

## Traditional Systems of Water Conservation in the Eastern Bādiya of Jordan

This paper is concerned with the conservation of ground-water resources in the eastern Bādiya in the past and their management by local populations. Our knowledge of them comes from work with the present users of the area, through our research carried out in cooperation with Dr. Alison Betts' Burqu'–Ruwayshid Survey; from information in the volumes of Musil collected in the early years of this century; from the archaeological work of Dr. Betts and her team in the same area; and from Mr. Neil Munro of Hunting Technical Services and the Jordanian Soil and Land Use Survey. We would like to thank all those mentioned, as well as the Higher Council for Science and Technology, the Department of Antiquities, Dr. Elias Salameh of the Water Resources Department of the University of Jordan, Dr. Daud Eisawi Professor of Botany at the University of Jordan, and the Shurṭat al-Bādiya.

The ground water comes from rainfall. This can be as rain falling on and soaking into suitable soils, or as stored water collected on the surface from runoff, or deeper within the earth's crust where pockets of water collect having passed through particular soil and rock types. The rainfall in the Bādiya is by definition not high, varying between 200-100mm in a wet year to 50-25mm in a dry one (*National Atlas of Jordan*, Part 2: 13, 16). The effect of this variable rainfall for groundwater resources is exacerbated by the time of the year when it fell, and the weather conditions following the rainfall, as losses due to evaporation are greater if rain falls in hotter times of the year or is followed by hot dry winds. Such conditions not only affect the vegetation but also the period that surface water in pools remains, and the amount of sunsurface recharge which can take place. Nor is the rainfall uniform over the whole area; it is possible for there to be heavy rain in one place and somewhere a few kilometres away to be completely dry. Thus the rainfall is limited, irregular, unpredictable and spasmodic.

This rainfall produces water and grazing that are of use to people, thus allowing hunting, gathering, herding and the provision of services to people living outside the

Bādiya but who need its products. It is also of importance to those who travel across the area for a variety of purposes, usually trade, pilgrimage or administration. Differences in soils and rock formations, between limestone and basalt, and between salts in the soils, as well as amounts of rain and temperature, produce a varied if patchy vegetation. In favourable years, this vegetation produces good grazing in perennials and annuals and supports the animal and human populations that use the area in conjunction with other regions. The eastern Bādiya is environmentally part of the wider region of Bādiyat ash-Shām or the Northern Arabian desert, whichever nomenclature is preferred.

People and their domestic animals need water. As there are no springs in the immediate area, all water traditionally available was stored rainfall. The differences in rock formation and soil types permit a variety of storage facilities, of which the users of the area were well aware; for example, Musil (1928: 676-684) gives a list of some seventy terms concerned with water and water storage used by the Rwāla Bedouin using the eastern Bādiya in the early part of this century. Some of the systems were natural, some natural but enhanced, and some entirely artificial. We would like to concentrate on those types of water conservation that have been either enhanced by man or are entirely manmade. These fall into four categories; rock basins and *birak* (sing. *birkah*), wells, *ghudrān* (sing. *ghadīr*) and *maḥāfir* (sing. *maḥfūr*).

To consider the rock basins first; it may be said that these are essentially natural phenomena, and are simply used by people. However, to take the best known rock basin first, that of Burqu'; it seems that this has been, at various dates, enhanced by the work of man. Dr. Salameh considers that some enlargement may have taken place in the Neolithic. According to Helms (1990: 59) further developments were made in the Byzantine/Ghassanid period with the building of the first dam together with the building of the "Qaşr". Wisād, some 35kms to the south, is a smaller version of Burqu', being a series of linked pools, at least one of which, in the

opinion of Dr. Salameh, appears to have been enlarged artificially, possibly in the Neolithic. There is nothing technologically difficult about this; stones appear to have been removed from the bottom of the pool to deepen it. Both sites are within al-Ḥarra, the black basalt area, but near its eastern edge, and as would be expected, rock basins are more commonly associated with basalt formations. Rock basins need not be the size of Wisād or Burqu', which are exceptional, for there are many small rock basins whose stored water was used and which appear to have been enlarged for that purpose. Also, of course, there are a myriad of rock basins that have not been enhanced and which are still used on occasion. At Luthayma, in Tulūl al-Asqaf, there is a birkah which appears to be wholly artificial: it consists of an excavated pool lined with stones and enclosed by a stone wall. It is filled by channelling water runoff from nearby slopes. We have included it here because it was referred to by the people using the area as a birkah, although we would regard it more as an enhanced ghadir; but the purpose of the structure is more relevant to its users than our regard for its form.

