. At the end of 19th century, mortality declined rapidly in all cities. In Finland the average mortality in cities and countryside was equal, a fact noticed by statisticians already at the beginning of the 20th century.

IMPORTANCE AND JUSTIFICATION

Improved water supply and sanitation, especially in today's developing countries are justified largely by improved health conditions. Naturally, health education, maternity clinics, etc. also contributed to the decline in mortality in Finland, but the effect of modern water supply, sanitation and improved hygiene has nevertheless been of fundamental importance.

The demand for urban water supply was created especially by the need for fire-fighting water, since most houses were wooden. Additional demand was promoted by the need for safe drinking water by households as well as industrial and commercial uses. In rural areas improved water supply was promoted particularly by cattle farming. Sanitation, water pollution control and solid waste management were the real forerunners of environmental protection, long before the concept was introduced in

Water, sanitation and solid waste services are primarily an answer to the demands of consumers and customers, and thus have also social justification.

the late 1960s. Water, sanitation and solid waste services are primarily an answer to the demands of consumers and customers, and thus have also social justification.

Especially the lessons learned from international development cooperation indicate that project failures are more often the result of poor institutions and management than technology. Although the historical situation in Finland some 50 to 100 years was different, there are also obvious analogies. This points out the relevance of new institutional economic theory in analyzing past experiences.

STRATEGIC DECISIONS AS A HISTORICAL PROBLEM

The Concise Oxford Dictionary (Oxford 1964) knows only the old meaning of the word strategy: "*Generalship, the art of war [...], art of so moving or disposing troops or ships or aircraft as to impose upon the enemy the place & time & conditions for fighting preferred by oneself*". Most of today's textbooks on strategy would offer the definition "*top management's plans to attain outcomes consistent with the organizations's missions and goals*". However, strategy can also be seen in a wider context including one or more of the following five dimensions: strategy is a *plan*, a *pattern*, a *position*, a *perspective* or a *ploy*, a maneuver to outwit an opponent or competitor. In any case, to formulate a strategy we have to start working as the general, to mark our situation on "the map" (what we have), to work with a time axis (history, present) and to learn the conditions (the context).

Examples of Solid Waste Management

The strategies of the 19th century cities were not called strategies then. Yet, the decision makers of the growing cities of Finland, which was urbanized relatively lately, had to take decisions – to formulate strategies – in order to prevent the city environment from threatening sanitary problems. What is interesting is that these "strategies" and the tried technical solutions seem irrational. The selections were based on foreign

experiences and the desire to minimize costs. Local circumstances were seldom discussed and observed. An exception was the intensive discussion about and the fear of water pollution at the end of 19th century. The actors and ideas of the future had a great impact on selected technical solutions. This led decision makers to choose an alternative which could be called *the second best solution*.

The second best solution implies a situation where the best considered alternative is rejected for seemingly economical, technical or social reasons; the second best is selected as a *temporary solution*. The plan is to implement the best alternative when the conditions, which seem to be the obstacle, have been reached. For example, sorting of waste in two fractions was chosen in Helsinki instead of three fractions in 1910. In the 1880s bins were chosen instead of water closets, and landfilling instead of incineration of wastes in the 1930s. When investigating the decision making process we may also wish to look at hidden motives: if a property owner, who was a member of the city government, was truly worried about the sanitary conditions, or primarily interested in disposing his own wastes more cheaply?

While new professional groups gained more power in the Finnish city administration in the 1870s and 1880s, the question of who actually formulates the problem raises. The person who is able to formulate a problem also has the power to heavily influence technical selections. A decision maker who does not “see” the actual problem cannot actively take part in the decision making process and influence the final result. The power of formulating strategies is then in the hands of professionals: medical doctors and engineers in the case of Helsinki at the end of the 19th century.

Do we actually learn from the past? During the 1980s and '90s the Finnish waste management system changed drastically. Much of the changes were, of course, a consequence of the implementation of EU-related legislation, but a change in attitudes is also noticeable. The environment has become more and more important for the ordinary citizen. No wonder that so-called new ideas also found their way into the

What strikes a historian is that discussions similar to the present days were led and the same kind of technologies were used already a century ago. The main focus has just changed from public health to the environment.

market. What strikes a historian is that discussions similar to the present days were led and the same kind of technologies were used already a century ago. The main focus has just changed from public health to the environment. Source separation was seen as a modern idea in the 1980s. How many engineers engaged in waste management know that the same kind of source separation was introduced in Helsinki already in 1910? How many are familiar with the early plans for building an incineration plant in the first years of the 20th century? And what about the early drum composting techniques that were implemented in Helsinki and Turku in the 1950s?

Examples of Water Services

In 1864 a doctoral dissertation on the health impacts of lead pipes was published. In the 1870s and '80s, related laboratory experiments were conducted and in 1889 the

use of lead pipes was forbidden in Helsinki while joints and other fittings were excluded. This decision, taken soon also by other cities, may seem a small technical detail but can be considered very farsighted. For instance the first water pipes in the U. K. were of lead and are still in use. Their replacement, required by EU directives, will be very costly.

Since the early days of the Helsinki waterworks in the 1880s, billing of water has been based on metering. It is a historical paradox that more than a century later England, the pioneering country of water services, had to hold a public debate whether to install water meters or not.

By the year 1910 a heated public debate was conducted on the availability and feasibility of using groundwater in urban areas. At that time, some cities decided to use surface water and others did the same in the 1950s. It was not until the 1960s that the use of groundwater and artificial recharge were re-established. The present

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Rural areas have a long tradition of private, consumer-managed water supply systems that are operated on a small scale non-profit basis. It is obvious that this approach has been, and still is, appropriate in a country with villages and sparsely populated areas. Central government subsidies have always been limited in water supply and sanitation: expenses are covered mainly by consumers, earlier partly through local tax revenue, and later completely by direct consumer fees.

In urban areas and townships municipality-owned enterprises are able to operate efficient services on a commercial basis. Private sector services are used to a large extent in planning, construction, operation, maintenance and related services. This public-private partnership dates back to the 1880s, and is nothing new as argued by several international agencies and policy makers in the 1990s.

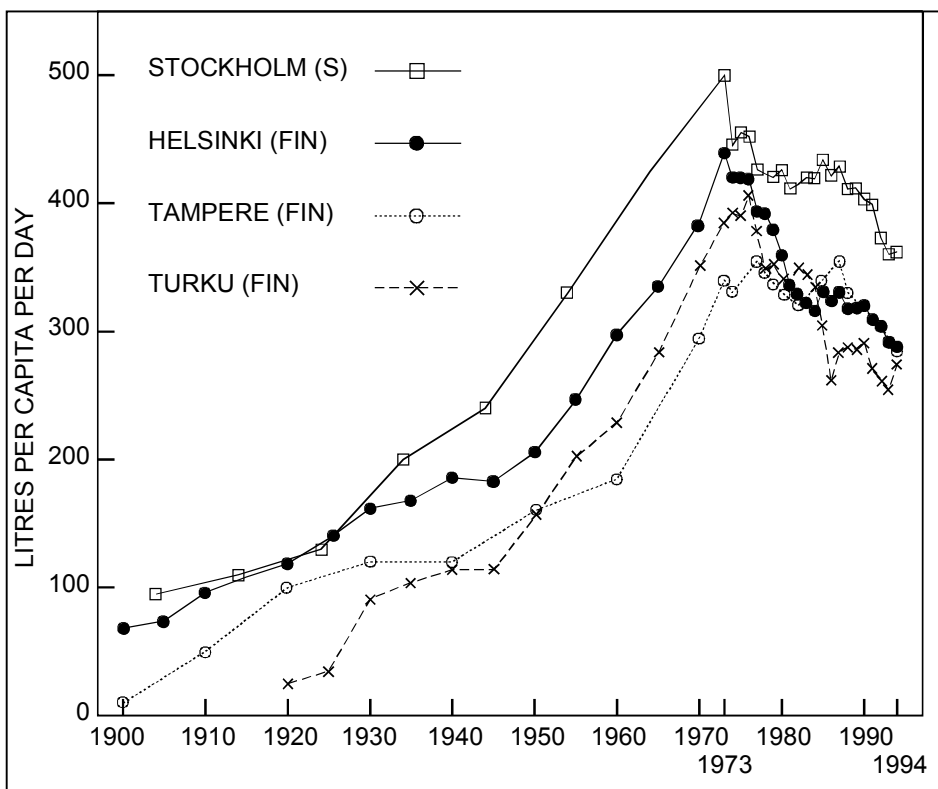
Sometimes technologies and technical knowledge move in cycles. For instance, in water treatment some old methods have been reintroduced as auxiliary methods or new applications.

Since the early 1970s the conventional growth paradigm proved not to be valid any longer in Finnish water use: per capita consumption, and in some cases even total water consumption, started to decline (Figure 1). We have a new special challenge: how to design systems for declining consumption.

ACCUMULATION OF KNOWLEDGE OR REINVENTING THE WHEEL?

When we consider the long term development of sanitary engineering, the question of how engineers and other professionals use accumulated knowledge raises. We can also ask whether we are making use of the accumulated knowledge – or more drastically, whether we ever learn from our experiences. In modern society one sometimes gets

the feeling that only the latest findings and products have relevance, while older studies are without significance. Instead of learning from earlier experiments, we launch new projects from scratch maintaining that enough “basic” studies” have been done. Maybe this is why, we sometimes get the impression of cyclical development and every generation seems to reinvent the wheel.



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Figure 1

Decline of per capita water consumption in selected Nordic cities in the 1900s.

It is of great importance – especially in the field of environmental protection – that we understand the relationship between knowledge and action. How is available knowledge utilized, and if not, why? As the Swedish environmental historian Lars J. Lundgren has pointed out it is also important to discuss questions like what is knowledge, and what does the utilization of knowledge mean.

Another interesting question is, whether knowledge can become outdated and obsolete. The authors have witnessed several cases where technology libraries abandoned, sold out or even destroyed publications that were over ten years old. Such an attitude is very unfortunate as concerns infrastructure services since most of the basic books on these services were written and printed in Finnish during the great expansion of these systems in the 1960s and '70s. The bulk of recent research reports

and other series are often meant for specialists while basic infrastructure and other related handbooks have not been revised and reprinted. These libraries argue that knowledge becomes outdated and thus useless. This argument is as absurd as claiming that an adult did not have his or her childhood. The attitude is probably based on development of information technology (IT) and other high-tech areas where the argument might be more valid. In infrastructure, environmental engineering and most probably many fields of basic engineering sciences, knowledge does not become old-fashioned but accumulates, and old knowledge is largely the basis of new. Thus, instead of promoting highly specific, exact sciences, we should remember that even in the development of IT, hermeneutic less exact sciences like psychology and other human sciences are becoming increasingly important. This is also a current challenge for the history of technology.

CONCLUDING REMARKS

The experiences from research on history of technology imply the need of analyzing and understanding the accumulated knowledge and history of technology even in the era of IT.

Firstly, it is important to *understand* the basic phenomena related to technology development and history of technology. A multi- and interdisciplinary institutional approach is needed rather than, for instance, in the case of history of technology, concentrating only on natural sciences, something that is probably overwhelmingly stressed as the basis for technology development.

Secondly, strategic decisions affect present and future options by binding us to certain alternatives, or limiting and postponing them. The analysis of these decisions would be very useful, especially for environmental and infrastructure *policy-makers*, instead of concentrating possibly too much on fashionable issues.

Thirdly, analysis of long-term development and history of technology is a sound base for future *planning*, a crucial factor in managing infrastructure systems. To be able to prepare such plans for different time horizons, we have to know where we are and where we are coming from.

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PART II

CASES

"Sanitation is more important than independence"

Mahatma Gandhi

FROM POLLUTED TO SWIMMABLE WATERS
– TAMPERE CITY WATER AND
SEWAGE WORKS, 1835–1998

PETRI S. JUUTI & TAPIO S. KATKO

Juuti P. & Katko T. (1999).
From Polluted to Swimmable Waters – Tampere City Water
and Sewage Works, 1835–1998.
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ABSTRACT

Already in the 1830s, water was pumped from the lake above the city and led via a wooden pipe to the centre of Tampere. In the 1860s, a businessman suggested that a privately-held waterworks be constructed but a city-owned works was preferred. A gravity system began distributing water in 1882, followed by a high pressure system in 1898. The first phase of a sewerage system was completed in 1894. The bodies of water upstream and downstream from the city of Tampere deteriorated by the 1950s and '60s, but have recovered surprisingly fast after the introduction of efficient water pollution control. Groundwater utilization was suggested in the 1910s, implemented partly since the 1950s to be possibly followed by artificial recharge by 2010.

Experiences from both water supply and water pollution control in the case of Tampere indicate that foreign solutions as such do not suit Finnish conditions. Applied development and research is needed. The role of public relations and education is becoming increasingly important as we enter the 21st century.

INTRODUCTION

This report describes the evolution of water and wastewater services in Tampere, the first industrial city and currently the third biggest city in Finland, located some 140 km northwest of Helsinki, the capital. In many respects, this city represents the development of water supply and sanitation in the whole country, but on a smaller scale (Katko, 1997).

Geographically, Tampere lies on an isthmus between two large lakes, Näsijärvi and Pyhäjärvi (Fig. 1). The centre of the city is traversed by the nearly one kilometre long Tammerkoski Rapids around which the city and its industry originally grew up. The Rapids, which run north to south, break an eskar formation separating the lakes, one of the highest traverse ridges in the world formed during the ice age. The eskar formation forks out at the western side and the eastern side of the city. For long, Tampere was the centre of Finnish industry which is reflected also in its nickname “Manse” which derives from Manchester, the English city of industry. Many types of industries were established in Tampere among the first ones in Finland: the first electric light in Scandinavia was also lit in Tampere in 1888, while water supply was practiced even earlier. As for later history of high-technology, the first GSM mobile phone call in the world was made from Tampere in 1991 (Tampere, 1999).

MATERIALS AND METHODS

The paper is based on a recent study by the authors on the evolution of water and sanitation services over the last 163 years (Juuti & Katko, 1998). The study was carried out from September 1997 to October 1998. A systematic analysis of literature was made including the city archives, an analysis of the articles in the local newspaper from 1881 to 1921, the national professional journals, the journal of the local historical society, and a review of the available historical accounts of the suburbs of the city. Initially, some 1,200 photographs were selected from the two local archives, the water and sewage works and private people, but the number was later reduced to 150. Open-ended theme interviews of 30 present or earlier staff members of the waterworks were conducted, representing all levels of the utility. Site visits to earlier and present facilities of the works were organized. The research was supervised by the managing director of the water and sewage works, and reviewed by several of the staff members. Over the years the responsibilities of the utility have changed several times, for example, earlier water and sewage services were originally run by separate bodies. Both these past services and present situation are covered in this report.

Our discussion uses the institutional economics approach where “institutions are seen as constraints – either formal rules or informal constraints that shape human interaction – while organizations are defined as groups of people united by a common purpose to achieve certain objectives” (North, 1990). In addition to the development of technology, institutional and management issues of water services, such as pricing, organizations, operation and maintenance, social activities, education and research as

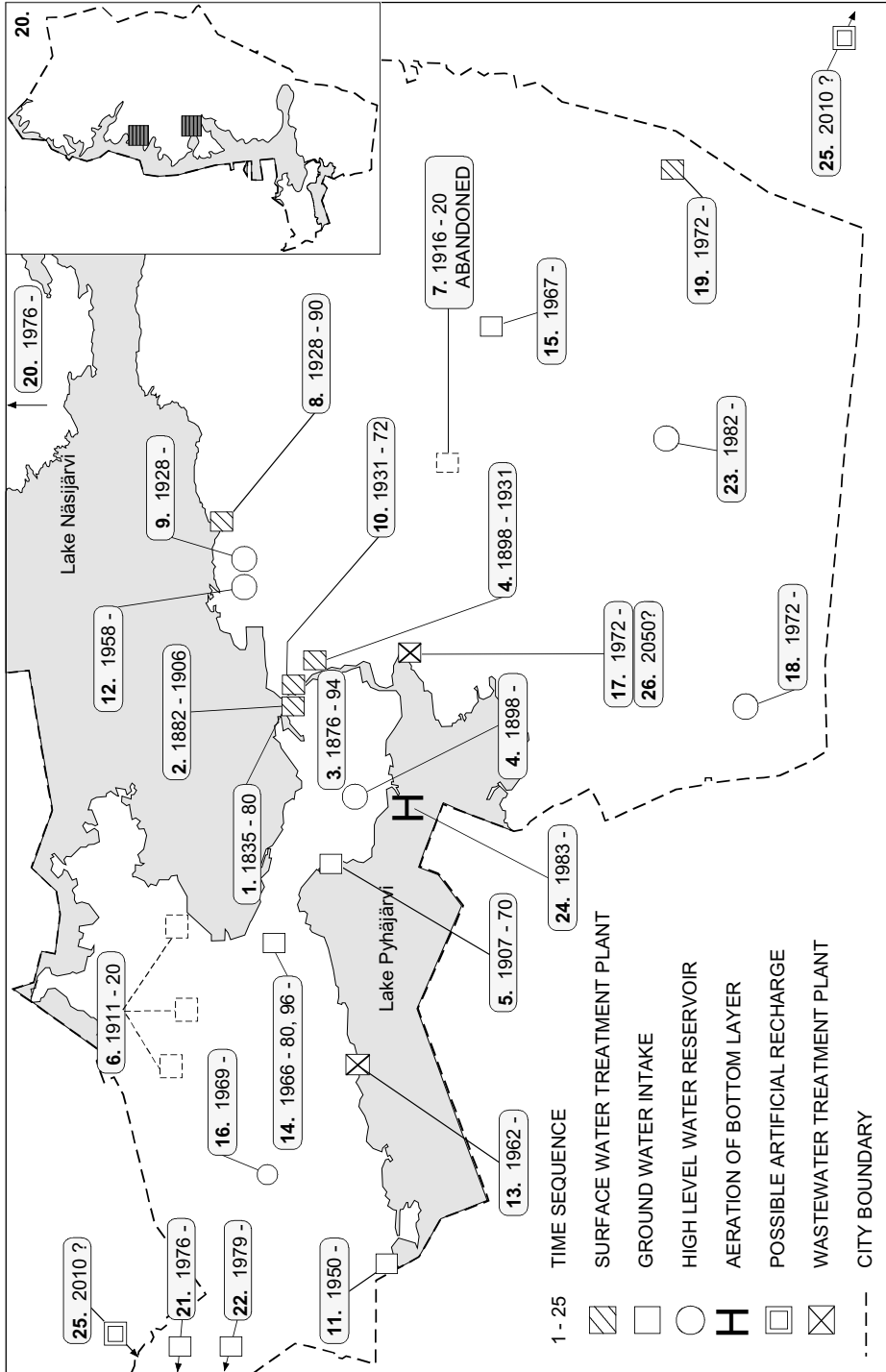


Figure 1
Evolution of Tampere City Water and Sewage Works from 1835 to 1998 (nos. refer to Table 1).

Milestone	Years
1. Head of rapids, iron pump	1835 to 1880s
2. Head of rapids, gravity system	1882–1906
3. Sewerage system, 1st phase	1876–1894
4. High-pressure water supply system	1898–1931
- Myllysaari high-pressure pumping station	1898–1931
- Pyynikki water tank	1989–present
5. Pispala water cooperative	1907–1962
6. Groundwater inventories, western side	1911–20
7. Groundwater inventories, eastern side	1916–20
8. Kaupinoja surface water treatment plant	1928–90
9. Old water tank of Kaupinkallio	1928–present
10. Mältinranta surface water treatment plant	1931–72
11. Mustalampi groundwater intake	1950–present
12. New water tank of Kaupinkallio	1958–present
13. Rahola wastewater treatment plant	1962–present
14. Hyhky groundwater intake	1966–80, 97–present
15. Messukylä groundwater intake	1967–present
16. Tesoma water tower	1969–present
17. Viinikanlahti wastewater treatment plant	1972–present
18. Peltolammi water tower	1972–present
19. Rusko surface water treatment plant	1972–present
20. Works in Polso and Kämenniemi	1976–present
21. Pinsiö groundwater intakes	1976–present
22 Julkujärvi groundwater intake	1979–present
23. Hervanta water tower	1982–present
- improved and expanded Rusko treatment plant	1989–present
24. Oxidization of Pyynikki depression	1983–
25. Possible artificial recharge	2010?
26. Relocation of Viinikanlahti wastewater treatment plant	2050?

Table 1

Milestones of the Tampere City Water and Sewage Works, 1835–1998.
(Juuti & Katko, 1998)

well as cooperation with industries and neighboring municipalities were dealt with. The first author has the background of a historian, and concentrated on the earlier decades, while the second author is a civil engineer and dealt with more technically-oriented subjects.

The research was conducted at Tampere University of Technology (TUT), Institute of Water Engineering (IWEE). The present case study on Tampere was preceded by a nationwide study on consumer-managed water cooperatives in rural areas (Katko, 1992), and the evolution of the services from the mid-1800s to 2000 (Katko, 1997). The study is also linked with the reviving interest on environmental history and long-term development of water and sanitation services in Finland. So far similar studies of Finnish water utilities have been conducted in Helsinki in 1938 (Lillja, 1938), while other cities have made less extensive studies. However, the research approach was affected by foreign studies, especially in the USA (Melosi, 1998; Tarr, 1996). As for fire fighting, the first author has written a book of its role on the national scale. Introduction of water works was justified particularly on grounds that it secured the supply of water and the necessary pressure to put out fires (Juuti, 1993).

EARLY TRIALS AND SUGGESTIONS

The evolution of water supply started in Tampere in the 1830s when the first plans to build a water pipe were made. The population of the city was some 1,520 in 1835, some 33,800 in 1900 and some 180,000 in 1998. The first municipal “water pumping installation” was founded in 1835. At that time, the first attempt was made to pump water by a German-made iron pump from Mältinranta (point 2, Fig. 1), upstream from Tammerkoski Rapids, through a wooden pipe to a well in the market square. The contemporaries deemed the effort a failure, since only a small amount of water reached the well and even that was dirty and smelled bad. Regulations, effected expansions and maps do, however, prove that water was pumped for several years.

In 1853, the Senate ordered the city to lay the groundwork for the establishment of a professional fire brigade and also demanded the building of some kind of a water pipe. The building of a water pipe was on the agendas of the meetings of tradesmen and town elders already before the mid-1800s. The latter applied for a loan from the Senate on the suggestion of certain merchants in 1858 for constructing a water pipe. Pipes were actually purchased, but the project was then delayed. After the Fire of 1865 the industrialist W. von Nottbeck, who originally moved to Tampere from St. Petersburg, made an offer to build a water pipe. His proposal would have meant stable income for him while the city would have borne all risks (Juuti et al., 1999). Thus, the city declined his offer. In 1874, Malakias Pasi, a rural freeman and builder of water pipes, offered to construct a wooden pipeline for the city, but this proposal also came to nothing. The city council also rejected the proposal for building a water pipe put forth in 1880 by civil engineer August Ahlberg, the “sanitary policeman” of the city.

THE FIRST WATERWORKS AND SEWERAGE SYSTEM

In 1881, the governor of the province ordered a waterworks to be built in the city due to recurring fires and the poor quality of well water. The same year construction began on a gravity water pipe from Mältinranta, upstream of the rapids, to a market square in the southern part of the city – the pipe also had several connections. The contractor was R. Huber who supervised the construction of the Helsinki Water Works the previous decade, and also operated the system for a few years. The pressure of the system was low but technically and administratively it operated much like a modern waterworks.

Several tall apartment blocks were erected in the city centre towards the end of the 19th century. Then it was noticed that water pressure was too low to carry water to the top floors. Therefore, the city council requested that C. Hausen, the engineer of the Helsinki Water Works, design a new high-pressure facility. The facility which was operated according to quite modern principles was completed in 1898. It had an underground tank (Fig. 2) high up in the Pyynikki Ridge (point 4, Fig. 1) which is still in use a hundred years later providing sufficient pressure for the core city.

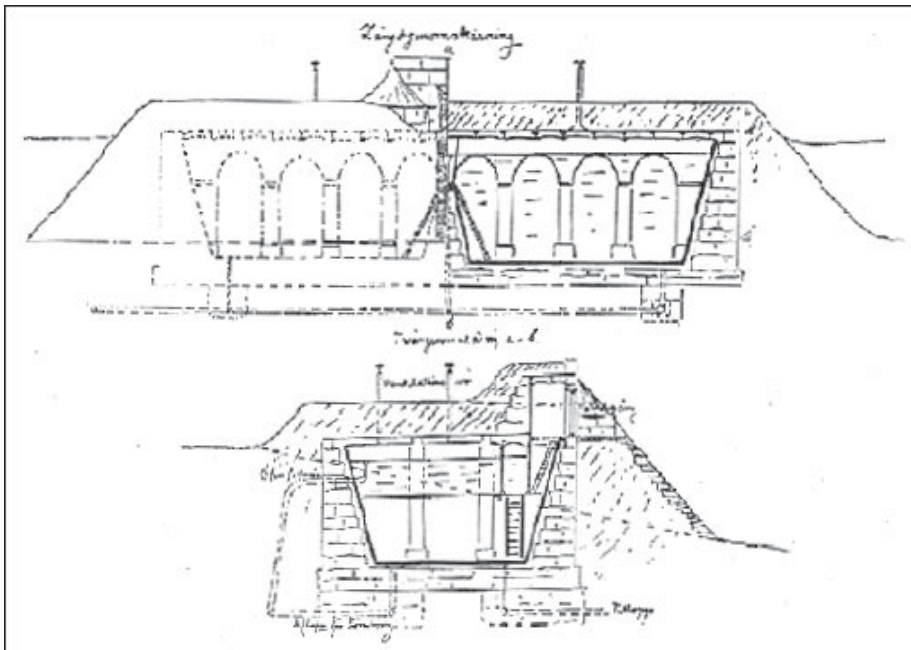


Figure 2

Underground, high-level water reservoir in the Pyynikki eskar, constructed in 1898, still in use in 2004.

(Teknikern 1899, p.28)

The evolution of sewerage in Tampere began with subsoil drainage like in many other cities (Melosi, 1998; Hietala, 1987). Actual wastewaters have been conveyed through sewers since the late 1800s. As the city expanded in the mid-1800s ditches

were straightened, opened and covered. These measures were, however, insufficient and the city's population was "greatly disturbed" by the filthy ponds, water-logged soil and such. A report by the health committee from 1866 describes the "ditching of the city" and notes how hardly any improvements had occurred in two hundred years. After the founding of the city in 1779, it was ordered that the previously free-flowing ditches had to follow the boundary lines of lots and be carried through culverts and under buildings. The health committee suggested the construction of a sewer system in the city. The next year the burghers decided to launch the design of such a system. In 1873, a surveyor prepared a plan involving two main sewers. The 1879 public health decree obliged the city to prepare a plan for a sewer system commensurate with the population within 10 years. The city administrators took seriously the deficiencies in sewerage and the demands of the government: starting in the early 1880s, the municipal health board repeatedly exhorted the city to expand and upgrade the sewerage system. The initial sewer line took from 1887 to 1894 to build: it consisted of a total of 15 kilometres of pipes and nearly 200 manholes. The initial phases of the water and sewage works were both built in the 1880s meaning that the utility is at least 115 years old.

WASTEWATER TREATMENT

The typhoid epidemic early in the century and the "dirty water" produced by households and industry led local decision makers to examine the possibility of treating wastewaters or conveying them further away. At that time it was considered economically too expensive to treat wastewaters: it was assumed that the Tammerkoski Rapids could purify them sufficiently. The matter was taken up again only in the 1950s and the first wastewater treatment plant was completed in 1962 in Rahola (point 13, Fig. 1), a western suburb of the city. Since 1972 the wastewaters of the central and eastern parts of Tampere have been led to the Viinikanlahti treatment plant (Fig. 3) on Lake Pyhäjärvi downstream from the city (point 17, Fig. 1). The plant is the largest environmental investment the city has ever made. It lies on top of what used to be waste masses and due to changes in land use is being encroached upon by the expanding core of the city. The Pyynikki traverse ridge divides the city into two natural sewerage systems which originally depended merely on gravity, but later introduced also pumping.

