WATER ENGINEERING AND MANAGEMENT PRACTICES IN SOUTH ARABIA

Aspects of Continuity and Change from Ancient to Medieval and Modern Times

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Since ancient times, humans have lived and even prospered in the arid regions of South Arabia, where the pre-eminent factor limiting life is water. How did people in the past interact with a natural environment that seems so uninviting, indeed hostile towards humans? What kinds of strategies did they use in order to deal with the scarce water resources? Did their practices change over time, or did the natural conditions restrict the options severely? There are numerous sites in South Arabia that can serve as examples for skillful hydraulic engineering and water management, both from ancient and medieval Islamic times. The following considerations are based on two case studies: first, the ancient oasis of Mārib that flourished during the first millennium BCE and was abandoned around 600 CE, just before the coming of Islam; and, second, the city of Zabīd, founded in the ninth century CE, with its agricultural hinterland that has been farmed continuously since then. These two sites where the author has conducted field research since the 1980s also allow us to address the question of continuity and change from pre-Islamic to Islamic times. In order to appreciate what people in the past accomplished and still do, it is necessary to start with a brief review of what aridity means in terms of the water resources.

WĀDĪ AND *SAYL*

Following a humid period with perennial bodies of stagnant and flowing water in South Arabia, the transition from the fourth to the third millennium BCE went hand in hand with the climate gradually becoming dryer. As a result of this so-called mid-Holocene climate change, the lakes and rivers disappeared eventually. Apart from minor fluctuations, the climate has remained basically the same, and it is no different today than 3,000 years ago (Brunner 1999: 38–39). The typical water course of arid regions is the *wādī.* This Arabic term designates a dry stream bed that contains water only in direct connection with rain falling on higher ground in its catchment basin. Generally speaking, the monsoon-influenced biannual rainy seasons are pretty predictable and can be expected during a shorter period in spring (March/April) and a longer period in late summer (July/August) (Kopp 2005: 13–16). However, it is important to bear in mind that the specified cycle is based on long-term averages, and considerable variability occurs both in terms of time and volume. Every now and then the rains will be missing entirely.

The surface run-off from the rains results in short-lived spates, for which the Arabic term *sayl* is used. Depending on the intensity and continuance of the precipitation, a spate may last for a few hours or several days, even up to a couple of weeks in case of regular thundershowers. Soon after the rain in the catchment area stops, the *wādī* dries up and remains dry until the beginning of the next rainfall. Thus, the main characteristics of the *sayl* are its seasonality and limited duration.

In order to make use of the water for irrigation, the *sayl* is diverted from the *wādī* by earth barrages that reach into the flood course like a finger and direct part of the water onto the fields on either side (see Fig. 1). Eventually, such a barrage will be washed away and has to be re-built by the farmers before the start of the next rainy season in the mountains; otherwise the *sayl* will remain unused.

Typically the individual fields are irrigated once per rainy season by submerging them with water at least knee-deep in order to have enough moisture stored in the soil for the ensuing growing season.[1] This requires the heaping up of earth banks around the fields (Fig. 2). Because of the erosive force of water, the surface run-off and the *sayl* carry considerable quantities of silt. Therefore irrigation with the muddy spate results in the deposition of a thin layer of sediment. While the process provides nutrients to the cultivated plants and helps soil fertility, it also leads to a very slow, yet continuous build-up of the fields over time. Consequently, when irrigation systems operate successfully over centuries, the irrigation structures need to be raised again and again or may have to be moved further upstream in order to gain height so that the water can still reach the fields under gravity flow.

IRRIGATION IN THE ANCIENT OASIS OF MĀRIB

Mārib, first mentioned in inscriptions written in Old South Arabian in the early first millennium BCE, was the capital of the Sabaean realm, Saba', and one of the main halting places on the ancient caravan route, the so-called frankincense route that linked the regions producing incense and other aromatic substances around the Arabian Sea with those consuming them around the Mediterranean (Müller 1991: 559b–60a). In the Hebrew Bible (I Kings 10:1–13; II Chronicles 9:1–12) the story of the tenth-century BCE visit of the fabled Queen of Sheba to King Solomon is told, an incident that may have happened as part of a trade mission. For sure, the income capital from the caravan trade made investment in infrastructure projects possible, most importantly water engineering schemes. Ancient Mārib was renowned for the fertility and abundance of its irrigated farmland, the Mārib oasis.

