The 'Great Sanitary Awakening' Questioned: Is There a Solid Argument in Favour of the 'Filthy Medieval City' Hypothesis?

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Abstract

The large archaeological dataset of more than 650 excavated water facilities and cesspits dating from the thirteenth to the nineteenth century in the Dutch town of Haarlem allows us to outline long-term shifts in hygienic infrastructure. In the late Medieval period, town dwellers used mostly cesspits and surface water from canals, but in the last quarter of the sixteenth century, the use of water facilities began to increase. Over the course of the next three centuries, more and more water facilities were built as pollution increased. Industrial waste contributed to pollution in the late sixteenth and seventeenth centuries and as a result, by the second half of the eighteenth century, human excrement was being drained from privies directly into the canals. In combination with sewage from factories established in the nineteenth century a 'great stink' emerged. A 'great sanitation awakening,' therefore, must be viewed as a response to the increased pollution of canals and rivers. In light of this, it is fair to argue that it was not so much the Medieval period that was filthy and unhygienic, as Victorian reformers suggested, but the nineteenth century.

Résumé

Une banque de données riche de plus de 650 structures de gestion de l'eau et de latrines datées du XIII^e^ au XIX^e^ siècle dans le ville néerlandaise de Harlem nous autorise à retracer l'évolution des infrastructures sanitaires dans la longue durée. À la période médiévale tardive, les citadins utilisaient le plus souvent des latrines et les eaux des canaux dans leur gestion des eaux usées et des matières fécales. À partir du dernier quart du XIV^e^ siècle cependant, l'usage de conduites d'évacuation hydraulique a progressivement augmenté. Durant les trois siècles qui ont suivi, leurs réseaux ont crû à la mesure de l'augmentation de la pollution urbaine. Les rejets détritiques industriels y ont beaucoup contribué dans la seconde moitié du XVIII^e^ siècle, les excréments humains étant directement évacués depuis les habitats vers les canaux. Tandis qu'ils se combinaient à l'égouttage des usines établies en grand nombre dans le courant du XIX^e^ siècle, survint la « grande puanteur ». C'est la raison pour laquelle le « grand réveil sanitaire » peut être vu comme la réponse à la pollution croissante des canaux et rivières. A la lumière de ce constat, il semble juste de prétendre que ce n'est pas tant le Moyen Âge qui fut une période putride et ahygiénique, comme l'ont prétendu les réformateurs victoriens, mais bien le XIX^e^ siècle.

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Background[1]

In his monumental 400-page book *Watervoorzieningen in Brugge* (*Water facilities in Bruges*), the Flemish historian Vandevyvere observed that the number of public water pumps in Bruges increased rapidly over the course of the nineteenth century. In 1830 Bruges counted 50 pumps, and by 1900 the number had risen to 200.[2] Vandevyvere rightly notes that 'the increase reflects a direct advancement of public health within people's every day affairs,' albeit using the slightly antiquated terms of neatness and cleanliness. According to Vandevyvere, the increase was the result of what he called 'a sanitary awakening.'[3] This has been carried over into international literature where the term 'great sanitation awakening' is used.[4] Such a statement correspondents with the widely and long-held notion that the further one travels back in time the less sanitary towns were, with medieval towns being the epitome of disorder and dirt. The BBC documentary *Filthy cities* being the best and most recent example of this popular notion.

Recently a 'major revision of the historiography'[5] has been advocated by historians trying to dispel this myth of the filthy medieval town.[6] Carole Rawcliffe's book *Urban bodies* is generally viewed as ground breaking in the flourishing field of the history of public health. She states that the idea that the town was dirty stems from 'pronouncements of Victorian sanitary reformers whose belief in scientific progress made them dismissive of earlier attempts to ameliorate the quality of urban life.'[7] In other words, filthy medieval (fourteenth- and fifteenth-century) towns were a Victorian (nineteenth-century) invention.

Not only English Victorian reformers believed that the medieval period was worse in terms of public sanitation than their own period, the Dutch reformers also suffered from this conviction. In the medieval period until the 1672 plague, towns regularly experienced outbreaks of epidemics, especially of the traditional diseases of smallpox and measles. In 1832 Asiatic cholera appeared in the Netherlands and claimed hundreds of lives.[8] Although the cause of cholera was not properly understood, it was obvious that cholera was a waterborne disease and that the water quality had worsened in the last few decades.

In light of the discussion about public health in his time, Vogelsang, a nineteenth-century professor, published a pamphlet on drinking water facilities, one year after the 1866 cholera outbreak. He made a mockery of the common observation that 'our fathers and grandfathers who drew their water from the same canals and same wells stayed healthy.' He attributed the situation to the fact that the water flow had decreased, and above all, to a 'modern way of life, as people constantly moved and changed their food habits.'[9] Given that the attitude of disdain and denial of contemporary environmental problems that Vogelsang expressed were widespread among sanitary reformers, Rawcliffe's call is welcomed. She rightly challenges us to focus on surviving archival and archaeological evidence rather than perpetuate the anachronistic ideas of nineteenth-century sanitary reformers. Her parole is 'less mudslinging and more facts.'[10]

Returning to the increasing number of public water pumps in nineteenth-century Bruges and the interpretation of 'sanitary awakening,' is this 'mudslinging' or a solid argument in favour of the 'filthy medieval city' school of thought? In this article, we will focus on the archaeological evidence, and the first question will be whether a trend of increasing numbers of water facilities existed and if so, whether this was a spontaneous cultural change or whether it was a reaction to the increasingly contaminated canals, a phenomena known as the 'great stink.' A great stink not only haunted Londoners in the summer of 1858, research shows that in the Dutch town of Leiden in the seventeenth century and in Haarlem in the nineteenth century, a great stink had already occurred. The change to draining privies and sewers directly into the towns' canals instead of collecting human waste in cesspits was the pivotal factor in this olfactory nuisance.[11] The disappearance of cesspits was an indirect indication of the increasing pollution and contamination of Dutch waterways.

The focus of this article will be on the town of Haarlem, as we are fortunate to have at our disposal an archaeological dataset of more than 650 excavated water facilities and cesspits dating from the thirteenth to the nineteenth century.[12] This allows us to consider the shift in hygienic infrastructures over the long term, that is, from the late medieval period till the nineteenth century, and to study trends in water facilities in connection with trends in cesspits.

Fig. 1. Town expansions of Haarlem. 1a. Pre-1300 town centre (31.6 ha) 1b. Burgwal first half of the fourteenth century (+ 5.5 ha) 1c. expansion *c.* 1400 east of the Burgwal, (+ 6.7 ha), expansion northeast (8 ha), expansion west (+ 34.2 ha) 1d. expansion of 1672 (+ 47.6 ha and + 8 ha). The surface areas were computed by J. de Nieuwe and L. Fialho (Municipal Archaeological Service of Haarlem) using MicroStation. The course of expansions follows Marsilje 1995, 23–34.

Historical background

Haarlem was a water-rich town in Holland that had, by 1400, grown from a small, walled village of less than a 10,000 residents into a town where the rural ways were disappearing and inhabitants increasingly made their livelihood through urban occupations.[13] Many worked in the textile industry, as spinners, weavers or tuckers,[14] although Haarlem's beer industry was considered by contemporaries to be of greater importance.[15] During the Late Medieval period, the population of Haarlem gradually increased, but beginning in the 1580s, Haarlem experienced a dramatic increase in population as it welcomed thousands of political refugees from the southern Netherlands. This influx of skilled workers contributed to the well-known explosive economic growth of Holland. For Haarlem, one of the towns at the centre of the economic boom, this obviously meant overcrowding and an on going shortage of dwellings for the new inhabitants. As Haarlem did not extend beyond the town walls until 1672 (Fig. 1), the population density, the number of people living *intra murros*, increased exponentially (Fig. 2).

