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The Social Differentiation of Access to Water in 19th & 20th Century Paris

Inégalités dans l'accès à l'eau à Paris aux 19e et 20e siècles

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Résumé

La distribution et gestion de l'eau dans les grandes métropoles est déterminée simultanément par leur configuration physique et leurs caractéristiques sociales. À Paris, l'interaction de ces deux dimensions a longtemps limité l'accès à l'eau pour une grande partie de la population. De fait, les très fortes inégalités foncières dans la ville constituent un déterminant essentiel des régimes de l'eau à Paris et de leur évolution dans le temps. Ce texte documente l'évolution des systèmes d'eau à Paris depuis le 19ème siècle, sous la double dimension de l'approvisionnement en eau (et sa qualité) et de l'évacuation des matières souillées. Il met en évidence les considérables variations sociales dans les modalités d'accès à l'eau dans la ville, conséquence des choix effectués pour l'organisation de la distribution de l'eau.

Mots clés : eau, égouts, quartiers, Paris, inégalités

Abstract

Water management in large cities depends on both their physical and social structures. In Paris, they interacted to limit and constraint access to water for large segment of the population for long period of time. The very unequal distribution of property in the city is central to understand the water regimes in Paris, and their evolution over time. In this text, we document the evolution of water systems in Paris in the 19th century, considering access to water (and its quality) as well as sewers necessary to get rid of soiled materials. Important social variations in the modalities of access to water within the city persisted for a long time. They were a consequence of choices made in organizing the distribution of water in the city.

Keywords: water, sewage, wards, urban amenities, inequality

JEL Codes: N33, N93, N34, N94

"D'eau de Seine il suffit d'un d'mi-s'tier,
Rien qu' d'un d'mi-s'tier,
D'un seul d'mi-s'tier,
Pour y pêcher un choix entier,
Un choix entier,
Vraiment entier,
D' microb's et d'bacill's par centaines,
Pour les Parisiens, quell's aubaines !
Car chacun d'eux sans s' déranger
Y trouve à boire et à manger !

Refrain :
Des gens rasants
C'est les habitants
Des arrondissements
Qu'on a dotes d'eau d' Seine;
Au lieu d' gober c'te boisson saine
Ils s' plaign'nt tout l' temps,
Sont-ils rasants !"

La chanson du jour
Le Cri du people, June 21st 1888

"Of Seine water, you need only half a pint,
Only half a pint,
Just one half-pint,
To fish a whole selection,
A whole selection,
Really whole,
Of microbes and bacillus by hundreds,
For Parisians, what a chance!
As each of them, without bothering
Can here drink and eat!

Chorus:
Boring people
Those inhabitants
Of arrondissements
That were given water from the Seine;
Instead of swallowing this sane beverage
They're always complaining,
Aren't they boring!"

Song of the Day [extract, our translation]
Le Cri du people, June 21st 1888

Introduction

The "song of the day", on the front page of the leftist newspaper *Le Cri du Peuple* (created during the Commune period, it was discontinued immediately afterwards before being reinstalled at the end of the 1880s) was an ironic commentary of a specific piece of news, using melody from popular songs. This occurrence, entitled "Drinking water," was commenting on the news that the ministry of war had ordered an inquiry into drinking water as a result of a typhoid fever epidemic. It ironically mocked Parisians from popular neighborhoods (*arrondissements*) who were complaining ("all the time") about the smell and taste of the water they used. The song suggested that they didn't understand how lucky they were to receive water from the river Seine, "a sane beverage". This specific stanza claimed

that they were unable to really appreciate the benefit of this water, which contained a large choice of microbes and bacillus; hence, without bothering too much, those lucky folks were able to drink and eat at the same time. Other stanzas added wordplays on the quality of water and satirically criticized the request of the poor to have clean and drinking water at home.[1] The song illustrates the acute perception of unequal access to water among Parisians from popular classes at the time. This group, the most numerous, was the last to access public goods. But, contrary to a prevailing narrative, they were both aware of their disadvantage and actively complaining about it.

It is difficult to underestimate the breath of change experienced by the city of Paris in the 19th century and the transformations brought about after (and by) the French Revolution, as it evolved from a large European city into one of the biggest industrial metropolises in the world.[2] At the same time, it is also hard not to fall into simple and linear narratives, describing the evolution of Paris over the long 19th century as a one-way street advent of modernity. This is probably nowhere truer than in the urban history of the city, where the dominant view centers on the changes brought about by "Haussmanization" during the Second Empire (1852-1870).[3] Indeed, this transformation is usually credited to a few central figures, such as the engineer Eugène Belgrand, whose bicentenary of birth was celebrated in 2010[4]. Such a narrative obfuscates more structural evolutions at work in the making (and destruction) of the physical fabric of the city. It also tends to relegate the social element at play in the development of large-scale infrastructures throughout the city and in the making and remaking of its buildings. The dominance of the linear narrative is in no way specific to Paris or France: the same could be said for the history of public health in England.[5]

Water regimes are often putting in relations political and social structures with the natural environment. A few characteristics set Paris apart, though. In particular, its water regime, and its evolution over time, produced strong social differentiation in access to quality water. First, the centrality of the city for the country as a whole –one could certainly argue that the main

[1] The complete song can be found in the digitalized version of the newspaper kept at the French National Library: https://gallica.bnf.fr/ark:/12148/bpt6k4682100d.

[2] On the French Revolution, see the synthesis by David Garrioch *The Making of Revolutionary Paris* gives a broad view of 18th century Paris (and the more recent updated French translation (*Paris révolutionnaire*) provides many references). Other classical references include works by Arlette Farge (*La vie fragile*), Steven Kaplan (*Les Ventres de Paris*), and Daniel Roche (*Le peuple de Paris*), among others.

[3] Olsen, *The City*; Fishman, *Bourgeois Utopias*.

[4] Deutsch and Gautheron, *Eaux Pour La Ville*.

[5] See an extended critic of this approach in Crook, *Governing Systems*.

transformation of the 19th century is that Paris became much more than the capital city of France, it became its main city, its only metropolis, as it concentrated economic, industrial, and political powers. As a result, the stakes were always higher there, as was the likelihood of political interferences. Second, the level of inequality within the city –many of the wealthiest people in France (and, to some extent, in the world) at the time lived there, not far away from the poorest ones– has important implications for the way water was managed in the city. Third, the strong demographic growth of the city, fueled mainly, if not solely, by migration, tended to exacerbate and multiply the difficulties in organizing it. The combination of these elements contributed to a pattern that is both unique to Paris and comparable to the general narrative described by Joël Tarr for North America.[6] Our objective here is to show to what extent Paris followed this general model and, at the same time, diverged from it.

In many ways, access to sanitation in Paris was slow not because of the economic and industrial development of the city but, rather, in spite of it. Indeed, the wealthy, and especially building owners, often opposed the distribution of clean water (and even more of its cleaning through sewers).[7] The specific social fabric of the city, where a small minority possessed almost all wealth, combined with its physical fabric, where housing was concentrated in large buildings divided in small apartments, was not a good recipe for innovation and improvement to buildings quality.[8] The fact that almost nobody in Paris owned the place they lived in contributed, in no small part, to the failure to improve and enhance the housing system. It is thus a little misleading to emphasize, as is often done, the key role of administrators and engineers of the city in developing water systems. One could frame the issue the other way around: it was because Paris was so polarized in terms of wealth and property, and so centralized in its organization, that little change could have been achieved within the political institutions.

The aim of this paper is to document the social differentiation of access to water and sanitation in the capital city. More precisely, the purpose of this chapter is twofold. The first is to describe the level of inequality in the city, focusing on the way it affected the physical fabric of the city and the life of its inhabitants. The second is to document the evolution of

[6] Tarr, "Urban Environmental History".
[7] Jacquemet, "La Bataille".
[8] This is in contrast with London for instance, where small houses were much more common, Olsen, *The Growth*.

water management in Paris, including by looking at the evolution within the city so as to document its social differentiation.[9]

To do so, I rely on different sources in addition to the usual aggregated statistics produced by the city itself (*Annuaires statistiques de la ville de Paris*, published yearly from 1880 to 1967) that provide information on access to clean water and how soiled water was dealt with: real estate censuses and rents from the archives of the treasury; estimates from various data collected at the individual level, on wealth, connection to water and to sewers. In the first part, we document the strong and enduring inequality in the city, focusing on both the concentration on property and the unequal length of life. The second part centers on the history of water management in the city, while the third part discusses the way water was delivered to Parisians. Finally, the last part analyzes the social differentiation in access to water and sanitation.

The unequal metropolis

A concentration of wealth and buildings

For most of our period, Paris was the second largest European city by population (after London) and one of the largest in the World.[10] After the extension of 1860, during which the city absorbed part of the suburb, almost tripling its surface area, the start of a new era, referred to as "Haussmanization". This concept is a nod to the head of the city at the time (Haussmann), who was tasked by Emperor Napoleon the Third with cleaning the city, both literally and figuratively, as it included taming its revolutionary elements. It tends to summarize a complex process, including various innovations on the real estate market.[11] Demographically, the city was growing at around 1% a year, from 1.7 million inhabitants

[9] The key reference on the history of water management in France is still the classical book by Jean-Pierre Goubert (*La Conquête*) that describes in great details the commodification of water over the course of the 19th century. On the history of water in Paris specifically, the book by Laure Beaumont-Maillet (*L'eau*) provides a flurry of details and precisions, while the PhD dissertation of Julien Souriau gives a comprehensive overview of water management in the city in the very long run (Souriau, "Stratégies durables", especially Chapter 3).

[10] According to Chandler, *Urban Growth*, Paris was the second largest urban area in the world in 1875, behind only London. It then gradually dropped in the ranking: third in 1900, fourth in 1925, as New Yok and then Tokyo took the lead.

[11] Yates, *Selling Paris*.

(1860) to almost three million at the eve of World War One, an exception in a country where the demographic picture was dominated by stagnation and even decline.[12]

Simultaneously, Paris was also a deeply unequal city, characterized by a high degree of concentration of property, income, and wealth. At a time where economic inequality was incredibly high everywhere, it was probably nowhere as high as in the large European metropolises that were locus for the concentration of capital fostered by the industrial revolution. What was characteristic of those cities, and Paris is certainly a prime example of that situation, is the relative proximity between the very wealthy and the very poor. They did not exactly live in the same place, but they did live in close proximity. As can be seen on Figure 1, the top 10% of wealthiest individuals in Paris owned almost everything (the dotted line on top of the graph). In fact, the high polarization is clearly reflected in the fact that 1% of the Parisian population always owned at least 50% of the total wealth in the city whereas the 90% poorer owned close to nothing.[13] In addition, this structure of inequality is quite stable over time: although the average amount of estate declined after WWI (the ratio wealth to income improved in the benefit of the latest), the share of total wealth owned by the top 1% barely moved.

