Chapter 11: Conclusions

This study has characterised the main methods for the transport, storage and use of water in the rural and urban areas of the Roman and late Roman East. It has raised several issues that have direct relevance to ancient water supply studies in general and in some cases also contribute to wider debates: the relationship between cities and their hinterlands as shown by aqueducts and differences in water management between the Roman and late Roman periods. How did water technology compare to earlier and later periods in the East? How did it compare to other areas of the Empire? Were there variations in the region itself? Why did changes occur (or not occur)?

Of direct relevance to Roman water supply studies has been the analysis of the constant-offtake principle whereby water was not stored in significant quantities at any point along its course. The use of dams in the East (Chapter 4), notably an indigenous technology, indicated that this model might need revision for the East as well as for North Africa, as it was clear that water storage did form at least part of the water management strategy. It was assumed, therefore, that urban water storage in the East might follow similar strategies to North Africa, for example the provision of buffer reservoirs alongside the use of complementary water sources. When tested, however, it was clear that such a direct equivalence could not be drawn (Chapter 7). Urban reservoirs in the East were not present in as high numbers as North Africa, nor could they store such large volumes of water. In addition, they often appear not to have been contemporary with aqueduct construction, but rather were a late Roman phenomenon. The response in the East to seasonal variations in water supply seems to have been to make greater use of complementary water sources, i.e. using aqueduct water in conjunction with rainwater cisterns and wells.

Supply of the cities was not, of course, the only concern for inhabitants of the East. Water management in rural areas was also important to provide water for drinking, animals and agriculture. Another main area of debate in Roman water supply studies is to what extent the provision of aqueducts to the cities disadvantaged rural areas (Chapter 6). Traditionally, it was felt that aqueducts symbolised the differences between the consumer cities and the producer hinterlands. Recently, this model has come under scrutiny. The

evidence from rural branch lines in the East has contributed to the idea that there was a more balanced and symbiotic relationship between urban centres and rural hinterlands. In some cases, it seems that the city may not have been the primary consumer of aqueduct water, for example at Tiberias, and that rural supply may have been an equal concern.

Rural water use appears to have undergone some significant changes in the late Roman period as illustrated by the study of dams and irrigation techniques (Chapters 4 and 5). In the main, the techniques and technologies were relatively static throughout the Roman and late Roman periods. One exception to this was the design adaptations in dam technology seeing the use of longer dams, some with stepped courses, and the arch dam. Qanat technology, whose date of introduction is contested, may also be counted as an exception. Overall the change seems to have taken the form of increased irrigation, shown by higher numbers of dams, irrigation channels, water-lifting devices (especially pot garlands) and (probably) field systems in this period. While many of these techniques were known and utilised before the late Roman period, it was in that period that there seems to have been a wider diffusion of these technologies. The trend towards higher levels of irrigation fits in with the picture of general agricultural intensification in the late Roman East, particularly in Syria. The construction and use of more irrigation networks appears to have been related to the need to supply the permanently-stationed late Roman army, population and taxation pressure and, in the case of irrigation systems associated with monasteries and the rise of the power of the Church.

In addition to increased irrigation, the late Roman period also saw some interesting changes in urban water management. The major shift here, most noticeable in increased use of water storage, was related to the character of the late Roman city in the East (Chapter 7). Water installations often encroached on previously public, monumental space, for example the reservoir and latrine inserted into the agora at Apamea and the *officina tinctoria* in the *macellum* at Jerash. The evidence from Jerash also suggested that more industrial activities, some involving spoliation of the earlier pagan monumental architecture, were taking place in the city in this period (Chapter 10). This change in urban character was associated with the decline of civic self-government, the rise in power of the Church and the decrease in importance of the idea of community. The increased threat from further east, as well as

natural disasters such as earthquakes and drought, may also have contributed to these shifts in emphasis.

While the most prevalent development in the Roman and late Roman period was one of intensification of previous practice, rather than transformation, for example in irrigation, there were some changes or additions to previous technology. The use of the pot garland with a *saqiya* gear and the *noria* were probably the biggest additions to previous water-lifting practices (Chapter 3). Arches and arcades, which were particularly important in aqueduct building, were also introduced during the Roman period (Chapter 6). There was also progress in waterpower, which saw innovations such as the *arubah* penstock mill and the Jerash sawmill (Chapter 10). One of the biggest advances in technology seems to have been in dam construction (Chapter 4). Increased length and steps improved earlier dam forms. In addition, a pragmatic approach to dam construction was taken that maximised a dam's utility. New designs, such as the arch dam, were also introduced, though with limited spread.

