

Water Systems in Renaissance Bologna

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Historians of Renaissance architecture and town planning have not shown much interest in water supply. This is surprising, given its prominence in the early theoretical sources. Vitruvius considered hydraulics an integral part of architecture, and he devoted one of his ten books to it (Lib.VIII). The same is true of Leon Battista Alberti, whose *De re aedificatoria* concludes with a book almost wholly focused on water—its critical importance for humankind and for the city; how to find, conduct, store, and distribute it; and how to gauge its quality. Other quattrocento writers—notably Filarete, Taccola, Francesco di Giorgio, and of course Leonardo—deal extensively with the theory and practice of water systems.

In the sixteenth century architectural theory abandoned practical hydraulics as attention shifted to questions of monument design and Antique style. Authors such as Sebastiano Serlio, Pietro Cataneo, Vignola and Palladio had little to say about water supply, even if some of them practiced as hydraulic engineers. Giorgio Vasari, in his *Lives of the Artists*, praises engineering achievements when appropriate, but he does not permit water to seep into the architectural portion of his technical preface. No discussions there of wells or cisterns, pipelines or artificial canals, dams or mills.

Thus orphaned from architectural discourse, toward 1600 the field began to reconstitute itself as an autonomous discipline. A new and varied corpus of literature was produced by architect-engineer-inventors such as Agostino Ramelli, Giambattista Aleotti, and Vittorio Zonca. The fate of hydraulics is comparable to that of fortifications, which around the same time emerged as an autonomous field with its own texts. Eventually, both areas would belong to schools of civil engineering; the effective separation of the art of architecture from hydraulic engineering would be permanent. Today the history of water supply is generally studied by social and economic historians as well as by historians of science and technology.

In this paper I wish to reconsider water supply as a viable subject for the study of the built environment. I have chosen to focus on Bologna because it is a large city with a wide variety of hydraulic systems that have ready and fruitful parallels in cities across *Italia padana*—from Milan to Treviso, and from Piacenza to Ravenna. In addition, Bologna enjoys exceptional depth and quality of archival documentation and scholarship. For many decades local historians and the communal planning office have traced the history and disappearance of the city's hydraulic patrimony, especially the Naviglio. University historians, for their part, have published fundamental work on water in medieval and eighteenth-century Bologna, mostly from an economic point of view. Here I attempt a survey from a Renaissance perspective. What interest me are the connections between the hydraulic infrastructure and urban form.

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Bologna is not a river town. Occupying a sloping site at the foot of the Apennines, however, it had access to three streams that medieval communal authorities would gradually and famously exploit. The first was the **Àposa** (or *Àvesa*), a *torrente* issuing from a small valley directly above the city. In 1070 the Aposa was made to flow in a brick conduit bisecting the city from south to north. The second stream was the **Sàvena** (or *Sàpina*) to the east. In 1176 a portion of it was drawn into a channel at San Ruffillo. After running some four kilometers the Savena passed through the Porta Castiglione and proceeded to water the eastern half of Bologna. The third source was the river **Reno**, a tributary of the Po, located to the west. In 1183 a massive sluice or dam (*chiusa*) was constructed at Casalecchio to funnel its water into an open channel stretching nearly five kilometers to the city. Inside Bologna, the Reno canal brought water and waterpower to the northwest quadrant of the city. Now all three water sources with their branching and sometimes converging channels, their public and private functions, and protective and regulatory laws, were inherited by early modern Bologna. The seigniorial regime of the Bentivoglio in the fifteenth century, and the papal government in the sixteenth, were equally dedicated to preserving and developing the water systems for a range of productive urban functions.

For example, proper defense required a reliable supply of water. The waters of the Aposa and the Savena were used to fill the ditch running along the city wall. Watery moats, of course, were an essential component of military defense, general policing, and even civic identity. They served the self-image of the safe, secure and autonomous

commune. With very few exceptions, Renaissance plans and views of north Italian cities proudly show watery moats, even when, in reality, the *fosse* were dry.