This concentration of wealth interacted with the specific urban structure of the city. With limited space, Paris was meant both dense and concentrated, contrary to London or Berlin for instance. It was an urban landscape dominated by multi-storey buildings divided in (mostly) small flats. Half of the total buildings in Paris had at least four stories and more than a fifth had six or seven. There was also some polarization, though, with almost a quarter of the buildings having at most one story (data from 1891 census).[14] And, as with almost everything in Paris, there were huge spatial variations. In the old center, the vast majority of buildings were rather tall, with a third (half in the most extreme cases, 1st and 2nd neighborhoods) of them having at least six stories and 80% at least four. The opposite was true on the other side of the city, in the "new" neighborhoods created in 1860 by the absorption of surrounding

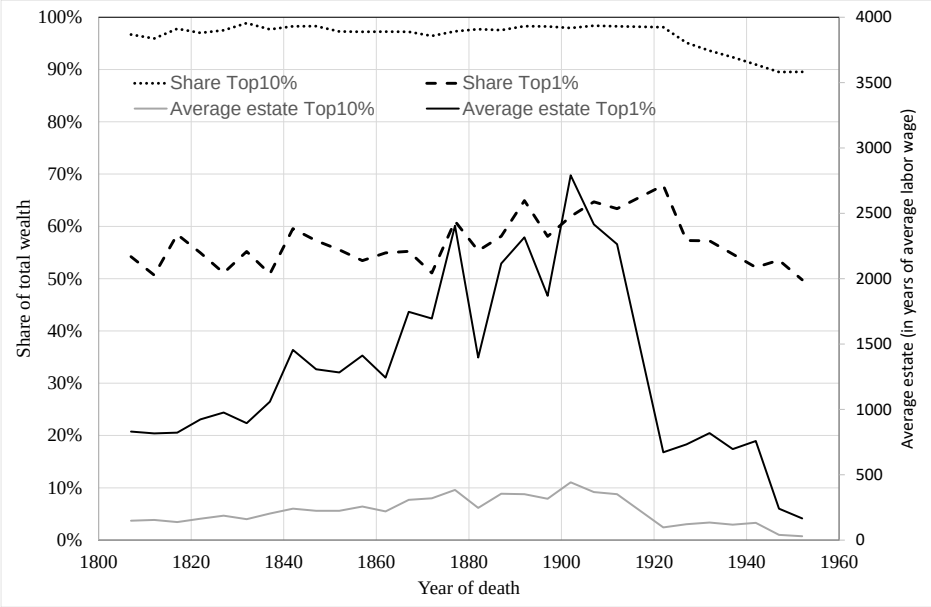
[12] To be sure, the rate of growth of Paris is rather comparable with that of French cities as a whole. The share of Paris in all cities rose slightly toward the end of the 19th century to around 17%, before starting to decline, towards 14% in the interwar period and 9% in 1962. One reason for this decline was certainly the rise of suburbs (*banlieues*).

[13] In addition, the importance of Paris in the economy of France as a whole means that they owned a large share of the total French wealth. See Piketty, Postel-Vinay, and Rosenthal, "Wealth".

[14] To be sure, ground level is not included in these figures, as in the French system. So, one level must be added to make it comparable to the US system. Hence, buildings with at most one story are either ground level or two-story buildings in the US system.

municipalities, with only a quarter of buildings having four-stories and higher and a much higher share of small buildings. It is important to note that this variation did not completely (or perfectly) recoup social variations. Hence the wealthy 16th *arrondissement* was closer to the poor 18th or 19th than to the wealthy (but more central) 8th. But there was convergence over time as high buildings started to become common in the peripheral neighborhoods, where construction was in full swing in the last part of the 19th century.

Figure 1 wealth concentration in Paris, 1807-1952



Source: Postel-Vinay & Rosenthal (2021).
Note: The dotted lines are the share of total wealth owned by the wealthiest 1% and 10% (left axis); the plain lines are the value of the average estate they owned (right axis). Hence, in 1902 the 1% wealthiest individuals in Paris (respectively the 10% wealthiest) owned, together, 62% of the total wealth (resp. 98%) and their average estate was equivalent to 2800 years of average labor wage (resp. 442).

More importantly, the selling of individual apartments was not possible until the interwar period, mainly because of the absence of the institutions, norms, and legal arrangements necessary to organize collective property within the same building (e.g., condominium associations). This contributed to a huge concentration of property in the hand of a few owners: the ratio apartments to buildings is always higher than a tenth. Hence, in 1891, there were approximately 900,000 (occupied) apartments in 75,000 buildings. In other words, at most 75,000 individuals owned 900,000 housings, where 2.5 million individuals lived. Given that many owners had more than one property and that a small, but growing, part of the housing stock was the property of private companies, the true number of owners is probably much lower, meaning that the physical fabric of the city was in the hands of a very tiny minority. This certainly helped fueled the resistance to change and reform as many costs were

supported by building owners. They could, and often would, retrofit those costs to their tenants, but certainly with various successes, especially in the poorer neighborhoods where tenants would not be able to afford any rent increase anyway. This very unequal distribution of property is central to understand the water regimes in Paris and their evolution over time.

Unequal length of life

This huge concentration of wealth is not without consequences on everything from housing to politics. One important consequence of this massive level of inequality is the large variation in quality of life both between Paris and other parts of the country and within Paris. In fact, urban disamenity is an important characteristic of most Western cities–especially large metropolises such as Paris or London–during the 19th and early 20th century. There are many ways to observe and assess it, from quality of housing or the availability of food to the working conditions. To sum it up, we consider life expectancy (Figure 2). Life expectancy in Paris was lower than in the country as a whole but experienced a significant increase at the turn of the 20th century, with urban mortality reaching parity with that of rural areas, which had long enjoyed a health advantage.[15]

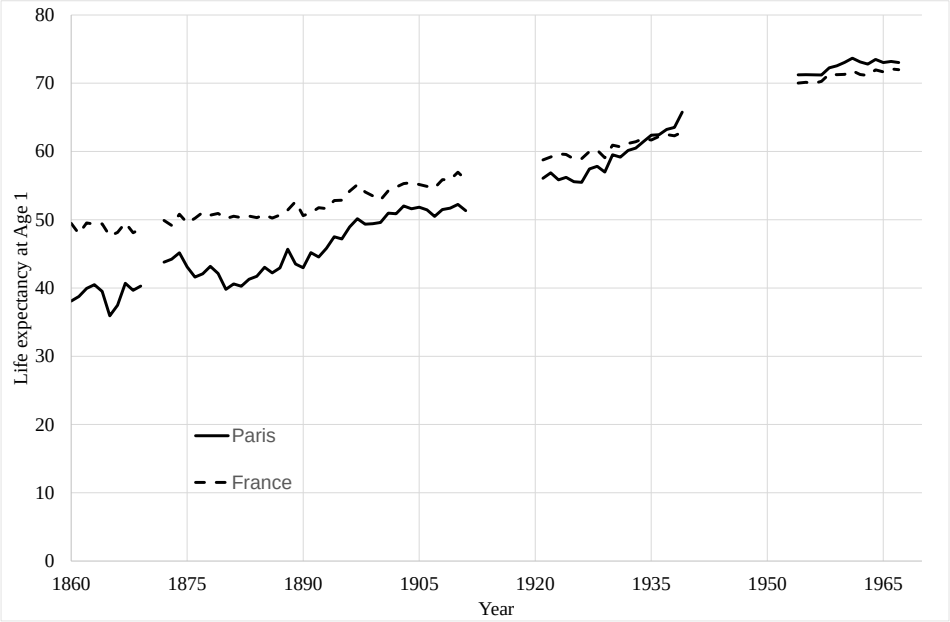
Explanations for this evolution are multiple and scholars have pointed to rising income, better nutrition, and better hygiene to explain why mortality fell so sharply and quickly throughout Western Europe and North America.[16] The strong urban penalty and its disappearance with the decline in mortality also suggest the importance of the diffusion of water infrastructures, whether to bring more and better quality water to large cities or to improve how dirty water is dealt with.[17] Paris is really emblematic of this experience, with the rise in life expectancy going hand-in-hand with better sanitation.[18]

To evaluate and measure precisely the impact of various factors on the decline of mortality, scholars relied on difference in the adoption of new water infrastructure across cities.[19] In addition, it is possible to look at specific improvements that diffused quickly (e.g. chlorination of water) once the infrastructure had been put in place.[20] These are informative approaches but they omit the huge variations that occurred within cities. Here, Paris is a case

[15] Cain and Hong, "Survival"; Preston and van de Walle, "Urban French Mortality"; Kesztenbaum and Rosenthal, "Health Cost".
[16] Fogel, "Nutrition"; Szreter, "The Importance of Social Intervention".
[17] Cain and Rotella, "Death and Spending"; Cutler and Miller, "Public Health"; Fogel, "Nutrition".
[18] Preston and van de Walle, "Urban French Mortality".
[19] Brown, "Reforming the Urban Environment"; Helgertz and Önnerfors, "Public Water".
[20] Cutler and Miller, "Public Health".

in point, with strong variations in life chances between neighborhoods, reflecting the social variations in composition. The variation in life expectancy over time is also a variation over space (Figure 3).

Figure 2 Life expectancy at age 1 in Paris and in France, 1860-1960



Source: data for Paris is computed from various statistical yearbooks.[21]
Note: yearly data, with gap 1870-1871 (Sieges of Paris and *Commune de Paris*), around WWI and WWII.

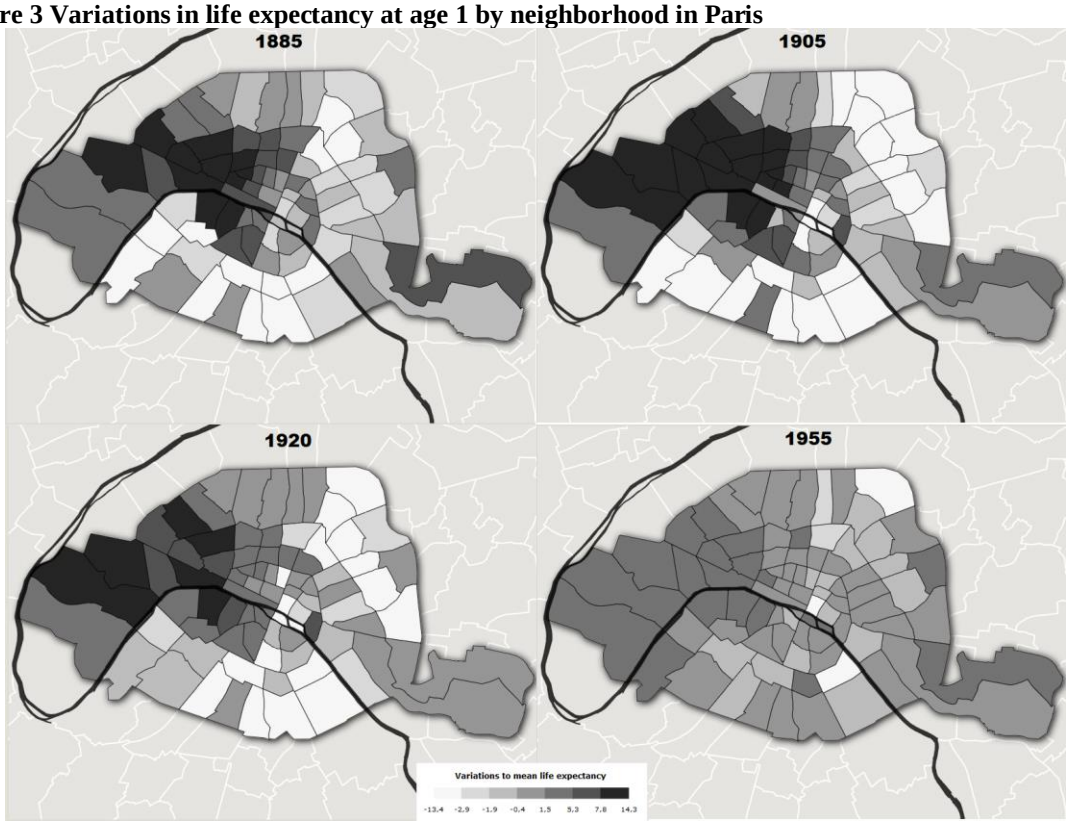
The main pattern, an East-West divide—with wealthier neighborhoods on the West of the city—is clearly visible on the mapping of life expectancy. It persists to this day.[22] But the picture is a little more complicated, given two factors. First, there was some degree of social mixing, related in particular to servants living in the same buildings as the people they were serving, though on segregated spaces. This vertical segregation was common at the time in most large European cities. As these cities expanded (and, especially, industrialized), this pattern was often replaced by horizontal segregation, as different social groups started to live in different neighborhoods. For Paris, variations between neighborhoods were more important than variations within neighborhoods, and the more so over time. Second, when the city expanded in 1860, there was a substantial difference between old and new neighborhoods. Contrary to the old city center (*arrondissements* 1 to 11), the new neighborhoods were more

[21] See details in Kesztenbaum and Rosenthal, "Democratization". Data from France comes from Meslé and Vallin, *Tables*.