Limited uptake of a new technology was not limited to the arch dam, but was also seen in the restricted use of lead in all contexts: inverted siphons, urban distribution pipelines and domestic pipelines. This suggests that while a technology might be viewed by some as 'superior', it would not necessarily be used to any great degree. In these cases, the established, older technology seems to have been viewed as adequate for its task and there seems to have been little propensity towards an 'onwards and upwards' attitude. Where such an attitude did exist, it seems to have been held either by the imperial authority or by one consciously trying to become or seem Roman, for example Herod (see below).

In addition, some new uses of water and management strategies were introduced during this period with varying degrees of spread (see below). Most notable among these were the provision of *castella divisoria*, *nymphaea* and latrines (Chapters 7 and 8). Facilities, such as public bathhouses became increasingly widespread during the Roman and late Roman period (Chapter 8). In addition, there was some use of water for display in high-class houses (Chapter 9). These developments must be linked to increased provision of running water in aqueducts.

The degree of this change is brought into focus by looking at the Umayyad period when it would seem that fewer new, large water supply infrastructure projects were

undertaken. There were, for example, only a few instances of new aqueducts being built during the Umayyad period. One new aqueduct was built to Khirbet al-Mafjar before 743 AD; the bridges over the ravines have tiers of pointed arches, which are associated with architecture of this period.[1] This lack of building may not necessarily point to a lack of interest in investing in water supply; it may reflect that the existing networks functioned effectively and provided water to all the necessary sites. A corollary to this is that where settlements were newly established, water supply and management networks were installed from their inception. The imposition of settlements in the Jordanian steppe or desert, for example, sometimes referred to as the 'Desert Castles', meant that new water systems comprising dams, aqueducts, reservoirs and cisterns, had to be constructed to provide these settlements with water.[2]

Table 11.1: Evidence for continued use of Roman aqueducts in the early Islamic period.

Site	Period of use	Comments	References
Jerusalem – Low Level	Until 20th century	Described by Arculfus in AD 670 when it supplied Umayyad Palaces and fountains on Temple Mount.	Mazar 2002a, 238-9. 'The Pilgrimage of Arculfus' in *Palestine Pilgrim Texts* 3, 1893.
Jerusalem - Arrub	Not clear when went out of use, but restored in Mamluk period.		Mazar 2002a, 238.
Samaria-Sebaste - Naqura	Abandoned in early Islamic period		Frumkin 2002, 275.
Samaria-Sebaste - Shechem	Early Islamic		Frumkin 2002, 275.
Cypros	Early Islamic	Repaired in this period. Used to supply travellers along main Baghdad-Cairo road.	Meshel and Amit 2002, 329.
Tiberias	Early Islamic	Supplied mills and bathhouse.	Winogradov 2002, 299, 303.
Caesarea – all aqueducts	Abandoned		Porath 2002b, 127-129.
Sepphoris	Early Islamic period	Abandoned soon after conquest.	Tsuk 2002a, 294.

[1] Reifenberg 1955, 68, 99; Wilson 2003a, 128.
[2] Harding 1967, 153-164; Kennedy and Bewley 2004, 217-239.

Although there was some continuity of supply to older settlements, some 'downsizing' does seem to have occurred (Table 11.1). Where multiple aqueducts supplied a site, for example, it seems that only one aqueduct was usually kept in service. Supply appears to have been aimed at the high status settlements. Bathhouses, for example, which had been ubiquitous in urban landscapes, seemed to disappear from the cities and to be associated primarily with hunting lodges and high status residences.[3] This may reflect lower levels of urbanisation in this period, but also may reflect a lack of research on Umayyad water management.[4]

Irrigation, however, appears to have been a subject of some concern to the early caliphs.[5] Maslamah Abd al-Malik led an irrigation channel from the Euphrates to irrigate the lands of Balis (Meskene). In the 8th century AD Hisham removed silt from the Hani and Mari irrigation channels near Raqqa. In addition, the Yazid irrigation channel at Damascus was widened. This suggests that the caliphs made new additions to the irrigation systems as well as maintaining the existing networks.

As well as these diachronic shifts, there were also some regional differences in water management in the East. In technological terms, these were most apparent in irrigation practices. The analysis in Chapter 5 illustrated that the irrigation technique used was largely governed by landscape setting, so that irrigation channels were most prevalent in Syria (particularly in the Euphrates area) and qanats, which needed access to aquifers, were located in limestone geology. Access to water sources also played a key role in the distribution of aqueducts in the landscape (Chapter 6). There were few aqueducts in the Syrian steppe, for example, because the water resources in that area were more suited to qanat technology.

