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RESEARCH ARTICLE

# Modern infrastructure? The long transition in urban water infrastructure in Milan, Naples, and Venice, c.1800–c.1910

Salvatore Valenti

Department of Humanities, Ca' Foscari University of Venice, Venice, Italy
Email: salvatore.valenti@unive.it

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**Abstract**

The narrative of technological conquest, modernisation and sanitary improvements has been influential in shaping the historiography of nineteenth-century water infrastructures. Although technological and scientific changes were important elements, however, the transition from the early modern system of water provision to an industrial one also involved resistance, conflict, and competition between different social groups. This article focuses on the issues of drinking water accessibility and related conflicts. It examines archival records of the daily water management, infrastructure projects, and municipal minutes of nineteenth-century Milan, Naples and Venice, as well as documents produced by local communities. Contrary to the consolidated narrative of decline and decay succeeded by innovation, the article contends that the early modern water infrastructure was complex, composed of many elements assembled into a whole, and that differences between these and modern water systems should be sought not in the assumed degree of systematicity. Instead, the division between the two types of systems was manifested in the latter type's scale and its driving concepts, derived from a view of the future for which modern water infrastructures were planned. Simultaneously, the creation of new social boundaries and the increase in inequalities in water access were among the products of modern infrastructure.

## 1. Introduction

In 1881, Milan's city council, in agreement with a private water company, planned to divert one cubic metre of water per second from the Brembo River springs in the neighbouring province of Bergamo.[1] Brembo Valley residents, private entrepreneurs, irrigation consortia and even local institutions opposed the project. It was, in their view, mere speculation since 'good water in Milan is not scarce, from a public health point of view.'[2] Moreover, the Brembo River users argued that Milan's

city council did not intend to improve the living conditions of the lower strata of the urban population, a claim it had used to justify the need for such a project. Since only a small fraction of the diverted water was to be distributed for free under the contract with the private company, 'actually, the municipality of Milan wishe[d] to increase the comfort and lavishness of the wealthy metropolis of Lombardy' at the existing users' expense.[3]

A few years later, in a different context, engineer Guglielmo Melisurgo conducted a months-long survey of the underground tunnels of the ancient aqueducts of Naples, which were to be replaced with a modern aqueduct. In 1889, this engineer noted that:

> The value of this underground system is inestimable, and I am amazed at the fact it has been decided to dismantle this network on the day of the arrival of the (modern) Serino aqueduct, and yet this network has been in use for twenty centuries. Rome… has many aqueducts, but the construction of a new one has never caused the dismantling of the existing system.[4]

These two episodes provide an alternative perspective on nineteenth-century water infrastructure compared to the influential interpretive framework of technological conquest, modernisation, and sanitary improvements.[5] They remind us that differing perceptions, resistance, conflict and competition between different areas play an integral part in this story. In Italy, these elements were largely hidden in the discourse of contemporary intellectuals, who often emphasised the declining and decaying state of Italian water infrastructure.[6] However, the associated discourse of improvement and progress in relation to water infrastructure was common in the European mentality of the time. It was one of the rhetorical devices of the social reformers of Victorian Britain who, according to Patrick Joyce, aimed at creating a new, hygienic self.[7] 'Improvements' in the water supply assumed the character of a civilising mission in the context of the British Empire.[8] This is not to say that discourses on modernity in the nineteenth century were merely a façade for the cynical extension of power. For some historians, modernity emerged in that century rather as a mode of ordering, a methodology of government rooted in the assembling and interaction of multiple systems.[9] As this article will demonstrate, however, early modern infrastructure in some Italian cities was already sufficiently complex and articulated to suit that definition. Consequently, a more limited understanding of modernity is preferable: a programmatic vision of the future based on the increasing incorporation of flows of natural resources into urban environments in order to restructure those environments in support of a healthier, more productive society. The article argues that this vision was just one of multiple logics at play in the discourses, projects and conflicts concerning water infrastructure, one that was at the centre of a perennial tension between designs intended to homogenise and shape the city as an organic whole and the actual boundaries, both physical and social, lines of fractures and distinctions that water infrastructure helped create, underpin and reproduce.

Access to, use of, and distribution of water are all controversial issues. In an urban context, water is a delineator of social power that has at various times worked either to contribute to greater urban cohesion or to exacerbate political conflict.[10]

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To be more precise, it is not water itself that possesses such a quality but rather the way in which water has been technologically manipulated and socially regulated to serve specific purposes that create or reduce social boundaries and conflict. A water infrastructure system is a complex assemblage of heterogeneous elements such as capital, technology, policy and culture, built by powerful social groups to increase their influence over time and space.[11] Through the creation of privileged circuits of water flow that benefit some social groups while damaging or bypassing others, water infrastructure sustains a specific social and spatial geometry of power.[12] Changes in the existing water system thus alter the balance of power between competing social groups and areas.

This article examines the transition of the water systems in Naples, Milan and Venice from the early nineteenth century to the early twentieth century. It aims to answer the following questions: does the actual management of water infrastructure in these cities over this period support the view of decadent infrastructure? More generally, what, if anything, distinguished an early modern from a modern system? Which conflicts and interests were involved with the transition to a new system? Did the new system promote greater urban cohesion or contribute to the (re)production of social inequalities? This article will answer these questions by focusing on three aspects: the competing projects for water infrastructure and the alternatives to refurbishing the early modern system or replacing it completely; the conflicts between city councils and local communities over control of and access to water sources; and to what extent the new system provided equitable access to water to the lower strata of the urban population.[13]

This paper analyses these dynamics through the cases of three Italian cities. The choice of Naples, Milan and Venice is based on their relevance and the typology of their water systems. In the nineteenth century, they were among those Italian cities with more than 100,000 inhabitants, and the first two remained the largest Italian cities at the end of the century.[14] Interestingly, they had substantially different water systems and related cultures. Naples had an articulated system of underground cisterns and piped water (usually for industrial uses) fed by two aqueducts.[15] Milan was built over an abundant aquifer and, in the early nineteenth century, the city was dotted with thousands of private groundwater wells.[16] Venice, meanwhile, was supplied by rainwater cisterns (more than 6,000 in the mid-1800s).[17]

Using the case study of Milan, Naples and Venice, this article focuses on the issues of drinking water accessibility and related conflicts. The structure is both thematic and chronological. The first section analyses the nineteenth-century water systems of the three cities and the projects and incremental works carried out to increase both the quantity and quality of drinking water. The second section scrutinises the implementation of projects to install modern infrastructure undertaken by the city councils and the resistance these encountered from local stakeholders and those who defended the existing systems. Finally, the last section examines the effects of the new systems in terms of water accessibility and the overlapping of new and old elements. This approach challenges the assumption that early modern infrastructure was 'inadequate' and that the nineteenth-century cities 'needed' new, modern aqueducts. This assumption represents the unquestioned starting point for Italian historiography on the subject.[18] In contrast, the article posits that in the nineteenth century, there existed a multiplicity of conflicting logics

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pertaining to the management of water resources, rendering the situation less clear and coherent.

## 2. Water infrastructure in pre-industrial times

The works of nineteenth-century health reformers and intellectuals communicate an image of decay and inadequacy with regard to the water infrastructure of early nineteenth-century Italian cities, in particular Naples, a view that historians have sometimes accepted and incorporated in their analysis.[19] In this section, we will see that the picture was, in fact, more nuanced.