The only traditional wells in the Jordanian eastern Bādiya are those in al-Ḥarra, like Bi'r Ghuṣayn. Before the development of new wells using new technology and financed by governments or shaikhs, people using al-Ḥamad (the limestone area to the east of al-Ḥarra) used wells further into Syria, Iraq and Saudi Arabia for watering their animals. The nearest wells in present-day Jordan available to the tribes who normally used al-Ḥamad were the wells at al-'Umari, southeast of al-Azraq. The wells in al-Ḥarra are not very deep, and exploit rainfall trapped underground by particular geological conditions. As they are entirely dependent on rainwater for their recharge, a series of poor rain-years cause some or even most of these wells to run dry; but traditionally users of al-Ḥarra moved northwest to the slopes of Jabal ad-Drūz or the Ḥawrān for the summer, thus reducing the pressure on the wells. In the late 1980s, when the movement of herds to the northwest became more difficult, both because of the increase in cultivated land and for political reasons, members of the local tribe dug new wells at Bi'r Ghuṣayn to replace those which had gone dry or fallen into decay. It was a swift process which we observed: one summer the well was being dug, by the next summer it was neatly lined with stones and fully operational. The reason for developing water conservation systems will be considered later, but given the particular geological and hydrological conditions in the area, neither birak nor traditional methods of well digging are possible in many places.

Ghudrān are probably the most commonly used water sources in the Bādiya, particularly in al-Ḥamad. Ghudrān are the places where water collects along the natural

wadi beds. The topography of al-Ḥamad is such that the groundrock appears to be relatively level. The rain runs off the slopes into the wadi beds which become scoured down to rock by the flow of water over the years. If the amount of water is sufficient, these wadis run with water and the flow is strong enough to carry the body of water past and over any obstacles in its course. But as the flow lessens, much of the water is trapped in basins in the wadi bed. These basins are ghudrān, and while undoubtedly they have their foundation in natural phenomena, it is also quite clear that many of them have been enhanced by the work of man. Sometimes these basins are deepened and widened; sometimes artificial blockages are made either to divert or trap water. Ghudrān are most noticeable in al-Ḥamad, particularly in the Ruwayshdāt where the topography seems to be especially suited to their formation, but there are also ghudrān in the shu'ub in al-Ḥarra. They vary a great deal in size and capacity: some are only 50 metres long while others may be up to several kilometres in length, although this enormous variation probably reflects the conditions under which they are seen. If they are visited after rain they are easy to spot, but if little or no rain has fallen they can easily be overlooked and appear as mere pockets of water in an otherwise dry wadi bed. Whatever their size, whether full or empty, artificially enhanced or not they are all referred to as ghudrān for, again, their function for users takes precedence over their form.

The maḥāfir are wholly artificial and are constructed in areas where there are no other water storage facilities possible. Not surprisingly they are found in areas which people wish to use for grazing or, possibly, along routes used for other purposes as well. Essentially they are artificial ghudrān, excavated basins with the displaced earth piled around. The exact intention of their design is not easy to determine: in some cases they appear to have earth (or stone-reinforced walls) to raise the water level artificially; in others the excavated hole appears sufficient. Some have low artificial walls to divert water into the excavated basin. In one case the maḥfir is a mere semicircular hook at the edge of a khabrah which traps water as it flows slowly past. Most maḥāfir are built along the edges of khabrāt, the natural mudflats (playa in technical terms) where much rainwater ends up. Unless the water is stored in maḥāfir it spreads itself over the entire area, often only a few centimetres deep and is fairly useless for watering stock. As a point of interest these playas are called khabrāt when filled, but qī'ān (sing. qā') when dry. Because of their size, the water is always shallow and evaporates quickly. The construction of maḥāfir enables a greater depth of water to be collected so that evaporation is slowed down and watering animals is made easier. Maḥāfir may be dug *impromptu* and only be of a size for an individual animal, or they may be up to

50 metres across with the excavated earth piled two to three metres high. These are for large numbers of animals and for repeated use over the years; several appear to have been rebuilt or modified at different times. While most maḥāfir are built on the edge of khabrāt, some are built along the edges of shu'ub or areas of vegetation collecting the runoff from surrounding slopes.

