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Chapter 7: Conclusion

Through a combination of systematic survey, archival research, and a reconsideration of existing research, this study traced the individual water histories of nearly 45 buildings in three city blocks of Ostia (III, i; IV, ii; V, ii) from the Republican to the Late Antique period. Aggregating this archaeological and hydraulic evidence at different chronological and spatial scales resulted in a holistic understanding of the hydraulic infrastructure of each building, but more importantly, it explored how neighboring buildings worked together or in isolation from each other. Through an extensive review of existing literature, this study presented an updated *status quaestionis* about many different aspects of water in Ostia, building upon the work of previous scholars. This study carried out extensive and systematic fieldwork within the three insulae selected, recording the current state of each building, as well as identifying a great number of unpublished water features. In total, nearly 450 water features were identified by this study. Yet, an investigation into the photographic archives and the primary excavation notes provided the present study with a great deal of information regarding the hydraulic systems of the researched insulae. From these archival sources also emerged a greater appreciation for the impact earlier excavations had on the present state of Ostia's urban environment.

Regarding the urban hydraulic system of Ostia, one of the main outcomes of this study involves the chronology and distribution of the sewer system.[862] This has been especially true for the 3rd century and the Late Antique period, for which new evidence has been produced by the present study to attest to the modest yet vibrant hydraulic activity happening in the city. Especially from insulae IV, ii and V, ii, the evidence has allowed us to propose an initial chronology of Ostia's sewer system and how it adapted over time to increased ground levels and to accommodate greater capacities of waste. In insula IV, ii, this study identified how a diversified sewer network was created in the 3rd century that linked nearly every building in the insula together. For insula V, ii the identification of two superimposed contemporary sewer systems provides a new dimension to appreciating the technical limits of Roman construction. Such a double sewer system has not been identified elsewhere in the Greco-Roman world. By establishing the chronology and distribution of parts of Ostia's sewer network, this study has taken some initial steps toward understanding how the city reacted over time to flood events, ground level raising, and the changing role of private citizens in constructing and maintaining these sewer systems.

While this study was concerned with the specific relationship of Ostia with water, broader conclusions have been developed that are more widely applicable to Roman water research. One aspect this study stressed was the role of proxy data sets for the study of Roman water, namely sinter (calcium carbonate, $CaCO_3$), and downshafts. Thick depositions of sinter have been studied in connection with aqueduct lines across the Roman empire. This study demonstrated that even small 10 x 10 cm patches of this material within an urban environment can act as clear footprints for following the path of aqueduct water. The absence of preserved lead pipes make the future incorporation of this material crucial to urban water studies looking to understand urban water distribution.

Vertical downshafts have been well-studied at Pompeii in connection to the presence or absence of upper-floor toilets, but these features have much more to reveal.[863] While they can be used to identify upper floor toilets, this study showed that these downshafts were often functionally divided between toilet drainage and rain drainage. This demonstrated that the resulting material from each of these different systems was put to subsequent uses. Specifically, by identifying the common occurrence of these rain drains within wells, this study could track the diverse methods by which Ostians acquired their water. It was the combination of sinter within downshafts that led the present author to conclude that there must have been an abundance of constantly flowing aqueduct water on upper floors in Ostia. Sinter only forms from flowing aqueduct water over extended periods of time, and the idea of slaves carrying thousands of litres of aqueduct water up several flights of stairs does not seem likely. Therefore,

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[862] Jansen 2002 is the only researcher to have begun this line of enquiry.
[863] Most recently by Trusler & Hobson 2017, who identified 286 wide-bore downpipes in Pompeii.

the presence of sinter 4 or 5 meters above the ground and far from any bath buildings must be an indication that pressurized water existed above the ground floor. Support for this interpretation comes from this study's identification of a water tower of the type known at Pompeii and Herculaneum. These towers have never been found in an urban context later than the 1st century AD. The water tower identified in insula IV, ii was dated to the late 3rd or 4th century and proves that a similar network existed at Ostia, ensuring pressurized aqueduct water travelled around the otherwise flat city at a constant pressure.

More than identifying the hydraulic histories of three city blocks in Ostia, it was the integration of this archaeological evidence with other data sources that proved to be the most enriching. The present study acted as an initial methodological bridge to connect Roman and 21st century ways of conceptualizing, managing, and using water resources in urban environments. It was inspired by current and on-going developments in sustainable resource management that attempt to integrate the three central factors of water sustainability: infrastructure, culture, and nature. The Roman Water Footprint method was created by this study as a way to apply the dizzying interconnectivity of modern water to the archaeological and historical evidence of water usage in Roman cities. Its successful application to the case-studies in this work attest to its further applicability at various scales of inquiry.

This study showed how the creation and usage of water systems is a product of the dynamic interaction of water technology, cultural values about waters, and environmental factors. More important than identifying what this "water culture" looked like in different phases of the city's life, was being able to diachronically track changes to its internal composition. Issues of definition remain to be further explored in subsequent studies, especially in integrating qualitative and quantitative data sets. This was most clear in the System Resilience section of the Roman Water Footprint, which sought to identify how many different types of each system were present (e.g. types of supply, of usage, and of drainage). The more types of each system that were present would equate to a higher degree of system resilience, or hydraulic sustainability. Identifying different types of water supply (rain water, ground water, aqueduct water) did show how combinations of these different types changed over time. However, when moving from the level of the individual building to the wider city block, this diversity was obscured. Combining the evidence of system resilience from all buildings in a city block offered a uniform picture of hydraulic sustainability, yet this did not necessarily reflect the reality: one hydraulically dominant building (e.g. domus) could overshadow the water systems in an insula. As it was developed for the lacunose data sets of Roman archaeology, the Roman Water Footprint method is meant to be a flexible matrix, into which different types of data can be juxtaposed, as long as they fall under the three main categories of infrastructure, culture, and nature. The aim of this study was not to frame Ostia as the "ideal city" for studying Roman water systems, or to create a method that can only function for Ostia and other archaeological *rarae aves*. Its aim was to construct an open matrix for placing water systems in their wider social and environmental context and to track how these three factors relate to each other in different time periods.