[22] In addition, dwellers of the poorest neighborhood were also disproportionately affected by the mortality crises that were a frequent feature of 19th century Paris, such as cholera epidemics (Le Mée, "Le Choléra") or the famine linked to the 1870 war and Commune (Cogneau and Kesztenbaum, "The sieges of Paris").

rural and much less densely populated. Over time, they converged to the older ones, as the city absorbed these new neighborhoods, and they started to be more urban, with higher buildings and increasing density. Nevertheless, the new buildings were arguably of better quality and, on average, the outer parts of the city certainly beneficiated from being newer.

Figure 3 Variations in life expectancy at age 1 by neighborhood in Paris



Source: various statistical yearbooks.
Note: the maps present the variation in life expectancy between a given neighborhood and Paris as a whole. All maps present the 80 neighborhoods in Paris, with the river Seine crossing through the city (in dark, coming from the south-east). The darker a neighborhood is, the higher its life expectancy. Lighter neighborhoods have a lower life expectancy than the average in Paris. The scale is the same for all years and is based on the quantile distribution of the neighborhood in the initial year, 1885.
All maps made with *Magrit* http://magrit.cnrs.fr.

When Louis-René Villermé set out to explain, on the basis of statistical measurements, the differences in mortality between Parisian neighborhoods that he observed in the first part of the 19th century, he began by reviewing the material conditions that characterized them: narrow alleys, population and buildings density, air quality, height of the buildings, proximity to the river, the main source of water.[23] Thus, he took up the dominant theories of the time that claimed to explain variations in mortality and, little by little, he got rid of each of these

[23] Villermé, "De La Mortalité".

factors and concluded that it was neither the quality of the air nor that of the water that mattered, not even population density, but poverty and affluence. It led him to conclude: "Surveying all this information, so numerous, so positive, so unanimous, he [the reader] will understand (in spite of all that is said everywhere), that the health of the poor is always precarious, their height lower, and their mortality excessive, in comparison with the development of the body, health and mortality of the better treated people of fortune."[24] Looking at the large variations in life expectancy presented on Figure 3, it is difficult to contradict him. What is perhaps even more striking is the extraordinary stability of these variations until the second part of the 20th century. For a century, living in working-class areas in the East of the city meant a life cut short compared to the more affluent West part of Paris.

Villermé faced the hostility of the scientists of his time, especially the medical profession.[25] Since then, evidence has accumulated (although there is still a debate today on the origin of inequalities in mortality),[26] but the complexity of the phenomenon persists and prevents any definitive conclusion. Indeed, the structure of the buildings is both a cause and a consequence of the social structure, and the way in which the two influence each other makes empirical analysis difficult. For us, what matters here is the role of this duality between the physical and social environment of the city: it is within this structure, both social and material, that water management in the city of Paris and its transformation over more than a century must be analyzed.

The rise of water

The development of water systems in Paris did not simply occur in a large and growing population within the new city walls, but was also set in a context of high inequality, concentration of property, and social unrests. At the same time, the role of water evolved, increasing the need for it, and, in particular, for clean water (whose very definition changed over time). At the intersection between these two contexts were private interests that heavily favored the *status quo*: building owners that didn't want to add connection and maintenance

[24] Villermé, *La Mortalité*: 93. Our translation.

[25] On the reception of Villermé and the novelty of his arguments, see Lécuyer and Brian, "L'Argent, La Vie, La Mort".

[26] For an opposite view on the rise of health inequality, see for instance Bengtsson, Dribe, and Helgertz, "Health Gradient".

costs and those making money to distribute the water (*porteurs d'eau*, water carriers) and to get rid of it (night-soil companies).

Quantity and quality of water

As the population in Paris grew exponentially, so did the need for water. Increased population affected water consumption through two different, albeit connected, channels. First, the increase in population translated directly in an increase in water consumption even without change in practices or behaviors. Second, the amount of water needed also evolved with changes in practices related to both public and private uses. Part of the increased use of water in Paris throughout the 19th century is, without doubt, linked to change in practices, at the city level (cleaning the streets, additional fountains, etc.) as well as at the individual level (e.g., increased preoccupation with personal hygiene).[27] In reality, increased need for water can often be explained by a combination of the two effects. Take for instance the tremendous increase of the number of horses in Paris in the second part of the 19th century: from around 20,000 in the middle of the century to 120,000 at the end, only counting those living within the city walls.[28] This was related to the increase in population and to the increasing need for transportation of that population, as the city expanded, with the development of horse-drawn transportation: coaches, buses, streetcars, and carriages. All these animals certainly requested huge quantities of water and, without doubt, contributed to the increase in demand (they also contributed to the increased pollution of nearby waterways).[29] After a peak at the turn of the century, the number of horses swiftly decreased, as mechanized cars and buses replaced them, for a lower cost and less inconvenience. In addition, and perhaps more importantly for the discussion here, all these variations were socially differentiated: not only did the use of water varied by social classes (and thus by neighborhoods), but the secondary evolutions also varied accordingly. Hence, horses were not evenly distributed in the city and, although their numbers halved just before WWI, they remained an important feature in working class neighborhoods, much less so in the more affluent areas of the city.[30]

From the beginning, bringing water to Paris had been an important issue, beyond the control and reach of local government. The centrality of the city for the country as a whole

[27] Vigarello, *Le Propre et Le Sale*, especially Part 4.
[28] Bouchet, *Le cheval à Paris* These numbers certainly overstate the increase given that the city expanded and that some horses used in the city were staying just outside its border.
[29] See Barles, "Undesirable nature" for an estimation of the consumption by animals in 19th century Paris.
[30] Bouchet, *Le cheval à Paris*: 46.

meant that the national government always played a key role in matters relative to its evolution, and the provision of water was no exception. The best illustration of this is certainly the long run project of the Ourcq canal, which illustrates the complex interactions, and conflicts, between and within scientists, politicians, and administrators.[31] Finally achieved in 1822, the canal highlighted the dependency of the city on river water up until the middle 19th century, with the Seine and its main tributary, the Marne, as well as the canal itself, providing almost all the water used in Paris, for whatever purposes. But the diffusion and increased use of water also brought discussion about its quality, a term whose meaning was not always clear-cut. Indeed, it is important to note that the initial question was more about quantity than quality and, until late in the first part of the 19th century, the main preoccupation, from ordinary inhabitants to key administrators, was the quantity of water delivered to the city. Hence, the 1826 report by the Comte Chabrol, préfet of the *Seine département* from 1812 to 1830, on the water situation in the city, starts with the word "Paris needs plentiful waters" (*Paris a besoin d'eaux abondantes*).[32] This statement sums up the dominant state of mind for the first part of the 19th century, when quantity mattered much more than quality. It reflects in part the fact that the water itself was not that bad, as industrial activities and population were still limited. But, more fundamentally, it probably reflects the limitation in water availability, as the increase in population had hardly been matched by an increase in the quantity of water distributed. It was also central to the idea engineers had of the way water must be organized in Paris and the role they would play in it.[33]

During the period we are interested in, after the extension of the city in 1860, the issue became both quality and quantity. People started to become aware of the poor quality of the drinking water in the city, as the result of various converging trends and observations coming from all part of society, from casual observers to the medical world, going through public engineers and operatives. The physical appearance of the Seine River (its smell, color, taste, *etc.*) changed over the course of the 19th century as a result of both overuse and industrial development.[34] Efforts were being made in the first part of the 19th century to avoid the river becoming an open-air sewer (contrary to its affluent within Paris, the *Bièvre* River, which became so filthy that it had to be covered in the early 20th century).

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[31] Graber, *Paris a besoin d'eau*.

[32] « Rapport fait par M. le Comte de Chabrol, sur le moyen d'amener et de distribuer les eaux dans la ville de Paris et sa banlieue », in *Recherche statistique sur la ville* volume 3.

[33] Graber, "Inventing Needs".

[34] Euzen and Haghe, "The Evolution of Perceptions".

Hence, far from being the sole result of rational decisions based on medical discoveries (e.g., explaining diseases transmission by water), the decision to improve water quality was a reaction to two phenomenon, epidemics and degradation of the quality of water. In that way, Paris is similar to many other major cities throughout the North-Atlantic area: an important part of public action related to water was dedicated to prevent pollution, especially fecal pollution, entering its main source of water (here the Seine River or one of its tributaries).[35] This really summarize the difficulty of water management in its primary, more simplistic form: as the population grew, so did the use of water but, as a direct result, so did the soiling of water, requiring more input of water. More people mean more water needed and used along with a sharp degradation of water quality.[36] This vicious circle often proved hard to break in the 19th century. It also highlights the close relationship between both elements of water regimes, namely getting the water in and out.

Aqueducts

The first solution was to dispose of dirty water elsewhere, ideally as far away as possible. Long before the role of water in the spread of certain diseases was known, attention was paid to the quality of water, measured according to *ad hoc* criteria, sometimes contradictory, and always relative to the use that was to be made of it. In this respect, scientists and engineers emphasized the danger of contaminated water and insisted that waste water should not be discharged too close to pumping points. As early as the 1830s, Alexandre Parent-Duchâtelet conducted experiments in Paris to test the quality of the water of the Seine at various points, comparing in particular the places where sewers were discharged.[37] During the 19th century, like other similar cities, Paris sought to discharge wastewaters as far away as possible.