In the early sixteenth century, when papal architect Antonio da Sangallo the Younger reviewed the defenses of Bologna, he produced a cross section of the nine-kilometer city moat. His drawing records the measurements of the fall of the ditch as it ran northward, gate by gate, around the city. The descent amounted to more than ten meters, and the gradual and nearly unbroken tilt of Bologna was, and still is, a major natural asset. Something of this is conveyed in the great wall map done for pope Gregory XIII in the so-called Sala di Bologna in the Vatican palace (1575).

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The **Aposa** contributed to defense but, like virtually all urban watercourses, it was *multifunctional*. As it descended through the city the Aposa delivered water to the monastic complex of San Domenico, and went on to clean the central slaughterhouse and meat market near the two towers. A major function of the Aposa canal appears to have been sanitation. **“When it rains—wrote cinquecento historian Pompeo Vizani—the Aposa comes down from the nearby hills with such fury that, passing right through the middle of the city, by means of certain aqueducts, underground sewers, and drains, it cleans and carries away all the refuse it contained.”**

Drains and sewer systems were a basic part of street design through paving. Medieval statutes stipulate the need to pave streets and piazze with stone slabs. Brick paving was also employed. Implicit is the desire to cover open sewers. In the late

quattrocento Gaspare Nadi, a *muratore* and diarist, recorded an enormous street and sewer project, giving the locations of a total of twenty individual subterranean conduits (*chiaviche*), some of considerable length. Many of the conduits emptied into the Aposa, some did not, but all pertained to a city-wide paving project. As the sixteenth-century chronicler Cherubino Ghirardacci described the quattrocento project, **“the Senate, in order to purge the city of putrid mud and to embellish it ... began paving streets with river stones from the Porta Maggiore and as far as San Michele Leprosetto, and then from San Benedetto di Galliera to San Pietro, proceeding to beautify the whole city, street by street, and in many streets excavating and constructing underground conduits.”** This public works project deserves further research but it was probably not unique. As the city grew larger and denser (in the 1490s the population neared 50,000 people, in 1587 it reached as many as 72,000) ever-greater demands were put on the urban infrastructure, especially drainage and sanitation systems. Here hygienic and aesthetic aims were pursued concurrently.

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Bologna’s second water source, the **Savena**, also assisted the sewer systems. The Savena, once inside the walls, forked in two main branches: one proceeding down Strada Castiglione until it joined the Aposa just above the slaughterhouses; the other turning eastward to follow a broad arc intersecting the great *strade* radiating from the Piazza di Porta Ravegnana. Since the Savena was a relatively pure and reliable source, it was especially esteemed and exploited for domestic use. Cinquecento accounts underscore its hygienic functions. Vizani states that the Savena waters brought **“the**

greatest benefit to nearly all the private houses to which it runs by way of diverse channels, to aid in the washing of clothing and pots and pans, and ridding houses of all dirtiness.” He might also have pointed out that the Savena contributed to the cultivation of private palatial gardens as well as the irrigation of larger plots of productive land just inside the walls.

In fact, the two main branches of the Savena watered prime residential real estate. A map showing the location of patrician palaces discloses that many of Bologna’s leading families especially favored this area of the city. The *domus magna* of the Bentivoglio stood on the Strada San Donato (now via Zamboni) precisely where it intersected the Savena canal. On the same street were the houses of the *bentivoleschi* (Malvezzi, Magnani, Paleotti, Poggi). Other noble residences rose on the *strade* San Vitale (Fantuzzi, Orsi); Maggiore (Sampieri, Ghislieri, Isolani, Bolognetti); and Santo Stefano (Bolognini, Bianchini). The grandiose Palazzo Pepoli (accompanied by the palaces of the Guastavillani, Cospi, Volta) had direct access to the channel descending Strada Castiglione. While further research is needed to clarify historical details, it seems clear that the Savena played a major role in promoting palace building across the east side of the city. At the same time, in keeping with the rule of multifunctionality, the Savena also had industrial applications. Natural chemistry gave its waters a superior capacity in the dyeing of silk and woolen cloth, especially the color scarlet. Paper making, another water-intensive industry, also flourished along the Savena, to the great benefit of government, the university, and the publishing industry.