In contrast with Paris and London, Naples, a city which was consistently among the largest in terms of population in early modern Europe and still ranked third in 1800, did not have a main river on which it could rely for the supply of water.[20] Its early modern water system consisted of two aqueducts, the Bolla (or Volla), which had presumed Greek or Roman origins, and the Carmignano, constructed in the seventeenth century.[21] The Bolla springs were located on the slopes of Vesuvius; their waters were channelled by tunnels and collected in a huge reservoir at Poggioreale, a villa outside the city walls. At the Porta Capuana, the water entered the city and subsequently flowed through a main canal and an articulated system of underground tunnels and cisterns to the ancient, lower city (Figure 1, in grey).[22] This water arrived in the city at only 13 metres above sea level and ended its course near the Maschio Angioino at 9 metres above sea level, so it was stored along the route in large underground, sometimes quite deep, cisterns (improperly termed *pozzi*, meaning wells) dug in the tuff and connected by an intricate system of secondary and tertiary branches.[23] Once filled with water, a cistern could serve a number of apartments for two or three months, depending on its capacity.[24] The Carmignano aqueduct, named after the Neapolitan noble who proposed and financed its construction between 1627 and 1631, brought water from the Faenza River and other springs in the Apennine Mountains near Benevento to Naples via a partially open, partially covered canal, serving urban grain mills as well as providing drinking water to the western part of the city through private and public fountains and underground cisterns (Figure 1, in green).[25]

Water for life necessities (drinking, cooking, washing) was free to any private individual or religious institution that requested it from the city council. However, these concessionaires had to pay for the construction and maintenance of the plumbing from the water main to their building, as well as that of the underground cistern, and for refilling the cistern.[26] A group of technicians, the *pozzari* and *fontanieri* (well attendants and fountaineers), managed these works. As civil servants and private entrepreneurs simultaneously, they received a small amount of money from the city council, thus most of their revenues were coming from maintenance work and cistern refilling.[27]

To a certain extent, Naples' water system was modern, if by 'modern' we mean a 'complex assemblage of parts adjusted into and working as a whole, being mutually dependent', with those parts including both material and non-material elements.[28] The parts of Naples' and, as we shall see, Venice's early modern water systems were assembled in a different way and according to a different logic to those of the nineteenth century. The main differences lay in the conception of the future approach

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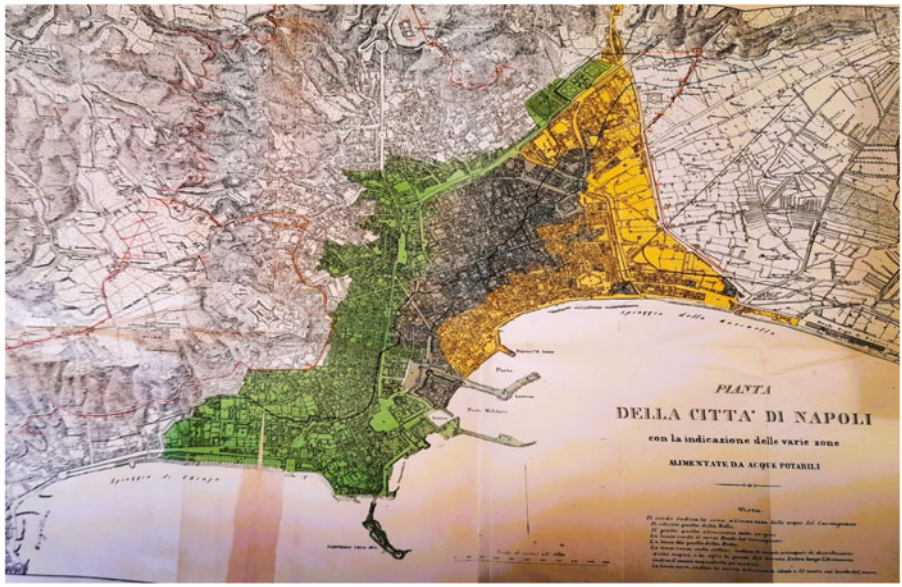


**Figure 1.** Map of Naples for source of water 1867.
*Source:* C. Firrao, *Come migliorare ed aumentare le acque potabili della città di Napoli: progetto dell'assessore Cesare Firrao presentato al Consiglio municipale convocato in seduta ordinaria nel maggio 1867* (How to improve and increase the supply of drinking water in Naples: Councillor Cesare Firrao's project presented to the City Council in May 1867)(Naples,1867).

to water consumption and conceptualisation of the city in the nineteenth century as an organic and coherent whole whose abstract, impersonal water needs could be calculated a priori. According to Frédéric Graber, this way of thinking was the invention of a small group of late eighteenth-century scientists, engineers and entrepreneurs who aimed to convince public authorities that there was a lack of water in Paris.[29] It is worth noting that, from the outset, their calculations of the city's needs tended to underestimate the amount of water available to citizens and contained an implicit assumption that a certain social restructuring was necessary: Parisian authorities would have to bypass the water carriers, the system that actually supplied the needs of many inhabitants.[30]

As we shall see, in Naples, this abstraction was not made in these terms before the 1840s: attempts to reform the system were, indeed, mainly focused on better controlling the activities of *pozzari* and *fontanieri* and the water available from the aqueducts.[31] Together, the two aqueducts provided something in the region of 27,000 cubic metres of water per day; but only between 8,000 and 9,000 cubic metres of water per day, depending on the season, were available for civic use, while the rest was for milling and industrial use. This left 26 litres of fresh water available per person per day on average.[32]

The two aqueducts, however, supplied only half of the population, while the poorest part of the city (the lower part towards the gulf; Figure 1, in yellow) relied mainly on shallow, often brackish groundwater wells, which could be easily contaminated by cesspits and sewers.[33] In the three poorest sections of Naples, those

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worst affected by the cholera epidemics (Porto, Mercato and Pendino), Federico Giambarba, lieutenant of the military engineering corps, reported that there were 2,000 shallow wells prior to the great renewal works that took place after the 1884 cholera epidemic, while the overall contribution of the Bolla and Carmignano aqueducts in these quarters (mainly distributed by means of public fountains) accounted for only 1 litre per capita per day.[34] The distribution of water in Naples was hierarchical. Periods of drought revealed the hierarchy. The aldermen of the water service (*Eletto Commissario alle Acque*) arranged the distribution in order to maintain the supply to the royal buildings, military buildings, and other public buildings such as hospitals – in that order – while the cisterns of private individuals could run dry.[35] The area of Porto was at the lower end of the distribution network of the Bolla aqueduct, and in the summer it suffered much from the diminished amount of water available.[36] By contrast, 'the monasteries, which are numerous in the city, are supplied with plenty of water.'[37] Nevertheless, great care was also taken to ensure that public fountains did not run dry. The early modern system of Naples contributed to the formation and maintenance of a hierarchical and paternalistic society, but it was not inefficient.