A second solution to the degradation of water quality within the city was to find other sources of water. Indeed, before large-scale water purifying technologies (e.g., chlorination) were available (in the 20th century), the best way to get clear water was to bring it from an uncontaminated source. This is probably the simplest solution, provided that another source was easily available. For instance, Chicago decided to pump its drinking water farther and farther away in the Lake Michigan (away from the main source of contamination, the Chicago

[35] Chicago is an obvious example, see the discussion in Cain, *Chicago*; and Ferrie and Troesken, "Water and Chicago".
[36] Tarr, "The Ultimate Sink".
[37] Parent-Duchâtelet, *Hygiène publique*.

River).[38] This is why Paris' authorities chose to replace the water from the local rivers (Seine and Marne, increasingly polluted over the course of the 19th century) with water from distant sources. The Ourcq canal brought only a short relief, providing quantity without quality and, pretty soon, became itself a source of contaminated water.[39]

Table 1 Origin of water consumed in Paris over time (m^3 per day)

	Date	Output (1880)	Output (1901)	Output (1935)
River & assimilated				
Seine		60 000	190 450	358 900
Marne		54 000	79 058	52 100
Ourcq Canal	1822	125 000	174 067	139 200
Total		*239 000*	*443 575*	*550 200*
Spring water				
Nord	c. 1200	170	157	400
Arcueil	May 1623	1 900	386	1 400
Grenelle	February 1841	350	408	2 700
Passy	September 1861	6 600	4 789	900
Dhuis	October 1865	21 000	16 359	17 900
Vanne	August 1874	100 000	105 251	109 600
Avre	April 1893	-	77 150	100 900
Loing	June 1900	-	34 605	77 000
Voulzie	June 1925	-	-	75 700
Total		*130 020*	*239 105*	*386 500*
Other				
Filtered water	1899	-	4 914	255 400
General Total		***369 020***	***687 594***	***1 192 100***

Source: *Annuaire Statistique*. Beaumont-Maillet, *L'eau*.
Note: Output is the yearly average in cubic meters per 24 hours. Smaller sources, or those discontinued before the 19th century are omitted. In addition, most spring water were the combination of various smaller springs, we kept the most common name for each source.

The experience of the canal was only the first step of a general pattern consisting to bring water from distant sources, sometimes a few hundred kilometers. This become the preferred solution to supply the city with water in the second part of the 19th century. The obstacles–of all kinds: technical, political, economic–were numerous and the costs substantial, but the period, post-1860 Paris, was friendly to major public works to reshape deeply the city, both in terms of social and physical fabric. The arrival of drinking water, transported at great expense to the city from far away sources, was part of the city's policy of hygiene and cleaning. But it

[38] Ferrie and Troesken, "Water and Chicago".
[39] The issue with the canal steams from the ambiguity at the heart of its construction, being at the same time a source of drinking water and a waterway (Graber, *Paris a besoin d'eau*).

was also part of the political will to modernize and sanitize the city, to protect it from both infectious diseases and social unrests: the aim was to simultaneously cure the worker from tuberculosis and revolution.[40]

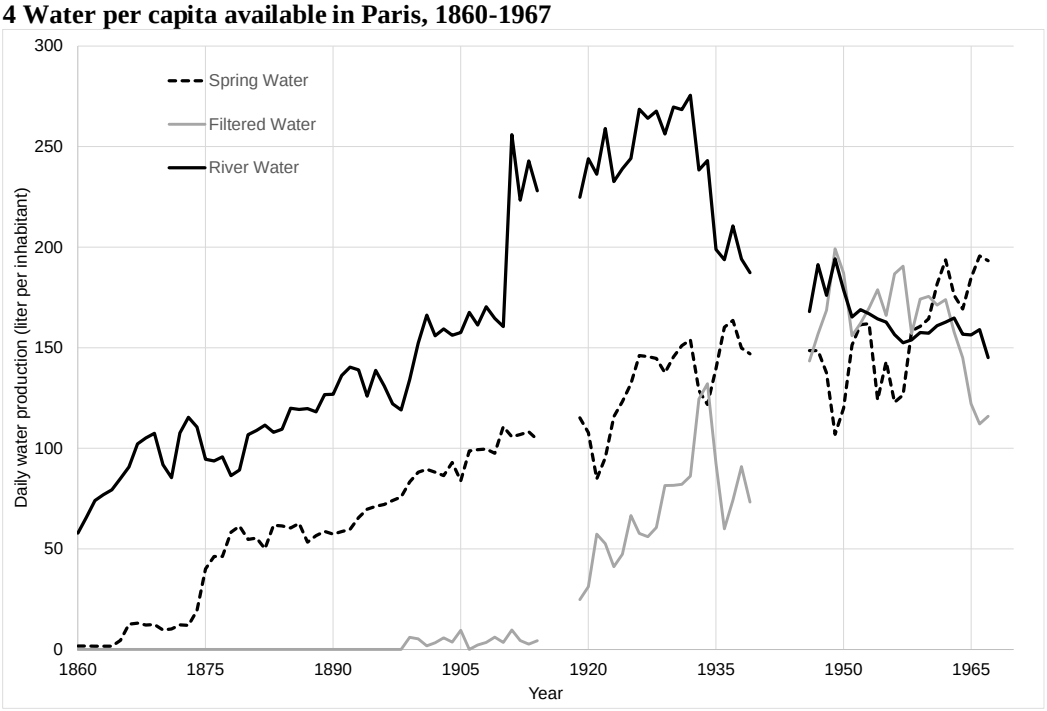
The first completed aqueduct brought spring water from the Dhuis River, around 130 kilometers from Paris. Connected to the city's pipes in October 1865, it delivered water to the North (and especially North-East) part of the city. Still modest, its contribution was limited in terms of quantity of water brought to the city (Table 1). But it was only the first step in a series of large-scale infrastructure designed to provide the city with large quantity of fresh water. The 1870 war with Germany and the ensuing revolution interrupted the work for a while, but the second aqueduct delivered water from the Vanne River, 150 kilometers in the south of Paris, starting in August 1874. As the city grew so did the demand for water and at the turn-of-the-century two additional aqueducts were built, bringing in the Avre river from Normandy in 1893 and the Loing River from the south-east in 1900 (see Table 1 for detail). In practice, these extensions were diverting water from local territories towards Paris and, as such, they were often met with hostility.[41] Their completion testified of the power and influence of the capital city.

The increase in water availability and quality must be put in perspective with the increase in population, continuous and significant until WW1. Still, water availability per capita increased continuously during that period (Figure 4). The evolution is characterized by three different periods. Starting by the arrival of the *Dhuis* aqueduct in 1865, the first one is defined by increasing availability of spring water, especially after 1875, with the flowing of water from the larger *Vanne* spring. Before WWI total water availability, both river and spring water, increased regularly. This brought a new familiarity with water use and, as a direct result, increasing demand for it (and it probably also resulted in overuse and waste). Thus, emerged a dynamics whereby increasing water availability stimulates more demand for water; a circle, virtuous in terms of public health but more ambiguous when considering water management, as it exponentially increased waste waters and the pressure on the environment.

[40] This is very obvious in the discussion about housing the poor and the genesis of social housing in the city. See for instance Dumont, *Le Logement social à Paris*.

[41] Resch, Lavie, and Arnaud-Fassetta, "'La Voulzie à Paris'".

Figure 4 Water per capita available in Paris, 1860-1967



Source: *Annuaires statstiques de la Ville de Paris*, various years.
Note: Average water production in Paris in liter per inhabitants. Yearly data from 1860 to 1967, except during the two world wars.

Despite its higher quality, spring water was not without limitation. The main issue was its yearly fluctuations, related to weather patterns at the source that reduced the quantities available, especially in summer. It contributed to brief but regular sanitary crises when the lack of spring water forced a switched back to water from the Seine, bringing with it all kinds of germs and pollution, often contributing to bursts of typhoid fever, such as the one alluded to in the song quoted at the beginning of the text. To solve this issue, so as to get rid completely of the Seine river as a source of drinking water, Paris followed the example of many other large city in the Western world and, starting in the early 1900s, implemented modern techniques to filter river water, first as an emergency relief (before WWI), and then as a permanent feature. In the interwar period, a large quantity of high-quality water flowed in the city, more than had ever been available. During that period, between 400 and 500 liters of water were available on average daily to each Parisian, from springs and, more and more often, from filtered water from the Seine.

Finally, after WWII, the population of the city has stopped growing in the interwar period (and even started to decline) and so has the distribution of water, with roughly 450 liters of water per Parisians, almost equally divided between three types of water: river water for public use, cleaning the streets, public fountains, etc.; spring water delivered at home for private use, and filtered water for industrial use and for supplementing spring water for

households. In fact, this is the situation that still prevails today, with a decline in water consumption driven by technological innovation and improved practices. This equilibrium was almost a century in the making, proof of the political and technical complexities of the operations, but also of the hesitations and changes in politics and science surrounding what kind of water was needed for the city.

Distributing and expelling the water

The picture at the city level helps to understand the dynamics of water flowing in the city. Over the course of the half century between the extension of the city and WWI, available water per head grew four times and the share of spring water in it moved from close to zero to two thirds. Aqueducts delivered spring water to large reservoirs located in the four corners of the city (and at various height, allowing to deliver water to different neighborhoods), fulfilling the global design envisioned by the engineer Eugène Belgrand in the middle of 19th century. This formed part of a larger urban metabolism through which the city interacted with its environment, extracting water and producing wastes that had to be dealt with.[42] A complementary dimension, necessary to understand the dynamics of water access, is how water was delivered to its many consumers.

Connecting buildings

We focus on households and regular inhabitants, deliberately ignoring the question of the water distributed to commercial or industrial entities. In fact, a key feature of the distribution of water in Paris was the distinction between the so-called public and private sectors. It is something that set the city apart from many other large cities of the time, and is still a specificity of the French capital city to this day. It implied to build a dual system with all incoming water tubes doubled: one dedicated to private consumption (mainly households), the other to public use of water (ornamental fountains, cleaning the streets, etc.). The distinction stemmed from the will of Parisian engineers to isolate and valorize drinkable water. But it was also linked with the commodification of water as a result of the decision to have a private company distribute the water to households. The main consequence, especially in the short-run, was to create a strong discrimination between the households connected to the system

[42] Barles, "Urban Metabolism"; Barles, "Cycle".

and those who still relied on the public distribution of water (*borne-fontaine*). In the name of modernization, it produced what Souriau calls a "sociotechnical segregation".[43]