Mārib is located on the eastern side of the Yemeni highlands, on the periphery of the great inner Arabian desert, and receives very little precipitation. Rain-fed farming is not an option to sustain the city. Agriculture is only possible by way of irrigation. The only source of water is the Wādī Dhana, on the bank of which Mārib is located, 8 km from the mouth of the gorge where the *wādī* debouches from the mountains. In accordance with the aforementioned biannual rainy seasons in spring and late summer, these are also the times of the year that are mentioned in the Old South Arabian inscriptions as irrigation seasons in Mārib.[2]

Over long periods of time, people constructed diversion barrages that originally must have been built of earth, in the same way that can still be observed today along the *wādī*s of Yemen (see Fig. 1). Because of the nature of the building material, though, they left no traces. With time, the barrages were moved further and further upstream, and the engineers began to cut stone blocks for bigger and more substantial diversion devices that date to the early first millennium BCE.[3]

The process culminated in the construction of a barrage across the mouth of the gorge, which happened most probably in the sixth century BCE (Gerlach 2012: 191, 196). In its final state that was recorded by the archaeologists, the so-called dam of Mārib was some 620 m long and 20 m high.[4] Its purpose was to block the spate and divert the water towards the fields, that is, like its more simple precursors it operated as a diversion barrage, not as a dam in the strict sense to store water in an artificial lake – even though in the literature the term 'dam' is used to refer to it. Two so-called sluices, massive cut-stone constructions at its northern and southern end, anchored it firmly on the bedrock on either side of the gorge. The northern sluice had two inlets that directed the water into a main canal; the southern sluice had only one. From a main division point

[1] Details of the irrigation methods and the archaeological remains they leave behind are discussed in Hehmeyer & Schmidt (1991: 40–46).

[2] E.g. Gl 1679 + Gl 1773 a+b, and Gl 1762 (Müller 1983: 270–71). Because of the variability and sometimes unreliability of the *sayl*, some inscriptions describe as well the desperate situation when the rains had failed, the fields were barren, the trees had died and the wells had dried up, e.g. Ja 735 (+ Ja 754) (Müller 1986: 10–11; Müller 1988: 450–52).

[3] These are the so-called structures A and B at Mārib that have previously caused much discussion about their age. The issue was most recently addressed by Iris Gerlach who comes to the convincing conclusion that they do not date before the early first millennium BCE (Gerlach 2012: 190–91, 195–96).

[4] The Mārib 'dam' has been described in numerous publications. A good general depiction including a schematic drawing can be found in Brunner (2000: 171–73). Since then, much work has been carried out on the barrage and the sluices by the German Archaeological Institute that has refined our understanding of some of the functional elements and in particular the dating (see Vogt 2004*a*, 2005 and – for the most recent account – 2007).

Fig. 1: Earth diversion barrage in the Wādī Zabīd (photo: Edward J. Keall).

Fig. 2: Field in the Wādī Zabīd, surrounded by earth bank (photo: Ingrid Hehmeyer).

at the end of the two primary canals the water was further distributed through a network of secondary and tertiary canals (for a description, see Schaloske 1995: 123–61).

The brilliance of the scheme is reflected in the fact that the centre part of the barrage was earthen and deliberately designed to be weak. It had the function of a fuse in an electric circuit: in case of an exceptional flood, the proverbial 'century flood,' the barrage would break, but the rest of the infrastructure – the sluices, the water distribution system and the fields – would remain intact. The earthworks of the barrage could be rebuilt in time for the next spate; the stone structures could not, and the water cutting deep erosion gullies through the oasis would lead to a disruption of the distribution system and destruction of the fields. However, repairing the barrage meant a huge communal effort, which is reflected in several inscriptions.