All the areas where these methods of conserving water have been practised also show evidence of use by man in the form of carvings of animals and patterns on rocks (where suitable rock exists), inscriptions, structures for storage or administrative purposes like the qaṣr at Burqu', the "markaz" type of layout in the Basāṭin and the "White Mounds", the "quṣūr" at Dumaythat Umm Qṣayr, the old "village" at ar-Rīsha, and the enigmatic structures at Wisād. Pottery may be found at sites of all types (but not at all sites), along some of the ghudrān, around some of the birak, some of the wells and some of the maḥāfir. While such evidence gives clear indications of human use, absolute dating is not possible. Some of the inscriptions are dated, such as the two at Burqu', one to AD 700 and the other to AD 1409-10 (Helms 1990: 57-58), but this only indicates the time of a visit. The Saffaitic and Greek inscriptions are seen as indicative of dates between the second century BC and the sixth-seventh centuries AD. The occasional early Arabic inscription found at some of the conservation systems do not apparently indicate a date except on somewhat controversial stylistic grounds. Some of the animal carvings, for example those at Wisād, seem to be of considerable antiquity as they portray animals, such as cattle, which are no longer found in the region. The majority of animal carvings, however, could, in our opinion, be of almost any date. The pottery from surface collections is all in tiny sherds too small to be of much use for even indicating dates; it all appears to be domestic wares (Dr. Cherie Lenzen, Ms. Alison McQuitty and Mr. Rob Falkner, pers. comm.). However, the excavation at the old "village" at ar-Rīsha produced pottery ascribed predominantly to the seventh and ninth centuries AD (Lenzen 1990: 156).

We know from the work of Dr. Betts and Dr. Garrard that the Jordanian Bādiya has been inhabited since very early times, and that these populations depended to a large extent on animals, either hunting wild ones or herding domestic ones. Taking the environmental constraints into account, the conservation of water would seem to be for animals and people and not for cultivation (though spasmodic rain-fed cultivation may have been carried out under favourable conditions). Looking at what the present users of the Bādiya say about the construction and use of water conservation areas, the emphasis is on individual decision and action in construction and maintenance. Use is primarily for the constructor and those

who are related or connected to him. This applies particularly to wells which represent a considerable investment by an individual or family. The ghudrān, like the khabrāt and the rock pools, are more open to use, and anyone in the area uses the water for his family and flocks, except where the individual who has improved the water catchment is in the area: he then has first call on that water. The same principle applies to the maḥāfir as indeed, it appears to apply to any enhanced natural resource all over the Arabian peninsula.

Who enhanced and/or constructed the large scale water catchments is not known. Nor is the exact method of construction known to the present day users of these ancient systems. However, every Bādiya user assumes he could enhance or construct a small scale *impromptu* catchment area, and has little doubt about his ability to make a large one. As they point out, everyone knows how to dig a well and the principles are not very different. Still nobody has suggested creating a new maḥfūr of any size and the construction of a really large scale one is a matter of hypothesis for them. Some, working on the analogy of wells, see no inherent reason why Bādiya users could not construct a large maḥfūr for themselves if they saw a need for such conservation. For example, the Maḥfūr ash-Shaykh near Anka' is said to be so called because it was made or cleaned out by the Sha'lān family, although present members of the family have no memory of this (it may, of course, be a metaphorical statement rather than one of historical accuracy). Others attribute the construction of most of these systems to the agency of some central administration, again in response to a specific need. This may well be true for some of them. The obvious needs that they mentioned were an increase in the number of animals, either for trade or administrative purposes, or a need for increased numbers of animals to stay in the Bādiya for longer periods of the year due to a loss of access to land further west. A series of different causes can be hypothesized, an increase in the cultivated areas (as is the case in the present), or because of political loss of territory (for example in the Mamluk and Ayyubid periods). However, more positively, the Bādiya users may have been responding to an increased demand for animals and animal products by town-dwellers (be they consumers or traders) or by the administration themselves, e.g. animals for warfare. Since these water systems are in the eastern Bādiya we would see them as essentially indigenous systems, developed by themselves for their own use, the systems being taken up and increased subsequently by more centralised administrations.

These Bādiya water conservation systems appear to complement those discussed by Betts and Helms at Ibn al-Ghazzī in al-Ḥarra, and by Gilbertson and Kennedy to the north of al-Azraq. In neither case have firm conclu-

sions as to dates been adduced for the structures, although there are possible indications that some may date from the PPNB period, others from late Roman-Byzantine or early Islamic times, while still others may be of a more recent date. While archaeological evidence, if available at these sites, will help, we feel that a close study of commercial history in conjunction with the political relationships between the Bādiya-users and centralised administrations at all periods represents the most likely path forward.

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