The aqueducts of Naples began to appear inadequate when, with the end of the Napoleonic Wars and the return of the Bourbon dynasty in 1815, the city entered a process of transformation. The newly apparent problem was particularly evident during the reign of King Ferdinand II (1830–1859), when plans were made to restructure the city.[38] Indeed, since the late eighteenth century, Naples had reached a plateau in terms of both demographic and spatial growth. The city was enclosed to the north and west by a semicircle of hills, to the east by the Poggioreale swamps and to the south by the sea. The majority of the population lived in the lower city, an extremely dense area where residential and industrial activities were packed tightly together, often in the same buildings and even the same rooms.[39] Due to the low elevation of Naples' water system above sea level (pumping stations were considered too expensive), urban growth into the hills was limited. King Ferdinand II planned instead to expand along the bay. Industrial activities would be located on the shoreline to the east. Meanwhile, from the eighteenth century, the land to the west had become a residential area for wealthy families and a hub for Grand Tour travellers, particularly along the coast (the Riviera di Chiaia).[40]

From 1825 onwards, new water concessions were rare; as a result, Neapolitan authorities tried to increase the quantity of water supplied to the city. These early attempts took an incremental approach. As early as 1822, the provincial deputation of Naples proposed covering the open section of the Carmignano aqueduct with masonry to prevent rural water theft, evaporation and contamination. In 1831, a committee of municipal architects drafted a project to build a new aqueduct to replace the open canal section of the Carmignano aqueduct: this would increase both the volume of water transported and the elevation at which it would arrive in Naples.[41] However, the funding of the works proved to be complex, and they started only in 1853, with very limited funds, which made progress very slow.[42] Before the works started, private entrepreneurs tried to take advantage of the municipality's financial difficulties to gain control of the water system. For example, in 1833, a private company proposed to carry out the project; however, this private company requested the right to manage the city's entire water system and its

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associated revenues as payment.[43] The proposal was refused because the municipal council considered it inadvisable to lose control of its infrastructural assets and because of the alarm that a private company managing water for its own interests would have generated in the public.[44]

Increasing the volume of water in the Bolla aqueduct was a further objective. In 1828, the Abbè Teodoro Monticelli, a naturalist who in 1809 had published a treatise on the ordering of the waters of the Kingdom of Naples, which he dedicated to Joachim Murat, suggested that additional water could be collected in the plain of the Bolla springs.[45] In the early 1840s, two artesian wells were dug in the countryside near Poggioreale, and their water was introduced into the Bolla aqueduct.[46] This leads us to a third type of innovation in Naples' water system, which between 1840 and 1860 seemed very promising due to its limited cost: artesian wells. Artesian wells are those from which water flows without pumping due to hydrostatic pressure in aquifers that drives the groundwater to the surface. In 1842, the municipal architect Luigi Cangiano proposed drilling two artesian wells, one in the garden of the Royal Palace of Naples and the other in front of the Royal Villa at the western boundary of the city.[47] As we have seen, this was one of the directions of Naples' residential expansion between the late eighteenth and early nineteenth centuries.[48] The first artesian well was started in 1844, drilled by the company of the French engineer Degousée under the supervision of Luigi Cangiano; however, the works came to a halt in 1847 and were started anew in 1850, together with works on the second well.[49] Finally, in 1859, water poured out into a basin built to collect it, and arrangements were made to distribute this water, which amounted to roughly 2,870 cubic metres per day.[50]

In Venice, a similarly incremental approach was taken. The city had experienced a significant economic crisis after the fall of the Venetian Republic in 1797. Over the next 20 years, many of the patrimonies of the great Venetian families were dissolved, overall consumption decreased, some textile producers disappeared and the city's population shrank by a third.[51] From the 1830s, however, population began to rebound, although there were still fewer inhabitants in 1871 (129,000) than there had been in 1797 (140,000).[52] Unlike many European cities in the nineteenth century, Venice did not experience demographic pressure on its water system. The city did, however, undergo the beginnings of an industrial transformation. The establishment of the free port and of public industries such as the tobacco factory, the arsenal and the mint, along with other, smaller industrial activities, sustained the city's economic recovery.

Venice was located in the water, but it had no fresh water supply other than that harvested by its more than 6,000 rainwater cisterns, a complex system to capture, filter (by means of sand filters) and store water.[53] A guild (from the nineteenth century a company) of watermen collected water using a special barge (*burchio*) from the *Seriola Veneta*, an open canal which channelled water from the Brenta River, to top up Venice's public and private cisterns.[54] This service was vital in the summer period, when rain was scarce. For example, in August 1861, the watermen collected and distributed 26,645 cubic metres of water to the public cisterns alone (with the addition of those of a few religious institutions).[55] Cisterns were the lynchpin of Venice's water system, an asset that required careful regulation and maintenance. A survey conducted by the municipal engineer Luigi Bianco in the 1850s, however,

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found that only 2,212 out of 6,600 private cisterns were in good condition, while a further 1,636 were 'acceptable', and 116 of 180 public cisterns were in a good state.[56] Cisterns that were considered to be in bad condition, however, still had a place in Venice, since they were used to provide water for industrial activities and any other uses where water purity was not required.[57] Overall, drinking-quality water provided by Venice's cisterns amounted to 810 cubic metres per day, which meant 6.25 litres per capita per day.[58] Indeed, Venetian public authorities considered 15 litres per capita per day a good target even in 1864.[59] The scarcity of fresh water in Venice also had an impact on the calculation of desirable individual water needs.

The construction of a bridge for the railway that connected Venice with the mainland triggered private entrepreneurs to draft projects to bring water from the mainland by means of an aqueduct, although the earliest proposals dated back to the sixteenth century.[60] The proposals of the 1840s, however, were too expensive or inadequately detailed.[61] The military security of the city in case of siege (an event that actually occurred in 1849) and the fact that water needed to be stored in some way (continuous water supply was not a feature of European cities at the time) led the city council to sign an agreement with the French engineer Degousée (the same person as in Naples) to drill artesian wells in Venice in 1844.[62] Seventeen artesian wells were drilled between August 1847 and October 1852, but only eight were still providing water in 1852.[63] According to the contract between Degousée and the Venice city council, the artesian wells were to provide 1,800 cubic metres per day, but in September 1856, the daily volume was slightly over 700 cubic metres, a significant addition in any case considering Venice's context.[64] Moreover, the artesian wells supplied industrial operations such as the gasometer, demonstrating the overlap between different aspects of the city's modern transformation.[65]

In Milan, demographic growth in the first half of the nineteenth century had been steady but slow.[66] The city's population lived mainly in the centre enclosed by the ancient walls; as a result, urban density increased as it did in the case of Naples. Water, however, did not represent a concern for the Milanese public authorities for most of the nineteenth century. In contrast to Naples and Venice, which had complex, stratified systems involving institutions, technicians and infrastructure to provide drinking water, Milan lay at the foot of the large water basin represented by the Alps and the Pre-Alps. Although Milan did not have a major river, surface water collected from natural streams and artificial canals flowed in abundance in its water network.[67] Drinking water came from private, shallow wells since the city lay on an abundant aquifer.[68] This had multiple layers, the first just three to four metres beneath the soil surface. Nineteenth-century historian Cesare Cantù praised Milan's water system:

> Only when we live in a different city, where it is necessary to pay for water with good cash, collecting it in the morning for the whole day, do we appreciate the fact that we have abundant water in each house, that we can draw it at any time, quite cool, and that once it is pumped, it reaches the highest floors in the houses of the well off.[69]

If the inhabitants of Milan were satisfied with the water supplied by their wells, this did not mean that the system remained static. Given the hydrology of Milan, it