One of the most famous inscriptions from ancient South Arabia is CIH 541 that reports the breaking of the barrage in the year 548 CE and the ensuing construction work to rebuild it and repair the damage on the sluices.[5] The text describes the great efforts and the enormous expenses regarding building materials and provisions for the workers. Besides flour and dates as staples, 3,000 cattle and 207,000 small livestock were slaughtered to feed them. As for beverages, in addition to date wine 300 camel loads of grape wine were delivered to the construction site. After fifty-eight days the workers had completed the repairs and could finally return home. These figures underline the scale of the operation.

The limited duration of the *sayl* meant that the success of the irrigation system at Mārib depended on distribution of the water under gravity flow that had to be completed as quickly and efficiently as possible, so that the fullest possible extent of the oasis could be farmed. In order to accomplish this, the water was allocated according to the principle of upstream priority, implying that those areas further up in the network received water before the lower-lying ones. It leads to the lower-lying field systems not receiving any water during a weak *sayl*, or only receiving water during the normally stronger late summer *sayl*, that is, once a year instead of twice. The consequences are visible in the way the fields of the northern oasis are stepped down sequentially, starting from the main distribution point towards the fringes (Hehmeyer & Schmidt 1991: 80–82 and Tafel 12; Schaloske 1995: 138–39, see 148 for an exception).

The whole settlement, the city with its two oases on either side of the *wādī*, flourished until the first centuries of the Common Era when it became obvious that Mārib began to suffer from problems caused by political squabbles in South Arabia and, possibly even more importantly, by transfer of trade to the sea-route that led to a decline of caravan traffic and the income derived from it (Müller 1991: 561, 564). In addition, there were severe problems with the stability of the main irrigation structures. The average annual sediment build-up of the fields is currently estimated at approximately 1 cm per year (Brunner 2005: 4), at first sight not much at all, but it developed into a major problem because of the long-term overall success of the irrigation system at Mārib. Even though one should be careful not to apply the figure of 1 cm per year as a straight-forward tool by which to date sediment accumulation "by the yardstick" (Vogt 2004*b*: 70), 1000 years of irrigation translate into a considerable rise of the field level. As a consequence, the irrigation structures needed to be built higher and higher, and over time this led to a loss of stability. It is therefore not entirely surprising that the Old South Arabian inscriptions report five incidents of the barrage breaking between the beginning of the fourth century CE and the middle of the sixth century (Müller 1999: 563–64). A sixth breach in the late sixth century CE was postulated by Brunner based on differences in the cross-bedding of the sediment deposits behind the barrage, so-called discordances (Brunner 1983: 51–53, 118–19, 123).

Interestingly, at Mārib it was the problem of too much water – which can have as devastating an effect as lack of it – that led to the final catastrophe: a particularly strong flood towards the end of the sixth century caused the barrage to break. By this time "the system had reached its technical limits" (Vogt 2004*a*: 387). In the Koran (34:15–17a) the demise of Mārib and its fabled oasis is singled out as divine punishment of people who were disbelievers and as a warning against worldly pride:

> "For Sheba also there was a sign in their dwelling-place – two gardens, one on the right and one on the left: 'Eat of your Lord's provision, and give thanks to Him; a good land, and a Lord All-forgiving.' But they turned away; so We loosened on them the Flood of Arim, and We gave them, in exchange for their

[5] The inscription was most recently translated by Müller (1999); for the slightly revised date of the breaking of the barrage, see Nebes (2004: 229, n. 12).

Fig. 3: The ancient oasis of Mārib as seen in 1984 (photo: Ingrid Hehmeyer).

two gardens, two gardens bearing bitter produce and tamarisk-bushes, and here and there a few lote-trees. Thus We recompensed them for their unbelief."