Bologna's principal industrial water source, however, was the **Reno** canal. Even before reaching the city it was exploited for profit. As historian Fra Leandro Alberti wrote, the open Reno channel, made of stone and brick, was large enough to accommodate **“the transportation of wood from the high Apennines: tree trunks of fir and other woods for both architectural construction and the making of barrels and wine kegs.”**

Entering the city through a grated portal known as *“la Grada”*, the Reno plunged eastward until it was cut in two at the so-called *“Sega dell’acqua”*. One channel, *Canale Cavadizzo*, went immediately north toward the city wall. The other continued eastward until, nearing the Aposa, it too turned north, becoming the *Canale delle Moline*. Conceived and built by a consortium of eleventh-century millers, the Reno canal was early acquired by the commune, and it remained state-run through the eighteenth century. The Canale delle Moline was developed as a series of cascades marked by pairs of mills on both sides, as can be seen in early maps and views. Today the flour mills are gone, but the Reno canal itself still flows through Bologna and is visible at a handful of locations. A block of row houses for the mill workers and their families, built in 1515, still stands in the nearby Via Capo di Lucca.

The Reno canal powered a remarkable variety of mechanized industries. Along the canal Leandro Alberti noted **“saw mills, machines for fabricating arms, making brass containers, shaping and polishing armor, fulling cloth and spinning silk thread.”** No industry was more important than silk. When Emperor Frederick III came

to Bologna in 1452, he was taken to see the “**spinning mills, which pleased him most of all, and he greatly praised the machinery**” (Ghirardacci). As if by capillary action the canal waters were drawn off into small underground channels which, penetrating the cellars of houses, powered spinning and weaving machines. The technology involved was so important to the economy of Bologna that it was declared a state secret, and in 1538 two men were condemned to death in absentia for exporting mill technology to Trent. Enforced secrecy undoubtedly accounts for the paucity of written accounts and visual records of the early Bolognese luxury textile industry.

In any case, around 1550 a Venetian pilgrim saw buildings with underground conduits in which **all** of the silk making processes were performed “**at the same time and in the same place—*cosa molto notabile***” (Fontana). Economic historian Carlo Poni has characterized the Bolognese factory system as a “proto-industrial revolution” launched in the sixteenth century. Thanks to the water-driven machines the city was able to diversify its productive capacity. Bologna was no longer just a market and university town, but something of an industrial capital. Just as the Savena encouraged palace building in the fourteenth and fifteenth centuries, the Reno did something similar for local manufacturing in the sixteenth. Already in 1481 Benedetto Morandi, a Bentivoglio court humanist, could boast that “**No city has ever profited more from a natural river than Bologna does from a man-made canal**”.

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Yet Morandi was not referring simply to the industrial corridor bordering the Reno canal. He was surely also thinking of its spectacular conclusion, the **Naviglio** (or canale Navile), Bologna's navigable waterway. The city's gradually sloping site forced all urban waters to run toward its northwest corner. Outside the walls they were eventually collected in a common bed flowing due north across the open countryside. Already in the twelfth century the commune was successful in turning this waterway into a shipping canal linking the city to Ferrara, the Po, and the Adriatic. The Naviglio facilitated commerce in agricultural and manufactured goods, moving heavy building materials (such as marble), and serving as a system of public transit.