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is not surprising that artesian wells seemed a promising technology to Milanese technicians.[70] However, innovation in the Milanese water system was even simpler. Giuseppe Croff, a bursar at the Mint, began a business in the 1840s drilling wells with waterproof pipes to reach the second layer of Milan's aquifer, located between 8 and 16 metres below ground level.[71] Approximately 500 wells were drilled in this manner by 1880.[72] One of these wells, which was drilled to supply a sugar factory, was capable of supplying approximately 1,380 cubic metres per day.[73]

Given these circumstances, projects to draw water from distant springs did not find acceptance in Milan, the lack of need compounded by the costs of such enterprises and the fact that there was little room for the commercialisation of water. Indeed, in 1847 Luigi Tatti, architect and engineer, proposed bringing water from the springs located nine kilometres north of the city to supply water for public fountains, which he understood as a way to embellish and clean the city, particularly public spaces such as markets, and to provide fresh water in the city's streets, which could be helpful for firefighting and for snow removal in winter.[74] Tatti was convinced that the cost of the enterprise (two million Austrian lire) would be covered by selling water to hospitals and private companies such as cafes and theatres, but neither Milan's municipality nor the private entrepreneurs to whom he submitted his plan were persuaded. Between 1860 and 1880, a period which saw a significant renewal of Milan, including the construction of two early examples of public housing as well as public lavatories and baths, water was still drawn from groundwater wells for domestic uses and from the canals for laundry and cleansing purposes.[75]

One could raise the question of the quality of water in these three cities. Importantly, historians have shown that early modern societies had their own understanding of water quality. With regard to Venice and Naples, the use of cisterns allowed impurities contained in water to settle out, and in the case of Venice, water was also filtered by sand, which left it colourless, odourless and agreeable to the taste.[76] These criteria remained key to the understanding of 'good' water well into the nineteenth century and were not immediately superseded by the modern notion of purity forged by the chemists of that century.[77]

Quantity, elevation and ease of collection were also important parameters. Italian cities of the early modern period had been among the largest and richest in Europe. By the eve of the nineteenth century, however, their growth had reached a certain impasse. The question of water was one of the key factors governing their further development. The peculiar aspect of the projects undertaken in the three cities considered here is that until the mid-nineteenth century, they were based on an understanding of water needs that addressed only the present situation, without imagining a future of ever-increasing consumption. Elsewhere in Europe, major diversion schemes were being planned and constructed, such as the *Canal de Isabel II*, which supplied Madrid with abundant water from the Lozoya River, making the Spanish capital the second city in Europe in terms of water supplied per capita.[78] Nonetheless, the existing systems in Naples, Venice and Milan, with their class divisions expressed through the use of public fountains or cisterns by the lower classes, still provided a strong framework for approaching the question of drinking water. Rather than following abstract principles of quantification, changes were oriented by existing practices.

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## 3. A contested change: social and geographical conflicts

In 1861, Naples passed from being the capital city of the Kingdom of the Two Sicilies to a provincial city of the Kingdom of Italy, though its largest.[79] The issue of water infrastructure reached a climax at this time. The bulk of works, studies and experiments over the preceding decades had contributed to clarifying the key points for the renewal of Naples' existing system: vaulting and partial rebuilding of the Carmignano aqueduct, new catchment works, and artesian wells to increase water quantity in both the Carmignano and Bolla aqueducts. However, the new municipal authority had received various proposals to bring water from other sources during this period, one of which intended to restore the Serino aqueduct, the ancient Roman aqueduct that had been out of use for centuries.[80] In 1861, the municipal council prudently decided to continue the vaulting of the Carmignano aqueduct started in 1853, and 5,000 cubic metres of water per day were diverted from the mills to be allocated to citizens for life necessities in 1865, increasing by 50 per cent the overall volume of fresh water distributed to the population.[81] In 1867, the councillor Cesare Firrao, colonel of the Italian military corps, provided a highly detailed project, accompanied by a financial plan, to achieve the renewal of the existing aqueducts and the new catchment works in order to reach a daily distribution of 50,000 cubic metres of water within a few years and up to 100,000 cubic metres (if needed) over the longer term.[82] Firrao, however, considered the latter amount utterly beyond any reasonable projection for water consumption in Naples: he had calculated it purely to compete with the astonishing amounts promised by other proposed projects. The municipal council approved Firrao's project, but just a few months later, a committee of municipal engineers, which had studied the feasibility of the restoration of the Serino aqueduct, drafted a competing project which promised to deliver 170,000 cubic metres of water.[83] This project was based on the view that there was never enough water in a city and on a significant and evident underestimation of costs.[84] In 1867, Firrao admonished the supporters of the project that:

> Many of the users of the Bolla and Carmignano aqueducts, approximately half of the Neapolitan population, will continue to use them since they are accustomed, fully satisfied, or unable to afford to replace pipes, tanks, and similar items. As such, the many millions the Serino aqueduct will cost are for a few people, whereas those still using the existing aqueducts do not have improved water quality and quantity… in addition, they will be charged taxes for water consumption that is merely imaginary.[85]

In spite of this, and contrary to the ideal of preserving municipal assets and keeping the water service in public hands which had guided the actions of the municipality in the preceding decades, the Serino aqueduct project gained the approval of the city council.[86] Its funding and management were placed in the hands of the Naples Water Works Company, a private company that was actually synonymous with the powerful French *Compagnie Générale des Eaux pour l'Étranger*. The consensus around the Serino aqueduct was built on material and non-material reasons. The aqueduct marked the return of the city to its glorious

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Roman methods of water supply following centuries of foreign and barbarian rule, according to its supporters.[87]

The users of the Serino springs held a different opinion. For the economies of the provinces of Avellino and Benevento, the Serino springs were a staple resource. In addition to irrigating 2,550 hectares of land, the river provided 2,500 horsepower of hydraulic energy to a large textile industry, 25 mills, and other minor businesses.[88] These users opposed the Serino aqueduct project using every means provided by Italian law. In their view, the Serino aqueduct was mere economic speculation at their expense, since the volume of 170,000 cubic metres of water for daily drinking use in Naples was thoroughly disproportionate to the city's present and foreseeable future water consumption. This meant that under the banner of sanitation and the needs of the thirsty Naples, the redirected water would serve other uses such as irrigation and industry, reshaping the geography of production in the region, from which the private company would have gained good profits.[89] At the end of a long legal struggle that involved the Council of State and political lobbying of the Italian ministries and deputies by both sides, the Serino aqueduct project was approved by the Italian king and the Department of Public Works on 11 July 1877.[90]

This marked a significant moment in the development of urban water infrastructure in nineteenth-century Italy. With Naples allowed to divert a substantial amount of water to realise the modern vision of a city with abundant water for a range of purposes, other cities could make their own, similar claims. Nevertheless, resistance could temper their aspirations. Milan's city council started to discuss the possibility of an aqueduct for the city fairly late compared to Naples and Venice. The abundance, accessibility, and good reputation of Milan's aquifers presented a significant obstacle to the projects for a new aqueduct. In 1877, Milan's city council received 12 proposals, with proponents including engineers such as Eugenio Villoresi, well known in Milanese technical circles, foreign private companies such as the *Compagnie Générale des Eaux pour l'Étranger*, and Italian banks such as the Bank of Rome (*Banco di Roma*).[91] Milan's city council opted for the project of the *Società Italiana per Condotte d'Acqua* (Italian Water Conduits Company), whose century-long business constructing water infrastructure in Italy and the Mediterranean was then in its early stages.[92] The project planned to bring to Milan 'at least' 900 litres per second (77,760 cubic metres of water per day) from certain springs of the Brembo River in the province of Bergamo, conducting it to Milan by way of a 73-kilometre-long aqueduct.[93] Local stakeholders, the public authority, and the local engineers of the civil service in Bergamo revolted. In their view, the Brembo River was subject to appreciable seasonal fluctuations, and in the summer its water was already insufficient to serve all of its legally recognised users, which were 114 businesses, particularly textile factories, the three most relevant employed 800 workers each, and 21 canals which irrigated 7,918 hectares of land in the river valley.[94] The respected geologist Antonio Stoppani minimised the reasons for the antagonism towards Milan's aqueduct: 'What is a wheel that does not spin for a few days in a year compared to a city of 300,000 people whose inhabitants poison themselves by drinking bad water?'[95] As we have seen in the introduction, the Brembo River users were not at all convinced by this point.[96]