While other beer producing towns like Gouda and Delft suffered from a deteriorating brewery industry during the seventeenth century, Haarlem as an important exporter of beer 'staved off troubles longer than others.'[16] However, after the Dutch Golden Age in the second half of the eighteenth century, Haarlem too entered a period of stagnation. Unemployed spinners, weavers and tuckers faced sharply rising food prices, and for the growing class of paupers – the vast majority of the town's residents – it was a challenge to even feed themselves from week to week. By 1800 Haarlem had been transformed into an impoverished town. The establishment of steam cotton printing factories such as Wilson, in 1833, and Previnaire & Co, in 1834, revived Haarlem's textile industry,[17] but at a cost. Industrial sewage, contaminated water and air pollution now plagued Haarlem. Throughout the nineteenth century, the town continued to be experience high levels of poverty, and throughout the nineteenth century, the quality of living declined further as a result of waste dumping, decayed housing, dilapidation and 'slum lording.'

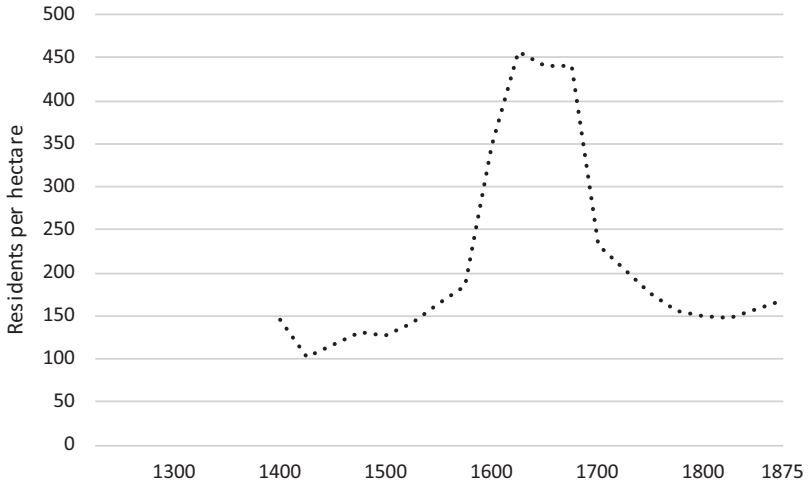

Fig. 2. Population density in Haarlem. Data taken from Van Oosten 2015a, Appendix 4.1.

Historical sources on water facilities in Haarlem

In tandem with Amsterdam, Haarlem was the first town to install water mains in the Netherlands. It did so in 1853.[18] Nieuwstad (fig. 1d), a wealthy part of the town, was one of the first areas to be connected to the water system,[19] but in 1875 only one third of the households had access to the system.[20] This meant that till the late nineteenth century, the majority of inhabitants used traditional drinking water facilities, such as rain water, well water, pump water and surface water. As demonstrated by archaeological finds, these water sources were supplemented by mineral water bottled in stoneware jugs imported from Westerwald.[21] In addition to being used for consumption, water from these sources was also used as household water (cleaning and laundry). Typically in Dutch households, domestic help would sweep the pavement in front of the house on Saturdays with water drawn from the canals with a well hook.[22]

Hardly any historical information is available about water facilities and household water consumption generally in the period before water mains were installed. Household water consumption was not a municipal affair and so not recorded systematically. Only a handful of historical sources exist, and as a result it is difficult to investigate how Haarlem residents used water. For post-medieval Haarlem, three historical sources provide us with snapshots of water consumption: 1) the 1783 annual report of the Physical and health sciences correspondence society (Natuur- en geneeskundige correspondentie societeit) written by Willemse, a local medical doctor, 2) the 1868 *Rapport aan den koning (Report for the king)* and 3) *De drinkwatervoorziening van Nederland voor de aanleg van de drinkwaterleidingen (The drinking water facilities in the Netherlands before the introduction of water pipes)* by Vogelzang, not to be confused with the earlier mentioned author Vogelsang, written *c.* 1900.

From Vogelzang's map of the main sources of water for all Dutch municipalities at that time, we can conclude that for Haarlem *c.* 1900 these were rain water and surface water.[23] In the case of Haarlem, it is unclear if surface water meant water that was imported from the dunes through the water mains or surface water taken from the canals. According to Vogelzang, consumption of surface water, for instance from the Rhine, was common, and he substantiated his statement with figures and quotations from primary sources.[24] He showed that even after a century of extreme pollution and contamination of surface water, the majority of people were without a private or even a shared water facility such as a well or rain tank: in 1904 in Leiden, a big industrial town like Haarlem, 27% of the residents (108 out of 399) had no water facility; in 1903 in the small, rural, town of Zwammerdam 60% (72 out of 120) did not; and in rural Haarlemmermeerpolder more than a quarter of the population (479 out of 1691) were without a facility.[25] Vogelzang concluded that these town dwellers consumed surface water from rivers.

Fig. 3. Cistern. Example of the underground portion of a cistern. Haarlem, excavation 104–106 Spaarne, in 1999.

Drinking surface water was also mentioned in *Rapport aan den koning* published in 1868. After the cholera pandemic of 1866, the drinking water facilities of all towns and settlements affected by the disease were systematically mapped. According to this report, the consumption of Rhine water in Leiden was 'exceptional,' but in Haarlemmermeer and Zwammerdam apparently not uncommon (no figures presented).[26]

Till 1852 Haarlem's lake (Haarlemmermeer) had provided the town with fresh, non-brackish water,[27] but after it was reclaimed in 1849–1852, the water became too brackish.[28] In the medieval period, town dwellers probably consumed surface water from the Spaarne. Archival records show that the surface water in Haarlem was considered good raw material for Haarlem's important beer industry, and until at least around 1600, Haarlem brewers drew clean water from the canals.[29] In 1480 Amsterdam's beer brewers started importing clean surface water from outside the town. They deployed a water barge, initially because of the increasing contamination of canals, later also because the water was too brackish, too saline.[30] In Haarlem the brewers also deployed such a water barge, but this seemed to be have been later and possibly less regularly. The cause of the deteriorating water quality in Haarlem mentioned in the historical sources was the waste from the bleaching industry; years of legal proceedings (brewers vs. bleachers) ensued.[31]

For 1779, the annual report of the Physical and Health Sciences Correspondence Society provides a rather detailed description of water facilities available. According to Willemse, rain water was the most widely used water source in Haarlem.[32] He mentions only the use of rain tanks (*regenbakken*), also mentioned by the famous seventeenth-century engineer Simon Stevin.[33] But rain tanks were not simple and cheap rain barrels. These would have had a volume far too small to last through a dry summer and water would have 'rotted' quickly in them due to the hot weather.[34] Rain tanks were actually underground cisterns, and in Dutch urban archaeology such a cistern is called a water cellar (*waterkelder*, fig. 3). Gawronski and Veerkamp, who inventoried eighty

Fig. 4. Cistern. Example of the above-ground portion of a cistern. The neck of the cistern is visible. Photo: Zuiderzeemuseum Enkhuizen F052023.

such structures in Amsterdam, argue that this term is misleading, as the water cellar does not constitute an accessible room below the house, but a closed tank next to or behind the house.[35] In this waterproof brick receptacle with glazed tile floors (fig. 3), rain water was collected from the roof via the gutter through the rain pipe, often made of lead, into the cistern (fig. 4 and fig. 5). The water in the cisterns was, according to Doctor Willemse, 'always clear, transparent, without smell or taste' (*'altyd helder, doorschijnend, zonder smaak en reuk'*) as Haarlem had no factories (*trafieken*) at that time. The water was used for a wide range of domestic chores (*'tot allerley huishoudelijke gebruiken'*).[36] Pollution from factories might have been the cause of a deterioration of rain water quality after they were established (*c.* 1833), but already for his contemporaries, Willemse's view was too optimistic. Simon Stevin for one was somewhat sceptical about water quality; he worried that dust could drain down from the gutter, or worse yet, the