Thus shortly before the coming of Islam the oasis of Mārib was destroyed and with it the most prominent example of large-scale *sayl* irrigation in the arid environment of ancient South Arabia. Without its intact irrigation infrastructure there was no life on the oasis, and the area was abandoned by the resident population – for archaeologists an ideal scenario because it resulted in a remarkable state of preservation of the archaeological record until the second half of the 1980s (Fig. 3) when recultivation of the ancient oasis started on a large scale.

SAYL IRRIGATION IN THE WĀDĪ ZABĪD DURING MEDIEVAL ISLAMIC TIMES[6]

After the rise of Islam in the seventh century CE, the ancient principle of *sayl* irrigation continued to be applied in Yemen. This comes as no surprise since for major parts of the country the *wādī* spate is the only source of water for anything but small-scale irrigation. The second case study of this chapter focusses on the city of Zabīd, located on the western side of the Yemeni highlands on the coastal plain called the Tihāma, about 25 km inland from the Red Sea.

As reported by the twelfth-century writer ʿUmāra al-Yamanī, Zabīd was founded in 820 CE by a certain Ibn Ziyād as a military camp that became the nucleus of a permanent settlement, the city of Zabīd (ʿUmāra 1968 [1892]: 3). The significant role of the *wādī* for providing the economic basis of the city is conveyed by the tenth-century scholar al-Hamdānī who points out that Zabīd was named after the *wādī* flowing by it (al-Hamdānī 1884–1891, vol. 1: 53/24–25, 119/17). Not long after its foundation, the city started to acquire an

[6] For a general description of *sayl* irrigation in Yemen during Islamic times, see Varisco (1983: 368–71).

'international' reputation as a centre of learning. The tenth-century geographer al-Muqaddasī, who travelled extensively in the Arabian Peninsula, describes Zabīd with the following words:

> "Zabīd, the capital of Tihāma, is one of its metropoles, this being the residence of the kings of al-Yaman. It is a splendid, well-built town, and popularly called 'the Baghdād of al-Yaman.' The inhabitants are reasonably polite, and among them are merchants, nobles, scholars, litterateurs. It is a profitable place for one who visits it, a blessed place for one who lives there. Their wells are sweet, their baths clean. [...] Around it are villages and cultivated fields. [...] Ibn Ziyād had a channel led to the town. It is an attractive town, without equal in al-Yaman." (Al-Muqaddasī 1994: 82)

Al-Muqaddasī's reference to Baghdad, the capital of the Islamic Empire during the so-called Golden Age, is clearly to be understood as an allusion to the level of scholarship that one would find in Zabīd,[7] and his description of the cultivated fields in the hinterland underlines that the Wādī Zabīd was controlled for irrigated agriculture at the time.

However, the reality of Zabīd's geographical location makes one wonder how the city could not only survive but thrive under the prevailing climatic conditions. The Red Sea coastal plain is one of the hottest areas of the Earth, and it receives an average of less than 150 mm of precipitation per year (Kopp 1981: 42 [tab. 2], 44 [figs. 5a and b]; Remmele 1989: 31 [fig. 4], 32 [fig. 5]). As with Mārib, the answer is skilful management of the *sayl* in the *wādī*. Other than the oasis of Mārib that lay abandoned from around 600 CE until the mid-1980s, the Wādī Zabīd has been farmed continuously until the present. Therefore it offers the unique opportunity of first-hand observation of the traditional irrigation and farming practices (Fig. 4), which can be of great help when it comes to piecing together archaeological remains. Working in the Islamic period also means that we have an enormous body of written sources at our disposal.

Zabīd's heyday was under the Rasulid dynasty (1229–1454), and the thirteenth and fourteenth centuries are a particular prosperous period in Yemen's history. The Rasulids made Zabīd their winter residence and they invested in a major way in infrastructure, including irrigation devices in the Wādī Zabīd (see below). The authority for the Rasulid era is a man by the name of al-Khazrajī, the official court historian of the Rasulids. He lived under four Rasulid sultans and died in 1410 at the age of over 70 (Bosworth 1978: 1188b). As a contemporary of many of the events that he reported, the information that we find in his main work poetically entitled *The Pearl-Strings* has a different quality than, for instance, ʿUmāra's references to occurrences that had happened up to more than 300 years before his time.