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In 1885, the Superior Council of Public Works, the technical board of the Ministry of Public Works, acknowledged that the proposed aqueduct would damage the Brembo Valley users and that the city council did not need more than 450 litres of water per second for the life necessities of its inhabitants, which required an average of only 110 litres per day per inhabitant.[97] Milan's city council had the choice to reframe the project according to the opinions of the Superior Council of Public Works or to launch another competition. An invitation for new proposals was launched, but the municipality was not satisfied with any of the 22 it received.[98] Meanwhile, the Milanese Chamber of Architects and Engineers (*Collegio degli Ingegneri e Architetti*) had started to assess the feasibility of a project proposed by engineer Angelo Riva, who was 'surprised by the fact that we want to face the risks of a long aqueduct… whereas we have the means to secure water in a comfortable manner by drawing it from Milan's underground.'[99] Riva's idea was simple: drilling wells under Milan at a depth of over 15 metres to find water that was not contaminated or at risk of faecal contamination. Physicians of the municipal laboratory of hygiene and physicians within the city council looked at this idea with scepticism.[100] Nonetheless, a project of urban renewal in the area of Foro Bonaparte, in the north of Milan near the Castello Sforzesco, led the city council to test the hypothesis by drilling two wells at a depth of between 35 and 65 metres in that area; the low cost of the enterprise and the fact that the water was indeed of drinking quality convinced the city council to turn its attention (again) to the city's aquifer.[101]

Turning our attention to Venice between the 1860s and 1870s, we find that the partial failure of the artesian wells encouraged the municipal engineer Giuseppe Bianco to draft a proposal to obtain water from groundwater wells in the Lido's sand dunes.[102] As early as 1832, the reputed engineer Pietro Paleocapa had proposed such a method to collect water; in fact, he was convinced that Venice's Lido was in fact a large cistern that filtered rainwater.[103] Giuseppe Bianco revived this idea in the late 1850s and presented a detailed project, supported by fieldwork on a testing well, to the municipal authority. The plan was to dig 33 shallow groundwater wells to a depth of three to four metres below sea level, which Bianco calculated could provide 1,950 cubic metres of water daily, an amount sufficient to supply 15 litres of fresh water per capita per day, and to conduct this water to the city by means of a pipe under the lagoon. Alongside the peculiarities of Venice's socio-environmental configuration, financial constraints limited the calculated water needs. If the last years of Habsburg rule were not favourable to large investments, the passage of Venice to the Kingdom of Italy in 1866 did not substantially change these financial constraints. The revenues of urban municipalities came mainly from indirect taxes, particularly excise duties (the *dazio consumo*) on goods entering the city, and there were no major recurrent financial transfers from the central government to the municipalities.[104] Bearing in mind the lack of financial resources, we can appreciate engineer Bianco's careful analysis of the local socio-environmental context to find an affordable and technically straightforward source of water. A committee of distinguished Venetian and Paduan engineers rejected the project, not because of water quantity or quality, which were – as Bianco had stated – enduringly abundant and pure, but for the difficulties of installing a water pipe under the lagoon connecting Venice and the Lido and for the maintenance

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costs, which would have surpassed the sum the city council paid to the watermen to fill the cisterns in dry conditions.[105]

Abandonment of the cisterns was not an option. Storage capacity of water systems was at a premium in many early modern societies, as it enabled cities to cope with periods of drought, war and other events that could threaten the continuity of the water supply. In mid-eighteenth-century Amsterdam, for example, it was considered technically feasible to install a system of piped water, but this could not match the flexibility of the city's existing system of cisterns, which was, in fact, expanded over the decades that followed.[106] Venice's city council similarly wished to retain the flexibility of its system. In fact, in 1867, the city council opened a bidding process for aqueduct projects, but the drilling of a new artesian well and the maintenance of the public cisterns to secure a backup source of water both remained indispensable conditions for any deal. The sum the council spent on the water supply in a year was frequently adopted as a point of reference to assess the suitability of a project, and 'the guiding idea of the committee [was] to avoid any kind of financial commitment and risk to the municipality.'[107] The problem was that the construction, operation and maintenance of water infrastructure and the selling of water were also perceived as risky business by private entrepreneurs. Finding a balance between these competing interests was one of the reasons for the exhausting back and forth that took place before a decision was taken and works began. In 1876, ten years after the first public competition, Venice's city council reached an agreement with two British engineers, Louis Antoine Ritterbandt and David Croll Dalgairns, for the construction of an aqueduct and the drilling of an artesian well.[108] However, the two were unable to raise the necessary funds and finally, in April 1879, sold their licence to the *Compagnie Générale des Eaux pour l'Étranger*.[109] This meant that both Naples' and Venice's water supplies were in the hands of the same French company. Venice's aqueduct would bring water from the Seriola Veneta, the same canal used since the seventeenth century by the watermen to fill Venice's cisterns. This saved Venice from encountering the conflicts that often arose regarding diversion schemes, as we have observed in the cases of Naples and Milan. A minimum of 5,300 cubic metres of water per day were to be supplied in this way to public cisterns and private households, which meant around 40 litres per capita per day.[110] The change seen in Venice was not technologically radical. Its most important feature was instead the social redefinition inherent in the replacement of the local company of watermen as the city's supplier by a powerful French company.

The change in water systems, broadly speaking, involved a social restructuring of who benefited from water and who controlled it, alongside a geographical redistribution between rural and urban areas. Intermediaries such as the Neapolitan *pozzari* and *fontanieri* and the Venetian watermen, who had significantly influenced both the mode and timing of water distribution in the early modern system, saw their autonomy reduced or their role completely replaced by modern aqueducts. In the case of urban–rural conflict, the outcome was not decisive. In the nineteenth century, the concept of the public interest was still sufficiently elastic not to be fully identified with urban interests, as was the case, conversely, in France, where opposition to diversion projects was only noticed to the extent that those projects stood to damage settled interests in Paris.[111] Moreover, in late nineteenth-century Italy, the

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standard for water needs remained uncertain and context-based. Nonetheless, the fact that new projects were based on unprecedented estimates of water needs was indicative of a new way of thinking about urban water supplies. To sustain urban growth, no amount of water could be enough.