A type of chlorination of the waterworks' supply began after the typhoid epidemic of 1917. In 1920, the suggested groundwater project (point 7, Fig. 1) was abandoned only to be reintroduced in the 1950s. The Water Works expanded quickly following WW II. At the turn of the 1960s, the quality of raw water became a problem. The pulp industry had polluted Lake Näsijärvi, the age-old upstream raw water basin. In 1972, Lake Roine, which lies in a neighbouring municipality, became the new source of raw water. It constituted one of the best raw water basins in the country, but later some seasonal problems were faced in relation to odour and taste due to algae. Water treatment (point 19, Fig. 1) was enhanced by introducing activated-carbon and flotation treatments. Also, the alkalinity of treated water was increased to prevent corrosion of pipes. Water treatment and quality assurance of piped water are continuously



Figure 3

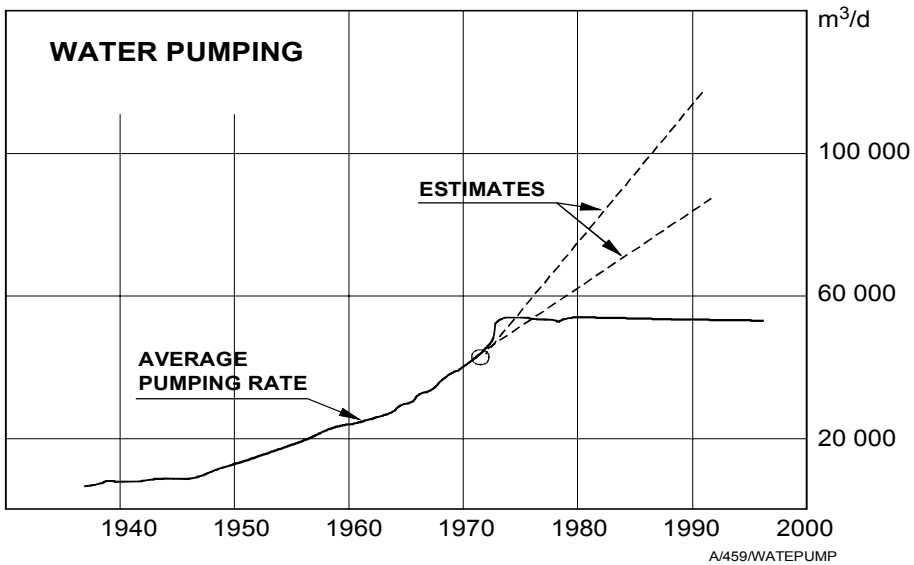
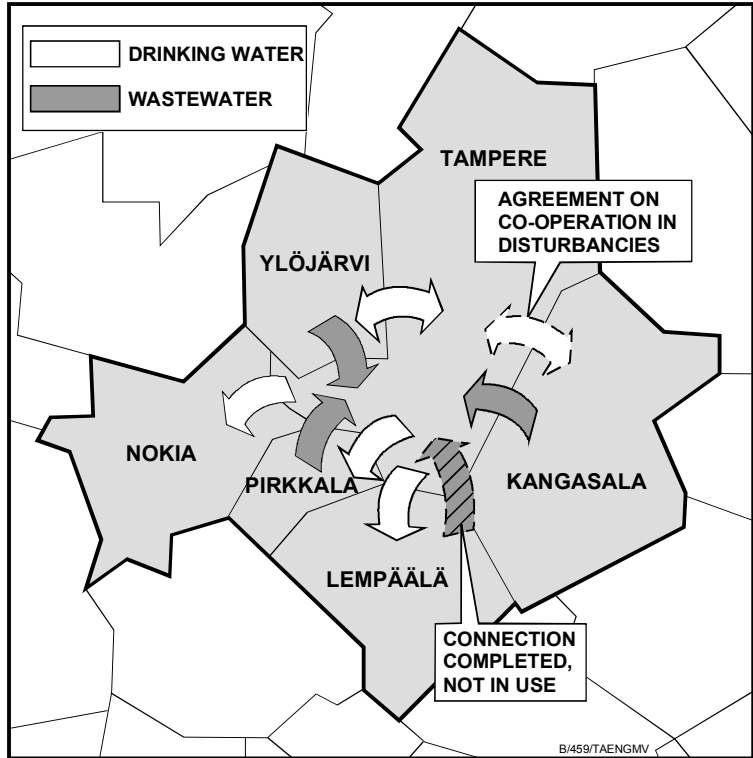
Viinikanlahti biological-chemical wastewater treatment plant in the 1990s.
(Tampere Water)

improved. The utility has cooperated with the neighbouring municipalities of Kangasala, Pirkkala and Ylöjärvi (Fig. 4) since the 1960s in water supply and wastewater treatment on a contractual basis.

THE PRESENT SYSTEM

Presently, the water supply system of Tampere has over 650 km of pipeline and about 16,000 connections. Single-family houses have been equipped with water meters since 1898, i.e. over a 100 years. Apartment blocks generally have a common meter. Maintenance of service pipes rests primarily on property owners. The water supply system has six high-level storage tanks with a combined capacity of about 23,000 cubic metres or less than half the average daily consumption. In addition, there are ten booster pump stations. As the year 2000 approaches, the utility is responsible for the water supply and sewage treatment of over 200,000 inhabitants of the Pirkanmaa Region (Fig. 4). Contrary to the sky-rocketing water consumption estimates of the mid-1960s and even early 1970s (Fig. 5), the total pumping rate has since 1977 become more or less balanced and the per capita consumption has declined. This is similar to the general trend in Finnish cities (Katko et al., 1998).

Figure 4
Inter-municipal cooperation of Tampere Water and Sewage Works in 1997.



T. S. Katko 1999/TUT, IWEE

Figure 5
Estimated pumping rates of Tampere Water Works from the mid-1960s vs. the real rates 1940–1995.

The total length of the city’s sewerage system is about 1,100 km presently of which 660 km consists of actual sewers and 440 km of storm sewers. There are some tens of kilometres of combined sewers in the city centre, while their relative share has declined continuously. The rest of the system consists of separate sewers. Sewers as well as water pipes have been increasingly rehabilitated and modernized. Today, the sewerage system has a total of 66 wastewater pumping plants that are monitored from a central control room. About 20 per cent of the water supply piping is plastic – in the case of new pipings the figure is over 50 per cent.

INDUSTRIAL AND RURAL WATER AND WASTEWATER SERVICES

The factories on the banks of Tammerkoski Rapids, representing the textile, leather and woodprocessing industries, had their own water intake plants and sewers by the Rapids from early on. Later on they also built water treatment facilities. The Finlayson factories in Tampere were the first in Scandinavia to introduce sprinklers six years after their invention. When water pollution control became topical, enterprises started to clean their effluents and gradually also to lead them to the city’s wastewater treatment plant. Industry also underwent a major structural change in the 1980s which further reduced the wastewater load.

The peripheries of cities relied for long on wells and latrines. Sections of surrounding municipalities have been incorporated into the city over the years. Finland’s first consumer-managed water cooperative was founded in Pispala (point 5, Fig. 1) in 1907. The community was part of a neighboring municipality at that time, and was incorporated into Tampere in 1937. The city water works assumed control of that particular system in the 1960s. Two built-up areas of the Teisko-Aitolahhti rural district (point 20, Fig. 1), which nowadays is part of Tampere, have water supply and sewerage systems run by the city. In other sparsely populated areas water supply and sewerage will continue to be provided through cooperatives or by individual property owners themselves.

DISCUSSION

Over the years, the utility has sought knowledge from abroad (mainly from Denmark, England, Germany, Sweden), the Finnish capital and other cities – even the countryside. As a rule, the development has not, however, been quite as capital-centered as historians until now may have led us to believe. Some imported solutions have been unsuited for the conditions of Finland and Tampere. They include, for instance, the heat-treatment of sewage sludge, a digester plant of inappropriate construction for cold climates, and sludge aerators that proved difficult to maintain. The importance of R&D on the local level is emphasized by gained experiences. Joint R&D has been conducted especially with Tampere University of Technology, other cities and enterprises. Since 1996 the Water and Sewage Works has been involved in a twinning arrangement with the Daugapils city water and sewage works in Latvia, supported by the Ministry of the Environment in Finland, as part of the Baltic Sea protection

programme. The Works' contribution during the three years of cooperation was equal to two person-years (Juuti & Katko, 1998).

Table 1 and Figure 1 depict the key milestones marking the evolution of Tampere Water and Sewage Works. Certain strategic selections have been made with regard to the utility which have determined the direction of its activities and closed out other development paths for decades to come. At least the following selections belong to this "path dependence" group:

- Despite plans, water treatment filters were not constructed to save money. That questionable savings combined with the wrong point of discharge of wastewaters in the end led to the loss of nearly 300 lives in the 1916 typhoid epidemic.
- A groundwater project was abandoned in 1920 which led many other cities also to use surface water. Wider interest in the utilization and protection of groundwaters resurfaced only in the 1960s.
- Treatment of wastewaters was studied also around 1920, planned seriously in the 1950s, and started gradually in the 1960s.

Compared to other Finnish communities, the city started to treat its wastewater efficiently somewhat later, arguing that it was futile due to the overwhelming pulp mill pollution discharged upstream from the city.

KEY PRINCIPLES AND FUTURE IMPLICATIONS

The history of water supply and water pollution control in Tampere is much like that of Finland as a whole except on a smaller scale. Firstly, surface water was initially drawn from nearby sources, and as these became contaminated, from farther away. Utilization of groundwater started later and artificial groundwater will likely be produced in the future. Secondly, wastewaters spoiled water systems until efficient treatment started at a relatively quick pace. Industry began to protect waters later in increasing cooperation with the water and sewage works when the time was ripe. Thirdly, when the increase in water consumption levelled off in the 1970s, the emphasis shifted to water quality.

As for institutional and management issues, the utility has developed as part of society: it has had, and continues to have, an impact on technology as well as health and industrial and commercial activity. The development of the utility has required versatile institutional development: education, research and cooperation with business, political decision makers and the actual owners, the inhabitants. Sometimes water supply and sewerage have formed a single organization, at other times they have been separated. yet, it is obvious that they constitute a natural entity.

Related to the roles of stakeholders, state authorities have played their own role, but the crucial factor has been that the utility has been, and continues to be, capable of providing water supply and sewerage services locally at a quite reasonable unit price. Since the beginning the municipality-owned utility has bought a considerable share of services from the private sector. In environmental matters the utility has played, and will continue to play, a key role in Tampere and its surroundings.

As we enter the new millennium, the following issues will probably be of key importance:

- increasing cooperation with the neighbouring municipalities in water and sanitation services
- further improvement of water treatment and possible production of artificial groundwater
- renovation of networks and assurance of network water quality
- increasing focus on consumers' views and client-oriented service
- possible covering or relocation of wastewater treatment plants
- further engagement of water works in international cooperation of various forms and the possibilities it opens.

CONCLUSIONS

All in all, the Tampere City Water and Sewage Works is an example of a local government-owned public utility that has been, and will continue to be, capable of providing services at reasonable cost. From the very beginning public/private partnership has taken place: the core competence is taken care of by the municipality-owned utility, while supporting services are bought from the private sector based on competition. The utility has decisively improved the city's fire safety, hygiene and health conditions, and the quality of the city environment. It has also been central in enhancing the operating conditions of industry and commerce. Although many facilities of the works are hidden underground, we all daily come into contact with its key products: potable water, wastewater and cleaner water bodies.

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WATER AND CITY
– ENVIRONMENTAL HISTORY OF WATER
AND SANITATION SERVICES
IN TAMPERE, FINLAND, 1835–1921

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BACKGROUND

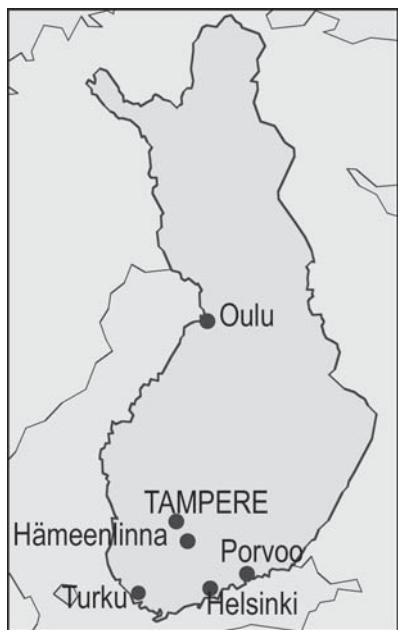


Figure 1
Location of the case city
Tampere and some other
Finnish cities.

The city of Tampere is situated approximately 140 kilometres northwest of Helsinki, the capital of Finland. The city was established in 1779 along the rapids between two lakes, Näsijärvi and Pyhäjärvi, with an elevation difference of 18 metres. The centre of the city is traversed by the nearly one kilometre long Tammerkoski Rapids around which the city and its industry originally grew up. The rapids, running from north to south, break an eskar formation separating the lakes. The eskar is one of the highest traverse ridges in the world formed during the Ice Age. Nowadays, Tampere is the largest inland city in the Nordic countries and the third largest city in Finland with a population of 200,000. This paper reviews the birth and early development of the City water and sewage works in Tampere. (Fig. 1).

In many respects, this city represents the development of water supply and sanitation in the whole country. Tampere shows a case of somewhat problematic growth of a city at a time of the emergence of the water issue, when traditional water sources, i.e. wells, were polluted and their yield was inadequate. Along with industrialisation the city grew rapidly. The systems were established in Tampere quite early compared to other parts of Finland and were also extraordinary in some respects. As a big industrial city on the Nordic scale, Tampere also influenced the choices of other cities trying to solve their water problems.

At first the objective was to ensure the supply of fire-fighting water, then meeting the demand for domestic water supply. Thus, fires promoted indirectly the improvement of hygienic conditions along with sewerage systems. In spite of the incorrect scientific theory of miasma, the solutions made, however, advocated the right causes, i.e., improvement of the environment and safety of the city.

The first municipal “water pumping installation” in Tampere was founded in 1835.¹ The high-pressure facility was completed on 1898, but not on the scale of the original plan. Since slow sand filtration was rejected and the outlets of the sewers were too close to intake pipes, the efficiency of the new facility was also its weakness: later typhoid fever spread fast over a wide area aided by the water pipe network. In 1916 the death of hundreds of people finally prompted the necessary decisions to be made. The threat of typhoid fever and other diseases spreading through water was removed in 1917 when chlorination of water was started. There have been no typhoid epidemics in Tampere since then.²

RESEARCH QUESTIONS

The research questions fall into two main categories. The first is concerned with the emergence of the water problem and its solution. In this study, the water issue refers to the crisis in urban water acquisition based on wells, which began to dry up and become contaminated due to inadequate or non-existent sewerage. Secondly, the water issue includes the aspirations of contemporaries for finding an answer to the question.

Contemporaries were searching for a solution to water acquisition from waterworks, and for drainage and environmental pollution from sewerage. Thus, water supply and sewerage were seen as solutions to the water issue. Fires ravaging the wooden cities of Finland were also a central motivator. When contemporaries in the various Finnish cities spoke about these problems, they were commonly using the term “water question”.³ This problem of water supply was solved only after prolonged planning and transitional periods. The transition from the so-called bucket system – based on wells, carrying and the bucket – to the protosystem and modern water supply was a demanding process for municipal administration: many decisions requiring special knowledge had to be made.

More concrete research questions are related to solving of the water issue. How the water issue became a social problem, and how the view that something had to be done arose in municipal administration? It is essential to clarify central policy-level decisions connected to the principles and practises. This also includes central technological choices made. These choices were at times a cause for bewilderment and indecisiveness among municipal decision makers, especially when specialists had different views on the matter. Did this indecisiveness cause any problems for water supply and the environment?

In the 1860s there were plans to organise water supply by private entrepreneurs in Tampere. How and why did Tampere, however, end up having municipal water supply?

In the 1860s there were plans to organise water supply by private entrepreneurs in Tampere. How and why did Tampere, however, end up having municipal water supply? The question of pressure levels in the water network was also important: water flowed in Tampere for many years under low pressure, as also in Oulu (Figure 1.). Health reasons and, for instance, the requirements of fire protection, however, led to the laying of a high-pressure water pipe in 1898.

A water charge based on consumption was also established in 1898, but why? The measurement of consumption is not as self-evident as one might imagine: earlier water was charged for at a flat rate in Tampere while in Oulu during the first period of waterworks charge was collected according to the method the water was fetched.

It is interesting that Tampere initially chose to use surface water while many other cities such as Hanko, Hämeenlinna, Lahti, Turku and Viipuri (Vyborg) went for groundwater (Table 1). In some cities, the establishment of a waterworks was postponed far into the 20th century – in Savonlinna until 1951.⁴

City	Water works (years)	Water source	Waste-water (year)	Professional fire-brigade	System classification
Helsinki	1876	river	1880	1861	Modern system
Viipuri	1892	groundwater	1873	1881	Modern system
TAMPERE	1882	LAKE	1894	1898	PROTOSYSTEM
TAMPERE	1898	LAKE			MODERN SYSTEM
Oulu	1902	river	1897	1919	Protosystem
Oulu	1927	river			Modern system
Turku	1903	groundwater	1896	1869	Modern system
Hanko	1909	groundwater	1906		Modern system
Lahti	1910	spring	1910	1911	Modern system
Hämeenlinna	1910	spring	1910	1911	Modern system
Jyväskylä	1910	groundwater	1911	1922	Modern system
Mikkeli	1911	groundwater	1911	1911	Modern system
Porvoo	1913	groundwater	1894	1905	Modern system
Kuopio	1914	lake	1906	1913	Protosystem
Sortavala	1914	lake	1907	1913	Protosystem
Vaasa	1915	groundwater	1915	1909	Modern system
Kotka	1916	river	1890	1898	Protosystem
Kokkola	1917	groundwater	1923	1921	Modern system

Table 1
Years of establishing the first urban water, sewage and fire works in Finland, 1876 to 1917.

The next category of questions throws light upon the effects of the decisions made and their relationship to the environment. Was the answer to the water issue feasible and operational? How did the decisions made affect the environment? Were the solutions practical or did they cause problems for inhabitants and the environment? Was the well-being of people and the environment improved by different solutions like the establishment of waterworks?

The water supply and sewerage of the city is also essentially connected to industry, especially as it is related to wastewaters. Industry was also an important water user and partly connected to the city water system. When considering solutions for their water supply, contemporaries did not pay attention to the problems of industry, even if their influence was felt. The focus during the research period was on community wastewaters.

Many industrial plants had at an early stage established their own waterworks and sewerage systems. These industrial water questions are examined only briefly, because in the early days industrial water use was significantly different from that of the community. The main industrial water use was for hydropower, while process water

and other uses came later. Solid waste management was touched upon wherever it was closely connected to sanitation and sewerage systems. One such area is the flush toilet (WC).

Finally, when was the water supply and sewerage system of Tampere in its entirety consistent with a modern system, so advanced that it could also take into consideration environmental impacts?

This article is mainly based on archival sources and national professional journals. Articles in local newspapers from 1881 to 1921 were also reviewed.⁵

DIFFERENT TYPES OF WATER SYSTEMS

Development stages of water supply and sewerage systems can be divided roughly into three systems and five stages. Used points of comparison must be from research subjects (water supply and sewerage) that are not only contemporary but also of similar technological level. The systems are roughly divided as follows (Juuti 2001):

- 1) Bucket systems Symbolised by the bucket, reflects carrying.
- 2) Protosystems Symbolised by the WC, reflects leaking and flushing.⁶
- 3) Modern systems Symbolised by the drop with wavy lines, reflects water circulation. (See Tables 2 and 3)

The purpose of this is to show that various solutions for city infrastructure, at different times, could have been feasible then. This way, we can also avoid a predestined, technologically deterministic view of water supply and sewerage advancing unavoidably towards the modern, “right” solution.

Table 2 shows the most characteristic features of the three systems. *The bucket system* is associated mostly with the use of buckets or similar vessels to draw, carry and hold water from wells, springs and various natural water sources like rivers, lakes and rainwater. Transportation of wastewater and refuse was also done with buckets to ditches, rubbish heaps and pits. The most characteristic feature of fire fighting during the bucket-system period was the use of untrained people to put out fires with water transported by “bucket brigades”.

The period of rapid growth increased population density and demanded new constructional solutions. The densely built blocks of wooden houses, and later the first apartment houses, brought new challenges both for water supply and fire protection. Simultaneously, water acquisition, fire protection and refuse disposal demanded new solutions – otherwise the existence of the city would have been endangered.

In the middle of growing environmental problems, great fires that ravaged cities, and heaps of refuse, the *protosystems* were created to hide the problems. This solution demanded recognition of the fact that there were problems, and that the decision makers had the will for a change. They had to understand that the community should take care of these things. Drawing of water from the vicinity of the city, not from the city area, was typical for the protosystem. This meant, for instance, wells and leading untreated or mostly slow-sand-filtered water by gravity through pipes to consumers.

Other main features were the building of sewers so that untreated waste- and stormwater were led in the combined system to nearby water bodies and transportation of refuse to the immediate surroundings of the city area or dumping it in the water systems. Voluntary fire brigades were part of this period. The protosystem can be described by its operational principle: into the pipe, out of the pipe. As always with prototypes, there were defects and errors in this system.

Modern systems, on the contrary, were quite different from protosystems. They aimed at more sustainable solutions than protosystems. The central features were use of groundwater or treated surface water before leading it under high pressure to consumers, charging for water according to metered consumption, use of elevated water reservoirs, and the introduction of a separate sewer system and wastewater treatment. In this period fire fighting included the hydrant system within the city area and regular fire brigades.

Based on these classifications, the water supply system of Tampere is compared with those existing elsewhere in various periods both in Finland and abroad.

The development of water supply and sewerage has not progressed linearly from primitive systems to more complicated, or from “bad” to “good” ones. The growth period of the city, and especially preparedness of the community to take responsibility for water supply, have been central issues. In different time periods objects of interest and methods have varied according to need, readiness and what has been considered important.

FIRSTS ATTEMPTS IN TAMPERE

The first municipal “water pumping installation” in Tampere, and probably the whole country, was founded in 1835. The system was quite simple and constituted a so-called bucket system. The first water-protection regulation in Tampere concerned this system.⁷ The rapid growth period in Tampere started a few years later.⁸

At the beginning, Tampere was like a farmhouse on a grand scale with pigs and cows. As the city grew, rural living habits began to disappear and the city began to lose its metabolic ties with the surroundings. Nutrients were no longer put back into circulation, for instance, to be eaten by pigs or to improve the soil. Instead, they were removed as refuse and deposited in rubbish heaps, dumps, and only later, in the water systems along the sewers. When there was no network of sewers, wells started to become polluted, and there was no longer enough pure water for people.

Polluted water and unhygienic living conditions created a favourable environment for epidemics, like the typhoid fever. The same sequence of events occurred also in several other European cities. Tampere is, however, an exceptional example because of the rapid growth made possible by industrialisation. Both the problems and their solutions soon became visible. Along with industrialisation the city grew rapidly; during the main research period of 1835–1921 the population rose from about 1,600 to over 40,000.⁹



BUCKET SYSTEMS 	PROTO SYSTEMS 	MODERN SYSTEMS 
<p>-Water acquisition, fire fighting and sanitation based on bucket. -Functional when cities were sparsely populated like the countryside. -Still in use in the countryside. -In Finland until the turn of the 20th century, still in many developing countries. -Population density was increased by the period of rapid growth. -Inadequate constructional solutions: densely build blocks of wooden houses and later apartment houses caused pressures for change. -Also epidemics and unhealthy conditions caused pressures for change. Water acquisition, fire fighting and sanitation demanded solutions, otherwise the existence of the city would have been in danger.</p>	<p>-In the middle of environmental problems, great fires and heaps of refuse P was the attempted solution. P took the problems out of sight, but drawbacks were still there -Into the pipe, out of the pipe. -Solution demanded: a) understanding that there were problems in water supply b) will for change among decisionmakers c) understanding among the decisionmakers that the community should take care of these things -In Finland B prevailed to the First, partly to the Second World War. -Used still in countryside in some extend -Still in use in developing countries, partly with B, partly with M.</p>	<p>-Attempt to solve problems, not only transfer them somewhere else. -Ancient city cultures along with P, in Finland partly after the First, partly after the Second World War</p>
TYPICAL FOR THE SYSTEMS:		
WATER SOURCE		
<p>-wells, springs, rivers and lakes, rainwater</p>	<p>-usually surface water, lakes, rivers, etc., wells in the vicinity of the city, not in cities</p>	<p>-groundwater or treated surface water, treating of raw water with rapid sand filtering</p>
METHOD		
<p>-various buckets and vessels</p>	<p>-untreated piped or slow sand filtered to consumers -gravity water</p>	<p>-charge according to measured consumption -watertanks -disinfection -high-pressure water pipe network -developed management and maintenance system -democratic / undemocratic</p>
SEWERAGE		
<p>-ditches</p>	<p>-waste- and rainwaters in same system, untreated to closest water system</p>	<p>-separate sewer system -wastewater treatment</p>
FIRE FIGHTING		
<p>-bucket brigade, fire guards</p>	<p>-volunteer fire brigades, fire guards, bucket brigade</p>	<p>-hydrants -regular fire brigade</p>

Table 2
 Three systems of urban water supply, sanitation, and fire-fighting.

The evolution of sewerage began with free-flowing ditches flowing 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. The exacerbated problem forced the decision makers of Tampere to work out a plan for underground sewerage following the hygienic reform started in England and personified by W. Chadwick¹⁰. A transition from the bucket system to the protosystem thus began.

When the growth of the city accelerated due to industrialisation, problems began to accumulate: there was not enough water and what little there was, was of a poor quality.

When the growth of the city accelerated due to industrialisation, problems began to accumulate: there was not enough water and what little there was, was of a poor quality. A discussion about changing this bad situation started. The first more visible measure in Tampere was the founding of the “Sundhetskommittén i Tammerfors” (Public health committee: Swedish was used as administrative language that time) called by contemporaries the “temperance committee”. The committee started its work in 1866, inspired, for instance, by the example of London: members knew closely the reform started in England and aimed to adapt its doctrines to Finland.¹¹

The local newspaper *Tampereen Sanomat* followed the work of the committee closely and considered it as progress.¹² The first aim of the committee was to organise drainage in parts of the city. It proposed the building of a sewer network as a remedy and appealed to the fact that the typhoid problem was worst in the least drained area of the city. The committee’s report clearly shows that the members’ beliefs about the causes of disease were consistent with the miasma theory. According to this theory, diseases were born in wet and contaminated soil as organic material was getting digested. The construction of sewers was a way to get rid of this. Thus, the model came directly from England, not from any other city in Finland.¹³

The building of the sewers in Tampere started after four decades of discussion in 1876.¹⁴ The 1879 public health decree obliged the city to prepare a plan for a sewer system commensurate with the estimated population within 10 years. The city administrators took seriously the deficiencies in sewerage and the demands of the government: starting in the early 1880s the municipal health board repeatedly exhorted the city to expand and upgrade their sewerage system.

The construction of a water supply system in Tampere was, however, forgotten because of the failure of the system of 1835, until a fire raised the issue again in 1865 after destroying 30 houses. This was very important in Finland as well as in other Nordic countries, since those days most of the houses were wooden.¹⁵ Then, the very same year industrialist Wilhelm von Nottbeck suggested to the City Board that a privately owned waterworks be constructed in the city due to the fear of fires. A tender was requested from von Nottbeck, because there already was a water pipe and sprinkler systems serving Finlayson’s cotton mill owned mostly by von Nottbeck.¹⁶

Since the proposed privately owned waterworks would have meant a quite big financial risk to the city, the City Board decided to reject the proposal of von Nottbeck and to have the city build a water pipe for itself. This plan was presented in an editorial of local newspaper in 25. of June 1866 with the descriptive heading “Lusted water leading”.¹⁷ This editorial was the first time the water question was treated extensively – especially that reasons of fire protection favoured the plant. Also usefulness and health concerns, although not argued for as vehemently, were in favour.

The discussion was now opened to cover both sewers and water pipes. Yet, the discussion started slowly. After the rejection, the city sought expert knowledge and contractors from the private sector, such as Mr. Malakias Pasi in 1874. This person was a rural entrepreneur who seemingly had made a lot of wooden constructions. The

... City Board decided “to leave the matter of water leading to the committee”. This meant the start of a new era in the history of water supply in Tampere: ever since all plans and projects have been initiated by the city.

next year the City Board decided “to leave the matter of water leading to the committee”. This meant the start of a new era in the history of water supply in Tampere: ever since all plans and projects have been initiated by the city.¹⁸

At the end of the 1880s, the Finnish people followed closely the development of the bacteriological revolution and hygienic reform started in England. Slowly the miasma theory began to lose ground.¹⁹ In this phase, discussion about the water question also started to become livelier. A. Ahlberg, a civil engineer and later the city’s first health official, made in 1880 the first proposal consistent with the modern system. It was, however, rejected by the city council. This was probably due to the public health decree issued a year before, although the proposal would have exceeded the requirements of the decree. The local newspaper *Tampereen Sanomat* commented on the proposal in a positive tone.²⁰

Ahlberg’s suggestion was the first extensive plan on water supply and sewerage. The argument covered all the central points of building a water pipe up to its social effects. Probably the greatest problem would have been the suggested house-specific water charge; metering was to be introduced later. Ahlberg aimed to satisfy the demand for water over a long time, not to provide a temporary solution to meet an immediate shortage. It would have been an extensive and far-sighted modern system, with only some features of a protosystem.²¹

SOLUTIONS AND THEIR EFFECTS

Water Question

The first actual waterworks in Tampere, a clear protosystem, was completed in 1882. In the construction no attention was paid to the critique presented by Ahlberg. The main newspaper in the city, *Aamulehti*, strongly advocated the establishment of the waterworks. This low-pressure system did not, however, meet the requirements and

the working principles of a modern waterworks: it was rejected as poorly functioning and incapable of being expanded after extensive critique in the pages of *Aamulehti*. Especially the inadequate pressure, the quality of water and the selling of water without metering were problems. However, it had several principles of modern water works, although perhaps of lower technical standard.²²

Tampereen Sanomat also treated the water question, but not as extensively (for example 27.2.1886). The increasing amount of newspaper articles and the information disseminated through professional papers made people understand that the problems in water supply and sewerage could be solved.

Frequent fires and the various epidemics gave city officials and inhabitants the determination needed to establish water and sewerage systems.