Zooming out to the theoretical framework of this work, an outcome of this study was to show that Roman water should be seen as a socially constructed "object", just like any other from the Roman world. The way in which (modern or ancient) cities or individuals deals with water is complex, but this study showed how changes to this complexity can be measured over time. The main result was that there is no 1:1 correlation between how complex a society's technology is and how it uses water. It is the local, small-scale choices which often have larger and long-term impacts on relationships with water. For non-water specialists of the ancient world, it is hoped that this work highlights the possible flexibility of how ancient cities and ancient populations dealt with water. The point here is not to detract from the excellent specialist research on aqueducts, fountains, or bath buildings. Rather, the aim of this study is to place large-scale water features in their wider social and technological context, and to use the wealth of previous research into Roman cities and water usage to shift our focus from "how" to "why".

As mentioned above in connection with Ostia, the role of sewer systems in Roman urban studies has only begun to be explored.[864] Incredible new sources of data are contained within these often well-preserved contexts, and although their subterranean and culturally liminal position has led to their minimal study, this may just be what has ensured their excellent preservation. Roman water studies can be conceived of as an iceberg, with supply features such as aqueducts and fountains the most well studied, largely as a result of many of them visible for many centuries. These research agendas may equally be one result of our modern obsession with the supply of ever-increasing amounts of water in our homes and cities. While a wealth of information has been gained regarding the architectural, art-historical, and hydraulic functioning of these features, what lies beneath the surface has an equal amount of information to provide us about Romans and their cities. By integrating sewer and drainage systems into subsequent research agendas, and by taking a systems approach to Roman water systems, future research will be able to fill in tesserae currently missing in the mosaic of these ancient systems.

Roman water management is often defined by its technical precision in large construction projects. But by applying the Roman Water Footprint to Ostia, this study demonstrated that on an urban level, a city is not just an amalgamation of systems directing water from point A to point B following the most efficient gradient. Messy, overlapping, and personal hydraulic choices dynamically interact within larger social and environmental frameworks. Through the comparison outlined in the preceding chapter between the different insulae, it is clear that while each block is certainly connected to the wider city, they each have different ways of expressing this dialogue. Some are very flexible and constantly renewing their system and architectural layout in step with dynamic social changes, while others remain more rigid and add new features onto old systems.

Future Directions

By taking a thematic perspective, this study used water to add an important new dimension to the rich socio-historical evidence from Ostia. As a result, the present work shed light on how buildings of different functions interacted with each other, by taking over a neighboring building, or working together to create mutually beneficial hydraulic systems. This interaction between socio-historical forces and water systems can be explored further, with the expansion of the data set on Ostian water systems. In this way, greater spatial and diachronic trends across Ostia will become visible. The continued development of the Roman Water Footprint method will now make it possible to compare the hydraulic biographies of wider parts of Ostia to each other, and then to the entire city as a whole. Large yet discrete data sets on different aspects of water already exist for Ostia, and with the Roman Water Footprint method it is now possible to aggregate these data sets together to create the hydraulic biography of an entire Roman city throughout its life.

With much to consider for future approaches to researching Roman cities, several aspects of modern water usage have become more clear as a result of this study. Surely the most important take-away from this study has been the sheer flexibility of Roman water systems, long-represented in primary literary sources but lacking a more pronounced archaeological definition. To see a 3rd century house using rain water, ground water, and aqueduct water all in one room, and with separated systems for each of these types of water, immediately confronts the modern researcher with an uncomfortable comparison. How many of our homes or buildings have such systems? Does this mean that the Romans used water more sustainably than we do? In light of the evidence raised by this study, it is clear that the same types of relationships or entanglements bind modern and ancient people to water. However, while the Romans can be accused of having overflowing fountain water running through the streets, their cultural values of using different types of water for different activities seems quite opposite to our habit of using the same type of water to flush toilets, to bathe, and to drink.

[864] Koloski-Ostrow 2015 offers a good recent handbook on this subject.

To put it another way, Roman cities were filled with a polyphony of waters, in which the different types of waters were combined together to form dynamic hydraulic assemblages and put to diverse uses. Our modern approach to urban water usage was to replace this polyphony of waters with a soloist, to prefer to have one type of water for all purposes. It is clear that this tactic puts a great deal of pressure on the soloist; this course of action is decidedly un-sustainable at local and global scales.[865] Perhaps by placing modern and ancient perceptions regarding water in dialogue with each other we can become more aware of our contemporary hydraulic habits and values, and subsequently more open to changing them. By looking more closely at the diversity of the trail of liquid footprints leading from the past to the present, perhaps we can propose new directions for this trail to take in the future.

[865] Watts 2018: At time of writing, Cape Town, South Africa, will be the first modern city to experience "Day Zero" in April 2018, when the city administration will turn off all water supply to 1 million homes.