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WATER SUPPLY AND WASTE DISPOSAL IN CITIES OF THE BALTIC AND SUDETEN-CARPATHIANS ZONES IN THE 13TH–16TH CENTURIES

SUMMARY

The issue of water supply and waste disposal has always been one of the fundamental problems faced by densely populated settlements. This paper presents the topic in the context of Central Europe within the economic zones distinguished by Marian Małowist, namely the Sudeten-Carpathians zone and the Baltic zone. The choice of such an area is due to the state of research. This subject is being described for the period between the 13th century, when cities and towns were emerging and developing in the area, and the 16th century, when the system of water supply and waste disposal was constructed and which continued to be used without significant change up to the 19th century. Included in the research base were water wells, waterworks wells, sections of waterworks, latrines, gutters and drains.

The oldest methods for supplying water were water wells. Around the third millennium BC in Mohenjo-Daro, a large city of the Indus civilization, houses and large baths were supplied by numerous wells. At the same time in Egypt and Mesopotamia water was drawn from the river. The conditions in Greece and on the Aegean islands forced the construction of cisterns and wells. By the Middle Minoan period (2000–1600 BC) on Crete the first aqueducts had already been built and were made of ceramic pipes. In the Archaic period and the Classical period these structures were improved. Cities were supplied with water through tunnels cut into rocks and by ceramic water pipes. In the Hellenistic period long distance aqueducts were built, working on the principle of communicating vessels. The Romans learnt Greek technology and greatly improved it. Numerous long aqueducts were built with an advanced delivery system to municipal baths (thermae) and individual customers. Waterworks ran beneath the streets' surfaces and water flowed into public wells. Water pipes were made of wood, lead or clay, depending on which raw materials were available locally.

Cesspits have been found in Mohenjo-Daro. In Greece numerous latrines were built, which could be rinsed with water. In the Roman Empire latrines were of a considerable size and were widely used in cities. Sewage from the latrine ran into street sewers, which discharged outside of the built-up area.

As a result of migrations in the 4th and 5th centuries large areas of the Roman Empire were depopulated and devastated. These areas were then settled by people coming from the Barbaricum who had no urban tradition. The settlement type was changed and only the settlement location continued. The question arises of how much survived of the ancient achievements in water supply and sanitary installations. Long distance aqueducts supplied the cities with water until they ceased to work due to lack of maintenance. From the early Middle Ages there are occasional remarks on the ancient aqueducts that still functioned. New structures were also built, usually associated with ecclesiastical architecture. Ancient technology was therefore able to survive in monastic settlements that had both the strength and resources for developing technical improvements.

There are several main sources of water for a city – fast-flowing water (rivers and streams), standing water (ponds and lakes), spring water and groundwater. The use of each source depended on their availability in a given city. Frequently, water was drawn from rivers and wells and water-carriers

worked in many cities. Together with the spatial and demographic development of a city, waterworks were constructed that drew water from the closest available source. In the study zone, most of the water was drawn from rivers.

The issue of water quality in the Middle Ages was not too important. The relationship between waste disposal and the quality of drinking water was not perceived. Latrines were often situated next to wells, poisoning the groundwater. There was no certainty about which water was better (the well one or the waterworks one). It was necessary to disinfect water with alcohol.

Water was essential to households – for people, numerous domestic animals and baths. Vast quantities of water were used by craftsmen such as tanners and dyers, and especially brewers and maltsters who often became initiators of the development of the water supply system.

The primary devices for the supply of water were wells. In the study area they were built from the Neolithic period onwards. Until the late Middle Ages the most common technique for the well construction was log construction. In late medieval cities there were several methods of construction of the well lining. Construction work began with digging a shaft that could be either narrow or broad; numerous examples of both types of shaft were found in Wroclaw. It seems that a broad shaft was dug in cases where there was a lot of space available. Dense urban development necessitated the digging of a narrow shaft. The shaft's depth depended on the water table and could reach from a few meters to more than ten meters in depth. In the period between the 13th and the16th century in the study area wells were built mostly of oak and less frequently of conifer wood. A small number of wells of this period were stone-lined, using the dry masonry technique and some were brick-lined.