Frequent fires and the various epidemics gave city officials and inhabitants the determination needed to establish water and sewerage systems. In 1890 the city council of Tampere requested C. Hausen, the engineer of the Helsinki waterworks, to prepare a plan for a new high-pressure facility. The plan, based on latest research, was presented the same year, but was accepted only after a long debate in 1895.²³

The facility was completed on 22.11.1898, but not on the scale of the original plan. *Aamulehti* followed closely the matter and urged that the decision be made, when the process became drawn out. The paper also monitored closely the building process and the opening ceremonies were publicised prominently.

The new high-pressure waterworks provided safety and comfort. However, since the suggested slow sand filtration was rejected and the outlets of the sewers were too close to intake pipes, the efficiency of the new facility was also its weakness: later typhoid fever spread fast over a wide area aided by the water pipe network. Security was essentially increased when a regular fire brigade was founded in Tampere the same year. The lack of water pipe had also caused various other difficulties, extra work and trouble. After the founding of the waterworks, it was a great relief for the city's inhabitants not to have to carry and transport water and also to get rid of the extinguishing duty after a transition period. This increased the comfort and security of the inhabitants. In Tampere this quite long process also improved, after some setbacks, the sanitary situation and the appearance of the city area (see Figure 2: i-iii)

In cities sufficient water for fire fighting became available only after the emergence of high-pressure waterworks and professional fire-brigades. This was the case both in Tampere and Oulu, since both cities had initially low-pressure waterworks. (Table 1) It is probable that the decisions in Tampere were known well in Oulu as the two cities followed closely developments in each other's water supply and sewerage. In addition, Tampere and Oulu used same external experts, like Hausen from Helsinki.²⁴ Networking of experts in the Finnish water sector was quite advanced already in the last years of the 19th century. Besides, Finnish experts and civil servants went on numerous fact-finding tours abroad (Sweden, England and Central Europe) to familiarise themselves with the foreign solutions.²⁵

Problems with water quality were also largely solved only after the introduction of high-pressure waterworks, although Tampere needed a severe typhoid epidemic before economically minded decision makers realised the necessity of efficient water treatment. There had been knowledge of proper equipment and the dangers of not having it for years as a result of the domestic expert network and the active foreign connections.²⁶

In 1916, one year before the national independence, hundreds of people died which finally prompted the necessary decisions to be made which *Aamulehti* had been determinedly advocating for (see Figure 2: iii-iv). In Helsinki, Hämeenlinna and Lahti related problems were not as great, because they did not use untreated surface water. Lahti was using good quality groundwater from the Laune spring, Hämeenlinna used groundwater from Ahvenisto and Helsinki used from the beginning surface water treated with slow sand filters. These modern systems were thus safer than the one in Tampere. In addition, the other cities were taking care of their wastewaters in a modern way compared to the protosystem in Tampere: in Lahti the wastewaters from the entire planned city area were treated already in 1910. The facility in Lahti was the most advanced in Finland then. The systems in Hämeenlinna and Turku also surpassed the one in Tampere in most areas since they were using safer groundwater.²⁷

Apparently economic interests also stirred up dispute since some people were afraid that the costs were going to be shared by everyone while only a few could enjoy the advantages. In Tampere there was no opposition against the waterworks at any point. In Hämeenlinna the committee preparing the plan for the waterworks followed the principle of not forcing the facility on the public. It thought that the importance and necessity of the facility were so well known that no discussion was needed. This nearly destroyed the whole plan. With hindsight it can be said that the importance and necessity of the waterworks were not a big enough factor to sell it, at least, to the local newspaper *Hämeen Sanomat*.²⁸

Sewerage Question

The other side of the water question, i.e., sewerage also had to be solved. The public health decree of 1879 obliged cities to do so since the act required that levelling of the city areas was to be carried out. In Tampere, engineer Bergbom and architect Calonius proposed in 1882 to the city council that the city should draw up a sewerage plan for the needs of the city west of the rapids. Engineer C. O. Helenius did make a plan, according to which sewers were to be built of bricks. A plan for a sewer for the city east of the rapids was completed in 1883 and for the rest in 1894. This is how the protosystem for sewerage was introduced – also the forerunner of a modern system.²⁹

Although the wettest area of the city was drained and hygiene improved, lakes were still being polluted since wastewater was not treated. The bucket was replaced by a drainpipe, and the problems were flushed out of sight untreated to the nearest water systems as is typical of protosystems. Luckily wastewaters were not used for irrigation like in Germany and France³⁰ at that time. This kept the groundwater unpolluted.

In the beginning of the 20th century the raw water basin of Tampere, Lake Näsijärvi, was polluted and typhoid epidemics were plaguing the inhabitants. The threat of typhoid

The threat of typhoid fever and other diseases spreading through water was removed in 1917 ... when chlorination of water was started.

fever and other diseases spreading through water was removed in 1917, the year of Finland's independence, when chlorination of water was started. There have been no typhoid epidemics in Tampere since then. The modern system did not, however, include collection and treatment of wastewater.³¹

The typhoid epidemic for its part made local decision makers examine the question of community and industrial wastewaters. For various economic reasons it was finally decided not to do anything about the wastewater at that time: it was assumed that the Tammerkoski Rapids could purify it sufficiently. Yet, the situation in Tampere was considerably better than in certain cities in Germany: in Tampere the amount of wastewater was only a fraction of the amount of supplied water.

The matter was taken up again only in the 1950s, and in 1962 the first wastewater treatment plant was completed in Rahola, for the western suburbs of the city. Then, finally, Tampere had a modern water and sewerage system in every respect, although it did not cover the entire city. *Aamulehti* was no longer keenly interested in the wastewater question: it mostly reported the decisions of various administrative organs. Interest was aroused again after the lakes became indisputably polluted by the turn of the 1960s.

Groundwater

During the typhoid epidemics, there were discussions about whether Tampere should begin to use groundwater, which in terms of healthfulness and taste was better than the water of Lake Näsijärvi. Extensive groundwater inventories were made in the surroundings of the city and a quite rich groundwater source was found in Vuohenoja.

The matter was considered and explored for a decade and active discussions were held at times. The result was, however, that in 1920 the city council finally abandoned the plans for establishing a groundwater intake in Vuohenoja. It was thought that the groundwater would not suffice for the needs of the growing city. *Aamulehti* followed closely the inventories. Mostly it referred to the decisions of various officials, but some writings favoured the groundwater option. After the decision, a solution other than groundwater had to be found, and in 1921 the city council approved the building of a plant using surface water with rapid sand filtration. The idea of using groundwater in Tampere was not reintroduced until the 1950s.³²

The new Kaupinoja surface water intake was in a safe place, opened in 1928. The water from Lake Näsijärvi was chlorinated and filtered in sand filters. Another new plant for the western parts of the city was built in Mältinranta, upstream of the rapids in 1931. After World War II the water works grew rapidly. At the turn of the 1960s, precedence was given to the quality problems of raw water caused by forest industry

pollution along the lake nearby. 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. It is planned that by 2008 a regional water supply system based on groundwater through artificial recharge will serve the city and its neighbours. Thus the question on whether to use ground or surface water has been there for a century (see Figure 2: iv-v)

Main Decisions and Their Effects

In Tampere many decisions have been made on water and wastewater management that have affected the development and the environment:

Strong industrialisation made the city grow rapidly and, thus, created also problems. Industry needed vast amounts of water while the city water supply was still at the bucket system level. The biggest factories built their own proto-level systems. The actions, on the whole, were initiated by demand.

The waterworks were born as a solution to the water question after long discussions, often after various, inadequate and temporary solutions. In terms of quantity there was enough water, and the selected technological, administrative and economical solutions were also successful. The well-being of people improved compared to the earlier situation and equality between them increased as waterworks expanded and better quality water slowly reached also working class people.

The waterworks was excellently suited for the needs of fire fighting. There were no great fires in the city after the founding of waterworks and fire department. The choice of the pressure level, the charging based on metered consumption, the selection of materials and machinery, the working methods and the financing of the project were especially successful in Tampere.

The biggest threat to people was removed when the chlorination of raw water started after the typhoid epidemics in 1917. More efficient water treatment followed after some years and improved the situation even more. On the national scale, the health situation improved after the founding of the waterworks, especially typhoid fever cases decreased with the exception of a few epidemics and the civil war period in

In 1919 infant mortality was lower in the cities than in the countryside; earlier the situation was the reverse.

1918. In 1919 infant mortality was lower in the cities than in the countryside; earlier the situation was the reverse. At least in this respect, the cities had become healthier places to live than the countryside.

The environmental threat began to decline only after improvements in industrial processes and the building of the Rahola wastewater treatment plan (1962). Modern environment protection demanded decades of planning and extensive co-operation with the city, industries and other stakeholders.

This has, however, been successful and the beaches are again in good condition. Also experimental plantings of crayfish have been made with success.

Certain strategic selections have had an effect on the environment, health and security and have also closed out other possible development paths or options for decades to come. At least the following selections belong to this group:

- A decision was made in 1866, and again in 1875, to solve the water question, by a water-pipe network under municipal ownership. The decision could quite well have been different, and the waterworks could have operated as a private enterprise like, for instance, in France, and later also in England. When comparing the situation in water supply in the 1990s, on the one hand in France and England, and on the other in Finland, and especially when taking into consideration the direct income from the municipal water works and the health effects for the city, one could say that the solution was the right one, at least from the viewpoint of the inhabitants.
- The modern plan by Ahlberg in 1880 was rejected, and a cheaper and inferior low-pressure solution was selected. It proved to be only temporary. This protosystem was realised in 1882.
- Despite the plans, the water treatment filters were not constructed. This highly questionable savings combined with the wrong point of discharge of wastewater led in the end to the loss of 53 lives in the 1908–09 typhoid epidemic and nearly 300 in the 1916 epidemic.
- A groundwater project was abandoned in 1920, probably leading other cities also to use surface water. The choice in 1920 was made for the water source believed to be sufficient according to the knowledge at the time. This point was important, because during the dry seasons, even the waterworks could not always ensure the water supply of cities. For instance, Turku had a shortage of water in the 1920s. Similar situations prevail now in many developing countries and even in some European countries. Cairo and Lagos in Africa, Dacca, Shanghai, Mumbai (Bombay), Calcutta, Jakarta and Karachi in Asia, and Sao Paulo and Mexico City in South America will face the greatest difficulties unless a quick solution is found. Water-related problems do not concern only developing countries. It could be said that the solutions for water supply are not as much tied to a time and a place than to the developmental stage of a society and its infrastructure.
- The treatment of wastewater was also studied around 1920, but it was taken seriously only some 30 years later. The wastewater situation was good compared to the German cities examined: the proportion of wastewater to clean water was very small.

The models and the knowledge in support of the various solutions were collected both from abroad and other facilities in Finland. The perception of the determining role of capital, even the perception of it as a precursor in this sector, proved to be misleading, if not incorrect. Capital has, of course, played an important, but not necessarily the only and central role.

Discussion and Implications

The study shows how the technical principles of the water supply have remained nearly the same as in the days of ancient Rome: a simple water pipe and a sewer network follow wells and rubbish heaps. During the last hundred years, water treatment and disinfection have been added to the methods of Rome, and in the final stage, if even then, a wastewater treatment plant has been built. The bucket is slowly replaced by a pipe, the protosystem supplemented or replaced totally by the modern system, as in Tampere.

The growing cities of developing countries seem to be repeating the Finnish pattern in building their water supply. First, they build a water pipe to replace wells, then sewerage to replace ditches. At this point, diseases like cholera and, especially typhoid fever, very often plague growing cities. The excessive use of water, the assessment, the lack of maintenance, etc. also cause problems. Only after the occurrence of these problems, the systems are built to guarantee good quality of water, and only lastly – usually after yet further problems – a wastewater treatment plant is built.

Examples of successful and durable solutions in water supply are nevertheless available. In this sense, water knows no limits – neither in place nor time. It is noteworthy

... how similar the problems in many developing countries are at the beginning of the 21st century compared to those faced earlier by developed countries.

how similar the problems in many developing countries are at the beginning of the 21st century compared to those faced earlier by developed countries. The underlying factors are the same in both cases: rapid growth of cities and inadequate resources.

D. Okun, a grand old man of water management, mentions five principles of sustainable water supply: (1) The uniqueness of water projects, (2) Efficiencies and economies of scale, (3) Integration of water supply, sewerage and pollution control services, (4) Sound financial policies, and (5) A preference for pure rather than polluted sources of potable water.³³

Compared those with the development in Tampere, at least the Principles 1. and 2. had been applied successfully. Local expert knowledge was used amply and the adaptation was tailored for the conditions of Tampere – even too much considering the elimination of slow sand filtration. The dimensioning of the 1898 waterworks was a success, even if there was some criticism during the planning period. The estimates of the planners and specialists about the growth of the city and the capacity and extension possibilities of the waterworks needed proved to be correct.

The combining of water acquisition, sewerage and environmental protection started on the threshold of the crisis of 1909. Ever since that year, the food inspection office of the city supervised the quality of water in Tampere. It was decided to finance the activity on the basis of metered consumption (cf. Okun's principle 4.) following the failed system of lot-based charging with the low-pressure solution. This has made possible the sensible development of the utility, which probably would not have been possible in light of the examples with other charging principles.

Principle 5. is the most delicate issue in the history of the water supply in Tampere: preference was not given to better quality groundwater in spite of various warning signs, but the decision makers stuck with untreated surface water which contained unclean wastewater. The result was a catastrophe, from which it took the city a long time to recover. And even then better quality groundwater was not used – mainly because of the quarrels among specialists. Treated surface water and a better protected intake area were chosen instead of groundwater. Only decades later did groundwater become part of the water supply of Tampere.

These principles are mainly related to the city water supply and sanitation. Bigger industries like pulp and paper mills have traditionally had their own systems although they used to have some connections to the city water works at certain stage.

CONCLUSIONS

This paper has concentrated on the birth and early development of community water supply and sanitation in Tampere. Out of the development the following conclusions can be drawn:

- Surface water was initially taken from nearby sources, and as these became contaminated, from farther away. The utilisation of groundwater started later, and artificial groundwater will likely be produced in the future.
- Wastewaters polluted the water systems until their efficient treatment started at a relatively late. The industry began to protect waters later by increasing co-operation with the waterworks when the time was ripe.
- When the increase in the water consumption levelled off, the emphasis shifted to water quality.
- Mistakes have been made, but lessons have also been learned. It is better to do something than to do nothing.
- In environmental matters the utility has played, and will continue to play, a key role in Tampere and its surroundings.

All in all, Tampere city waterworks is an example of a public utility owned by the users themselves that has been, and will continue to be, capable of providing services at reasonable cost. The utility has decisively improved the city's fire safety, hygiene and health conditions, and the quality of the city environment. It has also been central in enhancing the operating conditions of industry and commerce. Although many facilities of the works are hidden underground, we all come daily into contact with its key products: potable water, wastewater, cleaner water bodies and easier and safer everyday life.

Figure 2

Ecohistorical stages of Tampere (next page>>)


In this the environmental history of Tampere is divided into six phases. Phases i to ii belong to the Period of Slow Development of the water supply (cf. Table 3). The same two phases fall into the category B and end of ii to P (cf. Table 2).

- (i) *Rural Town, 1779-1837*. After this period, fast industrialisation and urbanisation started followed by
- (ii) *Town with Environmental Difficulty/disadvantages, 1838-1897*.
- (iii) *Environmental Catastrophe: City of Tampere, 1898-1916*, in this period the city acquired a modern urban infrastructure (Table 3) and M (Table 2), but incomplete M and, thus, a very dangerous system.
- (iv) *Recovering City, Polluting Water System, 1917-1961*. In this period M system is fulfilled and treatment of industrial wastewater started.
- (v) *Recovering Water System, 1962-1980s*, in which the water systems began to recover because of wastewater treatment and changes in industrial processes. Modern system is completed with the separate sewer system.
- (vi) *Adjusting City, 1980-2010*, where water systems and city environment are in delicate balance.

(SOURCE: Juuti, 2001; Archives of Tampere City Museums)

**i Rural town
1779-1837**
-“water pumping
installations” 1835

IV




Wastewaters and
waste in cycle



Means of recovering

- Chlorination 1917
- Surface water treatment plant 1928
- Waste management

Pollution of water system continues

- More industrial wastewaters (to Näsijärvi & Tampere continues polluting (Pyhäjärvi)
- > Severe environmental risk to water system & urban water supply



**iv Recovering City
Polluting Water
Systems 1917–1961**

Solving attempts:
-groundwater inventories,
watersupply remains in
lake Näsijärvi > wastewater
discussion > no treatment
of wastewater



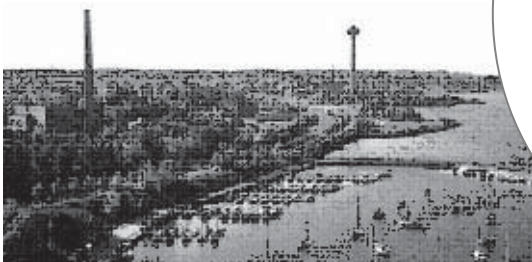
v Recovering Water System

- water intake to Kangasala lakes (Roine)
- water law 1962
- Improvement of industrial waste water treatment and closing of old paper factory
- Rahola wastewater treatment plant 1962
- Viinikanlahti wastewater treat plant 1972
- separate wastewater network





Industry and rapid growth of population: cycle breaks



ii Town with Environmental Difficulty 1838–1897

- City fires and lack of water > water problem
- Typhoid
- pollution – first steps of waste management
- first steps of water supply & management > no result
- from B to P, low-pressure system 1882, wc 1890



iii Environmental Catastrophy 1898–1916

- High-pressure water supply system 1898 >
- No lack of water, no great city fires
- wastewaters to watersystem, no wastewater or surface water treatment > catastrophe > dangerous tap water > typhoid epidemic > 300 deaths
- lawful WC 1898 > pollutes watersupply (lake Näsijärvi)



vi Sustainable City? 1980–Future

- water system and city in delicate balance
- purified water and beaches
- environment and city in balance
- each department has created an individual environmental program
- risks: pollution of groundwater, accidents, heavy use of soil, other threats









	TIME	CULTURE	METHODS	OBJECT OF INTERESTS	SYSTEMS	VALUES
I Pre-urban systems 	Before cities, c.10 000 B.C. and later.	Gathering	Rainwater, spring water, bucket	Cleanness, comfort, pleasure	Survival	Survival
II Early systems  	c.10 000 B.C. to 500 A.D.	Several, first cities, Roman culture	Water pipes, water tanks, sewers, WC, aqueducts fire-brigade	Cleanness, comfort, pleasure	Modern system (drinking water) & protosystem (rain water)	Military values Rich and poor treated unequally, "undemocratic"
III Period of quiet waters 	c. 500 - 1700	Several, in Europe religious culture	Old modern and proto-systems break up, nothing to replace Chamber pot, rubbish heap, bucket Bucket brigades: fire guards	Society is interested in water supply	Bucket system, side by side with protosystem	Symbolic values
IV Period of slow development 	c. 1700-1910	Several, enlightenment, scientific-technological culture	Into the pipe, out of the pipe. First drainage, then water works. Slow sand filtering inv. in 1804, to use in 1829. Volunteer fire brigades and other arrangements alongside bucket brigades	Work efficiency, health, miasma. Since the mid- 19th century miasma theory eclipsed by bacteriology, breakthrough of hygiene (Farr, Snow, Pasteur, Koch, etc.)	Protosystem, often alongside bucket system	Productional values
V Modern urban infrastructure 	Period of developed urban infrastructure, c.1910 to present	Several, enlightenment, scientific-technological culture	Rapid sand filtering (dev. in 1885) in extensive use. Bucket brigades replaced by regular firebrigades in substitution. Bacteriology applied at water works. Treatment of waste water. Charging based on measured consumption, pressured network of water pipes, water tanks, hydrant networks. Developed management and maintenance systems.	Environment; health, hygiene, later ecology.	Modern system, often alongside protosystem.	Productional, later ecological values. Poor and rich in nearly same position, "democratic" system Finnish system: municipal ownership and consumer orientation (information sharing, etc).

Table 3 Periods of water supply and sanitation.

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- ³¹ Juuti 2001, 182–185. The inhabitants of the peripheries were not necessarily in a worse position than the inhabitants of city centre. The peripheries relied for long on wells and latrines. For instance, in the suburb of Pispala, people organised water distribution based on a clear protosystem managed by a local cooperative. They largely escaped the great typhoid epidemics in Tampere, mostly due to their isolation. A somewhat similar case occurred in 1892 in Altona-Hamburg, in Germany where people living in adjoining areas were saved from cholera depending on whether they drank treated or untreated water. A system does not necessarily have to be of a high technical level, if the water source is protected or isolated. But surface water must be treated. Evans R., *Death in Hamburg. Society and Politics in the Cholera Years 1830–1910* (Oxford, 1987), 189–192, 289–299.
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FOR THE ENVIRONMENT AND HEALTH
– HISTORY OF WATER AND SANITATION
SERVICES IN PORVOO, FINLAND

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ABSTRACT

Since 1913 Porvoo City Water Works has been operating as a municipal utility with economic autonomy. From 1975 on the utility has provided wastewater services which earlier were the responsibility of the City Street Construction Department.

At the end of 2002 the utility supplied high quality groundwater to more than 40,000 people – some 90 per cent of the municipality's 46,000 inhabitants. The number of water supply connections was 7,500 and that of sewer connections almost 6,000. The utility had seven water intake plants, three of them on standby. The properties connected to the public sewer network house about 36,000 people or over 70 per cent of total population. Moreover, the utility supplied water to eight water cooperatives serving some 500 customers.

Following the merger of the two municipalities in 1997, investments have been exceptionally high, including a new wastewater treatment plant. Traditionally, the utility has bought services and goods from the private sector based on competition, while maintaining certain construction and management capacity within the utility. Based on any criteria, the supply and sewage services are of a high level. However, the road leading to the present situation has been long and sometimes also rocky.



Figure 1
Water tower of Slätberget. It was completed in 1997 and has capacity of 2,000 m³.
(P.Juuti)



Figure 2
Installation of the watermain under the Porvoo River in 1937.
(Porvoo Water)

BACKGROUND

Porvoo is assumed to have been founded in 1346, although the exact year is not certain. What is known with certainty is that Porvoo is Finland's second oldest city. The Porvoo River got its name in the 14th century from the ground fortress built on Linnamäki; it later became the name of the city as well. The name originates from the Swedish word Borgå (borg = castle, å = river).

For centuries the townspeople got along using traditional water sources: wells, springs and surface waters. As the population, and population density, increased and water became scarce and the environment started showing symptoms of deterioration, new measures were called for. One such measure was municipal water supply. First, gradual construction of a sewerage system was launched already at the end of the 19th century. A waterworks was founded in 1913 following a long period of discussion and planning. Since its establishment Porvoo City Water Works has been a municipal utility operating in accordance with the economic and operational goals laid down by the City Council. In keeping with the general Finnish practice, a sewerage system was built alongside the waterworks. The first wastewater treatment plants came into being in the 1970s.

SOURCES

A systematic analysis of the city and waterworks archives and the literature was made. Articles in local newspapers, and the available histories of the city were also reviewed. Open-ended theme interviews of some 20, present or past, staff members of the waterworks were conducted, representing all levels of the utility. Visits to the works have been an essential component of the project.¹

The article also relates the early developments in water use and sewerage in Porvoo before the founding of the actual water and sewage works. To that extent the text is based on historical accounts of the general development of the City of Porvoo.

Presently the City of Porvoo has some 46,000 inhabitants, of whom 64 per cent are Finnish-speaking, 34 per cent Swedish-speaking and about two per cent others. The total land area of the city is 654 km². The city is the thriving centre of an economic region in the eastern part of the province of Uusimaa. Porvoo lies about 50 km east of the Helsinki metropolitan area and the Helsinki-Vantaa airport: there is a good half an hour's drive from downtown Helsinki to Porvoo, situated along the E 18 Highway.

More than half of the citizens of Porvoo earn their livelihood from trade and services, a third work in the industrial sector. The traditions and structure of industry and commercial life are based on three vibrant industrial branches: the graphical, electro-technical and petrochemical industries. Porvoo originally grew up as a trading centre, and it continues to be an attractive hub of business and commerce. The volume of retail trade in Porvoo makes it one of the country's bigger municipal centres. Old Porvoo is famous for its narrow lanes and brick-red riverside warehouses. The low wooden houses in the Empire-style part of the city were built according to the classical town plan based on blocks. The home of Finland's national poet, Johan Ludvig Runeberg, one of Porvoo's most popular tourist attractions, lies there.²

MEDIEVAL TOWN

Documents mention *Porvoo Parish* already in the early 14th century. For hundreds of years the city extracted water from wells, springs and the Porvoo River. Although great fires did not occur in Porvoo as often as in other Finnish cities, the founding of a waterworks was facilitated by the fear of fires and the scarcity and poor quality of well water. The environment also became polluted as habitation spread; the problems came to a head especially in the poor sections of the city such as Pappilanmäki.

Before the establishment of the waterworks most houses had a well in the yard. Several public wells also existed – the first mention of one dates back to 1622.

Before the establishment of the waterworks most houses had a well in the yard. Several public wells also existed – the first mention of one dates back to 1622, but it is likely that there were some already earlier. Water was also drawn from the river. The best known public well was a so-called Laska well. The Rehtorin lähde (Headmaster's spring) at the corner of Vuorikatu and Rihkamakauppiaankatu streets was considered the only source of good water in town in the 18th century. Another well-known public well was the Brakan luukku (a covered well).³

ESTABLISHING A MODERN SYSTEM

After well-water quality deteriorated and water levels fell, new ways of satisfying water needs had to be invented. The risk of fires also speeded up the organising of water supply. Despite various reforms, the bucket remained the key implement in water supply, latrines and waste disposal until the end of the 19th century. Sewers were laid to get rid of rain waters that flowed into basements and also hindered movement of people. At that time, people still believed in the so-called miasma theory according to which humidity and dirty air spread disease. Yet, this belief for its part also facilitated the introduction of sewerage.⁴

House owners had an economic incentive to have public sewerage in town – before they were responsible for the maintenance of ditches and sewers on their section of the street. The organisation of water supply was speeded up by the poor quality and shortage of well water and the need for fire-fighting water.⁵

The *know-how* to solve the water problem was acquired at least from Stockholm and Helsinki. However, the first initiative came from within the town: professor Strömborg, involved in town administration, suggested as early as 1889 that a waterworks be established to solve the problems. House owners also supported the idea. A waterworks utilizing groundwater was completed a quarter of a century later in 1913.⁶

The Porvoo Water Works was designed by the director of Helsinki Water Works, Albin Skog, who designed the first waterworks of several other Finnish towns. The contractor was Yleinen Insinööritoimisto, YIT – Allmänna Ingeniörsbyrå, AIB. The headquarters of that company was in Stockholm; it established a branch office in Finland in 1912. The Porvoo Water Tower was the company's first actual project in

Finland and the beginning of its later growth into a leading sector contractor in this country. Construction of sewers had started already at the end of the 19th century.⁷

The total project budget stayed quite well within the planned framework. The financing arrangements were also skillfull and advantageous to the city. However, the initial estimates on the sufficiency of water appear too optimistic in hindsight due to population growth. During the first few years it was noticed that the water was not sufficient for the growing needs. City newspaper *Borgobladet* reported often about this development.⁸

The measures undertaken made the built environment safer and eliminated the immediate problems. Reforms in fire services also increased safety. The evolution of the sewerage system started from open ditches. As the city grew the ditches were straightened, dug open and covered. However, this was not enough, and the growing problems made the city's decision makers plan an underground sewerage system following the English example. Thus, progress from the bucket system to a proto system began. Development of a sewerage system was well on its way even though a wastewater plant was not yet built along with the waterworks.⁹

Thanks to the selection of the groundwater alternative, Porvoo avoided major problems such as epidemics which occurred in cities using surface water.

The Kaupunginhaka Water Works proved to be an interim solution in hindsight. Yet, its performance improved, and since 1921 the utility turned a profit. Despite the large investments early on, it continued to grow. Thanks to the selection of the groundwater alternative, Porvoo avoided major problems such as epidemics which occurred in cities using surface water. The new facility completed in Linnanmäki in 1923 ended the water shortage but quality problems, such as excessive iron content, remained unsolved.¹⁰

WATER CONSUMPTION AND FEES IN THE FIRST DECADES

If a house owner wanted to connect to the city's water supply in 1913, he had to submit a written application. A written contract was always required for water supply; the term of notice was three months. The regulations governing the water pipe of the City of Porvoo from 1913 read as follows:

“Each plot to which water is led is to have its own pipe extending from the street pipe to the water meter. The waterworks shall procure and lay said pipe at the expense of the house owner, charging the fee confirmed by the council, in the order applications are submitted and performance of the city's own works allows; the city also undertakes to put right without charge any possible defects in the pipes due to poor workmanship or materials for a period of one year.”¹¹

During the first years all distributed water flowed through the tower. The water of the tower pumped to capacity lasted for about a week. The capacity of the water tower at the time was 400 cubic metres. Water consumption increased quite rapidly as the network expanded. Today the combined capacity of the elevated tanks is about ten-fold – and all the water does not even go through the towers.

Since the beginning water fees were charged based on the readings of the city's meters. The waterworks ordered the meters to be installed where

“basic and surface water cannot penetrate into the dial housing to obstruct its reading, the meter is not exposed to subzero temperatures or other harmful influences, and the meter is accessible enough to allow attaching, reading and removing it without hindrance”.