The Rasulid rulers' great personal interest in agriculture and horticulture is reflected in the fact that new plants were introduced into Yemen and cultivated in the royal gardens; among them were fragrant flowers such as jasmine and roses (al-Khazrajī 1906–1918, vol. 5: 139). The seventh Rasulid sultan, al-Ashraf Ismāʿīl (r. 1377–1400), grew exotic trees in his garden near Zabīd, and according to al-Khazrajī he was the first one to cultivate rice in the Wādī Zabīd, apparently with success (al-Khazrajī 1906–1918, vol. 5: 300, 318). A number of texts on various topics related to agriculture were written by the sultans themselves, or at least in the name of a sultan.[8]

The fourth Rasulid sultan, al-Muʾayyad Dāwūd (r. 1296–1321), has left us a tax register that was compiled during the first years of his reign, that is, right at the end of the thirteenth century (Vallet 2010: 74–75).[9] It is subdivided according to the administrative regions and includes a substantial section on Zabīd and its agricultural hinterland, with a priceless map of the irrigation system in the Wādī Zabīd (Fig. 5) (Jāzim 2008: 387). By comparison with Mārib, there is no barrage built across the *wādī*. Instead, the map shows a succession of main canals (sg. *sharīj*) along the central channel of the *wādī* that leads from the mountains in the east (at the top of Fig. 5) to the Red Sea in the west (at the bottom). The city of Zabīd is located on the northern bank. Five canals divert the *sayl* onto the southern bank, and twelve onto the northern bank of the *wādī*. Clearly, the irrigation system was firmly established at the end of the thirteenth century.

In local dialect, the term *sharīj* implies a primary canal that is connected to a diversion barrage at its head and that leads towards the fields lying above the banks of the *wādī*, as well as the system of contiguous fields

[7] For a different interpretation of al-Muqaddasī's remark on Zabīd being 'the Baghdād of Yemen,' see Keall (2012: 137–39).

[8] For an annotated bibliography of these medieval agricultural texts, see Varisco (1989).

[9] The manuscript was edited by Jāzim (2008).

Fig. 4: Farmer in the Wādī Zabīd building a diversion barrage in anticipation of the *sayl* (photo: Ingrid Hehmeyer).

that is irrigated by it. This linguistic detail shows beautifully that the land and the water form a natural unit. One without the other is worthless. In the manuscript, the term *maʿqam* (and *ʿaqm* as a synonym) is used for the diversion barrage at the head of a primary canal (*sharīj*) that diverts part of the *sayl* into it (Jāzim 2008: 10).

The tax register talks also about the Rasulids' investment in irrigation infrastructure in the Wādī Zabīd. For instance, as the highest-lying diversion barrage in the *wādī*, Maʿqam al-Bunay was particularly vulnerable to the force of the *sayl* and was regularly damaged or even washed away completely. Government administration paid for its reconstruction, the farmers were not expected to contribute to the costs (Jāzim 2008: 11). Clearly, everybody understood that having Maʿqam al-Bunay in place was essential for irrigation in Sharīj al-Bunay, but also to break the initial force of the *sayl* and thus protect the infrastructure further downstream.

By comparison with the ancient oasis of Mārib, the second major difference is the principle of water allocation in the Wādī Zabīd. In order to understand the implications, let us consider briefly water allocation rights in Islamic law, *Sharīʿa*. According to Muslim belief, the Koran is God's word as revealed to the Prophet Muḥammad and eventually compiled and written down in the form of a book. It constitutes the first source of the *Sharīʿa*. The Koran provides more general guidelines and does not give answers to all the specific questions and problems that kept emerging in day-to-day situations. Therefore the Prophet's sayings and exemplary way of acting, his *Sunna*, became the second source of the *Sharīʿa*. This is of particular significance in the context of Islamic water law: since specific legal provisions are absent in the Koran, the Prophet Muḥammad's *Sunna* provided the framework.