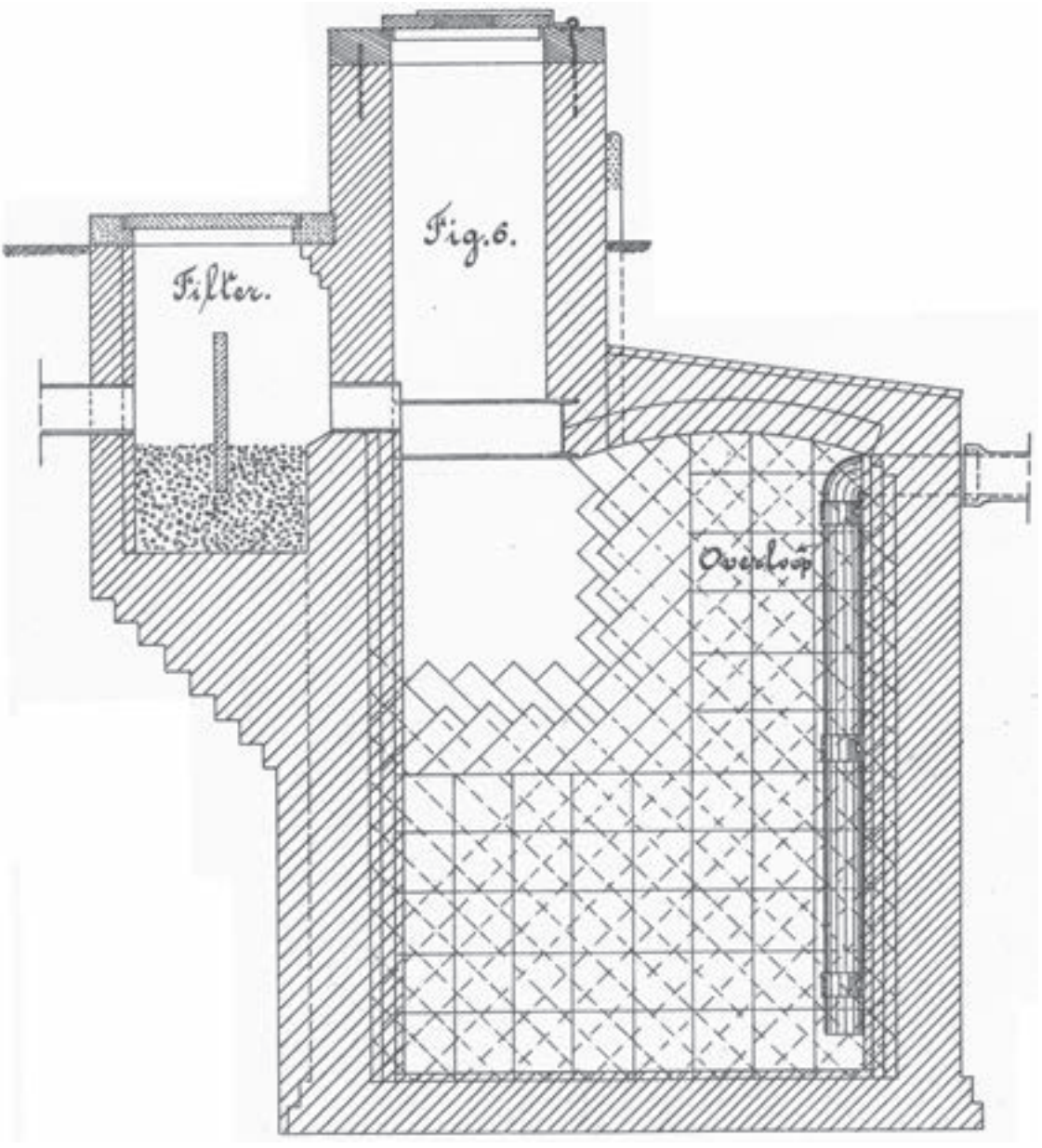

Fig. 5. Cistern. A schematic cross-section drawing of a cistern with a filter. Visser 1916, Appendix 15, fig. 6.

droppings of cats and birds, and that dead mice and rats would contaminate the water.[37] He pledged to construct a filter.[38]

The second source of water in 1779 Haarlem according to Doctor Willemse, were wells. A well, drawing bubbling water from the water table, could be constructed in at least two different ways. It could be an open well with a shadoof, that is, a pole fixed in the ground with a lever weighted at one end and with a bucket at the other end to draw water from the well (fig. 6) or it could be a well capped with a brick vault underground and a pump above ground (fig. 7 and fig. 8). As explained in more detail below, from the seventeenth century onwards, open wells were transformed into pumps. When Willemse mentions well water this should be read as including pumped water. He states that the town 'was very fortunate in being rich with very pleasant and excellent well water' (*'rykelyk voorzien van alleraangenaamst en uitmuttend putwater'*),[39] although in the town on

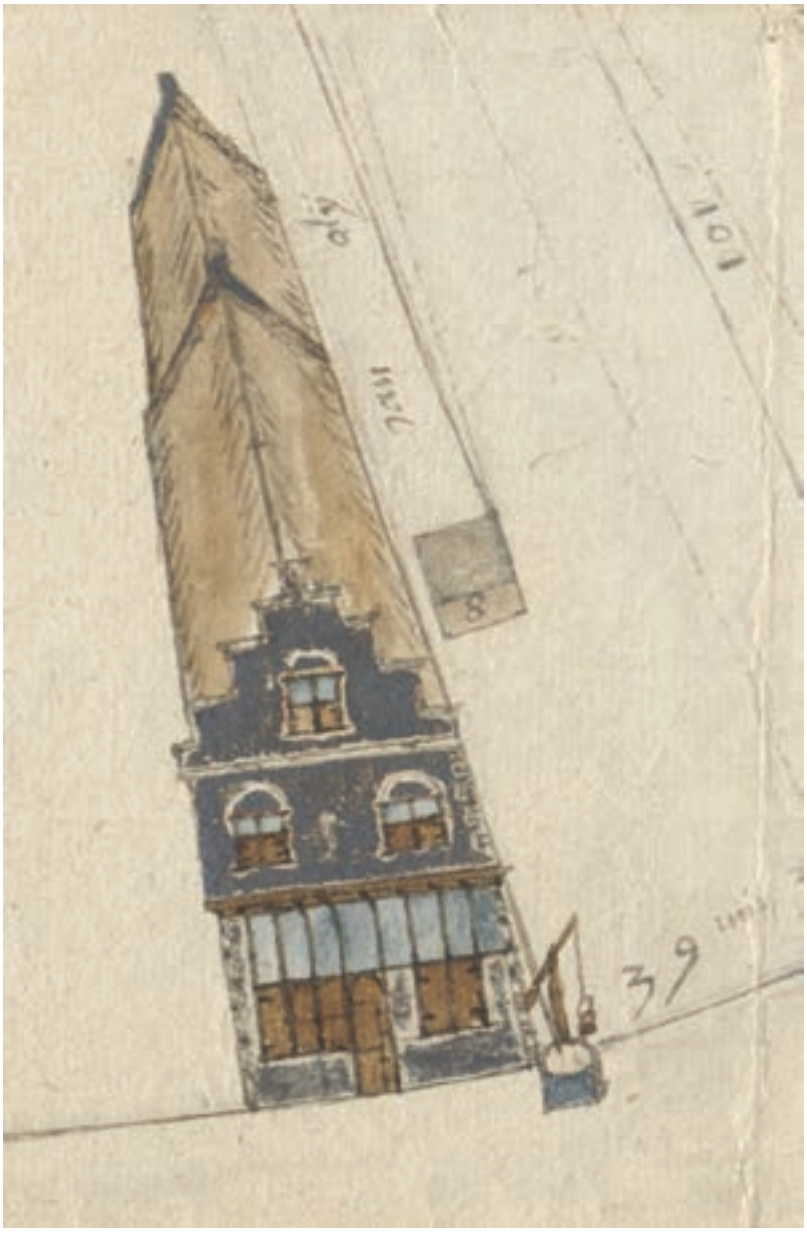

Fig. 6. house with an open, public well with a shadoof at the front, in the area of the current Wilsonplein in Haarlem. Drawing by an anonymous surveyor, c. 1610 (see Peters 2015, 15–16). Noord-Hollands Archief, a portion taken from NL-HlmNHA_51000430.