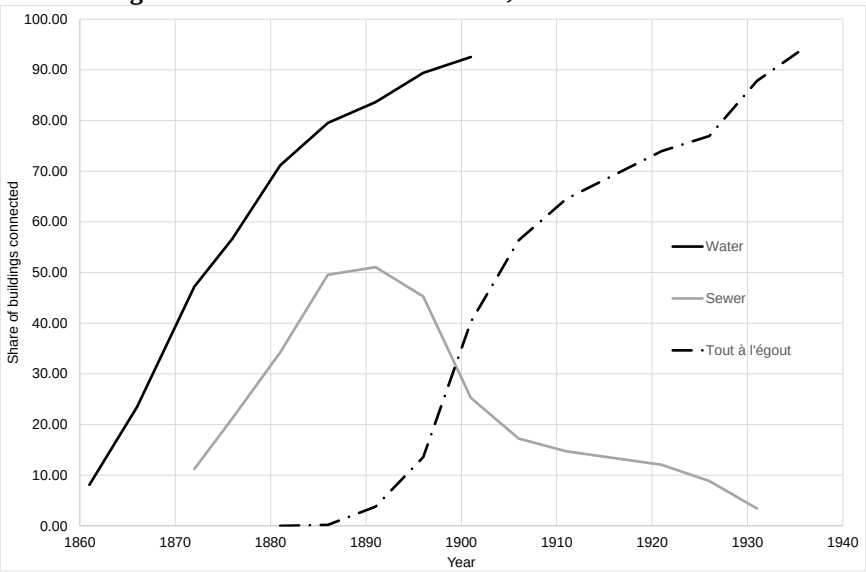
Indeed, the extension of the water network was motivated by both sanitary and commercial imperatives. On the one hand, the impetus for better water was growing, along with cholera epidemics. The first (and largest) of such epidemics (1832) led to the creation of a sanitary council (*conseil de salubrité*) tasked with identifying specific areas of the city that were at risk. This was the beginning of a series of public inquiries into the sanitary conditions in the city, and into ways to improve it. Although the aim of these surveys was much broader, the issues of water and sanitation were becoming increasingly important.[44]

On the other hand, the management of the water network, in particular the role of private compagnies was strongly debated, following the example of Britain.[45] Indeed, the increasing water access in the city was concomitant to a reorganization of its distribution. Before 1860, a happy (and very wealthy) few possessed a direct connection to water in their buildings, while the vast majority relied on public fountains (*bornes-fontaines*) whose numbers were greatly expanded in the 1830s and 1840s.[46] The use of these fountains varied by social classes though, the poorest queuing for collecting water almost every day, whereas those with less time and more money could pay to have the water brought home, usually by a water carrier (*porteur d'eau*), an expanding and regulated corporation.[47] In addition, many others probably relied on private wells within their property, although the real number are almost impossible to know.[48] With very few exceptions, all that water came from the river or the Ourcq canal. Starting in 1860, the water in Paris was distributed by a private company to private consumers (either households or industrial entities) under concession regime. Interestingly, while the privatization in London meant various different company distributing water, in effect a market of water distribution, the choice in Paris was made for a monopoly. One company, whose name speaks for itself, would distribute the totality of water in the city to private customers from 1860 on.[49] It goes without saying that the company was closely linked to

[43] Souriau, "Stratégies durables:" p. 137.
[44] Vigarello, *Le Propre et Le Sale*: 191-195.
[45] Chatzis, "Eaux de Paris, eaux de Londres".
[46] Beaumont-Maillet, *L'eau*: chapter 11.
[47] Beaumont-Maillet: chapter 15.
[48] Barles ("Cycle") quotes estimates by Parent-Duchâtelet of almost 30,000 wells within Paris in the 1830s. Their real contribution is hard to evaluate.
[49] The company started in Lyon seven years earlier, it was named *Compagnie générale des eaux*, that can be roughly translated as "main firm of water".

political and financial interests of the time, all the way to Emperor Napoleon the Third himself.[50] This monopoly would indeed turn this company into a giant, in France and then worldwide.[51] The privatization of water through the concession to the *Compagnie Générale des eaux* went along with various transformation of the organization of water distribution, e.g., the development of meter.[52]

Figure 5 Share of buildings connected to water and sewers, 1860-1940



Source: For connection to water, there are three different sources (individual data for 1861-1886; census reports for 1891 & 1896; *livre foncier* for 1901; see appendix for how we made them comparable. Connection to sewers and to *tout à l'égout* come from *Annuaire Statistique*, various years.
Note: the figures show the percentage of buildings in Paris that are connected to the water network ('Water), to the sewers for liquid only ('Sewer') or completely connected to the sewers ('*Tout à l'égout*'); there is one observation for each census year (every year in 1 or 6, e.g., 1861, 1866…), except for 1916.

At the same time, the city committed itself to extend the network and pushed for every building to be connected directly to the water system. Getting water inside the buildings, and in many cases inside the households, was deemed a key priority.[53] The takeoff was rather swift, with half the buildings having direct access to water by the early 1870s and three quarter a decade later (Figure 5). This pace reflected both the willingness of the city engineers and the strong demand from consumers. Still, it faced important opposition within the city, predominantly from building owners who feared (and certainly rightly so) that more water in

[50] On the history of the model of concession system in France, see Barjot, "The French Concession Model".
[51] The company still exists today under the name *Veolia*. It is currently (year 2021-2022) in the process of merging with its main rival, *Suez*, to become a huge player at the world level in distribution of water but also waste management. See Defeuilley, *L'entrepreneur et le Prince*.
[52] Chatzis, "Compteurs d'eau".
[53] Bocquet, Chatzis, and Sander, "Water in Paris"; Chatzis, "Le 'système Belgrand'"; Csergo, "L'eau à Paris".

the buildings would mean more water out of the building, thus increasing dramatically what they needed to pay to clean the cesspit of their property. As underscored by the historian Gérard Jaquemet, the cost of getting a cubic meter of soiled material out of a building was at least ten times the cost of bringing that same water in the house in the first place.[54] In the end, it took almost half a century to connect the majority of Parisian buildings to the water network. Hence, the curve for water on figure 5 could be read both ways, either emphasizing the celerity of connecting building or deploring the time it took to achieve it. More importantly, it must also be understood in a perspective of social differentiation within the city.

In addition, the evolution of access to water is also closely related to the expansion, or lack of, the sewer networks. Indeed, putting in place the processes and infrastructure to get that water out of the building proved a little harder and much longer than developing those to get the water in. As engineers and urban planners knew too well, the limited extension of the sanitation network was itself a check on the development of water access.

Dealing with waste water

The issue of sanitation and what to do with waste water was always to be more problematic, for both technical and financial reasons. On the technical side, the issue was how to move the soiled water from the buildings to the sewers. For most of its history, Paris had little appetence to regulate and organize waste water, an idea or a concept that was slow to emerge. Before the second part of the 19th century, the main concern was how to take advantage of human waste, urine and fecal matter. They were managed separately from waste water coming from domestic activities, usually in septic tanks (*fosses d'aisance*) located below the buildings (or next to them, indeed in many instances they were simply holes in the ground). These tanks were periodically emptied and the product collected was turned into fertilizers.[55] In the first part of the 19th century, population growth, increased industrial activities, and higher influx of water revealed the obvious limitations of this simplistic system. As elsewhere, epidemics also contributed to highlight the poor hygiene of the city and the burden of waste waters, that contaminated soils and often flowed in the river. Even though

[54] Jacquemet, "La Bataille:" 506.
[55] Barles, "Cycle".

at the time, the link between soiled waters and cholera had not been made, not even by association, as in London, sewage waters were starting to emerge as an ideal culprit.

Hence the city, becoming increasingly concerned with the sanitation system, started to look for ways to better deal with soiled water while, at the same time, preserving the fertilizer industry. The city decided in the 1850s that buildings could evacuate their liquid waste (but only the liquid part) by connecting them directly to the sewers. It was a way to collect and valorize both liquid and solid matters to be used, separately, as fertilizers, the first through spreading on the fields (mainly in the north-west of the city), the second as raw material for the production of manure.[56] This required two important transformations that formed the basis of the system at the time of the expansion of Paris in 1860. First, the separation between liquid and solid matters was required before the connection to sewers, as only the first one had to be emptied in the sewers. Second, the sewer system had to be expanded and reorganized in order to be able to accommodate the large quantity of liquids that were to flow through it and to reorient them to agricultural areas far from the city.

However, this solution did only partially solve the problem. Its main limitation was the need to regularly empty the tanks: given the growth of the city, especially after 1860, the number and frequency of such extractions had to increase to unsustainable levels. In fact, the dealing with waste matters, both liquid and solid, proved to be one of the most hotly debated issue of the second part of the 19th century.[57] As late as 1871, more than a tenth of the 68,000 buildings in the city had not declared an evacuation practice, meaning either they (illegally) rejected their waste water to the sewers without filtration or they simply dug a hole in the ground. And change was slow to come: even after two decades of strong incentives to connect to the sewer, only half of the buildings were connected in the 1890s (Figure 5) as the fixed cesspool remained the dominant form of dealing with waste matters. This bears testimony to the hostility of building owners that bulked at the additional costs, of installing a filtering mechanism (*tinette filtrante*), and of paying for the additional water needed to have the waste run through the system, all the way to the sewers.

Soon, the city began to realize the limitation of the old system: cesspits were too numerous, they often overflowed, soiling the floor of the cellar they were located in and even regurgitating their dirty content all the way up to the toilet cabinet. One of the most obvious

[56] Barles, "Urban Metabolism".
[57] Jacquemet, "La Bataille"; Barles, "Experts contre experts".

results is the summer stench that started to become an unpleasant characteristic of the city and a source of complaints in the 1880s.[58]

This increasingly precarious situation forced the municipality's hand. After years of debates, half-a-dozen investigative committees, and public inquiries, it decided that all wastes, liquid and solid, would be send to the sewers, in a *tout-à-l'égout* setting. This meant discarding completely the tanks (and the industry with it), modifying the connection with sewers at the building level (when it existed) or developing a new one, connecting all buildings to the main drain, and changing the structure of the sewers to accommodate larger influx of matters.[59] Above all, it meant increasing tremendously the available quantity of water in order to facilitate the circulation of the materials in the drains and sewers. This extra water requirement, and the cost associated with it, more than the necessary transformation to the building drains, was the main reason of the strong opposition from building owners. As a result, this was the beginning of a battle of more than a decade, with the vocal and judiciary opposition of both building owners and night soil companies. They were mostly successful, forcing the municipality to switch from incentive to obligation: the city made direct connection to the sewer system mandatory in 1894. Old buildings had three years to adapt to the new system.[60] As with water, incentive measures had proved insufficient to develop collective service in the city. Still, despite the obligation, the takeoff was rather slow (Figure 5). Indeed, as late as 1921, a good quarter of the Parisian buildings were still not linked to the main drain, a very good indicator of the size of the resistance from building owners, a direct consequence of the very unequal distribution of property in Paris.

In the end, the 19th century marked an important transformation of the relationship with waste materials, both solid and liquid. From a position with little regulation and a limited appetite for organizing their recollection, the city moved progressively to control and process them, first accepting to have them sent to the sewers, then inciting it strongly, and, finally, making it mandatory to have all waste materials sent together to the sewers. However, there is a clear thirty years lag between water connection and sewers connection, between the water coming in and the water coming out of the buildings. Part of the explanation for this gap is technical, related to rapid changes in technology that explain changing view on the system to

[58] Barnes, *The Great Stink*.
[59] On the vast extension and transformation of the network and its meaning, see Gandy, "The Paris Sewers".
[60] Jacquemet, "La Bataille": 544.

be implemented. But the most important reasons of the delay are political. Not only was delivering water more consensual and easier to sell than delivering sewers, but the people making money out of waste water were much more powerful than those making money out of water delivery. And probably even more important was the reluctance of building owners to incur the costs of connecting their building to the sewer systems.