## 4. New systems, new inequalities

Modern scholars of urban water in the global South pay attention to the conditions and inequalities of the water service, that is to say, who drinks what and how.[112] If we consider these questions in the context of nineteenth-century Italy, we find that although new water infrastructures were planned to provide coherence to each city as an organic whole, they actually contributed to the creation of new boundaries and lines of fractures. In Naples, the restored Serino aqueduct was inaugurated with the unveiling of a grandiose fountain on 10 May 1885 in the presence of the Italian King and Queen. The event was interpreted by journalists and the urban elite as a sign of the rebirth of the city following the 1884 cholera epidemic.[113] Celebrations, however, were premature. Changes were soon made to the original contract to meet the demands of private investors.[114] Two of the new clauses implied that Naples' city council guaranteed these private investors a minimum six per cent annual net profit on the capital invested for the construction of the aqueduct.[115] This meant that until 25,000 cubic metres of drinking water were sold in Naples per day, the municipality covered the difference to secure the net profits of the company.[116] The municipality was convinced it would never pay for this, given that the entire project was to bring 170,000 cubic metres of water per day to Naples. This was an optimistic picture. Between 1885 and 1894, the municipality of Naples paid an overall 9,793,362 lire to the *Compagnie Générale* to compensate for the company's loss of earnings.[117] It is hard not to think that with that sum, improvements could have been made to the city's old aqueducts rather than private company profits being topped up.

The profit guarantee clauses further discouraged the private company from expanding its consumer base and demonstrated that the space for a water market in Naples was limited. In fact, as Cesare Firrao had predicted 20 years earlier, many continued to use the Bolla and Carmignano aqueducts. The two old aqueducts, in fact, continued their service for at least a decade after the arrival of piped water. This was not simply a matter of inertia and old habits. Indeed, the Serino aqueduct scheme, like all such ambitious schemes in nineteenth-century Europe, not only entailed the abstraction of the city as an organic whole but also characterised its citizens as passive recipients of new habits and routines induced by the new technology; but novel 'practices did not automatically enact new technical directives.'[118] In reality, people's behaviours were varied and followed logic(s) that diverged from the script envisioned by the planners. An important feature of modern piped systems is their reliance on a continuous water supply, leaving them susceptible to breakdowns, disruptions and disasters that can compromise their functioning. As discussed in the previous section, storing water in early modern cities was a defence against such hard times. In London, a severe drought in the 1890s resulted in water shortages that forced water companies to revert to intermittent supply. The residents of the small houses in the East End faced particular

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difficulties, as since 1870, landlords had been removing cisterns, leaving those homes lacking the storage capacity to cope with prolonged periods of drought and intermittent water supply.[119]

Citizens in Naples and Venice reported uncomfortable experiences when the modern systems showed their fragility. In July 1887, a serious breakdown occurred in the Serino aqueduct, as a result of which the municipal service had to provide its users with water from the Carmignano and Bolla aqueducts, which also temporarily resumed supplying the public fountains.[120] In 1892, the city council voted for a more effective maintenance service for the two older aqueducts: 'The preservation of the Carmignano and Bolla aqueducts is not only a matter of prudence – given the fact that a pressurised pipe like the Serino aqueduct is subject to breakdowns – but also of contract agreements since many householders had bought water from the municipality' in the preceding centuries.[121] Breakdowns occurred in the water main of Venice's aqueduct in the 1900s, and the city council voted in favour of the aqueduct's municipalisation. The *Compagnie Générale* retained its role as service provider, though it had to assure the maintenance of the public cisterns and the availability of 20 metal tanks to carry water by boat from the Seriola Veneta in case of breakdowns, while the municipality had the right to use the existing artesian wells and to drill additional ones to supply public fountains and cisterns.[122] The diversification of water sources, a common practice in early modern cities, reduced the risks and inconvenience of taps' running dry.

This was one of the reasons behind Milan's successful aqueduct system. In Milan, a combination of an old source of water and industrial technologies for drawing and pumping, as well as municipal ownership, resulted in the expansion of water distribution. At the turn of the twentieth century, the technical offices undertook works to increase the quantity of water extracted from the aquifer. In 1907, seven plants for the drawing and pumping of water were active in the city, and others were under construction. As the municipal engineer Francesco Minorini argued, 'using (as a source) the aquifer under the city makes it always easy to follow the increase in water use by drilling new wells and building new pumping stations with relatively little cost', whereas longer aqueducts required massive investment that implied the projection of a theoretical maximum use of water, which often significantly exceeded the real needs and the economic potential of the population.[123] The limited investment required for Milan's pumping stations had a positive effect on water rates, which in 1908 were among the cheapest in Italian cities – half those seen in Naples, for example, and even cheaper for public housing (Table 1).[124] The municipal water service, in 1915, supplied 81 per cent of Milan's houses.[125] Milan thus benefited from its rejection of the modern long aqueduct option, while Naples suffered from the excessive inflation of anticipated water needs, which multiplied the costs of the change to its water system – costs that the city paid directly in the form of guaranteed profits, high tariffs and the limited expansion of water distribution.

In Naples, to reduce the amount of money the municipality was required to pay to guarantee the profits of the *Compagnie Générale*, the parties agreed to an increase in water fees and the minimum amount of water sold to each household in 1896.[126] In the following year, all of the old underground water cisterns were banned, eliminating *de facto* the possibility for private individuals to use the Carmignano and Bolla aqueducts.[127] The combined effect of these measures on the distribution of water was

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**Table 1.** Water tariffs in some Italian cities, 1912

| City | Price of water for cubic metre |
|---|---|
| Milan | 0.18 lire |
| Naples | 0.35 lire |
| Palermo | 0.20 |
| Rome | 0.15 to 0.07 lire (private company) |
| | 0.075 to 0.047 lire (municipality) |
| Turin | 0.15 lire |
| Venice | 0.60 lire |

*Source: A. Raddi*, 'Il consumo e il prezzo dell'acqua potabile', *Rivista di Ingegneria Sanitaria e di Edilizia Moderna*, VIII (1912), 23, 328–31.

paradoxical. The water of the Serino aqueduct, celebrated as the redeemer of the poorer parts of the city from the burden of cholera and other infectious diseases, was beyond the economic means of the population of Naples, as a commission on the financial administration of Naples city council (the Saredo Commission) recognised in 1901.[128] In spite of the demographic growth of the city, still at the end of 1908, only 54,066 of the supposed 170,000 cubic metres of water from the Serino springs were distributed to the Neapolitans.[129] People not connected with the aqueduct collected water for their daily needs from public fountains, which in 1908 numbered 270, and by other informal means.[130]

The progress of the distribution network of Venice's aqueduct was similarly slow. The aqueduct was inaugurated on 23 June 1884 and, as in Naples less than a year later, a purpose-built fountain in a crowded Piazza S. Marco received the first piped water.[131] However, Angelo Vivante, Venice's health officer, found in a survey on the housing standards of the city in 1908 that 46 per cent of Venetian houses were not connected to the aqueduct.[132] This was the average across the city, but there were huge differences between neighbourhoods (Figure 2) and parishes, with values ranging from 17 per cent of houses not connected with the aqueduct in the parish of S. Maria del Giglio in the neighbourhood of S. Marco to 74 and 71 per cent of houses not connected in the parishes of S. Pietro (Castello) and Angelo Raffaele (Dorsoduro) respectively.[133] Clearly, in Venice, water followed the spatial divide between rich and poor areas. The Angelo Raffaele parish in the nineteenth century, in particular, was like a ghetto: an overcrowded area inhabited by porters, fishermen and other marginalised social groups.[134] Vivante argued that:

> These fluctuations are even more marked if we look at the size of the house. In this way, we observe that 92 per cent of houses are not directly connected with the aqueduct among the small houses (those with a kitchen and up to three other rooms) in the parishes of S. Pietro, S. Francesco, and Angelo Raffaele.[135]