Following the eleventh-century legal scholar al-Māwardī (d. 1058), water is shared in accordance with upstream priority, that is, the higher-lying areas are irrigated first and then successively those further downstream (al-Māwardī 1996: 256–59). For spate irrigation this means that its overall reliability is "a function of proximity to the wadi, and distance downstream from it" (Tihama Development Authority n.d.: 31). Quite clearly, the land owners of the downstream areas are at a disadvantage, in particular in those years when the *sayl* is weak. Conflicts among the farmers are likely to happen.

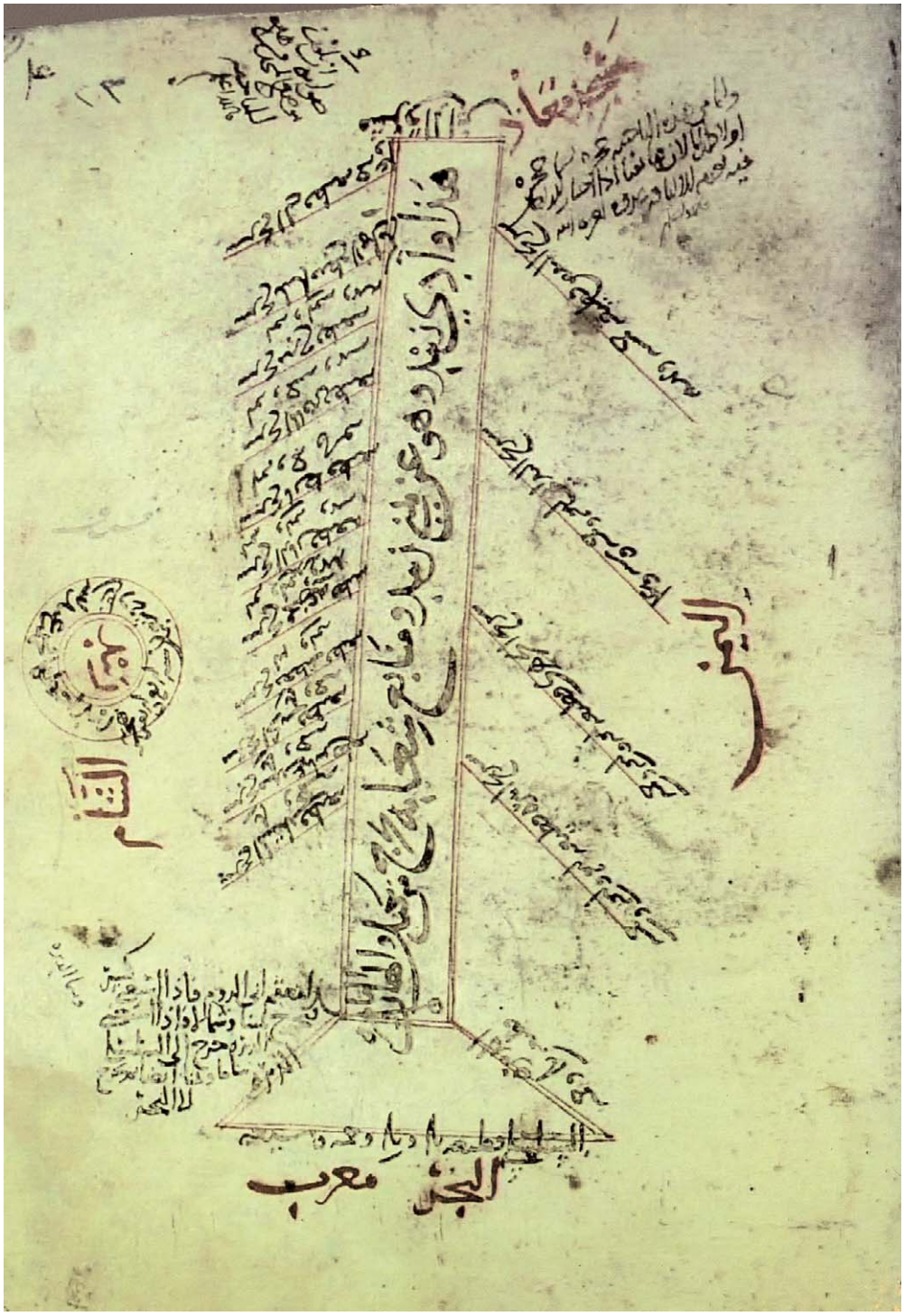

Fig. 5: Map of the Wādī Zabīd from the tax register of the fourth Rasulid sultan, al-Muʾayyad Dāwūd (r. 1296–1321) (from: Jāzim, Muḥammad ʿAbd al-Raḥīm (ed.). 2008. *Irtifāʿ al-dawla al-Muʾayyadiyya: Jibāyat bilād al-Yaman fī ʿahd al-sulṭān al-Malik al-Muʾayyad Dāwūd b. Yūsuf al-Rasūlī (al-mutawaffā sanat 721h/1321m)/Le Livre des Revenus du sultan rasûlide al-Malik al-Muʾayyad Dâwûd b. Yûsuf (m. 721/1321). (La bibliothèque yéménite/al-Maktaba al-Yamaniyya/Die Jemenitische Bibliothek, 2)*. Ṣanʿāʾ: al-Maʾhad al-faransī li-l-āthār wa-l-ʿulūm al-ijtimāʿiyya bi-Ṣanʿāʾ, al-Maʿhad al-almānī li-l-āthār, Ṣanʿāʾ/Centre Français d'Archéologie et de Sciences Sociales, Deutsches Archäologisches Institut, Sanaa Branch, 387).