If a house owner doubted the accuracy of his water meter, he could ask the waterworks to check it. If the reading error was less than five per cent, the house owner had to pay the costs of inspection. This rule is still in force 90 years later.¹²

It was not always possible for house owners to connect to the city's water supply network. For instance, in the old town the bedrock lying close to the surface prevented the laying of a water pipe. *Public standposts* were provided for these consumers; the key required to use them could only be given to the occupants of the house. Care had to be exercised in the use of the standposts also in other respects. Persons on poor relief could use water free of charge. In 1914 there were a total of 159 water connections and consumption was around seven cubic metres per inhabitant. In 1952 connections numbered 520 and consumption was up to 38 cubic metres per inhabitant annually. In 1940, during the Winter War, water consumption dropped significantly since a major portion of the city's population had been evacuated (see Figure 3).¹³

WATER SUPPLY AND SANITATION IN THE RURAL DISTRICT

In the first half of the 20th century the water supply of Porvoo rural district depended on private wells. Alongside them the largest water consumers started to build their own modest water pipes. Water shortage encouraged cooperation between inhabitants. This led later to consumer-owned and administered water cooperatives and common wells. The rural district concentrated on supplying water to its own institutions and offices in the early 1900s and maintained a few public wells and latrines.

In the early part of the 20th century public health requirements gradually tightened and the importance of hygiene was stressed. Well water quality was monitored closely, for instance, at schools. Deficiencies were remedied quite promptly. Yet, the state of the environment deteriorated badly in places due to the high increase in living standards and the spread of flush toilets among other things. For instance, in 1969 the board of health noted that the water bodies were polluted to such an extent that only a few beaches had water that was safe to swim in.¹⁴

The water supply and sewerage system of Porvoo rural district has made use of the expertise and services of authorities, other water utilities and the private sector from the beginning. For instance, water analyses were commissioned from Porvoo City Laboratory among others. Designs and construction work were commissioned from companies. Intermunicipal cooperation in water supply and sewerage was also practiced at one time with the City of Porvoo. At first, the rural district bought water from the city's waterworks. When the Saksanniemi waterworks of the rural district became operational in 1975 the roles switched and the district supplied water also to the city.

The Päijänne Water Tunnel was among the most prominent projects of intermunicipal cooperation in the metropolitan area. The rural district took part in its financing in order to secure the raw water needs of the petrochemical industry.¹⁵

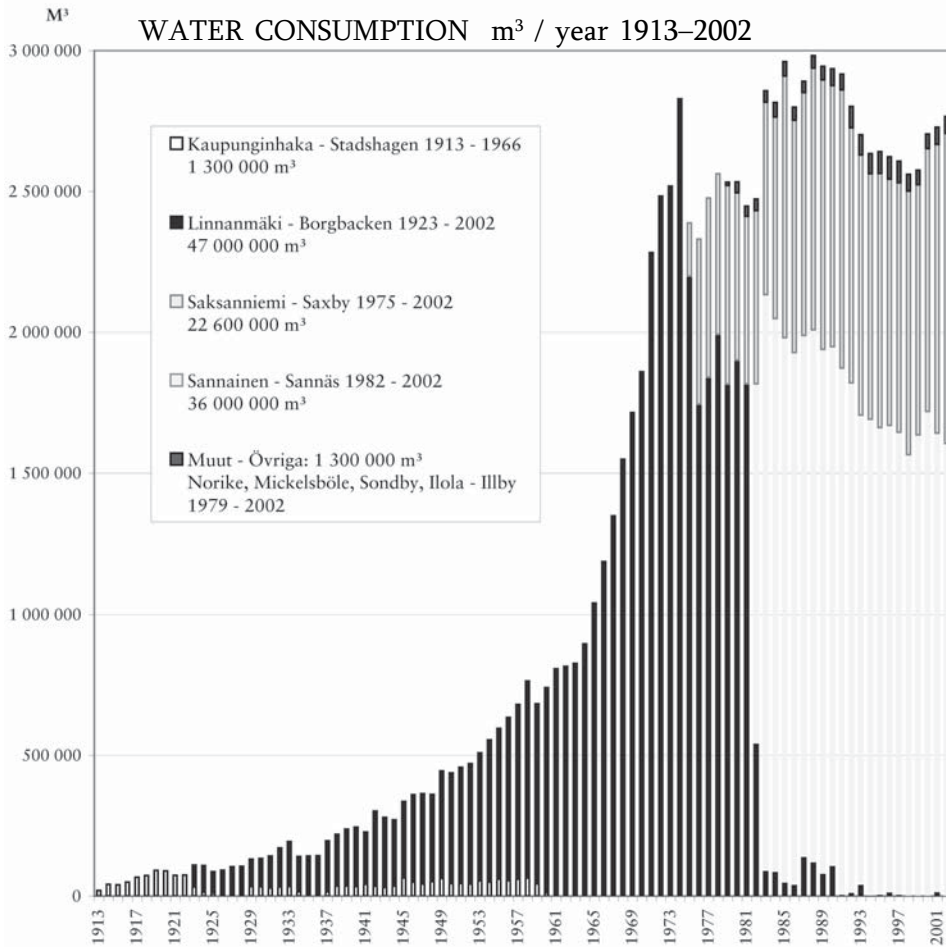


Figure 3

Development of water consumption 1913–2002. The volume of water pumped into the network i.e. total water consumption, increased until the 1970s as the supply network expanded. (Porvoo Water)

DEVELOPMENT OF THE CITY WATER WORKS, 1920s TO 1980s

The new Linnanmäki water intake plant was finished in January 1923. A concrete well 8 metres deep was dug in Linnanmäki, and the water was pumped by two large centrifugal pumps to the city through a six-inch cast iron pipe 610 metres long. Originally the water was treated only by adding soda lye to increase pH. The water intake plant operated satisfactorily for the first years. In 1923 about 70 per cent, and the next

year 87 per cent, of the water need was covered by it. The rest came from the Kau-punginhaka pumping station. But the water was quite rich in iron and carbon dioxide. Especially water that sat in the pipe overnight produced thick layers of iron deposits. When the water started to flow again, these “rust specks” worked loose and consumers got “beer-coloured” water. The engineer Skog was asked to help, and he designed an iron removal plant incorporating aeration of raw water, iron precipitation by adding lime water, filtration and storage of clean water in a tank.¹⁶

Water consumption increased steadily after WW II outstripping the capacity of the Linnanmäki water treatment plant. In 1951 it was operating 22–23 hours per day. The technical department of the Federation of Cities prepared a plan for the expansion of the water treatment plant. Accordingly, the capacity of the plant doubled and could be tripled later on. The expansion was completed in 1956.¹⁷

A new 2,000 cubic metre water tower was erected on Roviovuori in the City of Porvoo in 1966 condemning the old one into disuse. Despite public discussion it was decided to blow up the old tower. A street had been planned to go where it stood but was never built. The demolished water tower reflects the super modern design philosophy prevailing in Finland and elsewhere in the 1960s: the old had to be removed and replaced with something new and modern.¹⁸

The Linnanmäki water treatment plant was expanded in 1971 by constructing a plant operating according to the VYR method¹⁹. The filtration plant was also renovated. However, the new VYR method did not work as hoped – the water still contained too much iron, manganese and salts. A groundwater infiltration basin was built in the Linnanmäki area in order to increase the water resources needed by the waterworks. It was tested in autumn 1972 by infiltrating water from Porvoo River. Infiltration tests were conducted at three places along the river in 1972–1978. All of them failed since the water of the river was not of a quality suitable for raw water of artificial recharge. Water consumption in Porvoo doubled between 1966 and 1973 and levelled off thereafter. The idea of establishing a federation of municipalities for water supply in the Porvoo region at the end of the 1970s was never realised.²⁰

WATER POLLUTION CONTROL INCREASED IN EFFECTIVENESS FROM THE 1970S TO THE NEW MILLENNIUM

The sea area off Porvoo in the eastern Gulf of Finland is loaded by domestic and industrial wastewaters as well as the substance flows of rivers. Mäntsälänjoki River (also known as Mustijoki) is about 70 kilometres long with a relatively low flow rate. It is loaded, for instance, by the human settlements of Mäntsälä and Pornainen. Porvoo River is about 80 kilometres long with a slightly higher flow rate. It originates to the south of the Salpausselkä ridge and is heavily loaded starting from its upper reaches. The wastewaters of the City of Lahti have contributed to the state of Porvoo River in the 1960s through 1990s. The municipalities of Orimattila, Pukkila and Askola are also located by the river. However, the most significant loading source of the river is diffuse loading, of which the major part originates from agriculture.

Before the wastewater treatment plant was built, rain waters and domestic wastewaters were led untreated into water bodies. Domestic sewage was led via settlingwells to the city's sewerage system and on to the sea off Porvoo. Finns started paying attention to the state of the country's waters and, especially, the harmful effects of their loading in the 1950s. As a result, the 1961 Water Act and Decree were enacted which came into force in 1962 specifying the rules on water protection essentially. Until then, the Water Rights Act of 1902 was enforced. It already incorporated the main principles of the Water Act: prohibitions against blocking, altering the course and polluting waterways.²¹

Initially Porvoo had a combined sewer system, but since the 1960s, as the system was expanded and renewed, mainly separate sewers were built. Special attention has been given to the construction and rehabilitation of the sewer network. The investments have substantially improved the condition and performance of the network resulting in a reduction in the amount of wastewaters. The Kokkonniemi wastewater treatment plant was completed in 1973. Its purification process is based on so-called chemical direct precipitation. The sea area off Porvoo has been the subject of water studies since 1965. In the 1960s observations were still random, and regular monitoring has occurred only since the 1970s. The state of Porvoo River started to improve gradually towards the end of the 1970s.²²

In 1983 negotiations on a joint wastewater treatment plant were started with Porvoo rural district. The appointed working group suggested then that wastewaters be conducted for treatment to a joint treatment plant in Hermanninsaari. From there treated wastewaters were to be led to the open sea off Svartbäck by the mid-1990s.²³

Rehabilitation and expansion of the Kokkonniemi wastewater treatment plant could no longer be avoided at the end of the 1980s as the permit conditions tightened. The max. BOD₇ loading of treated wastewater was set at 40 mg/l instead of the earlier 60 mg/l. The BOD₇ removal rate increased from 70 to a minimum of 80 per cent and that for phosphorus from 80 to a minimum of 90 per cent. A maximum total phosphorus content of 1.2 mg/l was allowed as earlier. The necessary rehabilitation and expansion works were completed in 1987. These improvements helped the city get by until the new Hermanninsaari plant was finished. The Water Rights Court, however, changed the discharge permit on application in July 1995 easing the requirements on BOD removal and tightening the requirements on phosphorus removal. A composting area for treatment plant sludge was built in August 1991 at the Domargård landfill.²⁴

The new Hermanninsaari wastewater treatment plant was completed in September 2000. In November 2001 the wastewaters of Kokkonniemi could be led to Hermanninsaari thereby relegating the old Kokkonniemi plant to disuse. In 2002 the treatment requirements for the new plant were not only easily met, but with a wide margin as shown in Table 1. The removal rates for BOD and P, the key parameters, are 98 to 99 per cent. The plant is using the best available technology: the DN process with simultaneous precipitation.²⁵

Parameter	Requirement	Result achieved 4–12/2002
Organic substance, BOD ₇	> 90 %, <10 mg/l	98-99 %, < 3-5 mg/l
Total phosphorus, P	> 90 %, < 0.5 mg/l	97-98 %, < 0.2-0.3 mg/l
Total nitrogen	> 70 %	73-83 %, (>12 °C)
Total solids, SS	>90 %, <35 mg/l	98-99 %, 1-10 mg/l
Chemical oxygen demand, COD _{Cr}	>75 %, <125 mg/l	94-97 %, 25-35 mg/l

Table 1

Treatment requirements of effluents set by the environmental permit authority, and the results achieved from April to December, 2002 at the Hermanninsaari wastewater treatment plant in Porvoo.

Activity	Company million EUR	Share of budget %
Transfer and outlet sewers	3.28	22.8
Transfer sewer and outlet pipe	Lemminkäinen Ltd	
Pipe delivery	Uponor Finland Ltd	
Hermanninsaari wastewater treatment plant	9.53	56.8
Main contractor	Skanska-Tekra Ltd	
Sub-contractors:		
main machinery	YIT-Construction Ltd	
supplementary machinery	Seinäjäjoki VI-technology Ltd	
plumbing, heating, ventilation	Porvoo LVI asennus Ltd	
electrical installations	Tekmanni Ltd	
automation and instrumentation	Pantek Automation Ltd	
landscaping and pipeline relocation	City Street Dept., Waterworks	
Kokonniemi pumping station	1.10	6.3
machinery and building	YIT Construction Ltd	
automation	Pantek Automation Ltd	
Hamari pumping station	0.27	1.6
	Watercon Ltd	
Management, planning, permits, etc.	2.10	12.5
Consultancy services		
Others		
TOTAL	16.78	100

Table 2

Public-private cooperation in the implementation of the Hermanninsaari wastewater treatment plant in Porvoo 1996-2001 with the total budget of 16.8 mill Euro.

Note: Planning and design included environmental studies and outlet pipe by Vesihydro Ltd, and treatment plant and pumping station by Plancenter Ltd, totalling 1.67. million EUR. Most of the project (11.8 million EUR) was financed by Porvoo Water and Sewage Works, with profits from the years 1993–2002. External financing included a loan of 3.3. million EUR. In addition, the Ministry of the Environment contributed 1.9 million EUR to the construction of the transfer sewer and outlet pipe.²⁶

NEW SOLUTIONS – ARTIFICIAL RECHARGE AND BETTER MATERIALS

The total water distributed by public waterworks in Finland increased especially in the 1960s, 1970s and 1980s. Simultaneously, the combined relative share of groundwater and artificial groundwater increased. Only in the beginning of the 20th century did the relative share of groundwater fall as many Finnish cities chose surface water plants. The choice between surface and groundwater was also discussed in Porvoo. A chemist interested in this issue promoted the use of surface water. Yet, the city settled on groundwater. The bad reputation of drinking water made from surface water in Helsinki may have had an impact.²⁷

The view generally held in the early 1970s that water consumption would increase rapidly proved wrong towards the end of the decade. Increasing energy prices as well as the Sewage Fee Act slowed down growth in water consumption. In Porvoo a major reason for the significant reduction in water consumption was also the systematic search for leaks conducted in the mid-1970s. Porvoo City Water Works is, as far as is known, the first waterworks in Finland to carry out a systematic leakage survey of its water supply network. Leakages were detected primarily in the old water supply lines in the city centre.²⁸

By the 1980s the water quality of Linnanmäki had deteriorated further, and the need to extract water exceeded the resources available there. Especially the iron and chloride contents had increased. In 1977 a committee was appointed to review the drinking water situation in the city. This may also be regarded as the beginning of the planning work which led to the construction of the Sannainen water intake plant. The Sannainen artificial groundwater intake plant was completed in 1982. An infiltration water pumping station was built in Myllykylä from where raw water was pumped to the Bosgård recharge area. In 1983 the water pumped from the Sannainen plant covered as much as 96 per cent of the city's total consumption. Later, the volume extracted from Linnanmäki decreased, and in 1986 the plant served only as an auxiliary unit and headquarters of water supply and sewerage utilities. The Linnanmäki filtration plant was demolished in 1986–87. However, the VYR equipment remained operational and was rehabilitated in 1991. The Böle raw water intake plant was completed in December 1996. It pumped extra water to the Bosgård recharge area.²⁹

The iron-, and especially the salt-content, of Porvoo water were a great problem for customers in the 1970s. Only titanium hot water boilers could withstand the tap water in Porvoo. It was general practice among boiler manufacturers not to give a warranty to equipment which they knew was destined for Porvoo. In 1965 the amount of water pumped to the network exceeded one million cubic metres for the first time. The increased consumption in the years leading to the 1970s was primarily due to higher private consumption. The city council decided in April 1965 to supply water from standposts only to so-called consumer associations. From 1960 to 1975 water consumption increased about 200 per cent. In the same time connections increased by 150 per cent, the city's population by about 60 per cent and specific water consumption by about 30 per cent. As elsewhere in Finland, water consumption started to decrease

towards the end of the 1970s. Between 1975 and 1996 water consumption in Porvoo fell by about 35 per cent – specific consumption by as much as 40 per cent.³⁰

Initially, installation inspections were “just site visits” – no record of them was kept. Later, at the end of the 1950s, water supply and sewerage plans were increasingly required for new properties to be built. Actual installation inspections began in 1975 along with sewage treatment. A sewage fee was introduced in Porvoo in 1974. The income of Porvoo Water and Sewage Works was largely based on water consumption. Therefore, a basic fee was introduced in phases in 1987–89. The sewage works started collecting a connection charge in 1992.³¹

The original water supply network was built using steel piping. Later cast iron pipes were introduced as they are more durable. Plastic piping became prevalent in Finland in the 1960s, first as water pipes in the countryside and later also as sewer pipes.

Construction of the city's sewer system began already in the late 1800s.

Construction of the city's sewer system began already in the late 1800s. At the time, larger conduits were made of natural stone and smaller ones of glazed clay pipes. The pipe network was built as a combined sewer – a separate sewer system was adopted only in the 1960s. The primary material of the sewerage system was concrete prior to the changeover to plastic piping.

In 1978 plastic sewers became the standard throughout the city area.³²

PÄIJÄNNE WATER TUNNEL AND MUSTIJOKI WATER WORKS

The large industrial plants operating in Porvoo have for the most part provided their own water. The customer base of Porvoo City Water Works has never included any major process or large-scale industry that would use the works' water in its process or that would lead its wastewaters to the city's treatment plant. The population growth of Porvoo was above average in 1964 at 750 people or six per cent. The strong growth was primarily due to Neste Oy operating in the rural district – its employees lived in the rural district as well as in the city.³³

One of the largest investments in the rural district in the 1970s and '80s was the Päijänne Water Tunnel built in three phases in 1973–82. It is owned by Pääkaupunki-seudun Vesi Oy. Porvoo rural district subscribed to shares in the company in the early 1970s in order to secure raw water for industry in Kilpilahti should Mustijoki River be unable to provide enough water. In 1963 the not-for-profit Mustijoen Vesi Oy was established. Its task is to acquire and distribute raw water to industry at cost. In 1986 the operations were automated and remote-control of the pumping station from the control room of the oil refinery began.³⁴

The rural district has been the largest owner of Mustijoen Vesilaitos Oy with 60 per cent of the shares. As the city of Porvoo and the rural district merged in the beginning of 1997, the right to use the Päijänne Water Tunnel transferred to the City of Porvoo. The rest of the shares in the company was owned by two industrial enterprises.

NEW PORVOO AND WATER SERVICES

The City of Porvoo and Porvoo rural district merged into *new Porvoo* at the beginning of 1997. The merger meant a lot of work for the waterworks in the harmonisation of procedures and development of operations. New Porvoo placed special emphasis on the development of land use and environmental quality. This was also supported by subsidies for the establishment of water associations in dispersed settlements. Many villagers were content with using well water although a trunk main ran right by the plot. Wellwater was used even in areas where the inhabitants had expressed the wish for piped water due to the poor quality of groundwater. The investments of the waterworks subsequent to the municipal merger were exceptionally high. The targets were the new Hermannisaari treatment plant, the rural water supply network, automation, rehabilitation of the Saksala groundwater intake plant and construction of new office space. The combined turnover of five years was invested in six years.

The first wastewater treatment plants of Porvoo, in Hermannisaari (rural district) and Kokkonniemi (the city), were built in the early 1970s.

The first wastewater treatment plants of Porvoo, in Hermannisaari (rural district) and Kokkonniemi (the city), were built in the early 1970s. The joint treatment plant considered already at that time ran aground. Finally, in 2001, a new joint wastewater treatment plan was completed in Hermannisaari, an activated sludge plant with two process lines. The biological oxygen demand (BOD_7) loading of the sea area off Porvoo in 2000 was a seventh of what it would have been without the wastewater treatment plants.

ORGANISATIONAL CHANGES

From the early days Porvoo Water and Sewage Works has managed to have relatively high autonomy. This has been the case independent of the branch of administration, committee or board it has operated under. Administratively the sewage works was under a construction bureau or equivalent until the mid-1970s. The networks for larger housing projects have, naturally, been built in cooperation, which has also been practiced in other daily activities. Table 3 summarises the organisational changes during the 90 years towards a more autonomous water utility taking also care of sewerage.

In May 2003 the name of Porvoo Water and Sewage Works was shortened to Porvoo Water. In that connection a board was also appointed for it. The name change reflects the semantic change in Finland – the desire to make communication easier. The general trend in Porvoo as well as the rest of the country has been toward integrated water and sewage works which, in many senses, is well grounded.³⁵

ASSESSMENT OF UTILITY DEVELOPMENT

An overall summary of the development of water supply and sewerage systems in Porvoo from the late 1800s to the 21st century, in a form of a simplified map, is shown on figure 4 and 5.

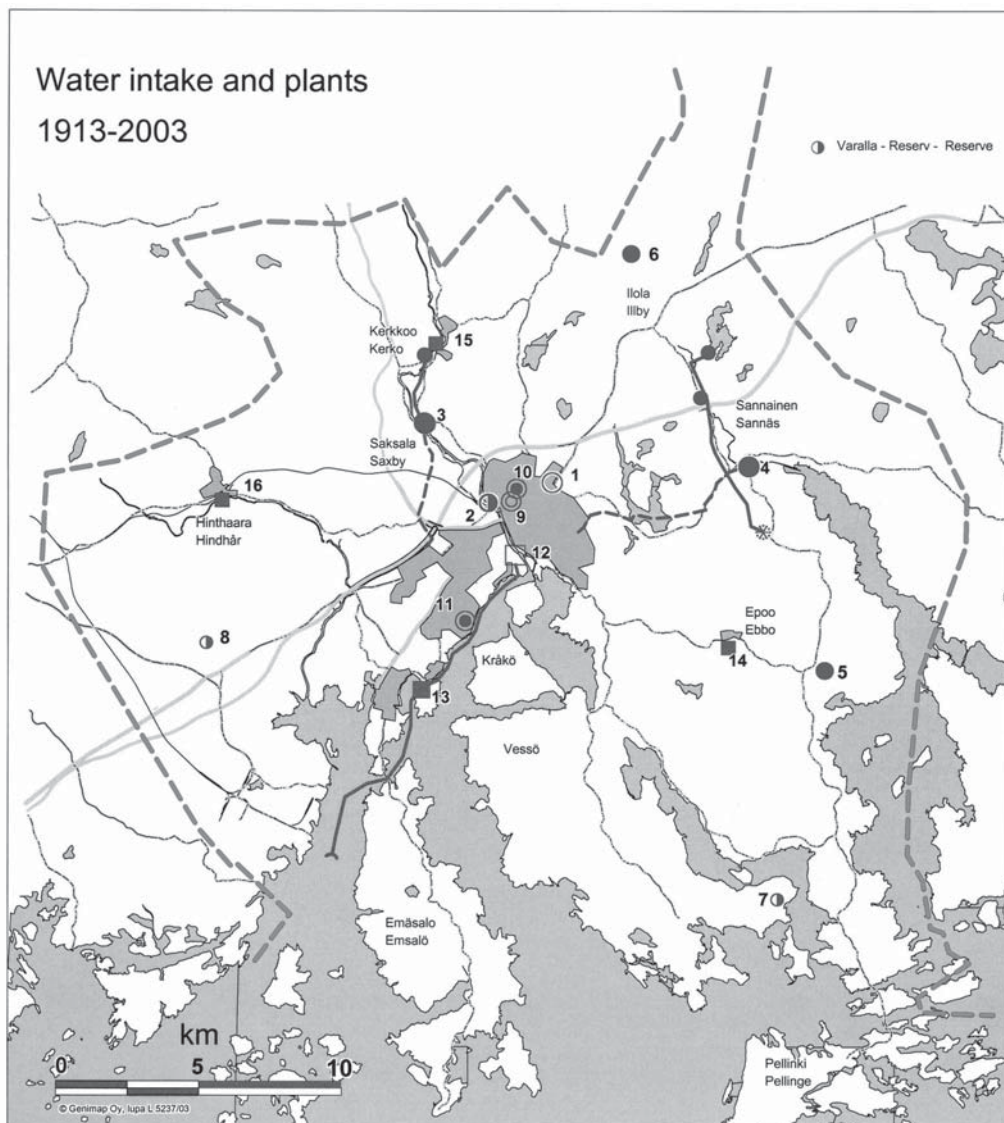
1912– 1913	Construction committee or water pipe committee -water distribution started in February 1913
1914	Executive committee of technical works -electric works -water works
1965	Municipal water and sewage works started operating in Porvoo rural district -until 1975 water was purchased from the City of Porvoo. Throughout that period the business was transacted under a technical committee and the technical department. A technical committee was established in the early 1960s.
1966	Technical committee -electric works -water works -construction bureau which became a technical office with its sub-divisions
1975	From water works to water and sewage works -sewerage was earlier under the construction bureau
1976	From electric works to energy utility
1985	Town planning and real estate committee established Technical committee supervised: -energy utility -water and sewage works -planning, construction, forest and parks divisions of technical office
1991	Technical committee supervised: -energy utility -water and sewage works -technical service and construction division of technical office
1992	From energy utility to municipal company (Porvoo Energy Ltd)
1993	The technical and fire committee supervised: -fire department -water and sewage works -technical service and construction division of technical office
1994	Board of water works (rules and regulations on 1.11.1994) -technical committee acts as the board of water works -water and sewage works to waterworks (name changes)
1997	Merger of municipalities -waterworks and its board (rules and regulations on 27.1.1997) -technical committee acts as the board of water works
2001	Board of public utilities (separate body with five members) -waterworks, and waste management works (regional waste management company starting on 1.1.2002)
2003	Board of waterworks – Porvoon vesi - Porvoo Water

Table 3

Key organisational changes related to Porvoo water and sewage works, 1912-2003.



Figure 4
Water and sewerage services in 2003 in Porvoo.
(Porvoo Water)



Groundwater intake

- 1 ○ Kaupunginhaka - Stadshagen 1913 - 60
- 2 ● Linnanmäki - Borgbacken 1923 - 82 -
- 3 ● Saksala-Kerkkoo 1975 - Saxby-Kerko
- 4 ● Sannainen - Sannäs Artificial groundwater 1982 -

- 5 ● Norike 1971 -
 - 6 ● Ilola - Iliby 1985 -
 - 7 ● Sondby 1987 -
 - 8 ● Mickelsböle 1975 -
- Water tower**
- 9 ○ Vanha torni - Gamla tornet The old tower 1913 - 66
 - 10 ● Myllymäki - Kvarnbacken 1966-
 - 11 ● Slatberget 1977-

Wastewater treatment

- 12 □ Kokkonniemi - Kokon 1973 - 2001 Pumping station 2001-
- 13 ■ Hermanninsaari - Hermansö 1974 - 2001 The new plant 2001-
- 14 ■ Epoo- Ebbo 1972 -
- 15 ■ Kerkoo-Kerko 1984
- 16 ■ Hintahaara - Hindhår 1967-

Figure 5
Water intake and plants 1913–2003.
(Porvoo Water)

The development of water supply and sewerage in Porvoo can be reviewed on the basis of the five key principles presented by Professor D. Okun, a U.S. sector expert:

1. Projects are *one-off* by nature: the optimal solution for each water-related problem is unique, and stereotype solutions may prove costly.
2. *Effectiveness and scale*: technical problems related to water supply or wastewater removal are as complex with small as with large systems. However, technical problems related to small systems are often more difficult to solve.³⁶
3. *Integration* of water supply, sewerage and environmental monitoring: as cleaning of wastewaters becomes increasingly effective, wastewaters of the past become important water sources. The wastewaters of one community may be the water resources of another, rather than problems, if all possibilities are effectively utilised.
4. Sustainable “*housekeeping*”: the role of water supply and sewerage has changed from being primarily a provider of public health and well-being to a public utility. Thus, the financing philosophy has also evolved towards charging consumers for services received. In order to be able to maintain the quality of water supply and sewerage services, the fees must cover the actual expenses and all consumers are to be treated equitably.
5. In the case of domestic water, priority must be given to *clean over polluted water abstraction sites*: even if polluted or otherwise low quality pools of raw water could be treated to render them satisfactory for use, it is better to use such waters, for instance, for industrial or other needs that do not require top quality. The highest quality water should be reserved for domestic consumption – such as groundwater. By doing so we can avoid unknown health risks that may be present in low quality treated water – for instance, due to chemicals.³⁷

Okun’s first principle was applied successfully in Porvoo. The expertise of the director of Helsinki Water Works, the engineer Albin Skog, was utilised and adapted to the conditions of Porvoo. However, the dimensioning of the first water intake plant in Kaupunginhaka was off. The estimates of designers and experts about the growth of the city and the related capacity and expansion needs of the waterworks were too low, and the planning of an expansion had to start almost immediately.

The second principle applies to the several *water cooperatives* that have cropped up in the rural district since the late 1990s, to which the works sells water. A joint water and sewage works for the entire area would, however, be too expensive at today’s population density.