Differentiated access

The last part of the 19th century was dedicated to simultaneous efforts by the city in order to improve water access in Paris: increasing quantity and quality water, expanding the distribution network and connecting buildings to it. But, the issue of how to get rid of that water took much longer to be solved, and it's not until the interwar period that most buildings would be connected to the main drain. More importantly, despite these improvements, a large share of Parisian inhabitants did not have an easy or regular access to clean water. Indeed, the general picture dissimulates strong variations throughout the city in access to both (clean) water and sewers.

Spatial and social variations

In May 1884, the Paris municipality decided to launch a public inquiry concerning its project to connect all buildings to the main drain. Over twenty days, people were asked to come forward and comment on the project. Unsurprisingly, most comments came from the upper strata of society, e.g., individuals describing themselves as "owners" (*propriétaires*). And, again quite unsurprisingly, almost all of them were very hostile to the project. Two sets of arguments were put forward. The first set was hygienist, insisting on the limited availability of water and the accumulation of fecal matter in the sewer that would result of direct connection. Many commentators used the word "poison" to refer to the main consequence of the new system. The second set of argument was, of course, financial, as building owners denounced the additional costs required to switch to the new system, not only the cost to implement full access to sewers in their building, but also of the resulting roaming costs in water consumption and taxes. In the 13th arrondissement, one of the poorest of the city, a sir Berthemy, living on *58, rue Patay*, neatly summed up the arguments as he "totally reject the foreseen measures that *would poison Paris* and impose huge spending to the city of

Paris and to building owners, especially small owners, who are already overwhelmed with taxes".[61]

Although, overall, the mood was resolutely hostile, a few commentators were aware of the strong social differentiation in access to decent living conditions. Hence, the hygienist Commission of the 8th *arrondissement* declared that "the bad state and defective installation of toilets for collective use, *mainly in working class housing*, is a permanent cause of infection."[62] This inquiry showed the strong opposition to improving sanitation (in that case by implementing connection to sewers, but the same was true, to some extent, of providing spring water to everyone), mainly among building owners, a small but very vocal and influential minority. The comments also highlighted the ambiguity of the standard hygienist argument. The central motivation for connecting all buildings to the main drain was that it would help sanitize the city, eliminate the stench that prevailed, contribute to better living conditions, and control epidemics that periodically affected Paris. But opponents of the development of *tout-à-l'égout* often mobilized this argument themselves: building owners suggested that the new system would create an accumulation of dangerous fecal matter in the buildings and contribute to increased contamination. According to them, relying on connection to the main drain would have exactly the opposite effect, as limited water availability would turn the new system into a germ pool.

The opposition from building owners, translated in protracted battles to slow and prevent the adoption of both water and sewers connections, had concrete consequences on the differential adoption of water sanitation systems, as can be seen on Figure 6, which plots the evolution of connection to both water and sewers in three neighborhoods.[63] For both water and sewers (connection to the main drain), the slope is pretty steep for all three, showing some success of the active municipality in promoting connections. The difference between

[61] *Archives de Paris* VO^3 169bis, our translation (emphasize added).

[62] *Id.*

[63] Given the difficulties to gather precise data on connection to water, we had to sample and restrain our analysis to some neighborhoods (see appendix). The choice of these three neighborhoods was motivated by a search for diversity of positions, both economic and spatial: the 8th arrondissement was the wealthiest of the city whereas, at the other end of the spectrum, the 5th and 19th represented two different versions of poor neighborhoods. The first one, around Sorbonne, represented the old Paris, dirty and dense, with small streets and elderly buildings, whereas the second one, in the North-East, along the Ourcq canal, was emblematic of the newly annexed parts of the city, part left untouched, part industrial, experiencing high urban growth.

access to water and to main drainage reflects the stronger opposition to the latter, the growth being much slower initially and the completion longer to achieve.[64]

However, there was also a stark difference between the three neighborhoods, with some degree of diminishing returns in connection in the two poorest ones. For instance, in 1880, for water, almost 90% of the buildings in the 8th neighborhood were connected against barely 70% in the 5th and not even 60% in the 19th. In the end, there was both a lag in connection between the wealthiest and poorest neighborhoods (approximately half a decade between the 8th and the 5th and a full decade between the 8th and the 19th) and a slowdown in connection in the poorest neighborhoods in the end. Both phenomena also occurred for connection to main drainage. In addition, the distribution within neighborhoods is certainly not homogenous, although this is difficult to measure: the buildings connected within a neighborhood were quite often those of the most affluent. In many popular neighborhoods, most households would not be able to afford the cost of the subscription to the water network and, as a result, the building owner was reluctant, to say the least, to connect his building. Thus, our evaluation at the neighborhood level certainly underestimate the social gradient in access to clean water and connection the main drain.

It is important to keep in mind the relationship between water connection and water quality. In that sense, the differences in connection reveal much more than simply differences in access to water at home (or, at least, within one's building). They can be more accurately thought of as a proxy for what kind of water people got. This was a direct result of the choice to separate the two networks of water distribution, the so-called "public" and "private" networks. These two networks run parallel, deserving different purposes, but, more importantly, using different type of water, river water to the public network and spring water to the private one, when possible.[65] Indeed, starting in 1892, spring water was only used in the private network.[66] Inhabitants of buildings not connected to the network relied on public fountains and, as a result, would most often receive river water. The opposite was not true, however: not everyone connected to the private network would have gotten spring water. A

[64] In addition, the curve for water probably underestimates the initial number of connections (before or at the beginning of the *compagnie générale des eaux*), thus slightly overestimating the slope.

[65] There were exceptions to this rule and the reality is probably slightly more complicated, with some neighborhoods receiving spring water for both public and private networks (at least for some periods of the year). However, it is certain that the private network was always given priority over spring water.

[66] According to Souriau "Stratégies durables" (p. 139), it was a push to motivate connection to the private network.

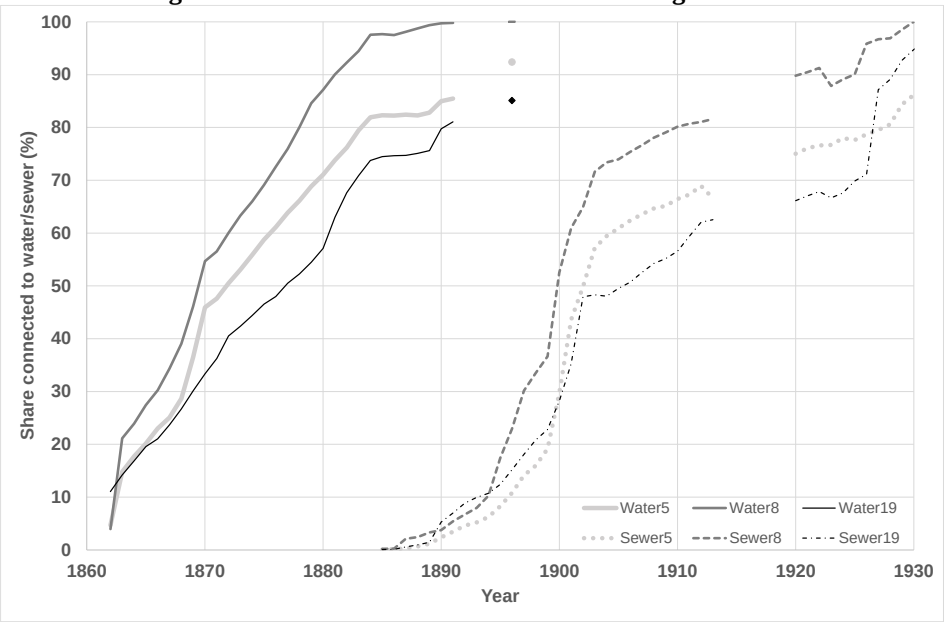
report by the head engineer (Deligny) in 1883 showed that a quarter of the water distributed in the private network for domestic consumption came either from the Seine or from the Ourcq canal.[67] The spatial distribution of that water is also telling: in a series of neighborhoods from the East to the South of the city, the 10th to 14th (included), river water represented around three quarter of the water distributed by the private network (for other neighborhoods, 5th excepted, its share was negligible). And this was neither an involuntary nor a temporary feature of the system: as late as 1902, in the poorest neighborhoods (mainly 13th & 20th), there were still hundreds of buildings that had a subscription for river water only.[68] In their poorest districts, they even represented a large share of the housing stock: in *Belleville*, in the North-East, more than half of all buildings either did not have water or had only river water; in *Maison Blanche*, in the South-East, it was a third of all buildings. In most other neighborhoods, the share was equal or very close to zero. All these districts have in common to be from the working class, industrialized areas in the East of Paris.

The song highlighted at the beginning insisted on these "boring people", the "inhabitants of arrondissements that were given water from the Seine", as a direct allusion to those from poor neighborhoods lucky enough to have their building connected to the network, but still getting very poor-quality water. The historical dynamic was stuck against them in more than one way. At first, they lagged access to the private network and relied on public water from fountains, often filled with river water. As more and more buildings connected to the private network in these heavily populated neighborhoods, the quantity of spring water available at the city level wasn't enough, and so they ended up receiving river water from the network. In short, no matter what they did to comply with the norms and to follow the municipality's policies, they were always last to get spring water. In the worst cases, some areas experienced a form of double jeopardy. The poor 5th neighborhood is a case in point: in 1883, it was lagging behind more affluent neighborhoods in connection to water (only 70% of its building were connected), but even for those connected, two third of the water they received was river water.

[67] Rapport Deligny (1883) ANNEXE n°1 "Consommation d'eau à la date du 1er juillet 1883." *Archives de Paris* VO3 610.

[68] *Livre Foncier*.

Figure 6 Share of building connected to water and sewers in three neighborhoods



Source: *Annuaires statistiques de la Ville de Paris*, various years. See appendix for details
Note: the figure is comparable to a disaggregated Figure 5. It gives the share of total buildings connected either to water (plain lines) or to *tout-à-l'égout* (dotted lines) in three Parisian neighborhoods.

At the end of the day, there is perhaps little surprise in this pattern of unequal social diffusion of access to water amenities in the city. Innovations tend to diffuse slowly across social groups and access to clean water is in no way an exception. Thus, it is important to stress that it could have been done differently. A good counter-example is the case of Stockholm, a much smaller city, but still an industrializing city, sharing the same issues of water access as many metropolises of the North-West Atlantic area. Although the city was not as egalitarian as it is today, the municipality did insist on a program for bringing water to all inhabitants (in particular without distinction of status and economic means). And to some extent they were able to do so: recent analyses demonstrate that indeed, inequalities in access to water (measured here also by buildings connection) were quite low, and the socio-economic status of the inhabitants of a building did not influence connection to water.[69]

Comparing access to water in Paris and Stockholm allows us to put in perspective the large disparities observed in Paris in terms of access to sanitation. In Paris, at each step, decisions were made that heavily discriminated against the poorest. Many of these choices seem technical and in line with what was prescribed by hygiene practices.[70] But in reality, in a

[69] Önnerfors, *Water for the Many*.
[70] For a good critical perspective on this view, still relatively dominant in the literature on water management in Paris, see Souriau, "Stratégies durables", in particular 129-145.

social environment as polarized as Paris, these decisions designated winners and losers. In other words, there was some sort of trade-off between efficiency and equity: on the one hand, municipal authorities could have favored the efficiency of the water system, for instance by maximizing the quantity (and quality) of water they brought in; on the other hand, they could have searched to maximize the equal distribution of the water received. In the political economy of the time, the second solution often wasn't even contemplated. And so, in almost all cases, the first option was selected, often on feasibility or technical grounds, but, also, frequently, various reasons related to financial and economic interests that, ultimately, rested in the incredibly unequal distribution of building ownership with the city. This reality shaped the choices available and the set the city water management on a path that resulted in strong inequality in access by social classes.