the east bank of Spaarne River (fig. 1b), well water were too brackish for use.[40] At the higher parts of Haarlem, water was 'very healthy and a daily beverage' (*'zeer gezond en eenen daaglykschen drank'*).[41] Well water might have been relatively clean in the pre-industrial period, but in the nineteenth century, the quality of well water was questionable. The most infamous example of contaminated well water was the Broad Street Pump that Doctor Snow blamed for London's cholera epidemic in 1854.[42] The same goes for the Netherlands. Nineteenth-century researchers demonstrated that water from pumps was frequently 'gestated with faecal substances' (*'met fecale stoffen bezwangerd'*).[43]

Fig. 7a. Municipal guest quarters called 'Heren Logement' at 140 Grote Houtstraat in Haarlem. Drawn by Romeyn de Hooghe in 1689 as one of the illustrations on the border of the bird's-eye view map of the town. NHA, NL-HlmNHA_53999031_06_G.

The third water source that Willemse mentions is fresh water imported from the dunes. Since the seventeenth century, Haarlem's brewers had used barges to bring in fresh water for their beer production. According to Willemse, poor people in Haarlem were allowed to draw as much water as they needed from the brewers' water barges daily.[44] A generous gesture to be sure, however, one could wonder how many poor could take advantage of this offer, as Haarlem had only three breweries in the 1780s and only one at the turn of the century.[45] The phenomena of water barges was also well-known in Amsterdam where, in 1853, one bucket of fresh water was sold for one cent.[46] In Haarlem the importation of fresh water was re-introduced by the Dune Water Society (Duinwatermaatschappij) in 1866. The *Rapport aan den koning*, mentioned that the municipality provided dune water on the east side of the town (fig. 1b) where the well water was brackish.[47]

Fig. 7b. Detail of water pump. Magnification of a portion of fig. 7a.

Fig. 8a. One of the water pumps at the Botermarkt. Drawn by Schouten in 1780, Noord-Hollands Archief, NL-HlmNHA_53002303_K.

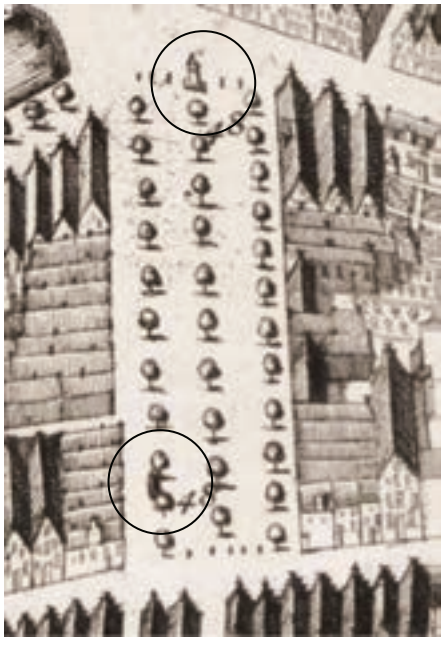

Fig. 8b. One, and possibly two, water pumps at the Botermarkt. Bird's eye-view map drawn by Romeyn de Hooghe in 1689, Noord-Hollands Archief, NL-HlmNHA_51001152.

Having reviewed three historical sources regarding the water supply in Haarlem, we now have a rough idea of its water sources. *Rapport aan den koning* may provide a less biased perspective in contrast to the jingoistic description of Willemse, but that the *Rapport* mentions neither rain water tanks nor Haarlem's famous piped water construction draws attention to the fact that historical sources do not necessarily provide a comprehensive picture at any given moment. If we hope to understand the shift in hygienic infrastructure over the long term, archaeological data are required.

Archaeological data of sanitary structures and issues in the identification of lifespans

Archaeological fieldwork has produced a total of 667 sanitary structures, both water facilities (water wells and cistern) and cesspits, dating from the thirteenth to the nineteenth century (table 1). Cesspits are lined pits in which human faeces and urine were collected. The privies and latrines would be situated above or just beside the cesspits. There are various forms and types

Construction Type	Function		
	Water supply facility	Cesspit (underground storage of human excrement)	Unknown
Unlined		42	
Brick	118	369	
Brick with a barrel at the bottom	3	4	
Barrel lined	18	22	24
Vault or cistern	46	21	
Total	185	458	24
Percentage of total	28%	69%	4%

Table 1. Data set of documented archaeological water facilities and cesspits in Haarlem.

of cesspits, but in towns like Haarlem eighty per cent of the archaeologically recorded cesspits were round, brick structures and covered with a brick dome. Because more and more field notes are becoming available in typed form, particularly from excavations carried out by local volunteers in the Archeologische werkgemeenschap Haarlem (Haarlem archaeological working group), 'old excavations' will likely generate additional data points in the future.

The dataset is big but far from ideal and has limitations stemming from the fact that the vast majority of excavations and watching briefs in question lack any form of basic archaeological report. Such reports, while long since commonplace in contract archaeology, only started being created in municipal archaeology relatively late. While a large number of these sites are described in the articles of the 41 issues of the *Haarlems Bodemonderzoek (Journal of Haarlem's Archaeology)*, more elaborate information can only be gleaned from the field notes and field drawings stored in the internal archives.

Another restriction of the dataset is that the ascribed lifespan of such pits comes with a margin of uncertainty. Most pits have had only 'preliminary dates' attributed to them, sometimes given in the field and documented in the field notes, an art known as spot-dating. At other times dates were attributed after a quick scan of the finds during post-excavation analysis. Common characteristics/features of preliminary dates are their wide dating margins (e.g., seventeenth/eighteenth century) and use of rounded dates (e.g., 1600–1800 instead of 1625–1775). It is often unclear whether these wide ranges are the actual life span of the cesspit or the result of caution on the part of the archaeologists involved. The definitive dated structures are also problematic because the assigned lifespan might be too short. The lifespan of a cesspit (and to a lesser extent of a water pit) derives from the date assigned to the find assemblage associated with the pit. Yet it is still not common practice in urban archaeology to include fragmentary finds from the top- and backfill deposited during construction of the pit. The key concern regarding cesspits has always been to deduce social stratification on the basis of complete finds from the primary fill and not to date the structure itself accurately.[48]

Compared to a water pit, the lifespan of a cesspit is easier to ascertain accurately. While in use water pits were cleaned often to ensure a continuous exchange of water water. Any material inside the water pit would therefore have been deposited during the period that the pit was no longer in use. A second problem comes from the fact that water pits are rarely excavated all the way to the bottom. Firstly, because excavating them completely is simply too risky for the adjacent buildings in a modern urban setting as they are usually quite deep in order to reach the water table. Secondly, cesspits have always received more attention from archaeologists than water pits.