As reported in a manuscript, the water law of the Wādī Zabīd was codified in response to violent disputes among the farmers of the Wādī Zabīd over water towards the end of the fourteenth century. Clearly, they felt that the allocation of the *sayl* according to the principle of upstream priority was unfair. A certain Muwaffaq al-Dīn ʿAlī ibn Abī Bakr al-Nāshirī is credited with having drafted the new law. He held the position of judge, *qāḍī*, in Zabīd from 1391 to at least 1400, that is, under the reign of the seventh Rasulid sultan, al-Ashraf Ismāʿīl (r. 1377–1400) (Salameh 1995: "Vorwort," "Nachtrag September 1997," 41–42, 58–67; al-Khazrajī 1906–1918, vol. 5: 220, 316).

The new water law of the Wādī Zabīd deviates from the *Sharīʿa* principle of unrestricted upstream priority in so far as it allocates the *sayl* by combining upstream priority and prescribed calendar dates. For example, the highest-lying area would have the right to use the water starting on a specific day for the duration of several weeks, the next area further down the *wādī* during the following weeks and so forth. Apparently it was felt that in this way, with the relative unpredictability of the *sayl*, the risks as well as the bounty were spread more equitably across the system. Clearly, al-Nāshirī took the natural conditions and established practice among the farmers of the Wādī Zabīd into account when he formulated the new law, that is, he integrated local custom.