A good example of such a choice is the separation between public and private networks we insisted on. Other examples abound, such as the decision to develop (and then force) subscriptions to water for owners.[71] Another example is the choice of a private company (and only one), to manage the subscription.[72]

Collective and private uses

Almost a century was needed for the vast majority of Parisians to get access to good quality water in sufficient quantities. At the end of our period, in 1954, all but a few Parisian buildings were connected to the water network which supplied clean, drinkable water, either from spring or from chlorinated water. Nonetheless, this convergence, often publicized, then and now, tends to obfuscate remaining inequalities in access to water, but also in the capacity to take advantage of this water for personal use.

Regarding water access, there remained strong variations between dwellings, especially within buildings. Indeed, in 1954, a fifth of apartments did not have directly access to water and the vast majority of apartments in Paris (more than 80% according to the census) did not have a shower or a bath, thus limiting the way people were able to take advantage of that water. The picture is the same when looking on the other side of the water distribution: in 1954, almost all buildings were connected directly to the main drain. Yet, more than half of

[71] For a discussion of other possibilities (for the cases of other French cities), see Graber, "Le Robinet Libre".

[72] And contrary to the case of England and Wales, where, after an initial role of private companies, municipalization became more important, the role of the CGE in Paris remained for a long time (Hassan, "The Growth"; Millward, "La distribution de l'eau"). In the US, Werner Troesken shows that public ownership of water distribution limited segregation towards black inhabitants ("Race, Disease, and the Provision of Water").

Parisian apartments did not have a toilet (in most cases, there was a collective one either for an entire floor or simply for the whole building).[73] As expected, the spatial distribution of these amenities was still heavily marked and conformed to the East-West pattern, the main social differentiation throughout the city.[74] In addition to this spatial variation, there was also strong social variations within buildings themselves, as access to water was unevenly distributed between floors, usually with the highest floors less likely to receive water. The reason for this is much more social than technical: it is where servants used to live (and where the lowest income groups live today) and they were the last ones to get water (in the best case, they would have a collective tap on the floor).

Hence, even though most buildings were connected to both water and sewer in 1954, strong variations in access to basic amenities remained, linked to social composition. To illustrate it, we can look at the presence of such amenities in various households in the 1954 census for Paris. The census results were published by building blocks (*ilots*), which varied greatly in size, depending on the neighborhood.[75] The smallest blocks were only a house–one building with one housing unit–, while the largest one encompassed 188 building containing 1665 housings. The average (resp. median) is a little more modest, 18 buildings with 250 housings (resp. 15 buildings with 191 housings). This allows us to get a more precise picture of spatial and social variations than when looking at the neighborhood level, as we did previously. It is still not a perfect observatory, though, as there is some degree of social mixing, e.g., the share of servants is positively related to that of white collars.

In 1954, the households situated in a block with a large share of unskilled workers were less likely to have running water than those situated in a block with a large share of upper white collars (Table 2). For instance, in a block where a quarter of all workers were unskilled (belonging to the top 10% for unskilled workers), only two thirds of the households were connected to water, compared to more than 80% for a block belonging to the top 10% for upper white collars). Hence, even once the buildings were connected, differences in the ability or possibility to use clean water persisted for a long time. The situation was the same for the presence of a shower or a toilet cabinet inside the household. Overall, there is a clear opposition between blocks with a high presence of white collars, whether upper group or middle-class, and the other blocks. Households in the first case are much more likely to have

[73] By contrast, less than 5% of apartments were without electricity and only a fifth without gaz.
[74] To see a visual illustration of this divide, see Pinol and Garden, *Atlas*.
[75] INSEE, *Données statistiques 1954*.

water at home, a shower and a toilet cabinet than households where the other groups are more numerous. Beyond access to water, inequalities extended to basic amenities to use it.

Table 2 Social composition of the block and presence of amenities in the household

Water	Water	Shower	Toilet
Upper white collars	Ref.	Ref.	Ref.
Clercs & assimilated	1.096	-4.934	0.090
	[0.334]***	[0.478]***	[0.335]
Shopkeepers	-2.617	-4.430	-2.630
	[0.331]***	[0.350]***	[0.369]***
Skilled workers	-0.913	-2.845	-2.244
	[0.482]*	[0.645]***	[0.372]***
Unskilled workers	-4.594	-7.059	-4.738
	[0.303]***	[0.414]***	[0.321]***
Servants	-2.951	-3.793	-4.364
	[0.383]***	[0.333]***	[0.469]***
Others	1.064	-4.654	-0.760
	[0.596]*	[0.389]***	[0.672]
N	4,424	4,321	4,421

Source: *Données statistiques 1954*. I am grateful to Jean-Luc Pinol for giving me the database he extracted from the volume (for his *Atlas des Parisiens*).
Note: generalized linear model (binomial). A unit of observation is a block (a group of buildings), the dependent variable is the share of housing units (within that block) that have access to water/a shower/a toilet cabinet. The independent variables are the share of workers (among those with an occupation) having a given occupation'. Models include other control variables: average number of rooms in a housing unit, average number of inhabitants by room, (log) total number of buildings, (log) total number of housing units, sex ratio, share of foreigners, presence of immigrants from North Africa.
Robust standard errors in brackets, * $p<0.1$; ** $p<0.05$; *** $p<0.01$.

You'll have to wait for the last part of 20th century, more than one hundred years after the arrival of the first aqueduct of spring water in Paris, to see that gap closed.[76] This is testament to the way social inequality in the city have been, and to some extent still are, designing water infrastructures. It also highlights the enduring legacy of a system that was never designed to distribute clean water to the vast majority of Parisian inhabitants.

From the very general, the quantity of water flowing in Paris, to the particular, individual access to water at home, the conquest of water, as Goubert called it, was both irreversible and slow in Paris.[77] More importantly, it was socially differentiated at each stage, with cumulative effects on the differences in access to everything related to water, from essential amenities (a tap, say) to important tools for personal hygiene (a shower or a toilet cabinet). In the end,

[76] Hence, in 1975, a third of Parisian apartments still had neither shower or bath, or were without a toilet cabinet (census results).
[77] Goubert, *La Conquête*.

there is some kind of continuum in the way water management in Paris impacted the poorest social groups, from the early difficulties to gather enough water to the presence of tap water or a shower in the household late in the 20th century.

Concluding remarks

One hundred and fifty years ago, in spring 1871, a Revolution erupted in the heart of Paris. Although short-lived, the *Commune de Paris* was a place of huge social innovations and renewals. Its impact was felt way beyond the city, as it became, for decades, a symbol of popular uprising (and their crushing) and the fight for social justice all over Europe, a symbol that, to some extent, it still is today.[78] Despite its central role in the 19th century making of Paris, the *Commune* is completely missing from the history of the development of infrastructures, water or sanitation systems in particular, in the city. Neither of the previous uprisings in half a century (in 1830 and 1848) are mentioned. It seems as if there are two distinct histories of the city, flowing parallel but strictly separated paths. On the one side, it is a history of the people living in the city, dominated by working class workers, migrants from the rest of France, the people of Paris. On the other side, it is a history of the physical fabric of the city, its infrastructure, the way they came to be and their evolution. Of course, this discrepancy–between the social and the physical or between the social and the environmental– is not really (or maybe not solely) about a separate history of the physical and the social environment or about delimitation between sub-fields of history (social history vs environment history vs history of techniques). It corresponds also to a certain way to tell the history of the metropolis, whether focusing on the bright or on the dark side of the city of light.[79]

Indeed, the story of water in Paris is often narrated in a very linear way, in line with the triumph of modernity. It is a story of big figures and key characters, engineers (Belgrand, but also Ernest Deligny or Alfred Durand-Claye), scientists (the chemist Jean-Baptiste Dumas for instance), politicians (think Haussman) or doctors (e.g., Appolinaire Bouchardat). This classical view still dominates the landscape and tends to emphasize the role of these

[78] On the *Commune de Paris*, among a vast literature, see the work of Jacques Rougerie (e.g., *Paris insurgé* and that of Robert Tombs (e.g., *The Paris Commune* For more recent takes on the events, see for instance Bantigny, *La Commune au présent* or the work of Michèle Audin at https://macommunedeparis.com/.

[79] This dual narrative plays out at various level throughout the city, as can be seen by the recent history of the emblematic Champs-Elysées avenue, Bantigny, *Champs-Élysées*.

personalities, especially engineers, as visionary–almost messianic–figures who had to confront and defeat greedy building owners, reluctant municipal councilors, and powerful companies while fighting for the public good. The fact that this story is being written by engineers certainly contributes a lot to its persistence.[80] But they are probably not the sole culprits.[81] To be sure, there is certainly some truth to that history; and the role and willingness of engineers of the prestigious *Ponts et Chaussées School* in providing Paris with elaborated infrastructures must not be underestimated. But at the same time, the way the story is told tends to obfuscate large parts of it. Let's focus on two of its main limitations.

First, that history tends to exclude almost completely large part of the population, as if it had little said in the matter of hygiene or urban renewal. There is almost no agency of Parisian popular classes, which constituted the vast majority of the population of the city. This produces a paternalistic narrative centered on the way educated engineers, reformist politicians and modernist administrators gave the masse the water and sewers they deserved. In fact, it goes beyond omitting roughly 95% of the Parisian population, as it also put in the front a narrative oriented towards the bourgeoisie and the triumph of modernity.[82] Doing so, it obfuscates the fact that social tensions were a permanent feature of the city, beyond the regular explosion such as the Commune of Paris. The fear of the "dangerous classes" was certainly one of the motivations beyond the improvement of sanitation systems.[83] Thus, there is some ambiguity in this advent of modernity and sanitization of the city, as it tended at the same time to improve quality of life and exclude some population from that improved living standard.

The second key limitation is related to the linearity of the story and the centrality of a few key characters, its "heroic" aspect, to borrow from Tom Crook's analyze of the making of public health in England.[84] As Crook convincingly demonstrates, the development of what he calls "water systems" was the outcome of many small inventions and events and not the result of a single, linear, process. They contributed to large innovations only through tremendously complex processes littered with trials and errors, mistakes and failures. For France, although

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[80] Cebron de Lisle, *L'eau à Paris*.

[81] Take for instance a recent book about hygienist policies in the city, which fits very much this heroic narrative Chevallier, *Le Paris Moderne*.

[82] Matthew Gandy demonstrates perfectly how sewers were part of a narrative related to the bourgeois construction of Paris. Gandy, *The Fabric of Space* .

[83] A large literature discusses the Parisian *classes dangereuses* and the social construction of Paris underground, e.g., Rosental and Couzon, "Le Paris Dangereux de Louis Chevalier"; Kalifa, *Les Bas-Fonds*.