The other major regional bias was in the distribution of latrines (Chapter 8). Latrines showed a very restricted geographical spread, with most examples coming from Syria and from two sites (Caesarea and Scythopolis) in Palestine. This was a clear example of rejection of this new installation in Jewish areas due to religious propriety (see below). Even in non-Jewish areas the spread of latrines was late in comparison to other areas of the

[3] On bathhouses in the desert castles, see for example Yegül 1992; Vibert-Guige 2001-2.
[4] This should be remedied in Jordan by a project by Bellwald (pers. comm.). On the general lack of survey work on the Islamic rural settlement see e.g. Philip *et al.* 2005, 30.
[5] Reifenberg 1955, 99.

empire, which suggests that similar inhibitions and concerns over modesty may have affected other cultural groups in the East, whose opinions and cultural tastes are not so easily observable.

How, then, did the use and management of water in the East compare to the rest of the Roman Empire, in particular the Mediterranean? There is literary and archaeological evidence for the widespread use of similar water-lifting devices (Chapter 3) across the empire, especially in Egypt.[6] Two possible exceptions are *norias* and *saqiyas*. Although there is some evidence for *norias* used elsewhere in the Empire, they seem to have been particularly associated with the eastern provinces. On present evidence, it would seem that *saqiya* pot use was restricted to Egypt, the East and possibly Spain.[7] It seems then that it was mostly used in the more arid areas of the Empire, whereas bucket chains were used more commonly in provinces further north. The difference here may be one of chronology as well as geography because the cheaper *saqiya* pots were the successor to bucket chains.

Dams (Chapter 4) seem to be an interesting example of a technology that derived from the East, but was modified during the Roman period when it also spread to other areas of the empire. Primarily, dams were used in other arid areas, such as Spain, Asia Minor and North Africa.[8] These dams exhibited some of the new design features noted in the East, such as steps on the Proserpina and Kasserine dams.

The irrigation techniques used in the East (Chapter 5) were also found in other parts of the empire. Large-scale irrigation channels were also used in Spain, but the date of their introduction is heavily disputed. The recent find of a bronze inscription from Agon near Zaragoza detailing irrigation regulations, however, demonstrates their use in the Roman period.[9] The date when qanats reached Spain is also controversial.[10] Qanats were definitely used in Egypt from the 5th century BC at ‘Ayn Manawir. Recent work in the Sahara suggests that the qanat had reached this area before the 4th century AD, from where it spread to Tunisia and Algeria. Floodwater farming and its associated field systems have

[6] See Oleson 1984.
[7] One would also expect *saqiya* pots from North Africa, but none has yet been found. The arguments for the use of pot garlands there rests on the shape and size of wells. See Wilson 2003a, 119-123.
[8] See Hodge 1992, 79-92.
[9] Wilson 2003a, 117-118, 139.
[10] *Ibid*, 133-138.

parallels in North Africa as illustrated by the UNESCO Libyan Valleys Survey.[11] As in the East, their distribution seems to have been governed by the landscape setting, for example the North African landscape is more suited to floodwater farming and aquifer-fed qanats than river-fed irrigation channels.

In general, the technologies associated with urban aqueducts in the East (Chapter 6) did not differ from those in the rest of the empire. The exceptions were stone pipelines, which seem to have been most common in the eastern Mediterranean and ceramic pipelines in inverted siphons, which have very few comparanda elsewhere.[12] The financing system for the construction and maintenance of aqueducts also seems similar to that elsewhere, with the exception of higher levels of private funding in North Africa. The biggest distinguishing factor may have been the extent to which their water was used in rural areas as well as in urban centres. There is some evidence, albeit limited to Tiberias, to suggest that rural areas were more of a priority in the East than elsewhere. This may have been a result of previous practice as well as a common-sense approach to limited water resources.

In urban contexts (Chapter 7), as has already been noted, there may have been less reliance on (stored) aqueduct water than North Africa, which was probably similar climatically. The use of *castella divisoria* was limited, but this was not surprising as they were rare in other parts of the Empire (examples are known from Nîmes, Pompeii, Carthage, Thuburbo Minus and Simitthus). It was unsurprising to find *nymphaea* in several cities as these were a common feature of Mediterranean cities.[13] They do not seem to have as elaborate as *nymphaea* in Greece and Asia Minor. It is possible that this represents a cultural dislike for ostentatious and seemingly wasteful use of water. The relatively low numbers of street fountains were unusual as they are well-documented elsewhere; Pompeii alone probably had 50.[14] It seems likely that this is an excavation and publication bias. One of the main differences was in the actual distribution network, where ceramic pipes were the eastern Mediterranean preference by far, not only in the Near East, but also in Asia Minor and Greece. This is in contrast to lead pipes across the western Mediterranean. Again this seems to indicate that older, established technologies were used unless there was a clear

[11] Gilbertson and Hunt 1996.
[12] Stenton and Coulton 1986. A few examples are known from Italy, North Africa and Spain: Hodge 1992, 110; Wilson 2000e, 599.
[13] Glaser 2000, 465.
[14] Eschebach 1979; Hodge 1992, 304; Jansen 2000b, 113.

advantage to be gained by using a newer, supposedly 'superior' technology. The other water sources, cisterns and wells, did not differ from other parts of the empire.