A range of constructions was used. The simplest was the hollowed tree trunk and it appears in three locations in both the north and south. The lack of wickerwork-lined wells does not prove their total absence. A simple and cheap way was to build a well from used barrels. The log construction was still in use and comprised a lining that was built of thick beams with dovetail joints in the corners and without any additional internal frame. The most widely used technique was the frame construction with four corner posts that formed a support for transverse boards and were reinforced by transverse struts. There were several variants of this construction, from the simple butt joints, to a sophisticated carpentry construction with through holes in the posts. Frame constructions with posts are found in cities in both the Sudeten-Carpathians zone (Wrocław, Brzeg, Namysłów, and Legnica) and the Baltic zone (Gdańsk, Elbląg). This construction was widespread over large areas of Central Europe. The other kind of frame construction is known only from Wrocław and consisted of reinforcing the lining made of vertical laths with a horizontal frame without any posts' support. The posts-struts construction, known from Silesian towns, consisted of placing posts in the middle of the wooden lining and supporting them with struts crossed in the centre of the well's shaft. The function of these objects is not clear; some scholars claim that these were privies. It seems, however, that some of them might have originally been wells. Only two cases of wells with timber lining, which are completely devoid of any internal frame or struts, are known. Masonry wells were constructed of crushed stones in the dry wall technique (rubble masonry), of cut sandstone blocks, of brick or in a mixed technique. This type of well was widespread, especially in cities in Germany.

Around some wells' linings a filter was constructed which varied from a few to more than ten centimeters thick, and was made of sand or clay. It was designed to prevent pollutions leaking into the well from nearby latrines.

The archaeological material failed to deliver any information about the superstructure of the well or any devices for drawing water. Probably wells were topped with a "fence" and water was drawn with a crane, a pulley with bucket or just a bucket with rope. Such devices are known from iconographic sources. Most of the presented features in this study are dated to the 13th and the 14th century. Access to water had to be a priority for inhabitants, thus it seems that wells were dug immediately after the location of the city, during construction works on the plots. The correlation between the construction type and dating is elusive. Over the whole period, various types were in use, often combined in one timber lining. The general idea was to save on expensive building material, and is probably why the number of log constructions was low compared to the early Middle Ages when log construction was more common (this also applies to dwellings). It is also difficult to determine the wells' duration. They were in use from a few to several hundred years (in the case of those of stone construction). It seems that average duration was few decades.

Private wells were placed mostly in the rear parts of plots, often next to the latrines. Only in two cases were they found in the front part of the plot. Such

a location is typical for both the Baltic and the Sudetes-Carpathians zones. The total number of private wells is incalculable. However, one can assume that not every plot had its own well; this is suggested by contracts relating to the purchase of a well's shares drawn up between the Świdnica brewers. Public wells were usually located on squares, close to trade facilities, and in the streets.

It is noticeable that in the Baltic zone wells are quite rare in the archaeological material. Perhaps this is related to the state of research. On the other hand, it is known from written sources that coastal cities often had problems with the quality of ground water and had to find a different ways to be supplied with water.

Along with spatial and demographic development of the city, and the gradual pollution of groundwater, it became necessary to find new sources of water. The solution to this problem was to construct waterworks. Such devices first emerged in the monastic settlements where the ancient techniques had survived. The first construction of waterworks in the cities of present-day Germany was undertaken in the 12th century on the initiative of the Church, but gradually, cities gained control over them.

The waterworks of cities firstly consisted of open canals running into the city, but these quickly became polluted. In the Baltic zone, where it was more difficult to find good ground water the waterworks had been built in the 13th century. The initiative behind the construction of these devices often came from private individuals (especially craftsmen). Many waterworks were built in the 14th and 15th centuries; Wrocław had its waterworks by 1386. Also in the 14th century, water plants were developed (German Wasserkunst, Polish kunszt wodny) in Kraków and Gdańsk. More cities in the research area had waterworks constructed in the 15th century. The 16th century was a period that saw the blooming of waterworks techniques in the study area.