There was a clear link between the poorer parishes of the city, the cheapest type of housing, and the lack of piped water. Water fees in Venice at the beginning of the

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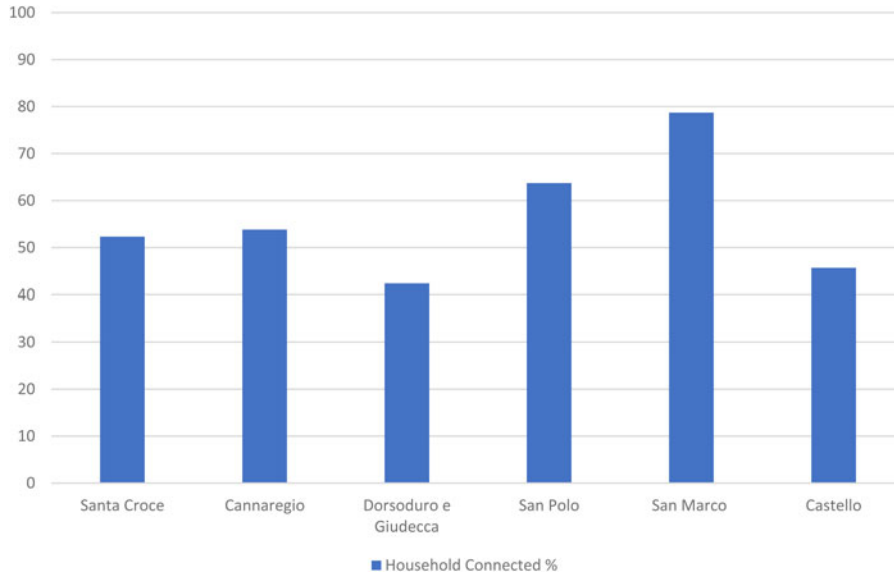


**Figure 2.** Households connected with the aqueduct (per cent), Venice 1908.
*Source:* Comune di Venezia, *Il problema delle abitazioni in Venezia* (The housing problem in Venice) (Venice, 1910). The survey was based on information collected by 32 municipal guards who, under the direction of the Venice Health Office, inspected 25,000 houses between November 1908 and March 1909.

twentieth century were the highest among Italian cities whose population surpassed 100,000 inhabitants (Table 1).[136] Amerigo Raddi, an independent engineer and prolific writer on urban infrastructure who worked for many Italian city councils, argued that the costs of water in Venice and also in Naples 'are enormous, unaffordable or practically unaffordable for the working classes and for the small holders too.'[137]

The average wage per day of an unskilled worker in the mechanical industry in the late nineteenth century was 2 lire in Milan and Naples and 3 lire in Venice.[138] A kilogram of bread in Milan at the time cost an average of 0.42 lire.[139] A working-class family (two adults, two teenagers and one child) spent 63 per cent of its weekly budget on food and the rest on housing, lighting, heating and clothing.[140] For families in this socioeconomic group, every cent counted, and even a few cents more for water could prove unaffordable (although they probably did not eschew buying coffee). It is difficult to compare modern water tariffs with prices under earlier systems, mainly because the cost charged in the latter case was meant to pay intermediaries rather than be exchanged for a specific quantity of water. Data do, however, give an indication of the order of magnitude of water costs in pre-industrial systems. In Venice in the summer of 1869, the municipality paid 4,732.50 lire a month to the watermen to have the public cisterns refilled to an established level.[141] According to the watermen's reports and records of the water distributed from the public cisterns, the total amount was approximately 26,600 cubic metres per month, meaning that the municipality paid less than 0.18 lire per cubic metre. Access to the public cisterns was free, but water carriers (*bigolanti*)

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were allowed to sell water from them to private individuals.[142] In 1868, the chief engineer of the municipal service in Naples calculated, using the register of works of the *pozzari* and *fontanieri*, that households connected to the municipal system paid 1.50 lire per year for maintenance and refilling costs. If 26 litres per person per day was the average supplied under Naples' early modern system, we can estimate that the cost of the same amount of piped water would have been 3.30 lire per year, excluding maintenance costs.[143]

In addition, in Venice and Naples, piped water was sold for a predetermined amount (in Naples, water meters supposedly had to be installed, but this was only done in a few cases before 1900) for minimum subscriptions of 100 and 125 litres per day respectively.[144] This rigidity, together with the cost of installing new devices, had an impact on daily life, creating a new boundary between those who enjoyed novel routines of cleanliness and those who had limited access to water despite its abundance. This divergence did not, however, mean that for the lower classes, the new aqueducts 'introduced a temporary deterioration in their access to water', as happened in the Low Countries, where the disconnection of the well-to-do and the disengagement of municipal authorities from the early modern system allowed the quality of older water infrastructures to deteriorate.[145] In 1886, for instance, Venice's city council provided 120 public cisterns with hand pumps to prevent the pollution of water by means of dirty buckets and ropes.[146] In Milan, the well system had always been a matter handled by private landlords, while in Naples, the attitude of the municipality towards the early modern system wavered between disengagement and attempts at preservation, but maintenance was still performed on a regular basis until the old aqueducts were abandoned, at which time new public fountains supplied by the Serino aqueduct were installed throughout the city.

Nonetheless, modern water infrastructure also contributed to social differences in more general terms. Nineteenth-century Naples, Venice and Milan all experienced processes of urban renewal. This was not, however, similar to the case of British cities, where since the 1840s, 'the question of water supply was indeed implicated in the question of sewerage systems'.[147] In Italy, water projects preceded any discussion of this sort, though in Naples, the sewer system was substantially rebuilt from 1885 onwards.[148] Although the processes of urban renewal in the three cities were heterogeneous and anything but coherent, they had in common the creation of more socially homogeneous districts. This was a consistent trend in nineteenth-century European cities from Barcelona to Antwerp. Dirk Van Laak has argued that nineteenth-century infrastructures tended to maintain social differences of rank.[149] As argued in this article, in the cases of Naples, Venice and Milan, water infrastructures not only reproduced existing differences but contributed to the creation of new ones. In Milan, despite the relatively high number of private connections for the period, a segment of the population did not enjoy a private connection to the aqueduct. Meso-segregation remained the norm, with many artisanal workshops remaining in the city centre among elegant new buildings, but the differences in water quantity, quality and ease of access between piped and non-piped households were unprecedented.[150]

In Naples, the tendency of the water supply system to exacerbate social differences was still more evident. Before the transition to the new system, while the

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**Figure 3.** Public well (cistern), Venice about 1870–1880.
*Source:* Giovanni Battista Brusa (Italian, active 1860–1880), photographer. The J. Paul Getty Museum. Public domain.