An important factor in dating wells, which has not received the attention it ought to in urban archaeology, is whether or not they were capped with a brick vault. This subterranean vault is a key feature in distinguishing between an open well, where water was raised with a bucket, and a pump. Piston pumps were

already known in the sixteenth century, as attested by the seven different types described in *De re metallica* (*On the nature of minerals),* a book dealing with the mining industry published in Latin in 1556 by a German named Georgius Agricola.[49] Pumps were, however, older. The earliest representation of a pump is a drawing in the 1431 book of an Italian engineer.[50] Pumps were commonly used on ships to remove the bilge water from the hold; every wooden ship leaked to some extent.[51] One of the oldest historical records of a pump on a ship in the Netherlands dates from the 1440s.[52] Bilge pumps do not seem to have been widely used on land. It was only in 1614 that a patent was granted by the state for a fire hose that could also serve as a pump for fountains and wells.[53] This type of piston pump was, however, ill suited for fire fighting. During the second half of the seventeenth century, pumps were further developed and Jan van der Heijden from Amsterdam is considered to be the inventor of the first fully operational fire hose. When piston pumps became commonplace for wells has not yet been systematically investigated in archaeology. An interesting observation can be found in the *Beschryving van de stad Amersfoort* (*Description of the town of Amersfoort*) published in 1760. The author mentions that all the open public water wells were capped with a vault and had piston pumps installed between 1656 and 1663.[54] It is safe to date caps as of the second half of the seventeenth century, yet this observation also provides another dating issue, that is, these seventeenth-century caps could have been added to much older medieval water wells.

Dating cisterns is problematic as systematic finds are lacking. In general, cisterns were only located at houses with tile roofs rather than with a thatched roof. To our modern eye, water from a thatched roof is foul and dusty, which can be seen during winters when light grey icicles hang from these roofs.[55] The vast majority of the houses were provided with a tile roof after the 1576 town fire in Haarlem (fig. 9). The mortar used, named *tras*, a finely chopped volcanic tuff, provides a second indication for a date. In 1599 a master bricklayer from Bruges mentioned that tras had been invented 'just recently.'[56] Thirty-three public cisterns were constructed by the Amsterdam town council between 1790 and 1824.[57] Archaeologists Gawronski and Veerkamp, who did an inventory of the eighty archaeological cisterns, assume that domestic cisterns became popular in the second half of the seventeenth century and disappeared during the nineteenth.[58] Following their lead, the 25 cisterns in the Haarlem data set lacking a date in the field notes, were dated from 1650–1875.

Before moving on to the results, I conclude with the disclaimer that one must keep in mind that the dataset outlines trends and does not generate exact results. This means that while the identification of shifts between the medieval period and post-medieval period have a solid footing, identification of shifts within the span of a century have less of a solid footing. The strength of the data set can be found in its size: 667 structures from a single town is unprecedented in archaeological terms.

Public wells and pumps

Only five of the 185 archaeological water facilities were situated in streets or squares and, hence, might have been public wells. From an archaeological perspective, wells in public spaces are underrepresented as only a few excavations or watching briefs were carried out in streets and in squares. Traditionally, the archaeological focus has been more on backyards than on streets.

When looking at historical bird's-eye view maps, it turns out that two of these wells are displayed on the map of Thomas Thomaszoon dating from 1578 (fig. 9). They are marked as wells 1 and 5 in figure 9. Three other wells are displayed on the map (wells 2, 3 and 4). Thomaszoon's map are recognized by historians as highly reliable.[59] The fact that wells were not an artist's impressions confirms the accuracy. The map was made to take stock of the 449 houses, that is, one third of the town, destroyed by a town fire.[60] The white, vacant areas on the map are fire damaged plots. On the 1649 map created by Pieter Wils, only the well at the Kroft (well 3) is displayed. On the 1689 map by Romeyn de Hooghe, only two of them are displayed (wells 10 and 11). This is remarkable as both the map by Wils and De Hooghe are known to be reliable and accurate.[61] Van der Steur argues that the wells were included on the Thomaszoon map because they played an important role in extinguishing the fire.[62] This may be part of the explanation as to why only this map contains a significant number of wells. A second explanation for the underrepresentation of wells on maps might be that open wells with

Fig. 9. An overview of the public wells in Haarlem known through archaeological, cartographic and historical sources.

Public wells	Historical or cartographic source	Archaeological source
Well 1	Thomas Thomaszoon, 1578; Smedestraat/Grote Markt	Schimmer 1981, 8; Smedestraat/Grote Markt
Well 2	Thomas Thomaszoon, 1578; Smedestraat/Krocht	
Well 3	Thomas Thomaszoon 1578	
Well 4	Thomas Thomaszoon, 1578, Zijlstraat; probably identical with the wells constructed by the Zijlcloister (in 1493) 1567	
Well/pump 5	Included by Thomas Thomaszoon 1578 and Romeyn de Hooghe 1689 (see Fig. 6 in this article)	Greevenbroek 1977, 31; Grote Houtstraat/Doelstraat/Gierstraat
Well 6	Map of Raampoort 4, drawn by an anonymous surveyor, *c*. 1610 (see Fig. 5 this article)	
Well 7		Greevenbroek 1977, 31, Doelstraat
Well 8		Greevenbroek 1977, 31, Breestraat
Well 9	Map of Bakenesserkerk, by Jan Pannenbakker, 1800 NHA, NL-HlmNHA_53000369_M	Wieland Los 1971
Well 10	Probably included by Romeyn de Hooghe 1689; (see Fig. 8 this article)	De Groot 2013, 52–54, Botermarkt
Well 11	Included by Romeyn de Hooghe 1689 (see Fig. 8a this article), drawn by Schouten, 1780 (see Fig. 8b this article)	

Fig. 9. (*continued*)

a shadoof were probably transformed into pumps during the second half of the seventeenth century, and when pump are situated against the building line as visible in figures 7a and 7b, the structures are not noticeable.[63] Hence they were not included on the maps.

It is revealing to compare Haarlem with Zutphen, a town in the eastern part of the Netherlands. In the fifteenth century, the town of Zutphen was subdivided into about 20 well communities.[64] Zutphen had approximately 3,000 inhabitants,[65] which means that about 150 inhabitants were assigned to one well or pump. In Zutphen the members of a well community would ensure that the communal well was properly maintained, and the members paid *Püttgeld* as it is called in German. Well communities or *Brunnengemeinde*, later *Pumpengemeinschaft* or *Pumpennachbarschaft* were only common in the German regions Niederrhein and Westfalen.[66]

Compared to Zutphen, remarkably few wells or pumps are known in Haarlem. However, we cannot rule out the possibility that the number of public wells in Haarlem was higher than cartographic and archaeological sources reveal. Doctor Willemse would suggest this when he wrote in 1779 that Haarlem was endowed with an abundance of town pumps in almost all neighbourhoods and at the wall of churches.[67] Haarlem, when compared to Zutphen, is remarkable for another reason as well. It is not known who owned and maintained the public wells in Haarlem. The maintenance of wells is not mentioned in the elaborate regulations of either 1671 or 1779 regarding the 89 neighbourhoods of Haarlem.[68] Neighbourhoods in Haarlem were strong social organisations, with an official board of more than three officials who executed many public duties, such as registering newcomers, levying taxes and making sure that the residents would attend funerals of their deceased neighbours. One historical document reveals that at least one public well was founded and maintained by a cloister. The Zijlcloister aimed at extending its area and drove a bargain with the town council. In 1493 the aldermen agreed, on condition that the cloister would construct a bridge, to pave the nearby street and construct a well.[69] In 1567 the well of 1493 had to be repaired. The neighbours were united in their preference that the cloister construct a new well rather than repair the old one. A tradesman,