Environmental monitoring mentioned in connection with the third principle began in its earliest form in Finnish cities with the enactment of the 1879 Public Health Decree. It required, for instance, the city to measure the relative elevations of different city areas which was a precondition for sewerage planning. Health and environmental issues were the responsibility of a board of health which also saw to it that good quality water was provided for the inhabitants. *Water charging*, according to Okun’s fourth principle, was based on metered consumption from the beginning. This allowed rational development of the works which, in the light of examples, would likely have failed with different charging principles. An exception were public standposts, which had

been in use for tens of years, and gave water against payment of a fixed water fee. The works operated this service at a loss, but it introduced equality into the distribution of water for citizens before the piped network reached the working class neighbourhoods.

The fifth principle, utilisation of groundwater, was the right solution in light of what was known then. The later problems with iron and salt showed that solutions that appear indisputable are not necessarily sustainable over the long term, but one must be prepared for surprises. The Linnanmäki water works built in 1924 eliminated the old water shortage problem, but quality problems remained a nuisance for decades. It can be said that perpetual quality problems were solved only by the completion of the Sannainen artificial groundwater plant in 1982 which did away with the “beer-coloured” water. The so-called VYR equipment installed in Linnanmäki plant in 1971 also turned out to be a temporary solution – it saw daily use for only about three years.

... the state of the environment in Porvoo had deteriorated quickly endangering the health of the population. The waterworks and the sewerage system improved the condition of the built environment.

Prior to the establishment of the waterworks, the state of the environment in Porvoo had deteriorated quickly endangering the health of the population. The waterworks and the sewerage system improved the condition of the built environment. Because a wastewater treatment plant was not built initially, domestic wastewaters loaded the environment. Since the city started treating wastewaters in 1973, and the new Hermanninsaari wastewater treatment plant was completed in 2001, the pollution load on water bodies from domestic wastewater has decreased significantly. Increased population and a higher living standard were a danger to the environment and people’s health also in the rural district: e.g. in 1968 only half of the wells contained water of good quality and the swimming waters were

polluted. The situation in the rural district started to improve slowly after the first Hermanninsaari wastewater treatment plant started operating in 1974.

The majority of the people were no longer faced with a water shortage after the completion of the first waterworks in 1914, but the needs of the growing population and increasing demand could not be satisfied until 1924. Water quality problems came to a head in the 1960s and ’70s as the network reached the age when rehabilitation became necessary. For consumers this meant an extra drawback: e.g. the service life of hot water boilers was very short. These problems were eliminated by the new Sannainen plant in 1982.

An artificial recharge basin was built in Linnanmäki in 1972 on the assumption that the high salt content was due to excessive water abstraction. Infiltration provided additional groundwater for the city’s needs, although the use of a recharge basin was not without problems. In 1977 a new infiltration area built near the railway station in Hattula was taken into use. This infiltration experiment, as well as the third and last one in the field between Linnanmäki and Orvokintie, failed. Infiltration did not have the desired effect since the quality of the water of Porvoo River was found too low to be used as raw water for artificial groundwater. The Sannainen plant completed in 1982, however, eliminated this problem.

The city and the rural district have cooperated in water supply and sewerage for half a century. Initially, the rural district purchased water from the city for its growing population centres at an increasing rate, but in 1975 the situation was reversed on the completion of the Saksanniemi groundwater intake plant. Water issues played a quite significant role in the municipal merger. The decision was a good one for the environment.

After the merger of the municipalities in 1996, the following factors have received emphasis in the operation of the water works:

- its role as a public corporation
- own, separate board and new premises
- strong focus on rural water supply
- Uusimaa Regional Environment Centre as a state authority and channeller of funds (e.g. in the Hermanninsaari project and rural water supply)
- the favourable publicity received by the Hermanninsaari project
- the stable finances achieved, for instance, by improving tariff structures
- development of land use and quality of the environment
- assistance to the founding of water cooperatives in sparsely populated areas
- strong growth of network and levelling off of water consumption growth.

FUTURE CHALLENGES

In the new millennium we must still keep in mind the threats to groundwater. In the new Porvoo, investments in water supply and sewerage as well as the environment are record high. The total costs of the Hermanninsaari wastewater treatment plant were about 17 million EUR. That is the largest investment ever made by the water works, and the city of Porvoo.

Prior to the inauguration of the new Hermanninsaari wastewater treatment plant, the City of Porvoo accounted for the following shares of the controlled total loading of the sea area off Porvoo: 6.9 percent of the nitrogen, 2.1 percent of the phosphorus and 7.0 percent of the BOD₇. Thanks to the effective operation of the new treatment plant, it is hoped that the above figures will be reduced to under three per cent for nitrogen, under two per cent for phosphorus and less than one per cent for BOD₇. Active water pollution control measures have and will be carried out to improve the state of Porvoo River and to reduce its loading of the sea area, and the impact of these measures on the sea area off Porvoo is expected to be strengthened by the increasingly effective treatment of the wastewaters of the City of Porvoo and the new discharge arrangement.

There is also a new situation with regard to water consumption. Throughout the early history of the waterworks, up to 1975, water sales increased. Thus, the waterworks did well financially, even though the city had a quite limited supply network. Water consumption levelled off as a result of the energy crisis and the wastewater charge introduced in 1974. Then, per capita living space began to increase in the city while family size gradually contracted. This meant that water sales no longer grew even as new buildings were erected. The revenue of the waterworks did not increase,

but it had to invest, for instance, in new networks. In the last six years about 1,000 new properties have been connected to the network, but investment has been limited to about 6.7 million EUR. The absolutely largest share of the waterworks' net worth is tied up in water supply and sewerage networks. They are part of the "invisible" city which is why their true significance may often be forgotten.

During the autumn season of 2002 the Porvoo region as well as most of the country experienced an exceptional lack of autumn rains resulting in lowered groundwater levels and lack of water in rural areas. This also affected the production of artificial groundwater.

In January 2003, almost exactly 90 years since the first waterworks commenced operation, the importance of the invisible city was dramatically proven. Two exceptionally large pipe bursts occurred in the main water supply network resulting in problems with iron and manganese levels in the city. Something like this should not happen in a network only 20 years old, but anything is possible as concerns human activities.

Due to the burst pipes an auxiliary water intake plant, for instance, had to be taken into use, which the works luckily was prepared for. Combined with the changes in flow directions this resulted in bad tasting and discolored water. Deposits accumulating in networks form plugs which in situations like this work loose, but may yet be quite local. In any case, this serves to remind how vulnerable systems like this can be. This stresses the need of anticipating possible risks, preparing for them, and preventing them to the extent possible. After all, most of the capital of water and sewage works is tied to networks – the invisible city.

While finalising this article the utility ran a vision and strategy process and identified four key foreseeable strategic issues that have to be addressed. First, *organisational development*: the present organisation formed through the merger of the two municipalities needs to be reassessed. Second, the *management of the network* is a challenge in terms of breakdowns and water quality. Third, *the rural areas* will present a challenge to organised sewerage services. Fourth, the *economy and tariff structures* need to be evaluated for current and future needs.



Figure 6
Two old wells in Porvoo, the one on right still exists in City Park.
(P.Juuti)

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WATER NATURALLY
WATER SUPPLY AND SANITATION
IN KANGASALA, 1800–2000

PETRI S. JUUTI & TAPIO S. KATKO

Juuti P.S. & Katko T.S. (2003).

From wells and yokes to inter-municipal water supply and sanitation for a ribbon development Kangasala.

Modified from the original summary chapter of the book: Juuti P., Äikäs K. & Katko T. (2003).

“Vettä luonnollisesti” [Water naturally. Kangasala water utility 1952–2002]. 201 p. (In Finnish, Summary in English).

ABSTRACT

This paper describes the evolution of water supply and sanitation services in Kangasala municipality, Finland – some 150 kms north of Helsinki, the capital and just east of Tampere, the third biggest city of Finland.

In Kangasala, water supply and sanitation has been implemented through different types of organizations over the years. The sector has developed gradually as have the organizations responsible for it. Initially there were farm-specific systems, small companies and cooperatives in several areas. A water and sewerage cooperative came into being in the church village; it later became the municipal water and sewage works. However, cooperatives operated alongside them and merged or otherwise disappeared from the scene as municipal water and sewage works evolved. Gradually intermunicipal cooperation also emerged, at first in water pollution control, and later in water supply. By 2002 four out of five of the 22,000 inhabitants of the municipality of Kangasala use its water supply and sanitation services daily

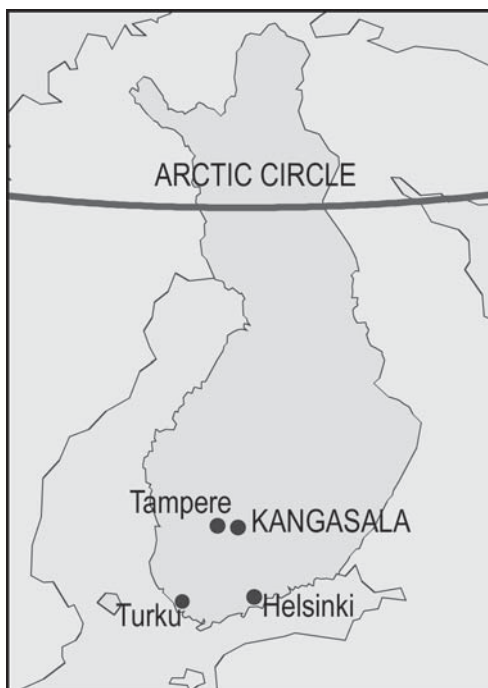


Figure 1
Location of Kangasala.

INTRODUCTION

The decision by the Kangasala Municipal Council on 31st May 1952, the year Finland hosted the Summer Olympics, directing the municipal government to organize the water supply and sanitation of the church village is considered to mark the beginning of water supply and sewerage there. This paper deals with both water supply and sewerage – starting from individual and small systems from the early 20th century and expanding gradually within the municipality and even in connection with its neighbouring municipalities.

The research has relied on archival sources as well as the local newspaper, *Kangasalan Sanomat*, a history of the municipality, village-specific histories, and interviews of several past and present employees of the works.¹

The chain of eskers traversing Kangasala winds its way from Kirkkoharju esker via Keisarinarju esker to Vehoniemenharju esker, which is a nature preserve. The nature of Kangasala includes nearly all features found in Finland: pleasant expansive fields, tall ridges, lakes small and large, waterfowl habitats and forest pools, pine bogs, expanses of coniferous and deciduous forests. Lakes, especially, are characteristic of the local landscape – a quarter of its area is covered by water (Fig. 2). The municipality has more than one hundred lakes. Kangasala locates near by The City of Tampere, a neighbouring municipality to the west.

FIRST ATTEMPTS AT ORGANIZING WATER SUPPLY AND SANITATION

The earliest sources of water supply in Kangasala were springs and wells (Fig. 4 & 5), but surface waters also had to be used in times of drought. Then, various types of simple piped systems started appearing on manors and larger farms. House owners also started to establish small associations in the early 20th century for the purpose of building wells.²

The conditions in some parts of Kangasala did not allow building wells. One such area was the church village where different types of well associations sprung up, another was the Ilkko area further away from the municipal centre where groundwater lay quite deep. The well-based system remained the primary form of water supply for several decades to come, although primitive piped systems also existed. Manors, hospitals, schools and other large consumers of water had their own small works or highly productive wells.³

The Tulenheimo manor in the church village had its own small-scale piped water system already at the turn of the 20th century. It drew water from a deep driven well on its own land. The large Lihasula farm in the northern part of the municipality led water by gravity via wooden pipes to the cowshed, stable and the main building of the farm already in the mid-1890s. As consumption increased, water was drawn from Lake Vesijärvi starting in the 1930s. The water was pumped by a wind engine into a 25-cubic meter tank on top of a hill.⁴

Kangasala municipality started first to supply water to its own units. Various regulations had already earlier been enacted to promote fire safety. Fire safety was the first concern immediately followed by water supply, sewerage and public hygiene. Wells played a central role in school development projects. One task of the Municipal Building Board was to oversee that public building projects, including their wells, were properly implemented in the early decades of the 20th century. The work was contracted out and its quality was monitored closely. The quality of the water in wells was also tested regularly.⁵

In 1927 the Kirkonkylän Vesijohto Osakeyhtiö (Church Village Water Pipe Co.) was established. Later it became known as the Tulenheimo Water Co. in which the municipality was also involved. The waterworks comprised a small pumping station on Lake Ukkijärvi, a 2-inch galvanized water pipe, a small water tank and a distribution network. Initially water was drawn directly from the lake, but later a well was built on the bank. Part of the water issued from an esker while the rest was absorbed from the lake through bankside gravel strata. The Tulenheimo Works served large water consumers and some houses. It played a major role in the development of municipal water supply and sanitation, though it did not supply water to the entire church village. The time of the modern conveniences of central heating, piped water and inside WCs was still far away. Only in 1936 did the first house receive such conveniences.⁶

POPULATION GROWTH

The population of Kangasala increased slowly until the 1940s, but in the aftermath of WW II over a thousand Karelian immigrants moved there. In 1949 the population exceeded 10,000 – it more than doubled in 50 years. Between 1940 and 1975 the population increased 2.5-fold. Accelerating population growth combined with the severe unemployment of the 1950s increased pressure to provide water supply and sanitation services (Fig. 3).⁷

In densely populated communities the lack of sewerage contaminated wells which also ran low. The isolated problems which occurred in the early decades of the 20th century, which the Board of Health attempted to control and eliminate, had grown into a serious problem. As the population continued to grow, it became a major issue of municipal administration. The requirements and needs of fire safety also become clear from the articles written for Kangasalan Sanomat during that period.⁸

MUNICIPAL WORKS

In 1952 the municipal council decided that something had to be done about water supply and sanitation. The Board of Health also started paying attention to the contamination of groundwaters. The need for sewerage services was apparent since Tulenheimo Water Co. did not provide them and it was feared that the source of water supply, Lake Ukkijärvi, would be contaminated by the waste carried by surface waters and discharged by the sewers of buildings on the shore.⁹

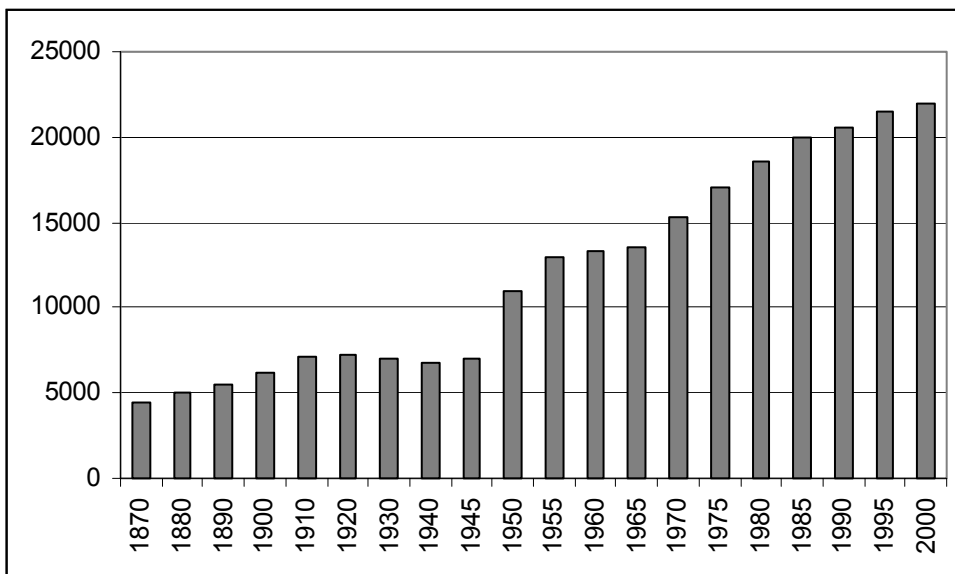


Figure 3

The population of Kangasala 1870–2000. After WW II population increased rapidly when over 1000 Karelian immigrants moved there.

In 1953 a decision was made to establish the Kangasala Water and Sewerage Cooperative or the so-called “smelly cooperative”. The municipality was the majority shareholder in this cooperative. The water supply and sanitation plan of the municipality was completed the next year. At that time the population stood at 13,000. The first stage of the Lake Ukkijärvi groundwater intake plant was completed also in 1954, and work on the Kirkkoharju elevated tank and Emscher tank was launched. It was decided to sell the Tulenheimo Water Co. to the Kangasala Water and Sewerage Cooperative. The distribution network of the cooperative was preserved and it started drawing water from the well of the new cooperative.¹⁰

In addition to a water pipe, the cooperative started building a primitive mechanical wastewater purification plant, a so-called Emscher tank. The construction of a main sewer line was hastened on by the completion of a secondary modern school building and the need of sewer connections by a state-subsidied block of flats, the cooperative store and the savings bank. The situation was critical especially as concerns the block of flats – if the wastewaters could not have been led into a sewer they would have contaminated the new well. Kangasalan Sanomat considered a sewer system indispensable. Financing for water supply and sanitation projects was drawn from different sources: own funds were complemented by state subsidies and the municipality’s unemployment reserves. Loans were also taken from local banks and the Social Insurance Institution.¹¹

The first stage of the water system was inaugurated in January 1955, at which time the Tulenheimo Water Co. was merged with Kangasala Water and Sewerage

Cooperative. Water was drawn from two wells on the shore of Lake Ukkijärvi. The new water pipes were dimensioned according to the fire hydrants so that two parallel hydrants would provide 15 litres of water per second. The feeder pipes of the former Tulenheimo Water Co. to the Kirkkoharju elevated tank had to be replaced with larger ones. In order to meet fire safety requirements, a new 300 cubic metre water tank was built atop the esker. It was later expanded to twice its original size. The tank produced a pressure corresponding to a 40–80 metres head.¹²

The main construction phase of the actual municipal water supply and sewerage works coincided with the major relief work periods in the 1950s and '60s. Public works eased the severe unemployment in the municipality and provided infrastructure. A study completed in 1957 found that the condition of the municipality's wells was merely satisfactory.¹³

By a decision of the municipal council on 7.3.1959 the main responsibility for water supply and sanitation transferred to the municipality, and a municipal water supply and sewerage works was established. The works implemented major water supply and sewerage projects in the western Vatiala part of the municipality, although the Ilkko Water Cooperative having operated there remained active alongside the municipal works until 1966. Several people worked for both the municipal and the cooperative organisation simultaneously. However, the cooperative society was financially unable to deal with the tighter wastewater purification requirements or build long transfer lines. The cooperative was finally merged operatively with the municipal water supply and sanitation works in 1974 and administratively two years later.¹⁴

Figure 4
A well with counterpoise
lift.
(P. Juuti)



ENVIRONMENTAL CATASTROPHE LED TO MUNICIPAL COOPERATION

In 1959 the municipal council decided that a separate biological wastewater treatment plant would not be built at the eastern end of Lake Pitkäjärvi, but that instead the sewage of Vatiala, Lentola and Suorama and Pikonkangas would be led via a pumping station to a trunk sewer leading to Lake Kirkkojärvi. The aim was to keep Lake Suoramanjärvi, Lake Pitkäjärvi and Lake Kaukajärvi clean of sewage as they were the only lakes suitable for recreational use in areas of population concentrations. The City of Tampere, a neighbouring municipality to the west, also adamantly opposed leading sewage into Lake Pitkäjärvi or Lake Kaukajärvi. It was also deemed that Lake Kirkkojärvi was already so contaminated that it did not have the same recreational value as the other lakes. Consequently, it could receive even more sewage.¹⁵

The municipal council approved the leading of sewage to Lake Kirkkojärvi on the condition that a mechanical treatment plant be built on the shore immediately. It also insisted that a pumping station be built by the plant to carry the treated water into Lake Roine. This idea was, however, never realised since the City of Tampere was planning to take its raw water from the same lake.¹⁶

A plan for conducting sewage was also on the agenda of the council meeting on 7.3.1959. Mr Väinö Pälli, a bank manager, predicted that Lake Kirkkojärvi would become polluted and was right on the mark, unfortunately.

Mr Väinö Pälli, a bank manager, predicted that Lake Kirkkojärvi would become polluted and was right on the mark, unfortunately. Lake Kirkkojärvi would become polluted and was right on the mark, unfortunately. Studies supported his views: the first signs of water pollution were apparent already at the end of the 1950s. In the early spring of 1961 oxygen depletion was detected in almost every part of the lake. Fish-kill occurrences were also noted.¹⁷

The final decision to build a wastewater treatment plant on Lake Kirkkojärvi was made in June 1959. Sewage from the Pikonkangas direction and, somewhat later, also from Vatiala was led there. The plant was dimensioned for the sewage of 4,000 people. It treated sewage only mechanically; it was then led via the Supanoja ditch into Lake Kirkkojärvi. Septage was also transported to the plant. Lake Kirkkojärvi could not take the effluent load and was consequently damaged, partially irreversibly. Yet, it must be kept in mind that the municipality acted lawfully and that the practice was not exceptional in Finland at the time.¹⁸

Various developments led to all municipal wastewaters being pumped since 1980 via a transfer sewer to the main wastewater treatment plant of the City of Tampere completed in 1973. It was later expanded into a chemical treatment plant in 1976 and into a biological-chemical plant in 1982.¹⁹

While the decision makers of Kangasala pondered sewerage solutions, those of the City of Tampere faced problems related to water supply: Lake Näsijärvi, the old raw water basin, had been contaminated especially by forest industry wastewaters which necessitated drawing water from some other source. At the end of the 1950s all eyes turned to Lake Roine in Kangasala. Its use was first suggested in December 1959. The project was given impetus by the water quality survey of Lake Näsijärvi released in

1962 which showed that the southern part of the lake was contaminated by sulphite lye. Initially, Tampere was unable to draw water from Lake Roine as the city could not buy land on the lake.²⁰



Figure 5

Nostalgic new well in Kangasala. Outside of centres old methods are still in use.

(P. Juuti)

The municipality of Kangasala offered Tampere the chance to buy an area of land for a water intake plant; the deal was made in 1968. Lake Roine, which is part of the Längelmävesi watercourse, was selected as the source of water supply since the water was of good quality and the satellite city of Hervanta planned for the southeastern part of Tampere needed much water. The city's water intake plant on Lake Roine and a water treatment plant on city land in Rusko were completed in 1972. The launch of the Rusko water treatment plant changed water supply greatly in Tampere. As water intake from Lake Näsijärvi was later discontinued, intake of groundwaters was increased. The first plan for broader intermunicipal cooperation was devised in 1972. The first general plan for water supply to Tampere and Valkeakoski, TAVASE, was drafted in 1993. It covered some ten municipalities. The idea of creating artificial recharge for the needs of the entire area also emerged.²¹

The construction of Kangasala's water supply and sanitation culminated in the early 1960s and continued until the late 1970s. Sixty percent of the network in use at the writing of this account in 2002 was built in 1962–1977. The period of economic growth required heavy investment by the municipality in district development which increased construction of water supply and sanitation facilities. The year 1971 broke all records in the construction of water supply and sanitation – over nine kilometres of water pipes and more than eight kilometres of sewage pipes were built in addition to a water intake plant.²²

A key principle in Kangasala, and more broadly in Finland, has been that municipality-owned water and sewage works have bought – and continue to buy – contracting, design and expert services from the private sector based on competitive bidding. The essential factor is that these services are of one-off nature instead of more longer term operating contracts.

RESIDENT PARTICIPATION AND SOLUTIONS FOR SCATTERED SETTLEMENTS

Residents' associations have been active thereby forcing water supply and sanitation on politicians' agendas. At the end of the 1960s and early 1970s sewers were also demanded in addition to water pipes. People started opposing the contamination of Lake Vesijärvi since wastewaters of the Ruutana residential area about 10 kilometres from the centre of the municipality ran into it. The situation was much the same as in cities at the beginning of the period of strong growth: human habitation polluted wells since appropriate sewerage did not exist, and what little water there was threatened to dry up. Although the time and place have changed, we are talking of a similar phase in communal development: population density and standard of living increased along with consciousness about the state of the environment.²³

About four-fifths of the population of Kangasala lived in built-up areas at the start of the 21st century. A ribbon development formed along the road to Tampere by Kirkkoharju esker. Ribbon-like water supply and sewerage trunk lines were completed towards the end of the 1970s. A major trunk line was built in 1995 in order to provide a connection to the network of the City of Tampere primarily for emergencies. The northern sections of Kangasala – Suinula, Onkijärvi and Haviala – received trunk lines towards the end of the 1990s. Ecologically sustainable human habitation is promoted by the municipality: the residents of the Riku Eco Village are responsible for their wastewater treatment on site.²⁴

The numerous lakes and long shoreline of the municipality have influenced its settlement greatly. It is in the best interest of the municipality to see to it that the lakes remain in good condition. It is in the best interest of the municipality to see to it that the lakes remain in good condition. settlement greatly. It is in the best interest of the municipality to see to it that the lakes remain in good condition. This in mind, different solutions have been developed for water supply and sanitation in dispersed settlements including the so-called mobile sewer: an information technology-based septic tank emptying system. In an extensive and dispersely populated area it is not possible to connect each property to a centralised water supply and sewerage system at reasonable cost. (Fig. 6)

FROM WELLS AND SHOULDER YOKES TO INTERMUNICIPAL WATER SUPPLY AND SANITATION FOR A RIBBON DEVELOPMENT

In Kangasala, water supply and sanitation has been implemented through different types of organizations over the years. The sector has developed gradually as have the organizations responsible for it. Initially there were farm-specific systems, small companies and cooperatives in several areas. A water and sewerage cooperative came into being in the church village; it later became the municipal water and sewage works. However, cooperatives operated alongside them and merged or otherwise disappeared from the scene as municipal water and sewage works evolved. Gradually intermunicipal cooperation also emerged, at first in water pollution control, and later in water supply.

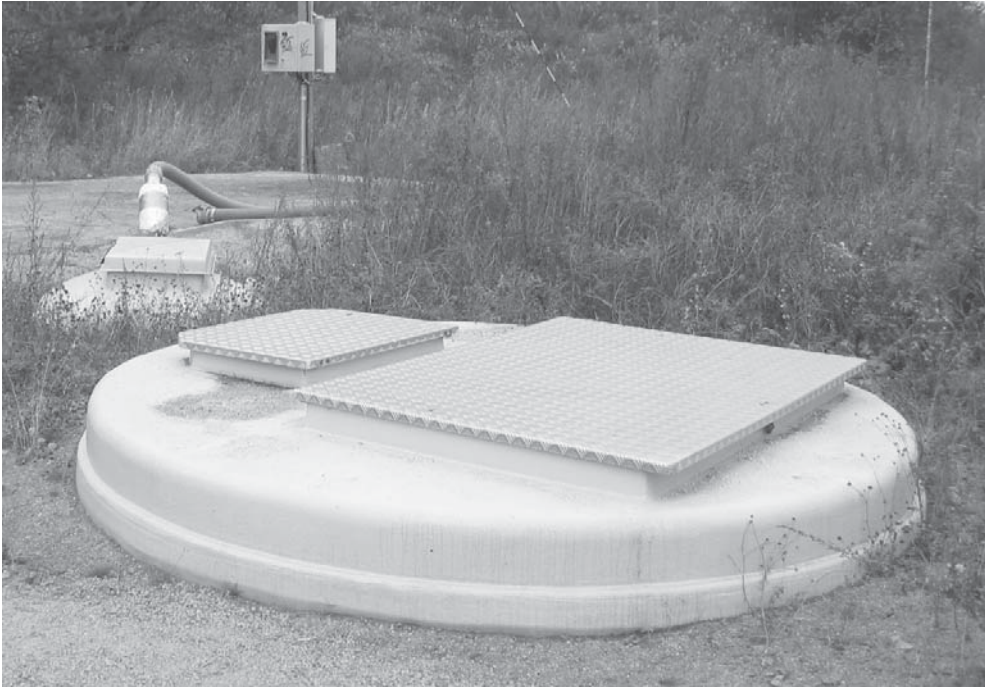


Figure 6

Mobile sewer: an information technology-based septic tank emptying system.

(P. Juuti)

Solving of the major issues concerning water supply and sanitation will require major investments including organising the services for sparsely populated areas. Various development projects provide a good example. Clean water and wastewater are nevertheless tied together. Inadequate sewerage may also lead to contamination of clean water. Mr. Taisto Lahtinen, an engineer, stated in 2002: “In district development water and sewer lines should always be laid at the same time”.²⁵ Where it is not possible to build sewerage, other alternatives must be provided.

Good results have been achieved in water protection as a whole. Yet, earlier discharges of wastewater, e.g. into Lake Kirkkojärvi in Kangasala, or measures such as lowering the water level of lakes, unavoidably affect their present and future state. The incorporation of water and sewage works also introduces new challenges.

In 2002 four out of five of the 22,000 inhabitants of the municipality of Kangasala used its water supply and sanitation services daily. Community water supply and sanitation probably touches the lives of more municipal residents than any other public service. An intermunicipal project is under planning (2004 to 2005) to use Vehoniemi esker to create artificial recharge to provide groundwater for about 200,000 people. Historically, inadequate purification of wastewaters and their discharge into small lakes has been opposed – even on quite good grounds. Time will tell whether sustainable grounds will be found for opposing improved tap water.

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PART III

LESSONS LEARNT AND POLICY IMPLICATIONS

“What is needed, along with fresh water, is fresh thinking. We need to learn how to value water. It is one of the crueller ironies of today’s world water situation that those with the lowest income generally pay the most for their water.”