poorer section of the city was predominantly inhabited by artisans, workers and the *lumpenproletariat*, contact between people of different classes was still frequent given Naples' high urban density, and meso-segregation was the norm before the building of the Serino aqueduct. In the Chiaia district, for example, the elegant streets of the waterfront, which were the residence of the nobility and the high bourgeoisie concealed areas of poverty in the less frequented streets and alleys inhabited by sailors.[151] With the construction of the Serino aqueduct, however, the socio-environmental constraints that had blocked Naples' growth were lessened, and an immediate consequence was the urbanisation of the hills. A case in point was that of the Vomero district: here, a powerful Italian bank built an elegant quarter, and although the financial crisis of the 1890s hindered the full implementation of the project, many wealthy families moved into the area.[152] During the same period, the (partial) demolition of slums in the old centre displaced 90,000 people, some of whom were relocated to the new working-class districts, which quickly became overcrowded, at the eastern end of the bay.[153] As we have seen, this division between an elegant residential west and a working-class east was already planned at the beginning of the nineteenth century, but it could only be fully developed with the arrival of the new aqueduct. In Venice, vertical segregation prevailed until the late nineteenth century.[154] The aqueduct contributed to the creation of privileged areas such as the Lido. In 1872, Giovanni Busetto, a Venetian entrepreneur engaged

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in the public works for the maintenance of the lagoon, had built the first bathing establishment there, but the great transformation came with the construction of the Hotel des Bains in 1900 and the connection to the aqueduct in 1901.[155] From 1901 to 1911, the population of the Lido rose from 1,796 to 4,202, and in 1907, the hotels recorded 3.5 million visitors.[156] Tourists enjoyed tap water while observing the 'spectacle' of the daily opening of the public cisterns and the unfortunate residents gathering to fetch their buckets of water (Figure 3). This image illustrates a net social distinction that was not possible under the previous regime of generalised, albeit socially differentiated, water scarcity.

## 5. Conclusion

Systematicity and complexity are not exclusive to modern water systems. The pre-industrial water infrastructures of Naples and Venice, in particular, involved both material and non-material aspects and were carefully maintained and regulated. In turn, they shaped the daily routines and behaviours of citizens. These infrastructures functioned within assemblages of interacting systems, including those of milling and manufacturing, and included subsystems such as those that facilitated their inspection. It is not in this sense, therefore, that differences between these and modern water systems should be sought. Instead, the division between the two types of systems was manifested in the latter type's scale and its driving concepts, derived from a view of the future for which modern water infrastructures were planned. Uncertainty about the future, the need for adaptability to periods of drought and the necessity of provisions for breakdown were all embodied in the water systems of early modern Italian cities, while an ideal of the perennial abundance of water, guaranteed by new, powerful technological devices, constituted the logic behind large diversion schemes. It is important to note, however, that different systems and ways of thinking overlapped substantially, with early modern ideas in this field persisting well into the twentieth century. This is exemplified by the case of Venice, where public cisterns continued to play a crucial role even in the 1910s, decades after the introduction of the new aqueduct in 1884.

The transition to modern systems involved the introduction of the concept of water needs, particularly the idea that cities have insatiable requirements for water. When the advocates of the ancient aqueducts of Naples calculated that they supplied a volume of water three to four times that actually carried into the city, they implicitly conceded the value of the main argument provided for rival, modern projects. The main opposition to large diversion schemes, meanwhile, came from riparian residents who saw their economies threatened. Although the outcomes of such proposed schemes for Naples and Milan differed, the right for cities to divert large quantities of water from distant springs to feed their urban growth was nonetheless established in the second half of the nineteenth century, marking a significant step towards the incorporation of ever-expanding amounts of water into the process of urbanisation.

In the cases analysed here, modern aqueducts contributed to the creation of socially homogeneous districts and areas of privilege, resulting in new lines of fracture and new spatial distinctions between privileged and disadvantaged areas within and between cities and rural areas. In Naples and Venice, the Vomero and the Lido

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presented a magnificent view, away from the crowds who still collected their limited amounts of water amidst its abundance. Ultimately, this article has demonstrated that the water transition in Italian cities was not a matter of conquest and human emancipation from nature's whims. Rather, it was the consequence of the convergence of multiple logics, which involved a conflict between different water cultures, materially and symbolically embodied in water infrastructure.

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## Notes

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## French Abstract

L'historiographie des infrastructures hydrauliques du XIXe siècle a fait la part belle à l'histoire du progrès technologique, à la modernisation et à l'amélioration des conditions sanitaires. Les changements technologiques et les avancées scientifiques constituèrent assurément des éléments majeurs autorisant à passer du système préindustriel d'approvisionnement en eau à un système moderne de type industriel. Cette transition, cependant, ne se fit pas sans susciter des résistances, des conflits et une compétition notable entre différents groupes sociaux. Le présent article se concentre sur les questions que posait l'accessibilité à l'eau potable et sur les litiges qui y furent associés. Il examine les archives concernant la gestion quotidienne de l'eau, les projets d'infrastructures et les procès-verbaux correspondants des conseils municipaux pour les villes de Milan, Naples et Venise au cours du XIXe siècle. Les documents produits par les communautés locales sont inclus. Au total, contrairement au discours historique ordinaire qui met en avant une situation conjoncturelle de déclin et de décadence rencontrant un mouvement d'innovation, l'auteur affirme que, dans ces milieux urbains, les infrastructures hydrauliques préindustrielles étaient déjà complexes auparavant, composées de nombreux éléments assemblés en un tout, et que les différences entre ces installations anciennes et les systèmes modernes d'adduction d'eau ne devraient pas être recherchées dans un degré supposé différent de sophistication. Bien au contraire, la différence entre les deux types de système d'adduction d'eau se trouve essentiellement dans leur différence d'échelle, le nouveau réseau hydraulique, à grande échelle, adopté au XIXe siècle, étant issu d'une vision futuriste des infrastructures urbaines. Mais, en même temps que se faisait cette transition structurelle, de nouvelles frontières sociales apparurent, qui ne firent qu'accentuer les inégalités d'accès à l'eau.



## German Abstract

Die Erzählung von technologischem Siegeszug, Modernisierung und sanitären Verbesserungen hat die Historiographie über Wasserinfrastrukturen im 19. Jahrhundert stark beeinflusst. Obwohl technologische und naturwissenschaftliche Veränderungen wichtige Elemente waren, war der Übergang vom frühneuzeitlichen zu einem modernen System der Wasserversorgung jedoch auch von Widerstand, Konflikt und Wettbewerb


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zwischen verschiedenen sozialen Gruppen begleitet. Dieser Aufsatz nimmt die Fragen des Zugangs zu Trinkwasser und die damit einhergehenden Konflikte unter die Lupe. Er wertet Archivmaterial zur täglichen Wasserverwaltung und zu Infrastrukturprojekten sowie städtische Sitzungsprotokolle für Mailand, Neapel und Venedig im 19. Jahrhundert aus, aber ebenso Dokumente, die von den örtlichen Gemeinden stammen. Im Gegensatz zur gewohnten Erzählung von Innovation als Überwindung von Niedergang und Verfall vertritt der Aufsatz die These, dass die frühneuzeitliche Wasserinfrastruktur ein komplexes Gebilde war, das viele Elemente zusammenfügte, und dass Unterschiede zwischen diesen und modernen Wassersystemen nicht darin zu suchen sind, dass letztere einen höheren Grad an Systematisierung aufwiesen, der von vorneherein zu unterstellen wäre. Vielmehr manifestierte sich die Trennung zwischen den beiden Systemtypen im größeren Umfang und den konzeptionellen Antriebskräften des modernen Systems, die sich aus einer Zukunftsvision ergaben, für die moderne Wasserinfrastrukturen geplant wurden. Zugleich zählt es zu den Ergebnissen der modernen Infrastruktur, dass dadurch neue soziale Grenzen geschaffen wurden und die Ungleichheiten im Zugang zu Wasser zunahmen.

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