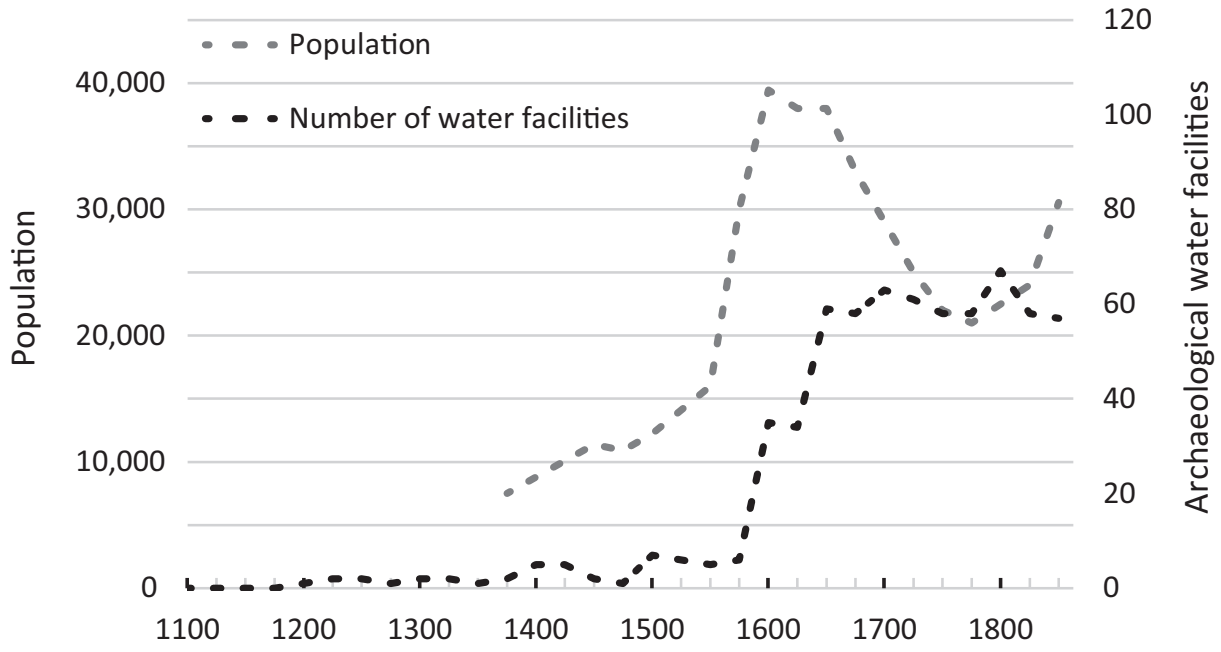

Fig. 10. The number of inhabitants, the number of active water facilities and the number of active breweries in Haarlem.

commissioned by the Zijlcloister, did the job for the benefit of the 'united neighbours' (*'gemeene buuren'*), on the condition that he would take responsibility if the well did not provide fresh water.[70] Under the direction of the local alderman, the neighbours declared 'in a united voice' ('*eendrachtelijk*') that they enjoyed the freshwater.[71] The new well might be well 4 on Thomaszoon's map.

Results and interpretations: Infrastructure from a long-term perspective

When plotting the wells and cisterns through time it is obvious that the number of water facilities increased (fig. 10). When taking into account the fluctuations in population in the plotting of the number of water facilities per capita (fig. 11), the pattern remains the same. The number of water facilities began to rise in the last quarter of the sixteenth century and this increase continued till 1800 (fig. 10). Figure 11 shows that in the Medieval period town dwellers used cesspits and mostly surface water from canals, and individual households shared cesspits with each other and had no water facilities, while in the post-Medieval period, cesspits gradually became less common and water facilities became the norm. A rise in the number of water facilities in the nineteenth century cannot be substantiated by the archaeological record. The available data suggest that the number of water facilities per capita in fact fell (fig. 11) during the nineteenth century. This finding may stem from a selective archaeological research focus, that is, archaeology of the nineteenth century was and sometime still is considered to be too recent to be recorded. In other words, the noticeable downward trend of both water facilities and cesspits in the nineteenth century might be explained by a sample bias. Given this bias, however, more water facilities than cesspits are known from the nineteenth century. The archaeological evidence shows that there were two shifts. In the last quarter of the sixteenth century, the number of water facilities started to rise, and in the nineteenth century, the number of cesspits decreased dramatically; cesspits all but disappeared. Before a suggestion will be provided for these two trends, a look into the development of sanitation management in Leiden is warranted.

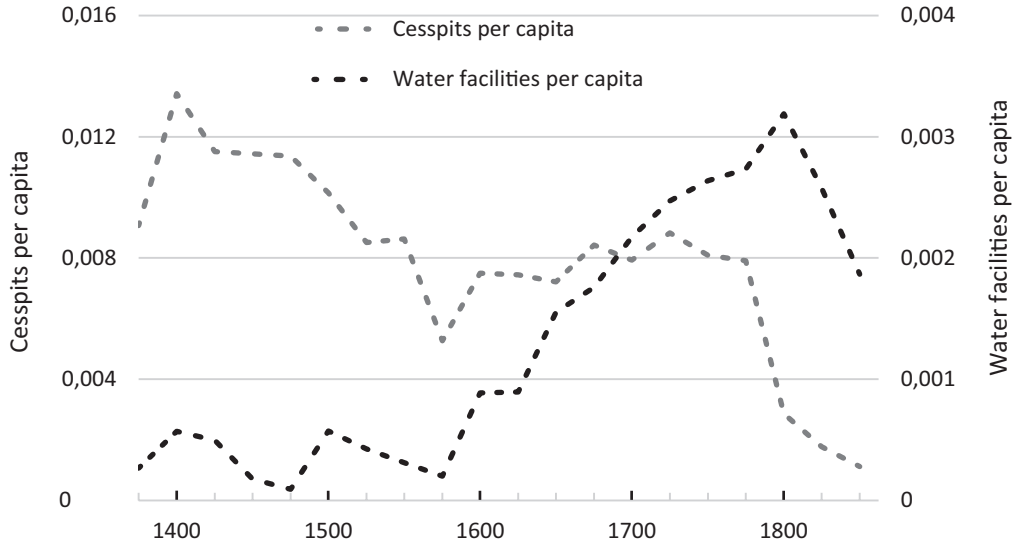

Fig. 11. The number of water facilities and cesspits plotted per capita.

The town of Leiden developed economically much like Haarlem.[72] After the Spanish siege (1574), the town of Leiden entered a Golden Age as, among other factors, myriads of skilled textile workers settled in the town. The population density reached such proportions that Leiden was forced to expand its territory three times during this period. The cesspit era in Leiden ended around 1600 as the newly built houses in these new areas were no longer fitted with cesspits but with brick sewers that drained from houses and cesspits directly into the town's canals, with all the negative consequences this entailed. The flip side of the Golden Age meant that the water-rich, overpopulated town was transformed into an open sewer; a 'great stink' had emerged. The seventeenth-century author Thomasz Verduyn observed that the quality of the water in Leiden was worse than in Haarlem, and fish could no longer survive in the Leiden canals.[73] He also noted that the Leiden brewers did not hesitate to draw their water from these same filthy canals. In his words: 'They served people their own foul urine, mixed with faeces and water' (*'Zij gaven den luyden haer vuyle pis, met dreck en water gemenght, te drincken'*).[74]

The cesspit era in Leiden ended in 1600 and there is convincing archaeological and historical evidence that cesspits were replaced by sewers that drained directly into canals. In Haarlem, as indicated by archaeological evidence, human waste was drained directly into the canals rather than deposited into the cesspits. Whether the hygienic infrastructure of cesspits was replaced with sewers on the same large scale as in Leiden is doubtful. Main or private sewers have been archaeologically identified at at least seven locations in Haarlem.[75] Unfortunately, none of these observations were made at an active excavation site, but only during watching briefs, that is, observations made while construction work was going on. As a result, archaeological observation and documentation is limited. In the Smedestraat, Grote Houtstraat and the Kruisstraat, public brick sewers located in the middle of the street have been uncovered. Any number of private brick pipelines transporting faeces from houses to the street could have been connected to it. But dating these foul sewers has proved problematic. The varying individuals who described the discoveries of these pre-twentieth-century sanitary sewers dated them from anywhere in the fifteenth to the eighteenth century, based on the dimensions of the bricks used. Indeed the dimensions, with lengths between 18 and 19 centimetres, provide the only indication so far. But dating on the basis of brick length alone is considered a tricky business. In addition, finds are systematically lacking.