Kofi Annan, Secretary-General of the United Nations

WATER POLLUTION CONTROL AND STRATEGIES IN FINNISH FOREST INDUSTRIES IN THE 20TH CENTURY

TAPIO S. KATKO, ANTERO A. O. LUONSI & PETRI S. JUUTI

Katko T.S., Luonsi A.O. & Juuti P.S. (2003).
Water Pollution Control and Strategies in Finnish Forest
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Forest Industry in Retrospective: Evolution and
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Submitted to Scandinavian Economic History Review.

ABSTRACT

The paper discusses and analyses the evolution of Finnish forest industries and their water pollution control. The Finnish pulp and paper mills are mainly located along the water courses in inland areas. The earliest documents on water pollution date back to the early 1900s. In spite of the remarkably good record during the recent decades in water pollution control, it can be found among significant strategic decisions only in very few cases.

BIRTH AND EVOLUTION OF FOREST INDUSTRIES IN FINLAND

Large-scale industry started to develop in Finland in the mid-19th century. Forest industries were established along rivers where they could utilise hydropower.¹ The production of sulphate and sulphite pulp started in the 1880s.² Railways connected factories to the coastal harbors and to the main market of forest industries of that time in St. Petersburg.³ Sawmills were established in several old towns like Oulu, Pori and Vyborg. A number of new industrial communities like Karhula, Kuusankoski, Mänttä, Nokia, Valkeakoski and Varkaus were established in the countryside. All of them relied extensively on the sawmill and forest industries.⁴

Most of these industries were located along the inland waterways which was advantageous from the point of view of the location of forest resources, timber floating, energy as well as access to good quality process and cooling water. However, at same time the water quality of the water bodies nearby and downstream started to deteriorate.

Industrial use of water increased gradually and the forest industries, in particular, needed a lot of water. Starting in the 1930s, large wooden water pipes were constructed to provide that need based on Norwegian know-how.⁵ The total amount of water used in industries increased continuously till the late 1980s.⁶

By the late 1800s industrial wastewaters were not the subject of public debate although city boards and boards of health paid attention to the worst polluters. Bigger problems were seen elsewhere like in air emissions. By the early 1920s *Aamulehti*, a newspaper based in Tampere, had made only a few occasional remarks concerning industrial wastewaters. Even till the early 1900s industrial wastewaters were considered beneficial in that they contained alkaline and mineral substances killing bacteria. They were deemed to hinder the spread of typhus while harmful wastewaters were also recognized. Typhus was made worse by wastewaters from pulp and paper mills, since *“these could be used as substrate by typhus bacteria”*.⁷

EARLY DETERIORATION OF WATER QUALITY

In 1907 a sulphate pulp mill was planned close to the city of Kemi. Expected loadings were commented on by the local newspaper:

“Does anybody think that salmon or white fish, or the lesser gourmets perch or even pike will ascend the river Kemijoki, when they face water laden with dirt and waste from the factories at the estuary. As for the smoke, it smells so strongly of rotten eggs that e.g. the residents of Hamina speak about the odours of Kotka.”⁸

In 1908 a national committee was established to review the environmental problems caused by sulphate pulp mills. Its report came out the following year.⁹ Air emissions were considered a major problem while water-related pollution was considered of secondary importance. The committee recognized also the harm caused by wastewaters to fisheries, while black liquor and turpentine loadings were not considered harmful to human health.

The committee was a pioneer in identifying environmental problems caused by industries. Committees had been set up earlier to assess water pollution but they had concentrated on the conflicts between various types of sectors of the economy.¹⁰

Mr. T. Hirn, a member of the committee, visited Norway and Sweden as well as Finnish sulphate pulp mills in Lahti, Lohja, Kotka and Valkeakoski to evaluate their know-how. The report and draft act proposed by the committee were considered controversial. The proposal was accepted a decade later as part of the Adjoining Properties Act.¹¹ In the draft Act the committee wanted to protect the neighbours of industrial and storage activities from harmful effects. The Association of Finnish Technicians¹² criticized the proposal because it placed the industry also “technically” under the control of local authorities, and thus made them dependent on the assessment and decisions of people without professional competence.¹³

In the 1930s, for instance in the Tampere region, industries paid attention to the water bodies: many of them used the services of the laboratory of the Board of Health for analysing their raw water quality and their wastewaters. Yet, it was difficult for the Board to set requirements for industrial wastewaters, since cities discharged their wastewaters to water bodies untreated.¹⁴ However, the deterioration of water bodies around Mänttä sulphite pulp mill was discussed as early as in the 1930s.¹⁵

In the 1940s, after the WW II, the quality of water bodies and the need for water pollution control was described by the professional journal, *Kunnallistekniikka*¹⁶ as follows:

“We have made severe mistakes in our country by discharging large volumes of untreated community and industrial wastewaters to our water bodies. By doing so many swimming beaches, shores and rivers in communities have become polluted and constitute a health risk while also reducing the fish stock. Therefore, we need new legislation in the near future to prevent the pollution of water bodies. The situation is worst in the basins of our three biggest rivers serving industry - Vuoksi, Kymi and Kokemäenjoki where wood fiber, black liquor and other wastes cause depletion of oxygen in the waters.”¹⁷

The concern of professionals could be detected from newspapers like *Aamulehti* in March 1953¹⁸ as it explained planned water quality surveys on Lake Vanajavesi near the forest industry centre of Valkeakoski. The article was biting titled: “*Bad water management is worse than losing a war*”. The article pointed out how water bodies next to biggest communities had become alarmingly dirty. It also referred to toxic compounds that make water totally unusable.

In spite of restrictions and industries’ own actions, the pulp mills had polluted heavily Lake Näsijärvi and Lake Pyhäjärvi. Thus, Lake Näsijärvi, the traditional intake water body of the Tampere City Water Works was already badly deteriorated. Its water quality was so low that it was not possible to treat it with conventional chemical methods.¹⁹ A survey carried out in 1960–61 showed that the major polluters were sulphite pulp mills, like the one in Lielähti, that had operated since 1914. *Aamulehti*, the major newspaper, did not criticize the mill, but only wrote about its construction in a neutral way. *Kansan Lehti*, the working class newspaper, paid attention to air pollution and low housing standards. *Aamulehti* considered that it was beneficial for the city to reserve industrial sites along the watercourses.²⁰

WATER POLLUTION CONTROL BY LAKE NÄSIJÄRVI, TAMPERE

At the turn of the 1960s *Aamulehti* started to write about water pollution. Mr. M. Murto, the managing director of Tampere City Water and Sewage Works, had several articles published on the threat of industrial water pollution.²¹ In 1962 a Water Act came into force enabling the authorities to set legal requirements and time schedules for water polluters. The quality surveys in the 1960s showed the worsening condition of water bodies. Therefore, the relocation of raw water intake to lakes in Kangasala, east of the Tampere city, was discussed.

Changes in pulp mill production processes, ... as well as effective treatment of municipal wastewaters since late 1960s, improved the condition of water bodies.

Changes in pulp mill production processes, like alcohol production as byproduct in sulphite mills already before WW II, later transfer to sulphate pulp production with evaporation and incineration of black liquor as well as effective treatment of municipal wastewaters since late 1960s, improved the condition of water bodies. In 1971 the sulphite pulp mill at Lielahdi started to treat its wastewaters mechanically in a 50-m diameter sedimentation basin and sludge thickener. In 1972 an evaporator and a recovery furnace were completed whereafter some 85 percent of the black liquor was recovered. Yet, pulping and bleaching still caused environmental problems

and the mill was about to be closed.

In 1985 the pulp mill was replaced by the first so-called chemi-thermo-mechanical pulp mill in Finland. Biological activated sludge treatment for wastewaters was also introduced. This decreased wastewater load to one tenth. However, at the same time external energy consumption increased dramatically. This is due to the high yield for pulp, of the order of 90 percent, compared to chemical pulping where the yield is less than 50 percent and most of mill's energy, even surplus, can be generated from the wood itself. The reduced wastewater volumes were now treated in an activated sludge process which was constructed by utilizing the old big clarifiers effectively for primary sedimentation and aeration.²²

Industrial changes and new community wastewater treatment plants together soon brought about visible effects in the quality of water bodies. Within the Tampere water and environmental district of that time, the industrial BOD loading was reduced by over 50 percent from the early 1970s to the early 1980s. Except for the Lielahdi pulp mill, industries in the centre of Tampere discharged part of their wastewaters to the treatment plants of the city.²³

By 2000 Lake Näsijärvi was deemed oligotrophic – containing only small amounts of phosphorous – something that could not be foreseen in the 1960s.²⁴ One of the first tertiary treatment processes in Finnish forest industries that uses flotation to further reduce particularly the phosphorous loading has been inaugurated in Lielahdi in 2002.

Clear examples of the change in the water quality of waterways, which was earlier evaluated mainly on the basis of biological organisms²⁵, could be given only after the general classification of water quality involving chemical characteristics was taken

into use in the 1970s and developed into water quality maps. Therefore, only the age of heightened environmental concern can be seen from these descriptive quality maps. The change in quality criteria, e.g. introduction of nutrients to the chemical classification in the 1990s as well as some other technical changes like improved geographical maps have to be taken into account when comparing the water quality of different times. One of the most interesting changes has been the development of quality criteria. Following the biological criteria of the 1950s and '60s, chemical characterization took over due to the development of reasonably priced and easily utilizable methods of analysis. This period covered the last 30 years. Now we are again returning to biological criteria through the implementation of the Water Framework Directive of the European Union.

OVERALL WATER USE AND POLLUTION CONTROL BY FINNISH FOREST INDUSTRIES

In the mid-1960s people were still skeptical of the need and possibility of efficient wastewater treatment in Finland as shown by Box 1.

In the 1960s people did not generally believe in the need for and efficiency of wastewater treatment . For instance, it was stated that

“in most cases it will not be possible to improve the quality of the water bodies through wastewater purification. ... The question could easily be solved by discharging the loads to a few water bodies while leaving the majority of water bodies clean. ...Equal distribution is self-deception and will lead to the pollution of all water bodies. ...The majority of communities are situated close to the sea. ... By discharging the wastewaters to the correct site and depth they can be led untreated without major harmful effects.”

The latter option was supported in the debate. Yet, it was also noted that

“the presently almost self-evident limnological phenomena related to lake water deterioration were still largely unknown in the early 1950s”.

Industries considered it their weakness that they had no panacea to solve the problem.

“So far the volumes of solids and wastewaters from forest industries are so large that it will be possible to reach the goal merely by wastewater treatment only in exceptional cases. From the point of view of water pollution control this seeming disadvantage contains, however, also a positive feature. It makes us approach the problem from the angle of the only sustainable future view – reassessment of the importance of water to manufacturing processes and especially wastes.”

Thus, sustainable development was thought about already then...

Box 1

Can untreated wastewaters be discharged to the sea? discussion from the 1960s.

Source: Kujala E., Niemelä J., Malmi E., Voipio A., Jätevedet mereen – mitä sanovat teollisuus, kunnat ja vesientutkimuslaitos. Suomen kunnallislehti. Vsk. 51, 1966:3, 176–179.

Compared to communities, industries were late to start treating their wastewaters. Very few industrial plants engaged in mechanical and/or biological wastewater treatment in the 1940s and '50s. The food industry had several wastewater treatment plants constructed in the 1950s that used stabilisation ponds as well as mechanical and biological treatment methods. The food industry was followed by the leather industry that started to treat its wastewaters in the 1950s and '60s.²⁶ These industries normally performed pretreatment and were gradually connected to municipal wastewater treatment plants. On the other hand, forest industries started later to construct their own wastewater treatment plants.²⁷

Water Use

The efficiency of water use can be described by water consumption or wastewater discharged per produced unit. For instance, in 1972 the production of one ton of sulphate pulp required about 350 cubic meters of water and the-then common, but older, sulphite method used even more²⁸. However, water use rates of that time cannot be directly compared to those of the early 1990s, since pulp and paper mills have become more integrated. Thus, we know just the total wastewater volumes rather than individual fractions. Besides, it is difficult to estimate total water use reliably, because some figures include cooling waters while others do not. In the mid-1990s the best sulphate pulp factories used about 40 cubic meters of water per produced ton out of which bleaching comprised less than a half. In the case of mechanical pulp the figure was in the range of 10 cubic meters per ton. Thus, by the 1990s water use per produced ton decreased dramatically.²⁹

Figure 1 presents a summary of forest industry production and the effluent load on bodies of water from 1950 to 2001. The production of paper and board has grown over 10-fold and the production of pulp some 5-fold during the same period. Biological oxygen demand and the suspended solids discharged by the industry increased along with production until the early 1970s. An international comparison showed that, except for chemi-mechanical pulp and newsprint paper, Finnish forest industries used more water than industries in other OECD countries on average. The losses of solids in pulp production as well as BOD-load from kraft production were also higher.³⁰

After the sulphite pulp factories were closed, the amount of water used decreased, recycling of water was introduced and biological wastewater treatment was widely taken into use. The development has been particularly fast since the mid-1980s, when the forest industry started to build biological treatment plants. In most cases sedimentation was introduced in the 1960s, sedimentation and aerated lagoons since 1970, and activated sludge since 1984.³¹

The need for water pollution control and wastewater treatment in the forest industry is, in fact, a fairly new phenomenon. As late as in the mid-1960s it was publicly suggested that wastewaters along the Kymijoki river could be led through a tunnel without any treatment out to the Gulf of Finland in the Baltic Sea. The argument was that the volume of water in the Gulf was many times that of all inland waters.³²

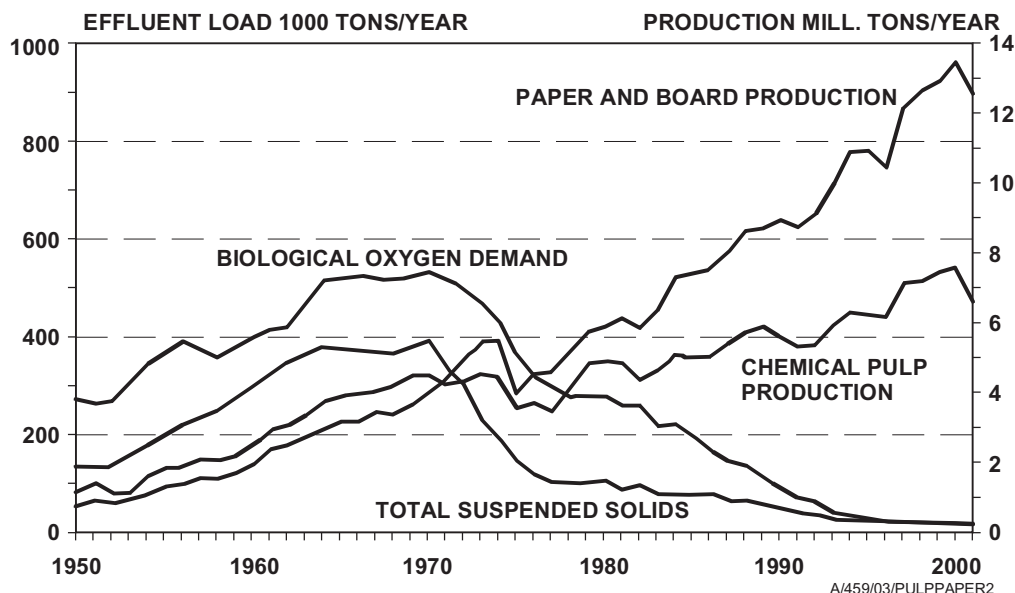


Figure 1

Production of the pulp and paper industry in Finland and related wastewater load, 1950–2001.

Source: FFIF 2002 <http://english.forestindustries.fi/figures/>, modified April 2003.

One important step for improved water pollution prevention in Finland was the establishment of Water Administration and the National Board of Waters in 1970. The key duties of the Water Administration were to promote the use, protection and research of water resources. The administration was also to provide regulatory services. Special emphasis was placed on comprehensive planning taking into account the multiple uses of water resources, water pollution control, water supply and sanitation, recreational use of watersheds, use of hydropower and flood control³³. The river basin based multipurpose planning was the first effort in the country for a holistic approach, involving also listening to people’s views. According to Heinonen³⁴ the planning exercise taught the administration especially how to collect systematic data.

In 1974 the first Water Protection Programme, a national strategy plan was completed. It was renewed in 1985 and again in 1995. The last one covers the period up to the year 2005. The programme set also certain targets to water pollution control for forest industries as well as all the other major polluters.

In 1975 the World Bank granted a loan on financing partially an industrial water protection programme for 1975–77. The loan was the first underwritten by the World Bank specifically for environmental protection³⁵. Related to this loan a water pollution investigation project was carried out. It covered the following key areas: (i) development of a water monitoring system (ii) development of an ecological model for inland waters (iii) development of cost-benefit analysis methods related to water protection (iv) industrial waste effluent project (v) development of an ecological model for the Baltic Sea.

Multipurpose water resources planning, the Water Protection Programmes and the World Bank supported project, among others, developed the basic modern principles and practices for water pollution control also in forest industries³⁶.

Trends of Selected Parameters

Figure 2 summarizes the trends of loadings from forest industries since the 1970s to 2001 in relation to key parameters. As for nutrients, changes have been smooth. Some interesting features like the increase in BOD-loading were experienced in the 1980s (Figure 2a). The implementation of activated sludge plants from 1984 onwards can be seen as an increase in the phosphorus loading curves (Figure 2b). This was partially due to the excess usage of phosphorous to ensure guaranteeing of the growth conditions in activated sludge. Gradually the experience gained from activated sludge process control has reduced P loadings.³⁷ The phenomenon is analogical to the learning process that took place among the community wastewater treatment plant operators in the 1970s: clearly better results were achieved after professional training of operating staff.³⁸ Other reasons were also behind the reported increase of P in mill effluents in the mid-1980s. For instance, earlier uncontrollable dissolution of nutrients from timber floating became measurable through treatment plants when floating practically ceased in the 1980s.

The analysis used to determine the total amount of organic matter in wastewaters is chemical oxygen demand (COD_{Cr}). The reducing trend of this loading (Figure 2d) is obvious, but like with many other parameters, the reduction has leveled down and further reduction may require finding more effective and appropriate measures.

A very important year from the viewpoint of the forest industry loading was 1993 after which elemental chlorine, excluding tailings of chlorine dioxide production, has not been used in kraft pulp bleaching.³⁹ (Figure 2f).

Role of Research and Development

The introduction of effective biological wastewater treatment in Finnish forest industries is largely attributable to certain pioneer projects like that of Hiidenheimo,⁴⁰ and later national research programmes. The results of the first-mentioned already revealed roughly the application which after trials with many other kinds of applications has turned out to be the most successful one.

The wider TESI project in the late 1970s brought information for later applications but did not fully convince industrial representatives for biological treatment. Statements against the feasibility of biological wastewater treatment in forest industries were made still in the mid-1980s. For instance, the director of the Finnish Forest Industries stated in 1985 that forest industries are in principle against biological treatment of wastewaters. The first reason given was the cost and the second the strive to dispose of waste instead of utilizing it. The third reason was that the solutions of that time focused on external instead of internal process development.⁴¹ This, in spite of the fact that around 1980 the TESI project had shown that at that time treatment of forest

industry wastewaters to the same extent as community wastewaters would have raised the price of one ton of pulp and paper by only one to two per cent.⁴²

In the early 1980s two forest industry firms (Enso-Gutzeit and Tampella) invested considerably in developing anaerobic treatment for pulp and paper industry wastewaters. For various reasons the development could not reach mature process for more than the present two applications.

The Mebite project in 1988–91 focused on developing activated sludge process for Finnish pulp and paper mills. In this project the knowledge of special characteristics of organic matter in pulp and paper mill effluents as well as that of biomass behaviour in activated sludge process was considerably increased for the design of the plants. Nutrients, their importance, behaviour and control were studied and methods for control developed. The overall situation in the mills, including slow introduction of changes, favours lowly loaded, easily controllable plants of activated sludge process.⁴³ The Sytyke research programme in 1990–93 dealt widely with the development of the environmental aspects of the forest industries. According to the results no radical changes could be foreseen but mainly smooth reduction of environmental discharges. Uncertainty was foreseen in closing of circuits and in waste management in 19 different projects of the programme.⁴⁴

Technology development programme CACTUS, 1996–99, with diverse parties around forest industry co-operated for reduction of water consumption, more effective utilization of energy and chemicals as well as for cleaner and more easily controllable process with less environmental effects in receiving waters, air and soil. The technology programme resulted in increase of expertise, new products and services.⁴⁵

Derivated from the reasonably wide research programmes and almost 20 years of activated sludge operation, Finland should have high potential in many types of forest industry related organizations for technology transfer worldwide. The activity of diverse expert groups in relation to the Finnish forest industry has been shown also by establishing a symposia series⁴⁶ and organizing several international conferences like the IWA symposia on forest industry wastewaters held in 1984, 1987, 1990, 1993, and 1999 in Finland.

A considerable amount of new knowledge for the future, e.g., for the problems of zero-effluent situation, has been attained through the research, development and cooperation. Yet, the continuity of such activity is essential in order to approach optimal solutions at any time.

Some Comparisons

Comparison to our closest manufacturer of forest industry products, i.e. Sweden, reveals that the approach of their chemical pulp mills to reducing the liquid effluent loading has been different (Figure 3). In Finland the biological treatment of total mill effluents was implemented in 1984–1996–8 as the major measure. At the same time more emphasis was placed on internal measures in Sweden.

Today we know that both internal and external measures are needed. The Finnish way, under our conditions with many pulp mills in inland areas beside shallow and thus

sensitive lakes, has been fairly successful in reducing most of the loading factors successfully to a reasonable level (Figure 3). This has provided more relaxed atmosphere for studying and implementing the internal measures which are more sensitive because operational stability and product quality are directly involved in these changes.

Undoubtedly, the Finnish forest industry has developed its wastewater treatment successfully, but much less attention has been paid to the fact that energy consumption per produced ton has increased at the same time: for instance, mechanical pulping methods require some two to four times more external electricity than chemical methods. This is mainly due to afore mentioned yield differences. In sulphate pulp production, where pulp yield is less than 50 per cent, surplus energy is currently produced and it can be supplied for domestic use.⁴⁷

Compared to the municipalities, the forest industry started to treat its wastewaters by biological and chemical methods an average of 15 years later. Smaller cities and townships also started to treat their wastewaters earlier than bigger cities. From the point of view of water bodies this order is irrational. It probably indicates that forest industries and larger cities have a bigger say in societal decision making. It probably also explains why people economically dependent on these activities have not paid too much attention to “secondary issues” such as water pollution. Besides, the forest industries have for long played a key role in the national economy and export activities. Yet, as social decision making is concerned, such a strategy was pragmatic from the authorities’ point of view.⁴⁸

Combining of Forest Industry and Community Wastewater Treatment?

There are examples⁴⁹ where combined treatment of two forest industry units or forest industry unit and community wastewaters have been studied and found appropriate. However, implementation of combined systems are rare or they are delayed. This is a case which shows that even the mills of a single company want to shoulder their responsibilities individually. Yet, there are good examples of improved wastewater treatment plant operation when municipal wastewaters have been led into a treatment plant of a forest industry company. Synergy is achieved in organic matter and nutrient balance and other favorable operational benefits, like improved activated sludge settleability, may be achieved. In 2003 municipal and forest industry wastewaters are treated by a joint system in a few locations, for instance in Mänttä and Rauma.

The negative effect of this combination, however, is that the possibility of recycling the treated combined wastewater back to the mill processes of the forest industry unit is reduced. This is due to occupational health concerns at the mill and people’s attitudes as well as to the hygienic requirements concerning the quality of the end product.

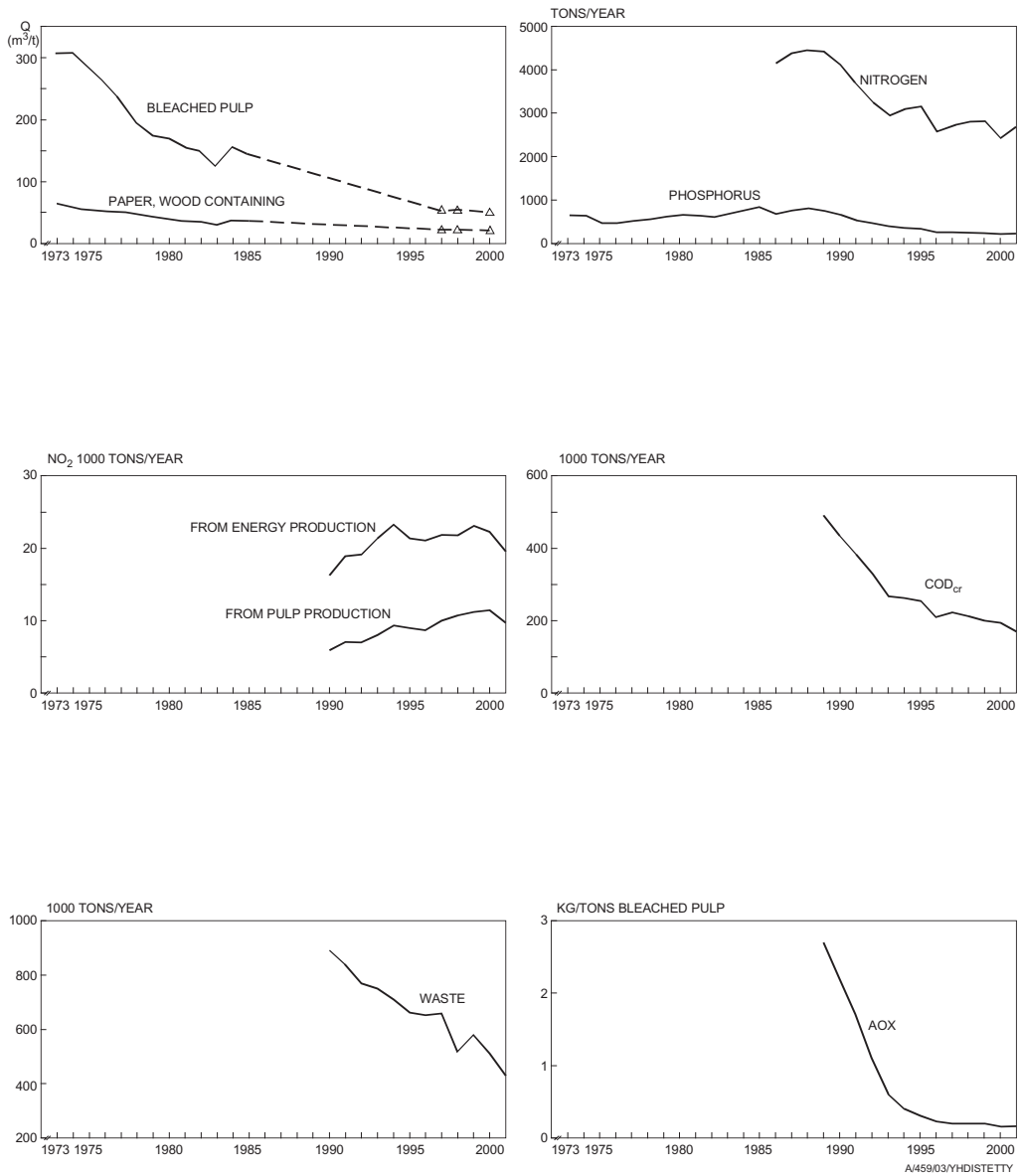


Figure 2

Trends of wastewater loadings from Finnish forest industries from the 1970s to 2001, in terms of six key criteria; quantity of water (a), nutrients P and N (b), NO₂ emissions (c) COD_{cr} (d), waste (e), AOX (f).

Sources: Finnish Forest Industries Association; Finnish Environment Institute (FEI); Jouttijärvi T. (FEI), Personal review data; Ruonala S., Personal review data.

The Case of Lake Päijänne

An important decision was made by the Helsinki Metropolitan Area as it decided to take its raw water from Lake Päijänne in the early 1970s. After the 120-km rock tunnel was taken into use in 1982, it supplied raw water to the whole Helsinki Metropolitan Area. At that time, some 0.5 million people were supplied by this system while in 2003 the number was almost one million.⁵⁰ Around the mid-1980s an environmental movement was born in Jyväskylä, at the northern end of the Lake. The movement raised general awareness of, and the need for, water pollution control. One of the key actors in this movement was the Helsinki Metropolitan Water Company that supplies wholesale water to various distributing utilities in the area.⁵¹ It is obvious that the pressure of public opinion from Helsinki and the metropolitan area for its part speeded up the development of water pollution control by forest industries in Äänekoski, located upstream from Lake Päijänne in Central Finland. In the mid-1980s the rivers downstream from these plants were still described as sewers.⁵²

In 1983 at the planning stage of the new pulp mill at Äänekoski the managing director of Metsä-Botnia criticized the Päijänne movement and the water company. His argument was that while the forest company decided to close down four old fashioned mills – in Nokia, Lielhti and two in Äänekoski – the new integrated mill would produce lower loadings in spite of higher production.⁵³

On several occasions critique was directed at the decision to construct the Päijänne tunnel. Later on, as water consumption has declined instead of the earlier estimate of high increase, this critique is perhaps partly on target. Thus, it might be that from the environmental protection point of view the Päijänne tunnel has proved unpredictably positive – in fact through its side effects.⁵⁴

The forest industry opposed the introduction of efficient wastewater treatment by referring to the high costs of such action, until the water courts started to tighten treatment and effluent requirements. The case of Äänekoski was the first with biological treatment requirement.