Until the fifteenth century the Naviglio terminated in a port located at Corticella, a village some three miles outside the city walls. There, a sudden rise in elevation prevented boat traffic from reaching Bologna. Giovanni Bentivoglio commissioned the first successful extension of the canal directly into the city. In 1491 he borrowed an architect named Piero da Brambilla from Ludovico Sforza. Brambilla employed the latest technology, engineering a series boat-locks, successfully extending the canal into the city. The inauguration of the new canal took place on 10 January 1494. Success was short lived, however, as within a decade the system broke down and the port was withdrawn to Corticella. A definitive solution came only in the late 1540s, when Pope Paul III Farnese authorized a complete reconstruction under the supervision of architect Jacopo Vignola. To correct Brambilla's errors, Vignola evidently returned to Milanese models—comparable to those found in the sketches of Leonardo da Vinci—and constructed three new boat locks (with oval, rectangular and octagonal basins) including

secondary sluices and bridges. He also laid out a new urban port inside the city, near Porta Lame, which remained in operation until the end of the nineteenth century.

In this way Bologna participated in a vast network of navigable canals connecting numerous towns within the *Val Padana*. In Lombardy there was Milan, Monza, Pavia, Lodi, Crema, Cremona and Mantua. Navigable canals connected Venice, Padua, Treviso, Verona in the Veneto. In Emilia, Piacenza, Parma, Reggio, Modena, Ferrara, all developed artificial waterways; and so too did Imola, Faenza, Forlì, and Ravenna in the Romagna. Canals were critical for the commercial affairs of the larger countryside, and they played important roles in irrigation and land reclamation. The long history of north Italian navigable canals is inseparable from that of regional development.

This point is made clear by a little-known but spectacular unexecuted project conceived by Pope Julius II della Rovere. Julius detested the power of Alfonso d'Este to exact heavy tolls on Bolognese barges crossing Ferrarese territory as they headed for the Po. He therefore proposed abandoning the old Naviglio and laying out a new one eastward, crossing the Romagna to meet the sea at the Marina di Ravenna. Joining two provincial capitals and many small towns of the Papal State, such a canal promised a general commercial bonanza, but its long-term benefit would have derived from land reclamation. For the Julian canal was to have been supplied with water from the numerous Apennine streams that otherwise kept feeding the pestilential marshlands

along the Adriatic coast. Although never executed, the scheme of Julius II lived on in territorial planning sessions until the arrival of Napoleon.

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And what—one must ask—can be said about **drinking water**? It is true that some Renaissance authors speak of drawing canal water for drinking and cooking [as well as for washing clothes], but for hygienic and practical reasons this cannot have been the principal source. Bologna, like most other early modern Italian towns, obtained its potable water from **wells**. Strict medieval laws stipulated wells in public streets and squares be maintained by neighborhood users. In the fifteenth and sixteenth centuries, private wells were certainly plentiful—not only within the many monasteries and palaces of the nobility, but also in smaller houses with courtyards. In 1602 it could be said that “**Bologna has so many wells, full of water, hand-made and walled ... that even the smallest houses have one**” (Vizani). Wells are now among the least visible of the historical water systems. Once ubiquitous, in nineteenth-century Bologna they were denounced as a threat to public health. This followed an outbreak of cholera in 1865 and typhoid fever in 1891. These epidemics hastened the implantation of a modern pressurized water system city-wide, making wells suddenly and finally obsolete. Once dismantled, they were filled with rubble and consigned to oblivion.

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The abundance of water thus emerges as a fact of urban life in Renaissance Bologna. And abundance is also a theme that informs the celebrated public fountain in the Piazza Maggiore, whose titular deity, **Neptune**, would come to symbolize the city.