The number of water facilities per capita in Haarlem increased beginning in 1600. However, it is not certain whether already in the seventeenth century the increased contamination of the surface water

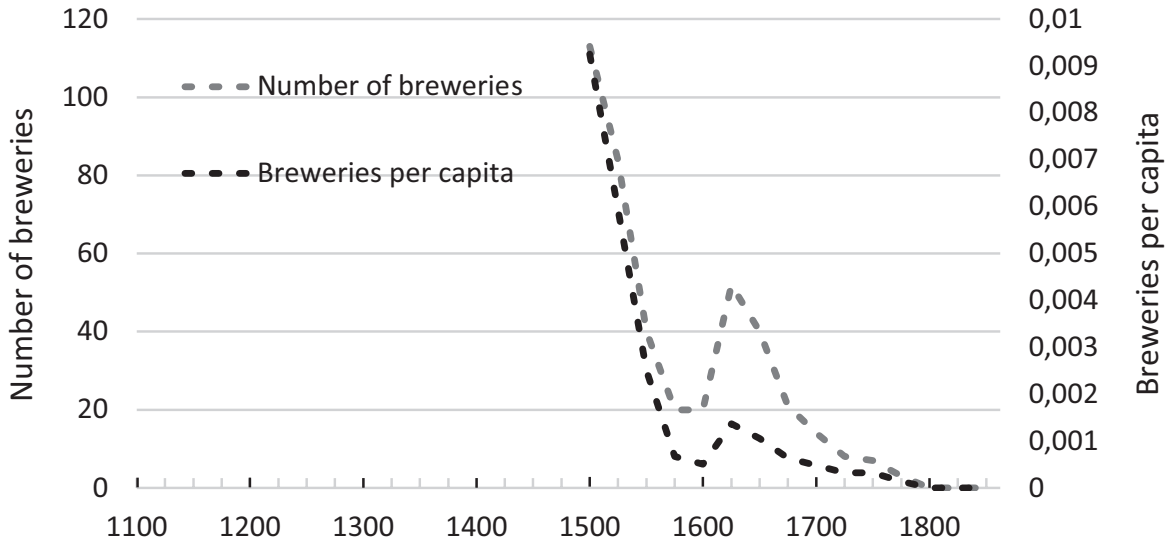

Fig. 12. The number of breweries and the number of breweries per capita.

was caused by human waste as was the case in Leiden. The increase in water facilities might reflect a growing private ownership or increasing individualisation. Earlier research shows a similar trend towards private ownership of cesspits.[76] Cesspits became smaller in diameter and shallower and as a result the capacity decreased, suggesting private ownership. A small water facility near a house or in the house would almost certainly be a private water facility, whereas one with a large diameter and capacity set further back in the yard would more likely be a shared facility. This development of the increasing prevalence of private rather than shared cesspits might also be true for wells. Research into diameters is necessary to shed light on this. Second, the increased number of facilities might be explained by rising levels of contamination of surface water.

Brewers were notorious for their interest in fresh water. Haarlem had more than a hundred breweries by 1500 but numbers dropped thereafter. The number of breweries is plotted in figure 12. The number of breweries per capita fell to a low point in the last quarter of the sixteenth century. However, the number of breweries is only a rough indication of the importance of the industry as according to Unger 'the use of larger kettles made it possible to increase output to record levels.'[77] In other words, fewer breweries produced larger quantities of beer. Counting the number of breweries or the output, the definitive decline of the brewing industry in Haarlem took place in the eighteenth century.

In the last quarter of the sixteenth century, Haarlem's brewers complained about water pollution caused by industries,[78] and they became involved in years of legal proceedings against bleachers who washed their cloth and drained their 'stench ditches,' polluted with buttermilk and soap suds, into the River Spaarne.[79] In the same period, as the number of breweries decreased, surface water became more polluted. The focus on the importance of the brewing industry and on fresh water was put on the political back burner.

I hypothesise that sewers were constructed on a large scale not earlier than the second half of the eighteenth century. In the seventeenth and the first half of the eighteenth century, the town council passed several ordinances and regulations aimed at preventing the pollution of canals. After 1751 this seems to be have ended.[80] Cesspit use declined. The local government did not have the capacity to monitor every sanitation infringement. Indeed, it is debatable whether they even had the will to safeguard water quality, at least in the nineteenth century. Rigorous enforcement with respect to private individuals would have been hypocritical, as the operators of the textile works (established in 1833 and 1834) were given free rein to pollute Haarlem's water on an industrial scale. The water quality in Haarlem further deteriorated after

the reclamation of Haarlemmermeer in 1852. A great stink had emerged. As Verduyn had done 200 years earlier for Leiden, in 1859 Kruseman, a pharmacist from Haarlem, wrote a pamphlet decrying the deteriorating water quality in his town.[81] The key question of his argument was whether or not 'it [was] indisputably true that the cause of deterioration [was] the sewers'[82] that have been draining excrements into the canals 'since time immemorial.'[83] Admittedly fish no longer swam in the canals, but Kruseman supposed that this was primarily caused by industrial sewage from factories, Wilson and Previnaire & Co in particular.[84] The results of scientific research, carried out in 1859, proved Kruseman wrong. It was not the sewage from the factories that fouled the water but, rather, the high levels of human excrement.[85] This indicates that human excrement, whether drained via sanitary sewers or dumped by the barrelful, was being systematically deposited into the canals on a large scale.

Conclusion

On the basis of the analyses of the distribution of wells and cesspits in Haarlem, it can be concluded that explaining the rise in the number of water facilities in the nineteenth century as a hygienic awakening, as Vandevyvere did for Bruges, is too limited an explanation. The archaeological record in Haarlem does not show a rise, but rather a decrease of water facilities, which might be explained by a sample bias. The case study of Haarlem shows convincingly that the number of wells rose significantly in the years 1575–1800. The increase in the number of water facilities in 1575–1675 might stem from a deteriorating water quality, caused by industrial waste from bleachings which was, according to the brewers, a serious cause of water contamination. Transforming canals into sewers was probably linked to the decreasing economic importance of the local beer industry and the continuous increase of water facilities in the second half of the eighteenth century was probably stimulated by dumping human waste. The number of cesspits declined and sewers were introduced. If there would have been a 'great sanitary awakening' in Haarlem then it would have been in reaction to the great stink.

Should research of other Dutch towns show a similar trend in the rising number of water facilities from the seventeenth century onwards, then there would be a solid case that medieval towns had cleaner public drinking water than did Victorian towns and cities; Victorian towns were much filthier than their Medieval predecessors.

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NOTES

[1] The dataset used for this project is larger than that used for *The town, its waste and the cesspit* (Van Oosten in press) and 'The Dutch great stink' (Van Oosten forthcoming). As is the rule for archaeological reports in the Netherlands, the datasets are deposited in the DANS archaeological e-depot, the old dataset as Easy-dataset 56516 (Persistent Identifier urn:nbn:nl:ui:13-xenb-dr), the new one as Easy-dataset 59844 (urn:nbn:nl:ui:13-e84u-v2).