The need for water pollution control and wastewater treatment in the forest industry is in fact a fairly new phenomenon. As late as in the mid-1960s it was publicly suggested that wastewaters along the Kymijoki river could be led through a tunnel without any treatment out to the Gulf of Finland in the Baltic Sea. The argument was that the volume of water in the Gulf was many times that of all inland waters.⁵⁵ Later on this idea has proved completely false, although fast flowing rivers as such naturally recover faster than lakes.

Impacts of Water Pollution Control

The impact of the water pollution control activities can clearly be seen in Finnish watersheds: the waters of the worst quality have already improved, although the load from several decades will have an effect over several years to come. Such areas are located especially downstream from forest industry sites. For instance, the River Kymijoki, along which some 20 percent of Finnish forest industries are located, has got rid of its “sewer reputation” and salmon has returned to it. However, the toxic

compounds discharged by industries for decades may be a long-lasting problem in the sediments of the river.⁵⁶

Table 1 describes the estimated BOD, P and N loadings from forest industries, other industries, fish farming and communities in 1991 and 2000. It shows that in all these sectors water pollution control has developed positively and loadings to water bodies have declined. Yet, forest industries still produce the biggest share of the BOD loading due to their large volume. In addition to point sources, we have to remember non-point sources which will probably be the biggest challenge in the coming decades in water pollution control in Finland. Since wastewater treatment requirements set for communities and industries have become ever stricter, it is high time to start to discuss whether it is economically feasible to make these requirements still tighter or whether the limited financial resources should be used for other purposes.

The water quality of Finnish water bodies is generally improving: particularly the worst polluted watersheds are getting cleaner. However, at the same time the quality of the best waters seems to be deteriorating little by little. This is at least partly due to the water loading from non-point sources as well as to air emissions both of which are much more difficult to control than water-polluting point sources.

Year		1991			2000	
Factor	BOD7	Ptot	Ntot	BOD7	Ptot	Ntot
Pulp & paper industries	71 320	530	3 770	17 280	200	2 820
Other industries	3 840	50	1 700	2 400	30	1 180
Fish farming	24 280	245	1 780	N.A.	125	1 020
Communities	9 600	300	14 600	6 032	249	12 204

Table 1

Estimated loadings from forest industries, other industries, fish farming and communities in 1991 and 2000.

Sources: Viitasaari M. & Katko T. (eds.). Water research development programme to the year 2000. National advisory board for water affairs. Report of the Ministry of the Environment, Finland, no. 3/1994, 13; Silvo et al. Effluents to waters 1990–2000. Interim assessment of water pollution control objectives. FIE. Helsinki, 2002. Report no. 242, 58.

DISCUSSION AND POLICY IMPLICATIONS

After forest industries started biological treatment of their wastewaters in the late 1980s, they soon announced the objective of closing their processes and recycling the waters to the extent possible. This happened quite shortly after they had deemed efficient water pollution control economically impossible.

Full-scale zero-liquid-effluent mills exist internationally for producing various products (e.g. brown box board, CTMP). Also, the most advanced estimates for the bleached kraft mills of the year 2020 regard liquid effluents meaningless at least from the viewpoint of their energy balances.⁵⁷ Finland has reduced liquid effluent volumes for long but

only in small steps. With old mills this approach can be considered appropriate because very complicated processes are very hard to manage with extremely reduced water consumption. Yet, the implementation of close to zero-liquid-effluent process would require a completely new mill and highly simplified production processes.⁵⁸

Due to the construction of biological treatment plants for the huge total volume of mill wastewaters, the Finnish forest industry has won time to plan and test the internal water system closure of the mills without panic. Yet, total closure of the water system in the present type of mills is very difficult, if not impossible. Therefore, radical trials in this matter should be conducted in greenfield projects where production process simplicity is the target, high diversity of expertise is available and financial risks are shared. Perhaps pilot-scale production lines should be implemented for these studies if this trend is wanted to be raised as one of the major competitive factors of the Finnish forest industry.

Importance of Environmental Issues for Finnish Forest Industry Firms

In a profound PhD thesis on the internationalization of Finnish forest industry companies, Sajasalo⁵⁹ mentions public goods like education and training, physical infrastructures like transportation and communication as well as welfare policies as having been important background contributors to the process of internationalization. He also brings up favorable energy policies as a compensating feature for the remote location of the country from the major markets. However, environmental aspects have not been mentioned in that study which is mainly based on information extracted from the annual reports of firms. A straightforward conclusion from the study would be that environmental aspects have not played any role in the internationalization of Finnish forest industry companies.

Although the zero-liquid-effluent process has been widely discussed in the public media during the past decades, one can ask if there is any real environmental motive for such a strategy. Now when the firms have environmental reporting systems and quality certificates, they satisfy the generally set requirements. In this situation the industry should ask whether any competitive advantage still could be achieved by reducing, e.g., liquid effluents. In fact, now after very active period of development there is a high diverse expertise for these subjects. Thus a good option could be effective transfer of the achieved technology worldwide.

Another study⁶⁰ about the strategic development paths of Finnish forest industry companies lists the major strategic moves of the four biggest Finnish forest industry companies during the 20th century. These extensive listings of strategic moves (one to two strategic moves/year/firm) include only two clearly constructive environmental investments made in the mid-1970s. That was a time of initial environmental measures like sedimentation basins and aerated lagoons. In the case of one firm this was one of the 134 strategic moves mentioned during 1904–1996. In another firm, the construction of a recovery facility for its sulphite pulp mill as well as the later cessation of all sulphite production and related activities were the two environment-related strategic moves out of 149 during 1920–1998. The listings of the other two forest

industry firms indicate no environment-related strategic moves (94 in 1918–1998, 50 in 1934–1998).

The force behind environmental investments up to recent times has been environmental authorities but also the public pressure like shown in the case of Lake Päijänne. According to the above listings, this does not seem to have had any strategic importance to the firms. From another perspective, it seems that environmental issues have not really been used proactively, e.g., in building the image of firms. Environmental management and quality certificates and reports have been prepared for showing the fulfilling of standards and the necessary facilities for these have mainly been made along with other strategic investments.

The only clear exception from the above has been the case when constructing a new kraft pulp mill in the mid-1980s by Lake Päijänne from which the Helsinki Metropolitan Area started to take its raw water somewhat earlier.⁶¹ In that case the active participation of local people really had a disturbing effect on the construction project and obviously also on the level of the technological solutions required to the discharge flows of the pulp mill. The confusion around the project is well described by a later statement of one of the leaders of the project in a seminar. He mentioned that if there had been any idea of the coming public concern and action at the beginning of the project, a highly qualified PR professional would have been hired for the project to keep all related parties well informed of every step of the implementation project.

Now, when good progress in loading reduction can be shown by appropriately scaled figures starting from the huge original numbers, and when the interest toward the loading from the forest industry production process has gradually decreased, it is interesting to see whether further environmental measures like the zero-liquid-effluent process can ever rise to strategic importance, e.g., as a result of image building.

It should be studied whether zero-effluent production involving only air emissions and solid discharges could provide incentives which would enable the Finnish forest industries to profile themselves also as a real environmental pioneer.

All in all, the evolution of pollution control in the Finnish forest industry shows that with development of technology, appropriate legislation and related enforcement amplified with public awareness and social pressure good results can be achieved.

CONCLUSIONS

The following are the major findings of this study:

- (i) The first findings of polluted water bodies by forest industries were documented in the early 1900s. However, it took almost a century to gradually introduce efficient wastewater treatment.
- (ii) Efficient biological treatment was not introduced to forest industries before adequate social pressure was exerted and public opinion was expressed in the 1980s. The Helsinki Metropolitan Water Company was a major actor in this area.
- (iii) Environmental issues and especially water pollution control, have only exceptionally had any strategic role in Finnish forest industries. Zero-liquid effluent production seems unrealistic through mill renovations and questionable from the environmental point of view.

In spite of some critique expressed, Finnish forest industries have undoubtedly made good, if not very good, progress in water pollution control, at least when internationally compared. It should be explored whether environmental protection could be used as one real strategic tool in their future business in Finland or abroad.

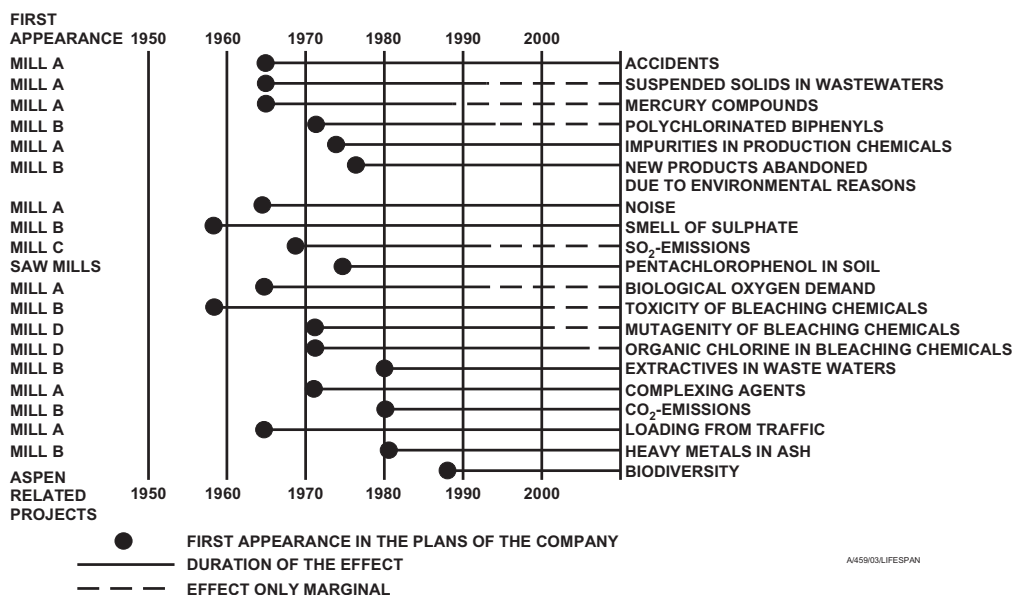


Figure 4

Lifespan of selected environmental issues in one of the major forest industry companies in Finland.

Source: Kettunen J. Kuuseen kurkottajat. Teknologian kehitys Metsäliiton piirissä 1950-luvulta vuosituhannen vaihteeseen. 2 print, 2002, 80.

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SEEKING FOR CONVERGENCE BETWEEN HISTORY AND FUTURES RESEARCH

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ABSTRACT

The objective of this paper is first to analyse how much common do the traditions of historian research (HR) and futures research (FR) have and how they could contribute each other. First, the role of time is analysed. Second, the path dependence theory, strategic decision-making, knowledge management and visionary management are discussed. Examples of the latter are shown from water and sanitation services and their long-term development. Finally, some argued views are presented on how the convergence between FR and HR could be improved.

The key note of this research is that there seems to be discontinuity between the presents, recent pasts and the near futures. Probably due to the tradition for HR it is more difficult to assess the effects of strategic decisions on the recent. If more convergence is wanted, the gap should be filled somehow. On the other hand, the hard core research of FR seems to concentrate more on strategic and visionary horizons while perhaps neglecting the operational horizon of the near future.

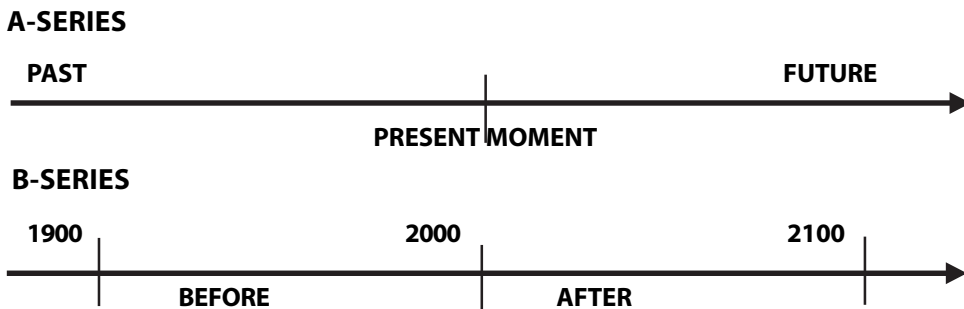


Figure 1

A and B series originally developed by McTraggart [5].

INTRODUCTION

History research (HR) and futures research (FR) are both interested in time-related phenomena. The tradition of HR points out the necessity of using original written documents while some researchers have also raised the need to expand the scope of HR to cover other sources like oral history. In a way FR is based on history, for instance, when using trend analysis and extrapolation methods. Conventionally research approaches are classified under *deductive* and *inductive* categories. Model-based FR is an example of the deductive, and document based HR of the inductive. It has also been suggested that more *abductive* approaches should be introduced and used.

The overall objective of this paper is first to analyse how much common do the traditions of historians and futures researchers have and how they could contribute each other. The paper concentrates on two key questions. First, the role of time in relation to history and futures research is analysed. The paper aims at analysing to what extent traditions of history and futures research cover the presents or recent pasts, or to what extent they do not meet. Second, within the framework of pasts, presents and futures, the path dependence theory, strategic decision-making, knowledge management and visionary management are discussed. Examples of the latter are shown from water and sanitation services and their long-term development. Finally, some views are presented on how the convergence between FR and HR could be improved.

The birth of this paper was originally stimulated by the presentations and ideas during the NorFa supported workshop “Management of water, wastewater and solid waste services in comparative historical and futures perspective”, held at Tampere University of Technology, 10-12 June, 2001 [1]. This paper is mainly based on the presentations of the authors at the workshop [2, 3, 4] added by further work by the authors, while also influenced by other presentations at the workshop and commentary.

CONCEPTS OF HISTORY, TIME AND FUTURES

In relation to the philosophy of time we commonly recognise the so-called A and B series (Figure 1), originally developed by McTaggart [5] already in 1908. A series events are classified into past and future events that are separated by the present fleeting moment. Series B events are fixed according to time, before and after a certain year or moment of time. According to Bell [6, p. 139], the A and B series are not different, but just two ways of looking at the same phenomenon in time.

According to Niiniluoto [7], *actualism* is a view where all real is actual. Yet, in *possibilism* also non-actual things and entities can be real. In non-statistical model theories we allow also states of affairs that are alternatives to the actual world, i.e., they could have materialised had conditions been different. Niiniluoto argues that in futures research it is important to analyse and forecast alternative desirable (preferable) futures and selection of actions in such a way that the probability of the desirable option is maximised.

Prior [cited by 7] considers *presentism* a view where all real is present at the present time. Many past events have causal effects/impacts that extend to the present.

According to Pierce [cited by 7], only issues that are independent of time are real. Thus *presentism* implies strong *pastrealism*. Pierce uses the concept of *abduction* when describing the process of inferring causes from effects”. One important aspect of abduction is analysis that goes back in time from present documents to the underlying historical reasons. Borg [8] points out that while in conventional sciences creative context is related especially to developing hypotheses, and argumentation to conclusions and results, the emphasis in FR is different. In FR creativeness and inventions are also directly related to conclusions and results through desire (will power) – not randomly and irrationally, but for instance, on the basis abduction or creative thinking.

As an alternative to realism Ankersmit [9, cited by 7] has presented the idea of historical research as constructing narration. He points out that a story should form a coherent entity together with the presently available data and knowledge. Thus, the object of historical research is not the past but the narrative interpretation of the past made by the researcher. During the last decade, the narration approach seems to have gained increasing acceptance among historians as well as other social scientists.

Kamppinen [10] views time from etnocronographic approach. Extremely short and extremely long time periods are very difficult for human understanding. Yet, philosophers have always been interested in these extremes. A survey showed that in etnocronographic sense most people viewed the present moment to last from one to 20 seconds. This is probably far shorter than researchers of futures and historians are used to. On the other hand, it shows how history and futures are needed for any serious analysis of long-term development and options.

The concept of an extended present was proposed as early as 1887 while modern futurists such as Slaughter suggested the notion of a 200-year present [6, p. 140]. Thus, we may have several interpretations of detention of time.

Dirlik [11] points out that the new types of history that have emerged since the 1970s have themselves contributed to the complication of our understanding of the past. He suggests that historians have always assumed the tentativeness and contingency of claims to so-called historical truth. According to Dirlik, constructivism is here to stay, but that does not necessarily point to the disappearance of history, only to more complicated ways of interpreting the past.

As a historian of technology, Hård [12, Table 1] classifies historical research approaches into three categories. A constructivist is interested in explanation, relies on diverse sources and uses theoretically informed analysis, while a reconstructivism is interested in rehearsal and uses detailed description. A deconstructivist is fond of understanding, uses highly incomplete sources and fictional narratives. Hård points out that it is obviously important to combine and apply all these three approaches in HR.

Bell [6, ch. 3] has identified nine key assumptions for futures research. In this context, we regard especially relevant the first, the *meaning of time*: time is continuous, linear, unidirectional and irreversible. Events occur in time before or after other events and the continuum of time defines the past, present and future. The fourth one concerns *the most useful knowledge*. It is the future that we need to know to make our way through our daily lives effectively. But this is hardly possible without knowing the

presents and the pasts, at least to some extent (author’s note). Furthermore, there are past facts, presents options and present possibilities for the future, while according to Bell [6] there are no past possibilities and there are no future facts. Yet, the assumption is that if evaluations about the future pass objective and rational tests, they are conjectural knowledge.

In decision-making and management we normally recognise three time frames. In *operative or operational* management the time frame is up to one year, in *strategic* management up to ten years, and in *visionary* management up to 30, or even 50 years (Table 2). Instead of operative management, Malaska and Holstius [13] use the term *opportunistic* management, referring to day-to-day type decisions without any further futures considerations. Such decision-making is typically aimed at maximising profit and cashflow and meeting short-term objectives. As for water and sanitation services that have a long-term perspective, this type of management is certainly inadequate as the only decision-making practice.

<u>EPISTEMOLOGY</u>	<u>KNOWLEDGE INTEREST</u>	<u>USE OF SOURCES</u>	<u>FORM OF PRESENTATION</u>
DECONSTRUCTIVIST	UNDERSTANDING	HIGHLY INCOMPLETE	FICTIOUS NARRATIVE
RECONSTRUCTIVIST	REHEARSAL	ALMOST COMPLETE	DETAILED DESCRIPTION
CONSTRUCTIVIST	EXPLANATION	DIVERSE	THEORETICALLY INFORMED

Table 1
Three epistemologies of the research on the history of technology with explanations [12].

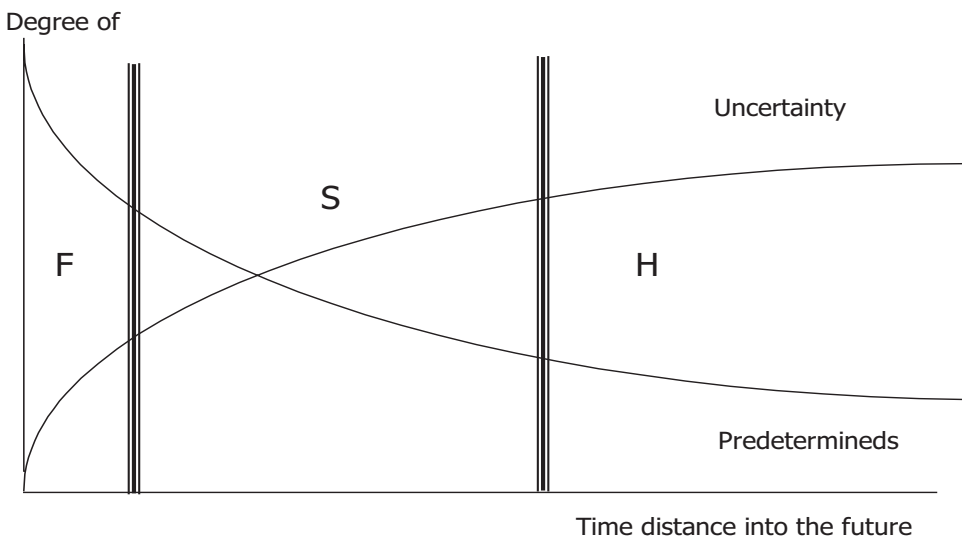
Determinant of decision	Opportunistic decision-making	Strategic decision-making	Visionary decision-making
Situation	Known	Uncertain but predictable	Discontinuous & unpredictable, emergent
Purpose and objectives	Maximise profit and cash-flow, short-run interests	Adaption, ROI, growth, middle run strategic interests	Excellence of performance, long-term survival, finding new options
Means and resources	Fixed	Reallocation of available and attainable resources	New skills, reframing of business, envisioning, creating new capabilities
Management by	Control	Reallocation	Visionary renewal

Table 2
Three forms of futures-oriented decision-making in organizations [13, modified].

In strategic management the situation is uncertain but predictable, at least to some extent. The focus is on medium-term strategic interests and adaptation. In *visionary* decision-making the situation is largely discontinuous, unpredictable and emergent. The purpose of visionary management is long-term survival and finding new options through reframing of business, envisioning and creating new capabilities (skills, knowledge and resources).

It is often the balance between momentum and volatility in the decision-making environment that determines how far actions are planned into the future. Figure 2 shows these critical time-related elements in context. When looking into the future the degree of predictability gradually goes down the further we look and uncertainty goes up. In the very short term predictability is high and forecasting is the working planning mode of choice (F = forecasting). In the very long term everything is uncertain and attempts to planning demonstrate diminishing returns (H = hope). In Figure 2, in the middle zone there is a level of predictability not, considerable uncertainty scenarios (S = scenarios and simulations) are the indicated way forward [14, p. 92–93].

Depending on the level of the above-mentioned decision-making hierarchy or time frame, the organisation's *information system* has different requirements. Forecasts with different information depths are needed to provide adequate information for decision-making. Decisions at the operative level are based on a rather short-term analysis to consider relevant factors for the day-to-day operations. For longer-term strategic decisions, an organisation needs information about the operational environment to reduce the uncertainty of decisions and to estimate their long-term effects on the organisation's ability to survive and develop.



F = Forecasting, S = Scenarios and simulations, H = Hope connected to commitments and strong visions

Figure 2

The balance of predictability and uncertainty in the decision environment [14, modified by 2].

In addition to forward-looking information, also past information – i.e. how the organisation is positioned in its previous operational environment – has to be considered. The organisation has to analyse how it has historically reacted on the changes in the previous environment, in order to obtain information about the possible and effective future actions, and possible effects of alternative actions. The amount of information also has to increase with a growing time horizon – i.e., increasing complexity of the environment with increasing distance into the future and subject complexity [4, 15].

As for economic fluctuations historians Hietala and Setälä [16] remind us of how during periods of depression a review of the past is necessary, while during economic booms the wrong decisions made in the past are forgotten. They point out how globalization presents new challenges to historical research, especially in environmental history and history of technology. To be able to understand globalisation, it is necessary to study long-term patterns and changes in environmental and urban history. According to Hietala and Setälä [16], the strength of historians lies in their capacity to discern long-term perspectives and development trends. If forecasts are made for the short-term, they may easily be overdimensioned.

PATH DEPENDENCE THEORY

Path dependence theory that is largely based on deductive approach, was originally used by economists, particularly those involved with evolutionary economic theory like Nelson and Winter [17], Magnusson and Ottosson [18], and Garud and Karnoe [19]. Fairly recently it has also been introduced to the research of history and the history of technology, e.g. by Melosi [20]. Path dependence contends that decisions made in the past are likely to have long-term impacts by binding, limiting or postponing alternative options. As such, path dependence is linked to history and futures research and their interactions.

Path dependence has been offered as an alternative analytical perspective for economics, a revolutionary reformulation of the neoclassical paradigm. Brian Arthur distinguishes between “conventional economics,” which largely avoids increasing returns or path dependence, and the “new” “positive feedback economics,” which embraces them [Arthur, cited by 21].

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 characterized by voluntary decisions and individually maximising behaviour. Path dependence literature is accompanied and motivated by mathematical literature of nonlinear dynamic models, known as chaos or complexity models, for which a key finding is “sensitive dependence on initial conditions.” Analogously, a key finding of path dependence is the property of “lock-in by historical events”, especially where those historical events are “insignificant.” [21]

Liebowitz and Margolis [21] recognise three degrees of path dependence. 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. First- and second-degree path dependence offer little in the way of an objection to the neoclassical paradigm while only the third and strongest form of path dependence significantly challenges the paradigm.

Liebowitz and Margolis [21] call instances where sensitivity to starting points exists, but with no implied inefficiency, *first-degree* path dependence. Initial actions, perhaps insignificant ones, put us on a path that cannot be left without some cost, but that path happens to be optimal. Where information is imperfect, a second possibility arises. Then efficient decisions may not always appear to be efficient in retrospect and the inferiority of a chosen path is unknowable at the time a choice was made, while we later recognise that some alternative path would have yielded greater wealth. *Second-degree* path dependence is sensitive to initial conditions and leads to outcomes that are regrettable and costly to change. They are not, however, inefficient in any meaningful sense, given the assumed limitations of knowledge.

In *third-degree* path dependence, sensitive dependence on initial conditions leads to an outcome that is inefficient – but the outcome is also “remediable”. That is, there exists or existed some feasible arrangement for recognizing and achieving a preferred outcome, but that outcome is not obtained [21].

According to Redding [22], 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 [23].

According to Margolis and Liebowitz [24], technological *lock-in* is a lock-in to something bad, or at least a lock-out of something better. They further point out that these lock-ins, bad economic outcomes, are avoidable by small but prudent interventions. In a way, they are analogical to the *weak signals* that futures researchers commonly try to identify. According to Margolis and Liebowitz [24], path dependence spilled over to economics from intellectual movements that rose elsewhere – in physics and mathematics the related ideas come from the chaos theory, while in biology it is called contingency – the irreversible character of natural selection.

North [23, p.vii], points out how history matters as “time and context”. This understanding of history, however, is seriously deficient in two closely related respects. On the one hand, despite their allowance for path dependence, the models and concepts used are ahistorical, asocial, timeless, and universal. History, time and context are confined to the random shocks or whatever which lead to one rather than another pre-determined, if stochastic, path to be taken. Yet, North [21] considers that literature has neglected the importance of transaction costs, without which past mistakes and the like could be costlessly rectified.

North [23] discusses the causes and significance of *institutional change* which is also path dependent. The path of institutional change is shaped by (1) the lock-in that comes from the symbiotic relationship between institutions and the organisations that have evolved as a consequence of the incentive structure provided by those institutions and (2) the feedback process by which human beings perceive and react to changes in the opportunity set. Incremental change comes from the perceptions of the entrepreneurs in political and economic organisations that they could do better by altering the existing institutional framework at some margin.

There is yet some criticism towards the theories of path dependence. For instance, David [25] has questioned some of the common conclusions and is suggesting overcoming “intellectual sunk cost hysteresis” and escaping from disciplinary “lock-in” to ahistoricism. According to David [25], path dependence is about much more than the processes of technological change, or institutional evolution, or hysteresis effects and unit roots in macroeconomic growth. The concepts associated with this term have implications for epistemology, for the sociology of knowledge, and cognitive science as well.

Meier et al. [26] point out how *prior choices* often dictate the outcome of policy events. Current policies are generally path dependent – constrained by prior actions. However, path dependence may involve ill-defined concepts that may have various meanings depending on the context. In practice, path dependence exists, when past decisions constrain current options. According to Meier et al [26], *strong* path dependence takes places when alternatives are restricted to one or a few while *weak* path dependence only modestly limits options. As a case in point they refer to education where students are often segregated into separate tracks of vocational and academic training at an early age which subsequently impacts their academic future. Path dependence can be seen as a natural product of institutional development – through bureaucratic structures, routines and operating procedures [26].

According to Gorringer [27], path dependence occurs whenever there are constraints on the processes of change, or whenever the directions of change tend to be self-reinforcing. This means that change is overwhelmingly incremental in nature – evolutionary rather than revolutionary. Thus, systems have inertia and stability more than otherwise would be the case. Policy makers may need to reinforce path dependence, e.g. in locking in good change. They may also need to guard against undesirable effects of path dependence.

STRATEGIC DECISION-MAKING

Management is essentially related to decision-making. Decision-making (in an organisation) is constrained by the principle of *bounded rationality* and *path dependence*. To avoid/eliminate/reduce these limitations, organisations need strategic thinking and – management in their decision-making. As for strategy, Mintzberg et al. [28] suggest five key definitions, “*the five Ps*”, instead of standard definition related to top management’s plans to attain outcomes consistent with the organisation’s missions and

goals. First, strategy is a *plan*, a path to get from here to there. Second, it is a *pattern*, consistency in behaviour over time. While strategy as plan is looking ahead, strategy as pattern is looking at past behaviour. They also recognize intended and realized strategies and ask whether realised strategies always have to be intended. Mintzberg et al. [28] further define strategy as a *position*, the locating of particular products in particular markets, as a *perspective*, an organisation's way of doing things. Finally they regard strategy as a *ploy*, a specific manoeuvre intended to outwit an opponent or competitor. In any case, they point out that "the real world inevitably involves some thinking ahead as well as some adaptation en route".