There were two types of waterworks; the gravitational ones, drawing water from a point above the city, which worked on the same principle as the Roman aqueducts, were built in upland areas. They were cheaper to build and operate, because there was no need to store water at a considerable height. The second type worked on the principle of communicating vessels. It started at the water house (Polish rurmus), which lifted water to the reservoir where the waterworks' pipeline started. In the late Middle Ages pressure waterworks that used water pumps were built.

The water intake source for the gravitational waterworks took the form of tanks or tunnels located nearby the city. Water plants drew water with a bucket wheel, which in turn was driven by a water wheel, a horse powered mill or a treadwheel. One of the first cities which used the bucket wheel was Lübeck, where there were as many as six of them in the post-medieval period. In Wroclaw there were three water houses.

Water conduits can be divided, depending on the material, into wooden ones (in the form of a trough or hollowed out), ceramic ones (thrown on a potter's wheel) and lead ones (these did not occur in the research area). The most frequent ones were wooden conduits and theses took the form of round or rectangular tree trunks dug out into U-shaped troughs covered with a lath that were used in the gravitational waterworks, where water did not flow under pressure. Conduits made of a hollowed out opening in the centre of a tree trunk in the form of a "classical" pipe were more durable and commonly used up to the 19th century. The wooden pipes were mostly made from oak and pine. Ceramic waterworks consisted of short pipe segments with bell ends and fitted with a sleeve at the narrower end, which was inserted into the wider end of the next segment. In the study area, most of the finds come from Wroclaw, where in the late Middle Ages waterworks were made of ceramic segments, and in the post-medieval period of wooden pipes.

The water from the waterworks supply was drawn from wells called sumps. This could be either flow wells, located on the waterworks line, usually in the streets, or final wells mostly located at the back of the plots and constructed on behalf of private users. Sumps usually took the form of barrel placed in a square box. The superstructure probably looked like drawing wells, but in wealthy cities, these were often richly decorated and became a sign of prestige.

The course of the waterworks in Wroclaw is known to a certain degree. Ceramic waterworks, consisting of the main conduit, which was made of three pipelines, ran along a lane between the first defensive wall and the inner moat. It was laid in a timber-lined ditch filled with sand and covered with boards on top. Minor pipelines ran from the main conduit and supplied private houses in the city centre. Along the course of the main conduit sumps were located, spaced approximately 35 m from each other. This waterworks supplied the southern part of the city. In the northern part of the city, on the Oder riverbank the Great Water Plant (Wielki Kunszt) was

situated, and from here five pipelines delivered water through the city. In Lübeck, the waterworks system comprised six water plants that in the 16th century served the whole city and was only replaced by a new one in the 19th century. It is difficult to assess to what extent the waterworks serviced a city's demand for water. Some of them probably supplied only the shareholders of companies that built them (mostly craftsmen) and had no public wells.

A specialized person responsible for the construction and maintenance of water supply appeared in the written sources in about the 14th century; pipe masters (rurmistrzowie) were itinerant craftsmen.

Litter can be divided into domestic (mud, garbage and faeces) and production (waste from tanneries and slaughterhouses). The main producers of faeces were numerous domestic animals (especially pigs). City authorities sought to restrict the loitering of animals in the streets but with meager results. Human faeces were usually placed in cesspits together with other garbage. A huge amount of detritus was produced by tanners and was especially responsible for polluting watercourses. It should be added that waste was also produced from craftsmen workshops and rubble caused by demolitions and fires. Heavy traffic in the city and the poor state of streets' surfaces resulted in them being covered in mud.

City legislation concerning waste disposal dealt with conflicts about the sharing of latrines and boundaries and drew particular attention to the condition of public space, especially the commercial zones; "Dirty" crafts were gathered in one place.