Designed by the Sicilian architect Tomaso Laureti and decorated by the Flemish-Florentine sculptor Giambologna, the Fountain of Neptune was commissioned in 1563 by Bishop Pier Donato Cesi, the papal governor, in the names of Legate Carlo Borromeo and Pope Pius IV. Cesi chose Neptune, god of all waters, as a metaphor of papal protection and beneficence, and he also determined that the fountain should be surrounded by an iron fence to guarantee its value as a piece of urban beautification. After being displayed, the water flowed underground to a cistern in the Legate's summer garden in the nearby apostolic palace. From there, finally, it was piped to the spouts of the large public wall fountain, the so-called Fontana Vecchia, in a crowded market-thoroughfare, where travelers and domestic animals were invited to drink. Like the canals, the spring-fed aqueduct involved a strict prioritization of access and use.

The Fountain of Neptune is actually the second, or perhaps third fountain to stand in the Piazza Maggiore. In the 1470s a modest fountain was erected there only to be dismantled in 1485. There was another fountain project in the 1520s, however the only trace of it is the hillside spring at Remonda, just below the Benedictine monastery of San Michele in Bosco. An eighteenth-century survey provides us with a detailed engraved plan and section of the Renaissance waterworks. The Remonda spring features several long tunnels that tap scattered veins, drawing water into a series of settling tanks before delivering it to a sealed terracotta pipeline. The design is elegant and functional and Vitruvian. Its much-battered Doric façade has been attributed to Baldassarre Peruzzi—Sieneese, heir to the technological culture of Taccola and Francesco di

Giorgio—who worked for the city and at San Michele in Bosco in 1523, when it was built.

The Fountain of Neptune was fed by the Remonda spring as well as by a second source located not far away at a spot called Castellano. Designed by Laureti, it was modeled on the older spring, but was larger in scale. It also tapped the ruined subterranean aqueduct that once served Roman Bononia. Laureti describes the entire system—sources, pipeline, display—in a lengthy unpublished fountain handbook. Calling hydraulics the “**most difficult part of architecture**”, Laureti seeks to instruct present and future *fontanieri* about how to clean, repair and maintain the system. He is particularly concerned about the sturdiness of the aqueduct. Running down hill for nearly two kilometers, the pipeline acquired considerable water pressure—pressure that was critical for artistic success, but dangerous for the fragile terracotta pipe sections.

And, in fact, records show that the Fountain of Neptune suffered frequent breakdowns. Giambologna's great bronze figure of Neptune, sovereign protector of a vast (if now largely invisible) aquatic empire, suffered numerous defeats. During a tour of northern Italy in the summer of 1878, the historian Jakob Burckhardt paid a visit to Bologna where he found the fountain bone-dry. In a letter to a friend, he described the sight this way: “**The poor Neptune of Giambologna is without any water; by their best squeezing and pressing the Sirens bring forth from their dry breasts not a drop. At the fence there runs a little fountain to which the thirsty avidly crowd. It**

is surely a disgrace that a city close to the foot of a mountain like Bologna has no running water.”

Burckhardt put his finger on the social and political roles of the public fountain. A dry fountain not only fails in its practical and symbolic functions, it openly advertises governmental neglect and mismanagement. And, in this case, it is also an offence to *art*. The “disgrace” must be laid at the feet of city officials.

Yet Burckhardt’s observation about the absence of running water in Bologna must be confined to the fountain. As we have seen, the great canals of early modern Bologna were an entirely different matter. The waters of the Aposa, Savena and Reno, aggressively extracted from the foothills, were kept in continuous productive operation for more than seven centuries. Moreover, the three bountiful canals were hugely successful in serving many urban functions. By way of conclusion, permit me to recall them briefly. They were: defense; urban sanitation (and housecleaning); manufacturing and heavy industry; transportation; irrigation; and alimentation. Each system contributed significantly to the health and economic success of the city, and each conditioned the evolution and the appearance of the urban environment.

Today the Fountain of Neptune happens to be brightly restored and in fine working order. It thus fulfills its role as a purveyor of beauty and well being. It remains a masterpiece of late Renaissance art, but we would be remiss to take it as the chief representative—much less the sole exemplar—of Bologna’s early modern water systems.

THANK YOU!