Schamp and Heene [29] have studied the role of path dependence in corporate strategic change environment. Corporate strategic decision-making exclusively refers to strategy change or non-change as a result of technological change, technological innovation and in the light of technology investments, partnerships, growth, competitive advantages etc. They have presented three forms of corporate strategic management path dependence:

- (i) the situation in which *organisational/corporate stress does not exceed organisational/corporate inertia* and the current strategic logic is unchanged as well as the organisation's strategy is considered to remain viable (hence, there is no clear need for strategy dynamism nor strategizing) to the benefit of the organisation; hereafter called *constructive path dependence* or strategy continuation,
- (ii) the case in which *organisational/corporate stress surmounts inertia*, corporate has started strategising but is lacking a viable strategy alternative, called *unconstructive path dependence*, and
- (iii) the situation in which organisational/corporate stress exceeds inertia within the presence of at least one viable strategic alternative but lacking choice for the new strategy and/or the implementation of the strategy change, called *destructive path dependence*.

Figure 3 illustrates a schematic proposal how certain strategic decisions can be linked to path dependence, and how they inevitably affect the available future development options or paths. By their nature decisions can be classified as binding, limiting or postponing ones. In the context of water systems, the planning period is often about 30 years, sometimes even 50 years, while the life-time of the infrastructure may even exceed 100 years, as in the case of networks sometimes.

A good example of a *binding* decision is the selection of a raw water source between the ground and surface water options which has continued, e.g. in Finland, for over a century. Once the decision is made, it sets the path to a large extent, although changes may happen. As an example of a *far-sighted* decision could be the case of water metering and related pricing systems. Those who selected the pattern have, at least from today's perspective, succeeded. But changing to such a system overnight especially in old houses is not feasible which is binding. Another example could be the abandoning of lead pipes, which have negative health impacts. Compared to some pioneering countries that chose to use them, the others were able to avoid the mistake and choose other materials. Many selections may also have *limiting* impacts. In larger

and complicated water management systems it is quite common that debate over issues and decision making takes time. Even the process itself may assume a *postponing* nature, if decisions cannot be made.[3]

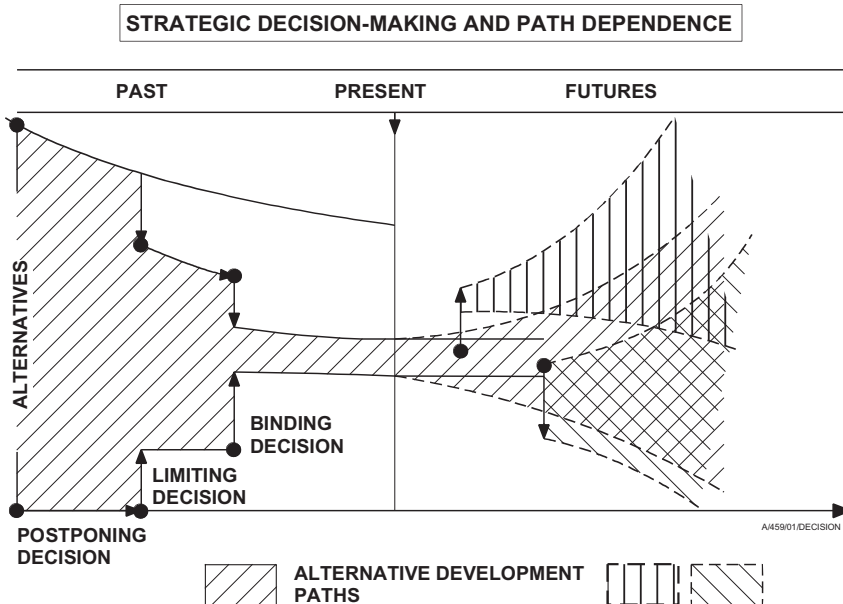


Figure 3
Path dependence and related decision-making [3].

In addition to techno-economic selections, decisions of political, social and environmental nature may often be path dependent. The beginning of modern water pollution control in Finland is an example of a pragmatic, social and political decision. Efficient municipal wastewater treatment started in smaller townships, and spread later to bigger cities. On the other hand, the pulp and paper industries started to treat their wastewaters efficiently some 10 to 15 years later, although their loadings were much higher. Treatment started upstream from Lake Päijänne, from which the Helsinki metropolitan area had started drawing its raw water some time earlier. This may have been one of the major impacts, although probably less predictable.

KNOWLEDGE MANAGEMENT, ORGANISATIONAL MEMORY AND VISIONARY MANAGEMENT

Today in many organisations foresight activities are connected to different kinds of sense-making systems [30]. In Figure 4, the dimensions of abstraction (high and low abstraction) and culture (teaching vs. learning) create the sense-making model. This model includes four open spaces or domains of knowledge, all of which have validity within different contexts [31, p. 5–7]. They are domains not quadrants as they create boundaries within a centre of focus, but they do not pretend to fully encompass all possibilities.

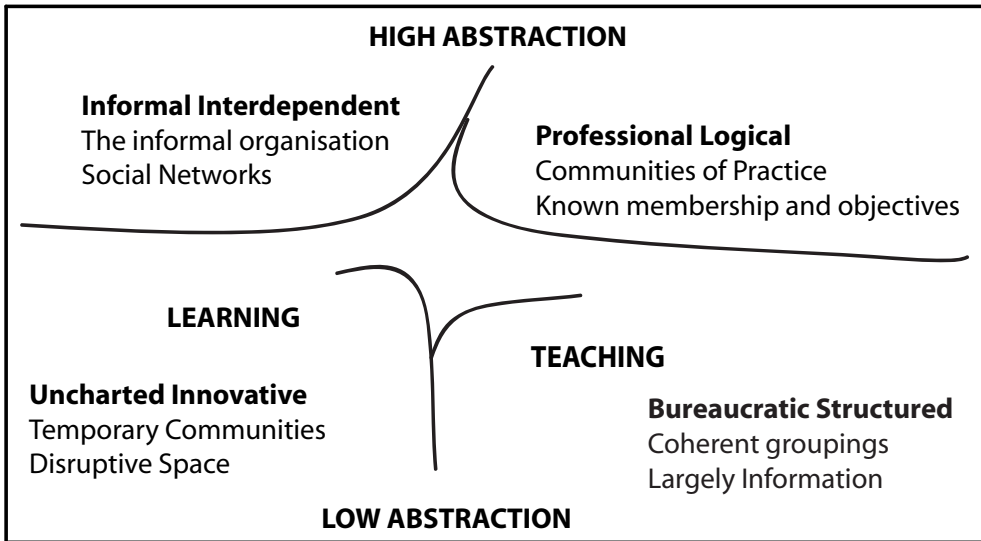


Figure 4
Typical sense making models in organisations [31, p.5].

The domain, where teaching and low abstraction are integrated, is a *Bureaucratic and Structured* organisation domain. Typically, this is the formal organisation, the realm of company policy, procedures and controls. It is a training environment. Its language is known, explicit and open. It is the legitimate domain of the corporate Intranet and its shared context is the lowest common denominator of its target audience’s shared context. In this domain it is possible that some things are certainly known and there are legitimate best practices. The behavioural model of this domain is to categorise and respond [31, p. 6-7].

Professional/Logical domain is a domain, where teaching and high abstractions are integrated. Commonly they are professional individuals, who through defined training programmes, acquire a specialist terminology, codified in textbooks. This is one of the most important domains because knowledge communication is at its most efficient due to the high level of abstraction. In this domain it is possible that some things are knowable. The behavioural model of this domain is sense and respond. [31, p. 6-7].

In the *Informal/Interdependent* domain learning and high abstraction are integrated parts. In this domain we have the abstraction of shared experiences, values and beliefs. This is usually the domain of the shadow or informal organisation, that complex network of obligations, experiences and mutual commitments without which an organisation could not survive. Trust in this domain is a naturally occurring phenomenon as all collaboration is voluntary in nature. It is the common understanding of the symbol structure and its sequence that provides shared context in this domain. Pattern management is best way to try managing issues in this domain of complex issues. The behavioural model of this domain is probe, sense and respond. [31, p. 6-7].

There is also an *Uncharted/Innovative* domain, in which we have neither the experience, nor the expertise because the situation is unknown. In this domain low

abstraction and learning are integrated. The organisation will tend to look at such problems through the filters of past experience. The history of economic life is littered with companies who failed to realise that the world had changed. Usually in hindsight such foolishness is easy to identify, but at the time the dominant language and belief systems of the organisation concerned make it far from obvious. This domain is turbulent, chaotic and unconnected. The behavioural model of this domain is act, sense and respond. [31, p. 6–7).

Futures studies are rooted in a deep understanding of social interaction and culture. It is very important to understand that there are different kinds of sense-making models in different kind of organisations [30, 31]. All organisations tend to study past events to create predictive and prescriptive models for future decisions based on the assumption that they are dealing with a complicated system in which the components and associated relationships are capable of discovery and management. Humans, acting consciously or unconsciously are capable of a collective imposition of order in their interaction that enables cause to be separated from effect and predictive and prescriptive models to be built. However, such imposed order is not an absolute or universal structure. That is a reason why it is often difficult to find “universal truths” in futures studies.

In connection with organisational memory Neustadt and May [32, cited by 33, p. 194] pointed out that decision makers must recognise that the future has no place to come from but the past. 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 – author’s note). In terms of organizational memory Neustadt and May [32, cited by 33, p. 194–195] present three key propositions:

- (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 this context reference is made to George Santanya who stated that “Those who cannot remember the past are condemned to repeat it” [33, p. 192]. Utilisation of the organisational memory and the *tacit knowledge* embedded in the organisation and its employees is essential for the future performance. Strategic, visionary and knowledge management are needed to utilise the past information and experiences and the proactive foresight in order to reduce uncertainty regarding the future decisions and actions.

Visionary leadership and –management is a means of applying futures studies in: (a) planning sciences and theories, and (b) the decision-making process of the organisation (e.g. water utility). It fulfils the tasks of futures studies, where future options have impacts on the decisions made in the present and vice versa. All the actors and their powers and interests are also analysed for defining desirable and feasible development paths for the utility.

Key concepts in strategic management include (1) mission, (2) vision, (3) business idea, and (4) core values. Visionary management utilises the same elements, but it goes a step further. Visionary management essentially builds on these principles – especially on the shared core vision – but it utilises more comprehensively the methodological tools of the futures research, especially the scenario working process. Visionary management involves a proactive approach to the organisation’s operations, but it is more participative than strategic management.

The main challenge of visionary management is to enable the organisation to utilise new opportunities in its future operations and to manage uncertainty. Water service organisations also need better leadership in order to commit their human resources to perform better towards known and shared goals and vision. Visionary leadership is especially important for policy-making organisations, but similarly for operational organisations such as water utilities.

Water utilities are natural public monopolies engaged in long-term and continuous operations. Often their management styles and practices do not adequately comply with the long-term nature of the operations and path dependence of the decisions. Moreover, most water utilities have traditionally not been futures-oriented, and in practice not very interested in the ethical basis of society as regards institutional arrangements of water and sanitation service provision.

The need for visionary development and management tasks in water utilities arises among others from the following very long-term considerations:

- Safeguarding availability of water resources in the long-term
- Long-term investments (long lifetime of assets)
- Need to consider regional cooperation (e.g. supra-municipal)
- Irreversible and path dependent nature of decisions (long-term concessions, privatisation, etc.).

In practice, there is a strong interlink between knowledge management, visionary- and strategic management in an organisation’s decision-making and implementation. Also water service organisations need to learn to utilize these management approaches in order to fulfil their growing requirements in the future.

INTERACTIONS BETWEEN HR AND FR

Figure 5 illustrates the interconnectedness of decision-making through time, showing how decision of the pasts, rather than the past, can be approached from the presents and the presents from the futures. Since historical and futures research are largely of hermeneutic rather than positivistic nature, we have a plurality of pasts as well as presents and futures. The plurality arises from more or less subjective *interpretations* by the researchers, or respondents in the case of interviews or questionnaires.

FR and HR could jointly form 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. This dual perspective ensures that the *diversities of the past* and *pluralities of the future* as pointed out by Jenkins and Witzel [34] are taken into account in decision-making.

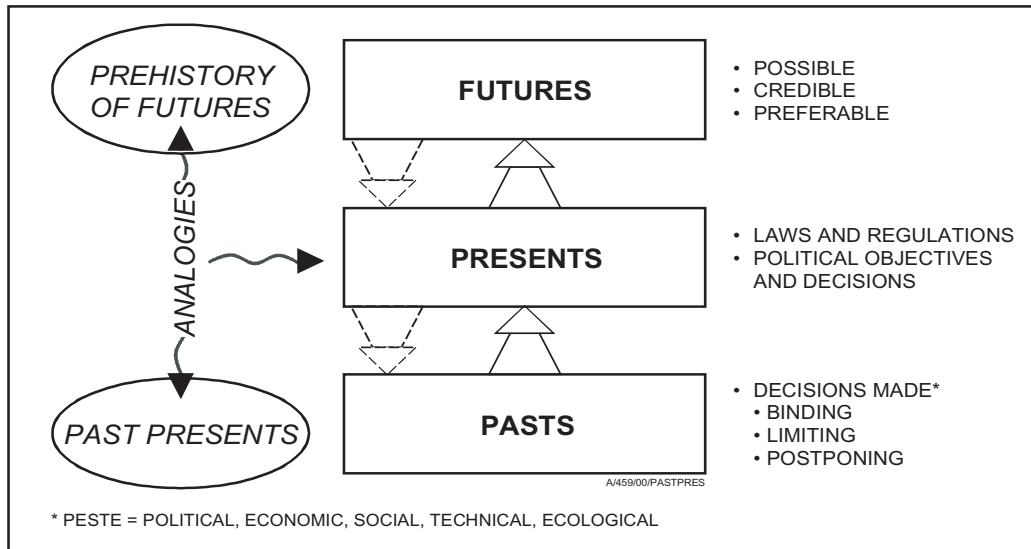


Figure 5

Past, present and futures and their analogical relationships [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 (desirable). Analogies and path dependencies, for instance, link pasts, presents and futures to each other. Sotarauta and Linnamaa [35] presents a schema (Fig. 6) showing the linkages between our experiences, presents and expectations. They point out that the past is present all the time and path dependence limits our options, at least to some extent. We may have many futures related to our visions, strategies, expectations and quality of decision-making processes.

Männikkö [36], a historian, points out how FR used to be clearly positivistic. Since the 1960s passive forecasting was abandoned and alternative futures were largely accepted. According to Männikkö [36] the viewpoint of HR is mainly from result to start, i.e. retrospective, while FR is largely prospective. Yet, most futures researchers nowadays probably favour the future-to-present approach, i.e. the retrospective one. Männikkö [36] further points out that the double perspective moves continuously with time, while there are also differences in the nature and use of knowledge - HR is closer to basic research, while FR is closer to applied, action research.

In relation to futures and historical research, Turoff and Hiltz [37, p. 65] recognised four key features while pondering whether we can “hear voices” from the future and history.

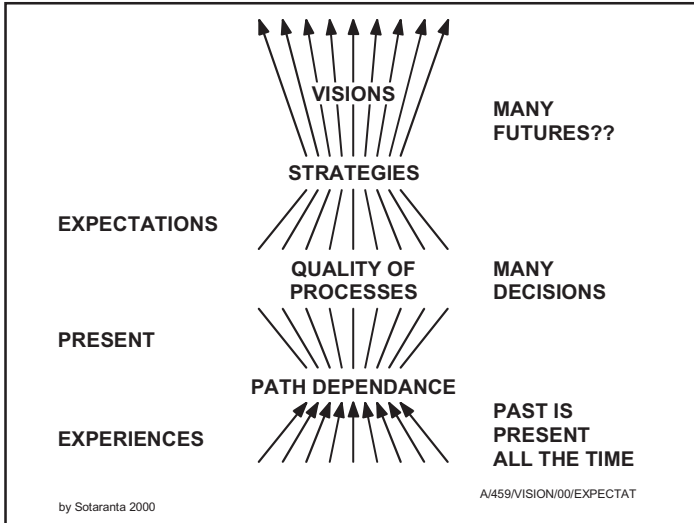


Figure 6
Decision making and many futures [35].

First, *desirability* aspect, which underlines the question to what extent do the future events be good or ill for us? What does it portend for our human interests and concerns? Second, *feasibility*, which aspect underlines the question, how feasible are future options and alternatives to us and different stakeholders? Feasibility is also related to questions, what extent can we humans shape the future and how far does it lie within our power to control or influence the shape of things to come? Thirdly, *importance aspect*, which underlines the question how important and meaningful are different issues to different stakeholders and individuals? Fourthly, *validity*, which aspect is related to question, how valid is observations concerning future events? In futures studies desirability and feasibility are typically related to resolution type of items, which are important when we are analysing policy alternatives and different strategy options. On the other hand, importance and validity are typically related to arguments of experts and laymen. Importance tells us how stakeholders see their interests in relation to different issues, for example are they for or against a certain resolution. Arguments tell us how different options and events are evaluated in different social contexts.

Rescher [38] has noted that

- (i) people live in a predictive halfway house – the details of the future can be foreseen only very incompletely,
- (ii) there is much we can achieve and there is much that we cannot,
- (iii) our potential in the predictive project depends on various circumstances,
- (iv) special conditions matter – predictive performance is bound to be a matter of local and contextual considerations,
- (v) we humans find various matters interesting exactly because they are hard to predict.

Thus, the fundamental idea that all people live in predictive halfway house means that the details of the futures can be foreseen only very incompletely. This fact concerning HR is very important, because it means that also people in history have lived in a predictive halfway house. In many historical studies this fact is often neglected and scientific explanations are presented without uncertainty analyses.

Secondly, the principle that “there is much we can achieve and much that we cannot” implies that so power relations and will power factors are very relevant research topics both for HR tradition and FR tradition. Our limitations of personal capacities and things like chance, contingency and chaotic situations provide insuperable obstacles to predication. Thus, the fact remains that very much of interest to us is not predictable. The predictive venture of securing rationality warranted foresight into the future faces rather equivocal prospects. For HR this point of view is very important, and thus, for example chaos theoretical analyses and probability analysis could be a part of historical studies.

Thirdly, our potential in the predictive project depends on various circumstances. This means that the particular substantive socio-cultural contexts - be it one of stability or volatility, or fixed regularity or probabilistic chance - have impacts on our predictive project. Another circumstance factor lies with the nature of predictive questions that we address. For example, do they deal with the near future of the remote time points? On the basis of this aspect, we suggest that both in HR and FR, actual time distance evaluations of decision-makers should be a part of scientific studies.

Fourthly, it is always relevant to note that special conditions matter. Predictive performance is bound to be a matter of local and contextual conditions. In HR and FR this kind of fact is always a relevant issue. Too general analyses can be problematic because of the complexity of systems.

Ulrich and Probst [39, p. 108] have distinguished between simple, complicated, complex and extremely complex systems and situations. Many everyday situations are so simple that we are practically not aware of having made a decision. Actually we solve simple problems routinely. As a rule, such a procedure leads to the expected result if we are dealing with a situation that is based on a stable structure of for which the rules of change remain constant. However, there are certainly situations where it remains impossible to acquire all the information required for an important decision. These situations are referred to as complex situations. The specific attributes of complex problems are structures with a high degree of cross-linking and processes that are highly dynamic. In such a case it is never possible to provide complete information [40, p. 20–21]. There are this kind of “hard to predict” situations. Usually humans find matters interesting because they are hard to predict. This kind of “hard to predict” situations should be in special research interest of HR and FR studies.

Billig et al. [41] discussed the ideological dilemmas in social psychology of everyday thinking. They stressed the dilemmatic aspects of ideology and opposed both cognitive and ideological theory. In contrast to the cognitive psychologists, they stressed the ideological nature of thought; in contrast to theorists of ideology they stressed the thoughtful nature of ideology. Ideology, according to Billig et al. [41, p. 2] is not seen as a complete, unified system of beliefs. Instead ideology comprises contrary themes without which individuals could neither puzzle over their social words nor experience dilemmas. Perhaps such a dilemma could be seen between history and futures research, which, at least to some extent, are necessary for each other.

DISCUSSION

On the basis of this article we can point out that futures research (FR) and historical research (HR) have promising *joint* possibilities. This could include the systematic use of “memory check” of futures studies, ex ante and ex post path dependence analysis, combined actors-oriented time related studies, and long-run time series analysis. According to Männikkö [36], the combining of HR and FR offers the most potential for analysing the recent past. We propose that the combining of HR and FR, offers the most potential for the analysis of alternative futures.

In history research one of the challenges is to expand the time horizon until the present. A sample of doctoral dissertations at the four chairs of history departments of three Finnish universities suggest this. Out of the 130 theses only one dealt with the 1990s being a study on information technology evolution, while two others covered years after 1970. The bulk of the studies dealt with the period 1901–1940. Considering the tradition of HR this understandable.

Figure 7 provides an overall conceptual framework for combining HR and FR. 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 possibly decreases. This is a main difference between HR and FR. We can expect that historical studies increase certainty, but in futures studies we cannot be sure about the same.

Figure 8 presents a recent view on the perspectives on fully-fledged foresight. In strategic planning a move from a “rational” towards more evolutionary approach has taken place. It is recognised that high levels of uncertainty are rather a norm than the exception. Although traditional “long-term planning” has been discredited, long-term still has to be taken into account - planners just have sought better ways to do it. Policy development has seen a shift towards more participatory approach. Decision-making has to face the fact that knowledge is distributed widely. While foresight goes beyond academic or consultancy-based forecasts, it does not displace existing decision-making and planning processes – but rather compliments those. [42]

In connection with the changes above FR has shifted from predictive to more explorative approaches as well as from one-off studies to more continual iterations. It is important to involve “users” to the process. This is partly due to the fact that such involvement is often essential so that the messages of these studies could be absorbed into policy and decision making in systematic and ongoing ways [42]. Participation is usually connected to strategy and planning processes or to networking of stakeholders. Thus, nowadays key elements of foresight activities are (1) futures studies methodology and tools, (2) strategic and planning processes and (3) networking. These foresight issues are always interconnected issues. [42]

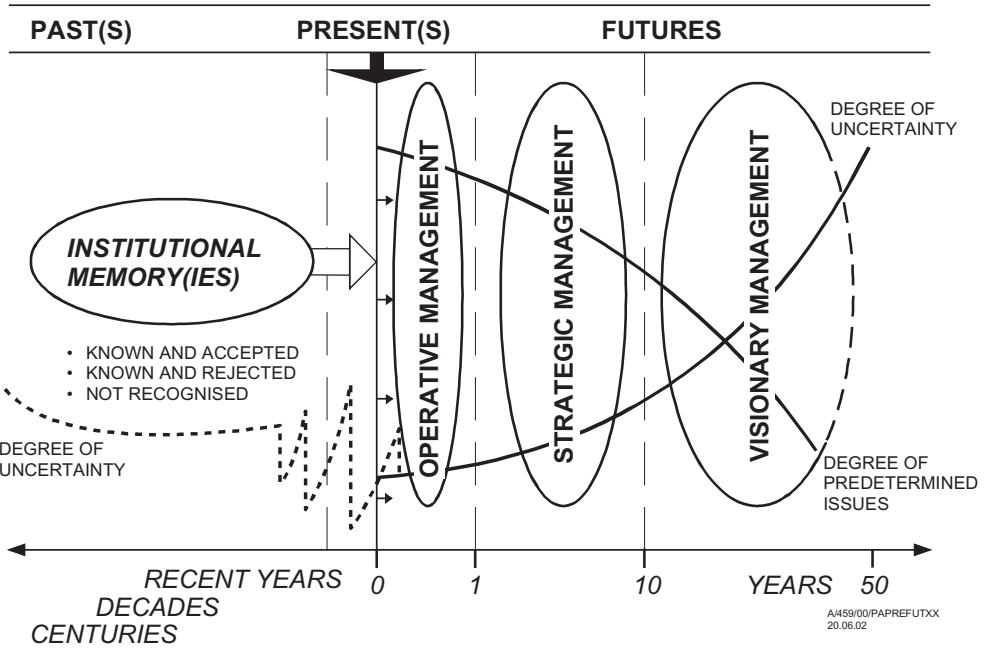
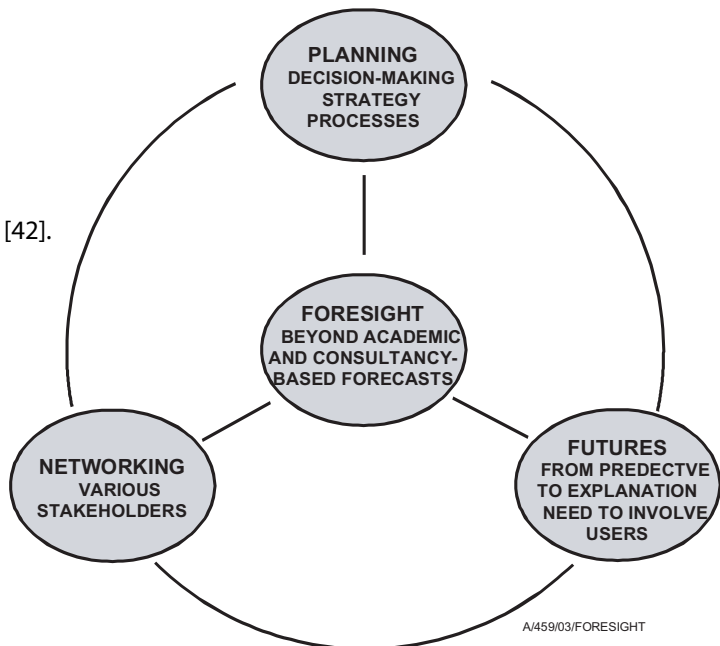


Figure 7
An overall framework for strategic management in relation to past, present and futures, suggested by the authors.

Figure 8
A perspective on fully-fledged foresight: a challenge for HR as well [42].



This kind of interaction implies that in the HR analysis of water sector development, we must analyse historical developments as an interaction of performed futures studies, networking and strategy/planning processes. Evolution of water services presents a sector where the pasts, presents and futures are unavoidably inter-related. A tentative analysis on key strategic decisions on water services in Finland from 1870s to 2000 reveal, for instance, that after a thorough HR “weak signals of the past” may later prove to be very important [43]. Such decision may not even be visible through rapid assessment. Due to path dependence such decisions also have certain impacts on the alternative future development paths.

CONCLUSIONS

The key finding is that there seems to be *discontinuity* between the presents, recent pasts and the near futures. It could be that due to the tradition for HR it is more difficult to assess the effects of strategic decisions on the recent. 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? Thus there is a paradox, since organisations such as water utilities seem to concentrate on operational management instead of having 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 could put it – what were the weak signals of the past? FR also points out the need to “look at the rear-view mirror while driving the car into the future”.

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EPILOGUE

*“Sadly, the tragedy of the water crisis is not simply
a result of lack of water but is, essentially,
one of poor water governance.”*

The World Water Development Report (WWDR), Unesco, 2003

FROM A FEW TO ALL

The above articles have several implications for the overall development and evolution of water supply and sanitation in Finland. The following findings can be presented as a tentative comparative analysis:

First, a *diversity* of development paths seems to exist. Although development has often been gradual, technological leaps have also occurred. Several alternatives have existed and been debated. The development was not as deterministic as rapid assessment might indicate. Another development path could just as well have been selected.

Second, knowledge and expertise have been sought from *various directions and by different means*. It is obvious that the development of water, sanitation and solid waste services in Finland has not been as capital-centered as could be concluded from earlier studies which have focused mainly on Helsinki, the Finnish capital. Both international, national and local expertise has been utilized.

Third, in the early days water supply, sanitation and solid waste disposal were largely interconnected –the root cause of the *sanitary problem* of the cities. Later, the paths and organizations in charge of these services split up while more recently some reintegration has been noticed.

Fourth, several *common factors* led to the birth of the systems. Thirst, fires, poor quality of water, and health concerns were the key arguments and justifications raised by decision makers for creating these services. At the same time, the need for local solutions to these challenges was evident. And “handbook”, standard solutions were not available, just like today. In some cases, the solutions or decisions to postpone one component like wastewater treatment, were influenced by the river flowing by the city. In cases like Tampere, the development of water supply and sanitation was largely dictated by the industrial tradition of the city.

Fifth, especially in solid wastes technological selection has been based on the so-called *second best solution* (Nygård H. 2000. Staden och avfallet. ÅAU, Licentiate’s thesis), whereby the best available technology has not intentionally been taken into use. In water supply a few cities selected low pressure systems for the first decades, so-called proto systems. In water pollution control a few cities introduced voluntarily first-phase wastewater treatment plants while technology, applicable to Finnish conditions, developed gradually. Even in this field the best available solutions were not always selected. Besides, modern wastewater treatment started with smaller townships, not with the bigger ones – let alone the most polluting industries. It was probably assumed that as soon as certain conditions would be met in the future, the best solutions could then be taken into use. However, the world changed continuously and thus such “ideal conditions” were never met.

Sixth, from the early days municipal water and sewage works have bought *services and goods from the private sector*. Use of private owners or operators has been proposed a few times but has not been practiced in Finland except in the first few years of Helsinki water works and in a recent case of wastewater treatment outsourcing. In small systems, the country has a long tradition of *consumer-managed water cooperatives*. They are private by nature, while instead of profit maximisation they rather tend to be cost minimisers, sometimes risking the service level.

Finally, in water supply and sanitation the key strategic decisions are to a large extent *path dependant*. Therefore, the decisions made earlier unavoidably limit the present options and potential development paths of plausible futures.

There are several interesting areas for further research including convergence between historical and futures research, or comparative country-specific studies in the Nordic countries, Europe or the USA. Such efforts could contribute much information to serve as a basis for policy development and good water governance.

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