The person responsible for removing litter was the executioner. As a man subjected to taboos, he could easily deal with the "dirty zone of the city". The first remarks about the executioner in this role stem from Germany from the second half of the 13th century. The executioner's duties were cleaning latrines, supervising lepers, removing garbage and carcasses from the streets, running brothels and keeping moats in good condition. An undertaker could also play the same role as the executioner. In some cities, a special officer was also appointed to supervise the operation of the entire urban infrastructure and information on these officers comes from Germany.

The most common feature, encountered in the archaeological research associated with waste, is the latrine. The construction of a latrine (i.e. cesspit) was similar to a well. Most frequently, the lining was set in a narrow shaft. In the study area, medieval latrines were built of wood. The simplest form of a latrine was just a shaft or a pit without any lining. Similar to wells the latrines' linings were constructed in wickerwork or with used barrels or in frame construction with posts, log construction, posts-struts construction and frame construction techniques. Stone-lined and brick-lined latrines are very uncommon in the study area; in fact only one specimen in Elbląg was found (which has many similarities to those in Germany). Bay window latrines were also used.

According to earlier views, features with a sand or clay filter around the lining were wells and the ones without a filter were latrines. In light of the studied material, it seems like an incorrect assumption.

The superstructures of latrines are not usually preserved. The most common feature found is the wooden toilet seat. A few remains may suggest the presence of a small roofed hut above the latrine's shaft. Some cesspits were located at the foot of buildings' walls, directly under the bay windows, which were supplied with some pipes leading waste straight into the pit below.

In the study area the beginning of latrine building is the 13th century, however, the majority of the features come from the 14th century. It may indicate that latrines were constructed only some time after a city was well established at its location, when there was insufficient space for waste and there emerged a necessity of developing a sensible waste treatment strategy to deal with the detritus, which covered streets, squares and burghers' plots in ever-thicker layers. It is difficult to determine the correlation between the type of construction used and the time of its building. It seems that in the northern zone the log construction was used primarily in the post-medieval period. The durability of latrines was variable.

Most latrines were situated in rear parts of plots, as far as possible from the domestic and work area and this trend is typical for Central Europe. They were often placed next to a watercourse or had a ditch connecting them to it. City legislation gave the minimum distance of a latrine from a neighbour's plot.

In the researched material, there is a visible difference in the size of latrines. In the north, they are bigger and reach a capacity of up to 40 cubic meters. It is hard to account for the difference in size. Latrines were filled up at a pace depending on the number of people using them. To delay this process there were draining ditches leading the excess waste to the nearest watercourse. The latrines' fills consisted primarily of human faeces, and considerable quantities of household and production waste. Nowadays, they are a valuable source of research on the material culture. In the early stages of city development, fully filled latrines were buried and then the next ones were dug. However, as a result of growing urbanization,

there was no space to dig new latrines, thus a need arose for emptying the existing ones, especially since overflowing latrines were a threat to residents. Cleaning the latrine was a very costly venture and the basic unit charge was a container (a barrel) in which the fill was transported. Latrines were cleaned at night, mostly in autumn and winter. Faeces were transported in barrels outside the city, where they were emptied to the river or into pits that had been prepared earlier. The time span for the use of a latrine varied and is difficult to determine. The stone-lined ones from Elbląg were used from the 15th to the 19th century, but it seems that an average time span was a few decades.

Another group of features related to the waste disposal are ditches, drains and gutters. Land reclamation features were drains and barrels buried in the ground and these were common in low-lying areas. Drains were used in particular in the reclamation of land for building. On the built-up plots, there were systems of wood-lined water drainage ditches and barrels were buried in the ground to lower the water level.

Gutters, used for rainwater and wastewater, took the form of open or covered ditches running along the streets. In tandem with the cobbling of the streets, gutters were also stone-lined. Sometimes, special ditches were built for wastewater and these discharged into the river or a moat.