The important role of local custom can also be observed in field irrigation in the Wādī Zabīd and it involves a second deviation from the *Sharīʿa*. When water is the limiting factor, one of the fundamental questions concerns how much water the individual farmer is entitled to. According to a regulation that is attributed to the Prophet Muḥammad, his *Sunna*, a field should be submerged to the height of a man's ankle, and then the field bank should be breached to allow irrigation of the next plot in succession. The aforementioned eleventh-century legal authority al-Māwardī points out, however, that this practice is not necessarily binding for everybody at all times and everywhere, since crop requirements, soil, climate and the availability of water differ. He does not consider his cautionary remarks as implying rejection of an explicit rule given in the *Sunna*. Instead, he interprets the rule about ankle-deep irrigation as reflecting the custom of a location where the Prophet Muḥammad settled a conflict over irrigation practices (al-Māwardī 1996: 257). After all, irrigated agriculture did not start with the rise of Islam, but was well-established in pre-Islamic Arabia, for which the oasis of Mārib can serve as a prominent example. Al-Māwardī's remarks are a reflection of the fact that the legal authorities of early Islamic times encountered customary rules of conduct that had been shaped over long centuries in accordance with a specific location's natural conditions and in response to the requirements of a community. It is this situation that is clearly taken into consideration by jurists such as al-Māwardī, even though recognizing local custom as a source of law can be problematic for certain legal experts.[10] For the Wādī Zabīd, the archaeological remains of field banks indicate that knee-deep irrigation was practiced instead of ankle-deep. Figure 6 shows exposed in section a field bank at the side of the Wādī Zabīd that became eventually buried in the rising irrigation sediments. Its construction and function correspond to the field banks described for the ancient oasis of Mārib, whose purpose was also knee-deep submersion of the fields. Given the hot climate, lack of direct rainfall and short duration of the *sayl*, this was the only way of ensuring that sufficient moisture would be stored in the soil to allow a crop to grow to maturity from a single irrigation.

CONCLUSION

From legal documents we know that the new water allocation law in the Wādī Zabīd did not solve all the problems. It was challenged several times. As an example, in 1570 the scholar Kamāl al-Dīn Mūsā ibn Aḥmad al-Dijāʿī completed his work *The Clear Statements about the Infamous Actions Which Happened in the Wādī Zabīd* (Salameh 1999). The author lists twenty such infamous actions, unlawful because they circumvent the water law in place. For instance, case 1 deals with barrages that were extended and made more solid, i.e. more permanent, and would therefore allow to divert more water than a particular primary canal (*sharīj*) was entitled to. A similar kind of manipulation is described in case 2, where the small temporary earth dikes built across a canal to direct the water into a unit of fields were constructed with bricks and mortar, i.e. made

[10] For a detailed overview of the relationship between customary law and *Sharīʿa*, see Donaldson (2000: 42–51).

Fig. 6: Remains of a field bank in section in the Wādī Zabīd (photo: Ingrid Hehmeyer).

permanent and would not allow water to pass to the next unit of fields in succession. Al-Dijāʿī's text is a reminder for everybody involved that the existing water law is binding, and this law is customary law (*ʿurf*).

Each time it was challenged, the water law of the Wādī Zabīd was upheld and apart from minor modifications it has been in use until the present. In the 1970s continuous sedimentation had raised the field levels to a point that made irrigation from the *wādī* impossible. As part of the Tihāma Development Project (completed in 1979), the main irrigation structures were built higher, and this time the diversion barrages and primary canal intakes were made permanent by using concrete instead of earth and stones, while leaving the subsidiary irrigation works and the general layout of the irrigation system largely unchanged. In preparation of the Project, a *Survey of the Agricultural Potential of the Wadi Zabid, Yemen Arab Republic: Land Tenure and Water Rights* was commissioned (Tesco-Viziterv-Vituki 1971).[11] It documented in detail the cycle of traditional water allocation according to the integration of upstream priority and prescribed calendar dates that makes the Wādī Zabīd water law unique in all of Yemen. The work recommended leaving the existing water law unchanged (Tesco-Viziterv-Vituki 1971: vii, 16), and this is what happened to a large extent.

The reason for its overall and long-term success is closely linked to the fact that customary law is shaped by the farmers themselves – in fact, many generations of them – who are intimately familiar with the natural conditions of a site, in the case of the Wādī Zabīd most importantly the variability of the *sayl* with regard to time and volume, and not by a legal authority who is removed from the harsh day-to-day conditions of irrigated agriculture in an arid environment. Or, in the words of Walter Dostal, unlike *Sharīʿa*, customary law is tailored to the specific needs of a group of people (Dostal 1987: 345–46). Its strength is its adaptability "in a very flexible way to changing circumstances" and thus, strictly speaking, it "contrasts sharply with the ideological vision of Islamic law as absolute, trans-historical and immutable" (Dostal 2005: 2).

[11] The main points are summarized in Kopp (1981: 125–28).

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