[84] Crook, *Governing Systems*.

the history of the hygienist movement has been widely reviewed,[85] its implications for urban development, in particular its social variations, remains to be studied.

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[85] Bourdelais, *Les Hygiénistes*; Frioux, *Les Batailles de l'hygiène*.

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Appendix. Computing connection to water

To compute the share of buildings connected to water at different levels of aggregation, we need both the total number of buildings and the number of buildings connected. Various published sources give them for Paris as a whole at different dates, with sometimes variations by neighborhoods (mainly administrative reports, by engineers of the city of Paris; census reports; fiscal reports–*livre foncier*; etc.). These sources are fragmentary and sometimes contradictory, as can be expected, for instance because they applied different definition of a "building" (e.g., there is a 3% difference in the total number of buildings between the fiscal and the demographic censuses). But the main issue is certainly that most sources only give the number of subscriptions, making it impossible to know the number of buildings (or of people) connected to water. This is the reason why most of the literature on the evolution of water access in Paris only use the number of subscriptions and not a share of inhabitants or buildings.[86] This approach makes it difficult to assess variations in time and space.

In order to overcome this issue, and also as we wanted to get a sense of the evolution of connections at a disaggregated level, we mobilized the original records produced by the company in charge of managing subscriptions (*CGE*). These records were organized by streets, with a list of addresses in that street and the characteristics of the subscription for that address: starting date, name of the subscriber, price, volume of water, etc. (see one example below). When a subscription ended, it was simply biffed and replaced by a new one. We collected all these addresses for three neighborhoods (5th, 8th, and 19th) for the period 1861 (start of the concession system) to 1891 (when published sources give more precise information). We selected these neighborhoods because they represented various aspects of 19th century Paris (rich or poor, new or old…).

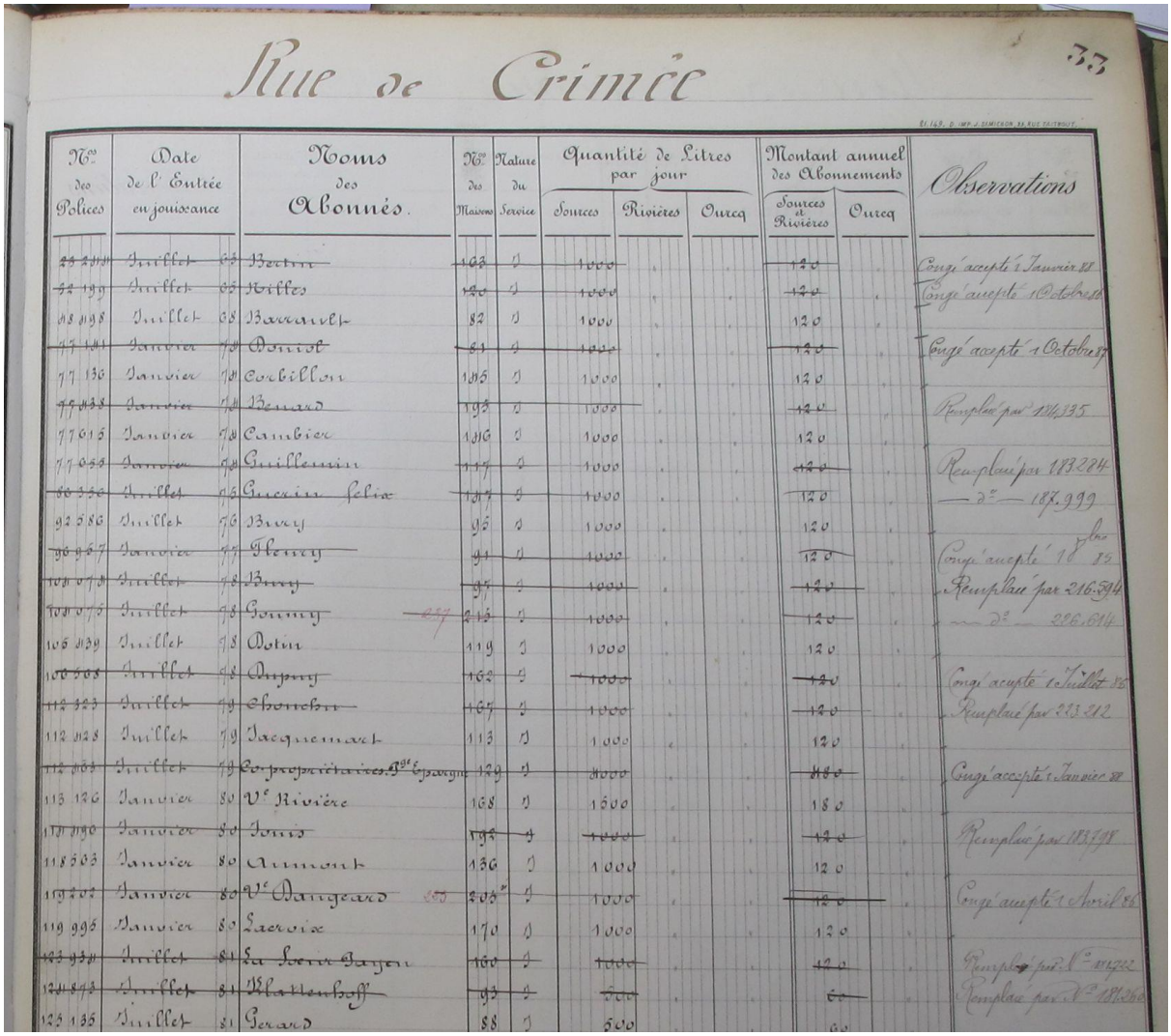
In the end, we obtained a little more than 16,500 entries, each a subscription with an address and a start date. Many of those corresponded to the same address so we matched them and kept only the initial (oldest) date. In other words, we assumed that once a building is connected, it won't lose its connection. In addition, we only considered exact matches (so 23 and 23b *rue des fossés Saint-Jacques* are considered two different buildings), which might overestimate the number of connections (if they are just two entrances to what would be

[86] E.g., Csergo, "L'eau à Paris"; Cebron de Lisle, *L'eau à Paris*; Bocquet, Chatzis, and Sander, "Water in Paris".

counted as one building in the census). Finally, this process produces a little less than 10,000 buildings with a date of connection that we then use to compute the number of buildings connected to water every year from 1861 to 1891. In the end date we can compare this number with the number of buildings connected according to the census. Our number is always higher, by around a fifth (and a third for the 8th arrondissement). This was to be expected: in addition to the ambiguity on entrances to the same buildings, we probably missed some matching, some parts of streets might have changed name, etc. To correct for this, we adjust the total number of buildings connected each year by the ratio between our total and the census total in 1891 (so we lower the number of buildings connected each year proportionally to the overestimation in 1891, by neighborhood). This doesn't alter our results in terms of spatial comparison (if anything, it reduces the advantage of the 8th arrondissement) nor the evolution over time (it tends to increase a little the slope). For Figure 5, we extrapolate the number of buildings connected for the three neighborhoods to the seventeen other ones, based on their characteristics. We then compare this number with the total number of buildings given in the census to produce a share of buildings connected for Figures 5 & 6.

To sum up, two things are important here. First, the results of this procedure should be considered as best as rough estimates. In particular in terms of level, the results presented on Figures 5 & 6 must not be overinterpreted. Second, the temporal and spatial dynamics, is quite accurate, since there is no reason to think that the recording would vary by neighborhood or over time. This is what matter for us: these records as indicators of spatial and temporal variations in access to water.

Example of records from *Compagnie Générale des Eaux*, rue de Crimée in the 19th arrondissement, period 1885-1891, *Archives de Paris* VO3 1421.



Rue de Crimée

N° des Polices	Date de l'Entrée en jouissance	Noms des Abonnés.	N° des Maisons	Nature du Service	Quantité de Litres par jour — Sources	Rivières	Ourcq	Montant annuel des Abonnements — Sources et Rivières	Ourcq	Observations
~~25 [illegible]~~	~~Juillet 68~~	~~Bertin~~	~~103~~	~~1~~	~~1000~~			~~120~~		Congé accepté 1 Janvier 88
~~52 199~~	~~Juillet 68~~	~~Welles~~	~~120~~	~~1~~	~~1000~~			~~120~~		Congé accepté 1 Octobre 88
68 198	Juillet 68	Barrault	82	1	1000			120		
~~77 141~~	~~Janvier 77~~	~~Daniel~~	~~81~~	~~1~~	~~1000~~			~~120~~		Congé accepté 1 Octobre 87
77 136	Janvier 77	Corbillon	105	1	1000			120		
~~77 138~~	~~Janvier 77~~	~~Bernard~~	~~103~~	~~1~~	~~1000~~			~~120~~		Remplacé par N° 114.135
77 615	Janvier 77	Cambier	106	1	1000			120		
~~77 033~~	~~Janvier 77~~	~~Guillemin~~	~~117~~	~~1~~	~~1000~~			~~120~~		Remplacé par 183.284
~~80 356~~	~~Juillet 78~~	~~Lucain felix~~	~~107~~	~~1~~	~~1000~~			~~120~~		— 2e — 187.999
92 586	Juillet 76	Bivy	96	1	1000			120		
~~96 967~~	~~Janvier 77~~	~~Thierry~~	~~91~~	~~1~~	~~1000~~			~~120~~		Congé accepté 18 [illegible] 75
~~100 078~~	~~Juillet 78~~	~~Bury~~	~~95~~	~~1~~	~~1000~~			~~120~~		Remplacé par 216.314
~~100 079~~	~~Juillet 78~~	~~Gonny~~	~~215~~	~~1~~	~~1000~~			~~120~~		— 2e — 226.614
106 139	Juillet 78	Dotin	119	1	1000			120		
~~100 503~~	~~Juillet 78~~	~~Dupuy~~	~~102~~	~~1~~	~~1000~~			~~120~~		Congé accepté 1 Juillet 88
~~112 323~~	~~Juillet 79~~	~~Chorchin~~	~~107~~	~~1~~	~~1000~~			~~120~~		Remplacé par 213 212
112 128	Juillet 79	Jacquemart	113	1	1000			120		
~~112 503~~	~~Juillet 79~~	~~Co propriétaires 9e Epargne~~	~~120~~	~~1~~	~~2000~~			~~240~~		Congé accepté 1 Janvier 88
113 126	Janvier 80	Ve Rivière	168	1	1500			180		
~~117 190~~	~~Janvier 80~~	~~Jouis~~	~~194~~	~~1~~	~~1000~~			~~120~~		Remplacé par 183.738
118 503	Janvier 80	Arnoux	136	1	1000			120		
~~119 202~~	~~Janvier 80~~	~~Ve Dangeard~~ 859	~~205~~	~~1~~	~~1000~~			~~120~~		Congé accepté 1 Avril 86
119 995	Janvier 80	Lacroix	170	1	1000			120		
~~123 934~~	~~Juillet 81~~	~~La Soeur Sagen~~	~~160~~	~~1~~	~~1000~~			~~120~~		Remplacé par N° 211.722
~~124 873~~	~~Juillet 81~~	~~Blattenhoff~~	~~93~~	~~1~~	~~500~~			~~60~~		Remplacé par N° 184.264
125 135	Juillet 81	Gerard	88	1	500			60		