[2] Vandevyvere 1983, 152.

[3] Vandevyvere 1983, 150.

[4] Salzman 2012, 87.

[5] Crawsome 2014, 363.

[6] 't Jong 2008; Rawcliffe 2013a; Jørgensen 2010, Jørgensen 2014.

[7] Rawcliffe 2013a, 203.

[8] Houwaart 1991, 98.

[9] Vogelsang 1867, 5–6. ('*Daarentegen is het misschien niet overbodig, kortelijk eene opmerking of tegenwerping te beantwoorden, welke zich zeer gemakkelijk bij iemand, die zonder vooroordeel over de zaak nadenkt, kan voordoen. Zij is deze, "Hoe komt het, dat wij dit [de slechte waterkwaliteit] zo laat inzien? Onze vaders en grootvaders zijn met dezelfde putten en dezelfde huizen gezond gebleven en oud geworden. Waarom zou dit voor ons en voor onze nakomelingen minder mogelijk zijn?*')

[10] Rawcliffe 2013a; Rawcliffe 2013b, 12–53.

[11] Van Oosten in press; Van Oosten forthcoming.

[12] Carried out by Van Oosten, with some additional work done by S. de Bruin (as part of her master's thesis).

[13] This section is an adaptation of the section 'A Socio-Economic Outline of Haarlem and Leiden' published in the 'Dutch great stink' (Van Oosten forthcoming) and Van Oosten in press, chapter 4.4.

[14] Kaptein 1998.

[15] Loenen 1950, 9–21; Ampzing 1628, 337.

[16] Unger 2001, 222.

[17] De Vries 1995, 342.

[18] Sliggers 1977, 30–33.

[19] Van der Weiden 2002, 43.

[20] Groen, 1978, 11–15.

[21] Bartels 1999, 71.

[22] A well hook is a long wooden staff with a metal hook at the end to which a bucket can be connected to draw water from the canal. *Woordenboek der Nederlandse taal* (WNT) Lemma Puthaak, http://gtb.inl.nl/, accessed 16 November 2015.

[23] Vogelzang 1956, Appendix, Kartogram I.

[24] Vogelzang 1956, 71, 135.

[25] Vogelzang 1956, Haarlemmermeerpolder: 130; Zwammerdam: 68, Leiden: 69.

[26] *Rapport aan den Koning* 1868, Haarlemmermeer, 146–147, Leiden: 151, Zwammerdam: 167.

[27] Willemse 1783, 635.

[28] Vogelsang 1956, 128.

[29] Alberts 2015, 189–190; Loenen 1950, 102.

[30] Groen 1978, 11–15, Groenewoudt/Benders 2013, 245.

[31] Loenen 1950, 103; Regtdoorzee 1936, 228; Unger 2001, 166; NHA, Archief van het brouwersgilde, inv.nr. 86, 'Stukken betreffende het proces met enige blekers over het bevuilen van de wateren ten zuiden van de Zijlweg, 1583.'

[32] Willemse 1783, 636.

[33] Stevin 1649, 86.

[34] Vogelzang 1956, 130, 124.

[35] Gawronski/Veerkamp 2007, 60.

[36] Vogelzang 1956, 127–128.

[37] Stevin 1649, 86.

[38] A more recent, early twentieth-century example of a cistern with a grind filter can be seen in figure 5 in this article (Visser 1916, 87). Vaulty, a nineteenth-century author, pointed out that the impurities of gutters and roofs absorbed by the rain water could be filtered out, as could be lead particles that cost deaths daily ('*Het regenwater, wel is waar, is met onreinheden van goten en daken en zelfs met looddelen bezwanger, waarvan velen de slagtoffers zijn geworden en nog dagelijks worden*'; Taunay 1845, 6).

[39] Willemse 1783, 636, 637.

[40] Willemse 1783, 636; Vogelzang 1956, 127–128.

[41] Willemse 1783, 636.

[42] Salzman 2012, 89.

[43] Den Bosch, Nieuw Stasdarchief, inv.nr. 42, Notulen Gemeenteraad n. 12, 8, 20 January 1874; a similar statement appears in *Rapport aan den Koning* 1868, 18.

[44] Willemse 1783, 635.

[45] Unger 2001, 223.

[46] Groen 1978, 23–24, 78, 83.

[47] *Rapport aan den koning* 1868, 146.

[48] This paragraph is an adaption of a portion of 'The Dutch great stink' (Van Oosten forthcoming).

[49] Georgius Agricola, Book VI, 176–188.

[50] Oertling 1996, 22.

[51] Oertling 1996, 1–9, 79; Boekenoogen 1990, 54–57.

[52] Alberts 2015, 197.

[53] Wildeboer 1993, 11.

[54] Van Bemmel 1760, 54.

[55] Alberts 2015, 186.

[56] Geleyns/De Jonge, 2003, 990. Heerding (1971, 20) mentions that *tras* was used in 1525 in the construction work at the Markiezenhof in Bergen op Zoom (NL). Haslinghuis/Janse (2005, entry 'tras') assume a fifteenth century origin, but arguments are lacking. In neither case is it clear whether we are dealing with 'strong tras' or 'bastard tras.' Bastard tras probably dates to the fifteenth century and strong tras to the beginning of the sixteenth, but only strong tras is a waterproof mortar and therefore suited for brick laying below ground water levels (De Roon 2005, 72).

[57] https://stadsarchief.amsterdam.nl/presentaties/amsterdamse_schatten/water/waterkelders/index.html; accessed 16 November 2015. Also Groen 1978.

[58] Gawronski/Veerkamp 2007, 61.

[59] Van der Steur 1993, 34.

[60] Dorren 2001, 22.

[61] Van der Steur 1993, 37, 44.

[62] Van der Steur 1993, 34.

[63] NHA, De Hooghe 1689, NL-HlmNHA_53002193_K.

[64] Benders 2014, 135.
[65] Benders 2014, 133.
[66] Baur 1989, 81; Groenewoudt/Benders 2013, 256–257; Benders 2014, 147.
[67] Willemse 1783, 637.
[68] NHA, Generaale ordonnatie op alle gebuurten der stad Haarlem, dd. 1671 and 1783.
[69] Gonnet 1891, 286; Van den Broek 1987, 86.
[70] Gonnet 1891, 370.
[71] Gonnet 1891, 370.
[72] The case of Leiden is discussed in more detail in Van Oosten in press, chapter 5.
[73] Verduyn 1670a, 5.
[74] Verduyn 1670a, 13.
[75] Smedestraat, possibly connected with the sewer at the Grote Markt (in 1981), Grote Houtstraat (in 1977), De Krocht (omstreeks 1975), Kruisstraat (in 1983), Jansstraat (by 1983), Stoofsteeg/Gedempte Oude Gracht (in 1985). The observations are described in *Haarlems Bodemonderzoek*, Greevenbeek 1977, 25; Schimmer 1981, 7; Numan 1984, 3; Brouwer/Van der Zon 1987, 48.
[76] Deneweth 2008; Van Oosten in press, chapter 2.6.
[77] Unger 2001, 222.
[78] NHA, Archief van het brouwersgilde, inv. no. 26.
[79] Unger 2001, 166.
[80] Van Oosten in press, chapter 3.4.
[81] The pamphlet was written by Izaak Cornelis Kruseman and published by his brother Arie Cornelis Kruseman, a well-known nineteenth-century publisher based in Haarlem. In 1837 Izaak Cornelis Kruseman is designated a pharmacist. NHA, Vrede- en politiegerechten, 1811–1838, inv.nr. 109, aktenummer 85.
[82] Kruseman 1859, 4.
[83] Kruseman 1859, 5.
[84] Kruseman 1859, 9, 19.
[85] Van der Woud 2010, 273, note 48.

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