Public latrines and bathhouses (Chapter 8) showed some interesting similarities and differences with the rest of the Empire. While the design of latrines was remarkably standardised and similar to other Roman latrines, they were a later phenomenon in the East than elsewhere, possibly due to cultural inhibitions. Bathhouses also flourished later in the East than in other provinces, which may have been for similar reasons. In addition, the more widespread use of cisterns for public bathhouse supply in the East was in marked contrast to other areas where the practice is almost unknown.

In the domestic realm (Chapter 9), Antioch had the most similarities with higher class housing across the empire, particularly Italy. This was very marked in the use of water for display, for example fountains. Housing in other parts of the East did not have such a focus on display, which may be related to a seeming dislike for ostentatious use of water. In addition, the use of lead pipes, as in urban contexts, was very limited in the East with a strong preference for ceramic. A common, though unsurprising, pattern for all housing was that only the highest class housing, both urban and rural, was connected to a piped supply.

The industrial uses of water (Chapter 10) in the East were broadly similar to the rest of the empire. The use of mills and waterpower in the East adds to a growing picture of the use of waterpower that must modify the traditional picture of technological stagnation in the Roman world. The use of *arubah* penstock mills was a particular feature of the East and must be related to their efficacy in areas with smaller stream flows. The East also provided some evidence for more specialised uses of waterpower, such as the sawmill at Jerash and the fulling mills at Antioch.

The answer to the question of why these developments and changes happened (or even did not happen) seems to vary in emphasis according to the different areas of water management. Who was the agent of the change appears to have been a key element here. In the early part of this period, one figure stands out as an agent of change and as a middleman in technology transfer: Herod. Herod and his palaces seem to have been primary locations for the introduction of new ideas and designs in certain areas of water management, notably arches and arcades on aqueducts, as well as bathhouses. The nature of the transfer from Herod to other areas of the East is not easy to elucidate, but in the case of Caesarea,

Herod's legacy and Roman influence appear to have been maintained throughout the life of the city, in the form, for example, of a *nymphaeum,* latrines and lead pipes, until its downturn at the end of our period.

The army in the Roman and late Roman periods also seems to have been a major agent of change. Military areas of involvement seem to have been in the construction of 'necessary' facilities for a Roman way of life: aqueducts, bathhouses and latrines. Although aqueducts would have had a tangible effect on urban and rural water supplies, the extent to which the army's use of bathhouses and latrines had a deeper and more far-reaching impact on the wider population, however, is debatable. In some cities, for example, Dura Europos and Palmyra, these facilities arguably were for the exclusive use of military personnel. The late Roman army appears to have made a stronger impression on rural water management, in particular dams and irrigation techniques. In this case the presence of the army seems to have made their construction both possible and necessary.

As well as the late Roman army, the Christian Church may also have been responsible for some of the intensification of irrigation in the later period. Furthermore, the Church had a powerful effect on late Roman urban water management. The shift from public benefaction to spending on religious building or charity meant that the nature of the cities changed. This affected water management as installations began to encroach on monumental public space (such as reservoirs and latrines) or even contributed to its dismantling (with the Jerash sawmill) and the towns and cities became increasingly industrial. As a corollary to this, the Church began to take on some of the responsibilities and roles of urban water management that might have been expected of civic authorities in an earlier period, for example the upkeep of the network and the building of storage installations and bathhouses.

Judaism also had a strong impact on the use of water-related facilities. The dictates of Jewish law made latrine use unacceptable among devout Jews as well as apparently slowing down the rate of spread of bathhouses. In this case then, religion was an agent that slowed, or even prevented, change.

The final group of agents were the indigenous population. It was this group of people that visibly were responsible for the uptake, or not, of many of the trappings of Roman life: latrines, bathhouses, *nymphaea* and water for display in domestic contexts. The

power of this group seemed to lie in their multiple identities: religious, public (civic) and private. Sometimes these hybrid identities clashed as in the case of the Herod and his latrine in his Second Palace where a compromise had to be met between his Jewish identity and his desired Roman identity. Balancing these identities, in which willingness to change behaviour was a key component, meant that a selective approach was taken to new ideas. Where a change in behaviour would have meant the loss of or damage to identity, it seems to have been met with varying degrees of resistance, such as in latrine use or public display in private houses. In other areas of life where a pragmatic approach would not be detrimental to identity, change seems to have been more acceptable.