

THE WATER CATCHMENT SYSTEM OF NAKHL, JORDAN

by

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Introduction

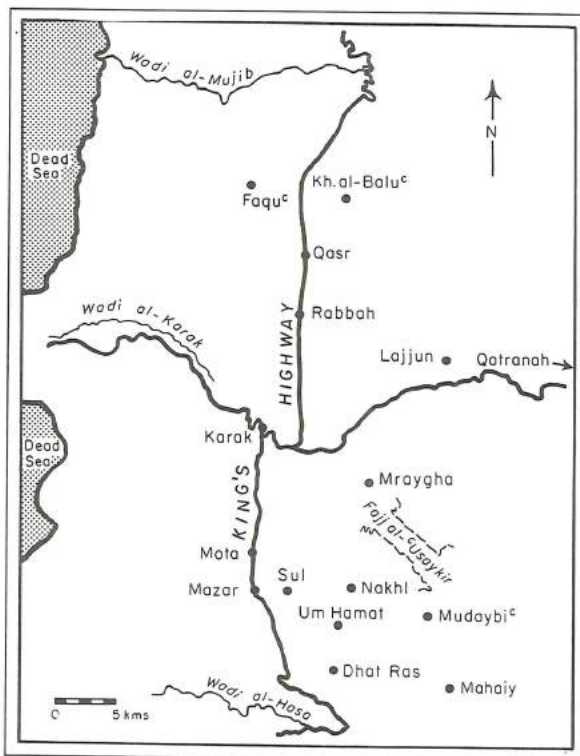
The pilot season of the al-Karak Resources Project (KRP), conducted between July 5 and August 7, 1995, was an intensive surface survey of seventeen carefully selected sites on the al-Karak Plateau. The plateau is 875 sq. km stretching between the Wādī al-Mūjib on the north, the Wādī al-Ḥasa on the south, the Dead Sea escarpment on the west, and the fringe of the desert on the east that is roughly marked by the modern Desert Highway. KRP is an outgrowth of the Miller-Pinkerton survey that was made between 1978 and 1983. That investigation examined 443 sites that ranged in date from Paleolithic to Ottoman times. The objective of the Miller-Pinkerton survey was to locate, name, place on a map, and extensively sherd ancient sites on the plateau. This information has proved to be invaluable in light of the fact that several sites observed on that survey no longer exist and others continue to disappear because of the rapid population growth that Jordan is experiencing.

The purpose of KRP is to build upon the work of the Miller-Pinkerton survey by employing a multidisciplinary approach to examine ways in which the ancient inhabitants of the plateau utilized the available natural resources of the area. It is our effort to study the interrelationship between archaeological remains such as architecture, artifacts, and off-site features and their environmental contexts, for example, climatic factors, water resources, surficial geology, and geomorphology. By examining both artifacts and ecofacts KRP hopes to contribute not only to the reconstruction of the history of the plateau, but to establish how, and on

what its ancient inhabitants survived, with the understanding that this knowledge will contribute to the future welfare of the people who live there. This underlying purpose, therefore, led KRP in its pilot season in 1995 to give special attention to surface features associated with water management at the seventeen sites surveyed. One particular site displaying remarkable evidence of the ability of its ancient inhabitants to harvest rainfall is Nakhl.

The Environmental Situation at Nakhl

Nakhl is an unoccupied ruin located about 8 km east of the modern town of al-Mazār, which itself lies about 13 km south of al-Karak on the ancient King's Highway (Fig.1). The extensive ruins cover an area of



1. Map showing location of Nakhl in the al-Karak region.

about 500 m (N-S)x300 m (E-W). The site, which is at an elevation of approximately 1100 m asl, is more than 1,500 m above the al-Ghawr. The edge of the uplands, at al-Ghawr, is approximately 20 km to the west. The site is situated at the head of three wadis, all of which drain into the Wādī al-Mūjib, the northern boundary of the al-Karak Plateau. The Wādī Sharmā is located on the southeast side, the Wādī Ghayth on the east, and the Wādī Nakhl on the northwest side. The Wādī Ghayth is structurally controlled by a graben, located about 3 km in an easterly direction, and extends southeasterly from the Wādī al-Karak toward the south-east, into Saudi Arabia more than 300 km away. Nakhl, interestingly enough, is located less than 9 km from the northern rim of Wādī al-Ḥasa, even though it is in the Wādī al-Mūjib drainage basin (see Koucky 1987: 31). This, of course, is due to the nature of the gentle north-easterly dipping strata making up the sedimentary rocks of the plateau.

The site of Nakhl is located on fairly resistant caprock known as the Bahiya Coquina. Beneath the limestone caprock the strata grades into a softer phosphatic chert formation which is more easily eroded. It also can be easily carved out to form cisterns or wells. Some caves, particularly on the eastern side of the site, are evident below the caprock as well. The "acropolis", upon which a Nabataean temple is situated, appears to be the center of the ruins. To the northwest of the temple, the headward erosion of Wādī Nakhl has penetrated the site. It is possible that this area has been subject to quarrying activities as well as other areas on the fringe of the site.

Nakhl, one of the larger antiquities sites on the al-Karak Plateau, required a considerable amount of water for its population, intensively cultivated crops and domesticated animals. The annual rainfall in this area is about 300mm, primarily falling during

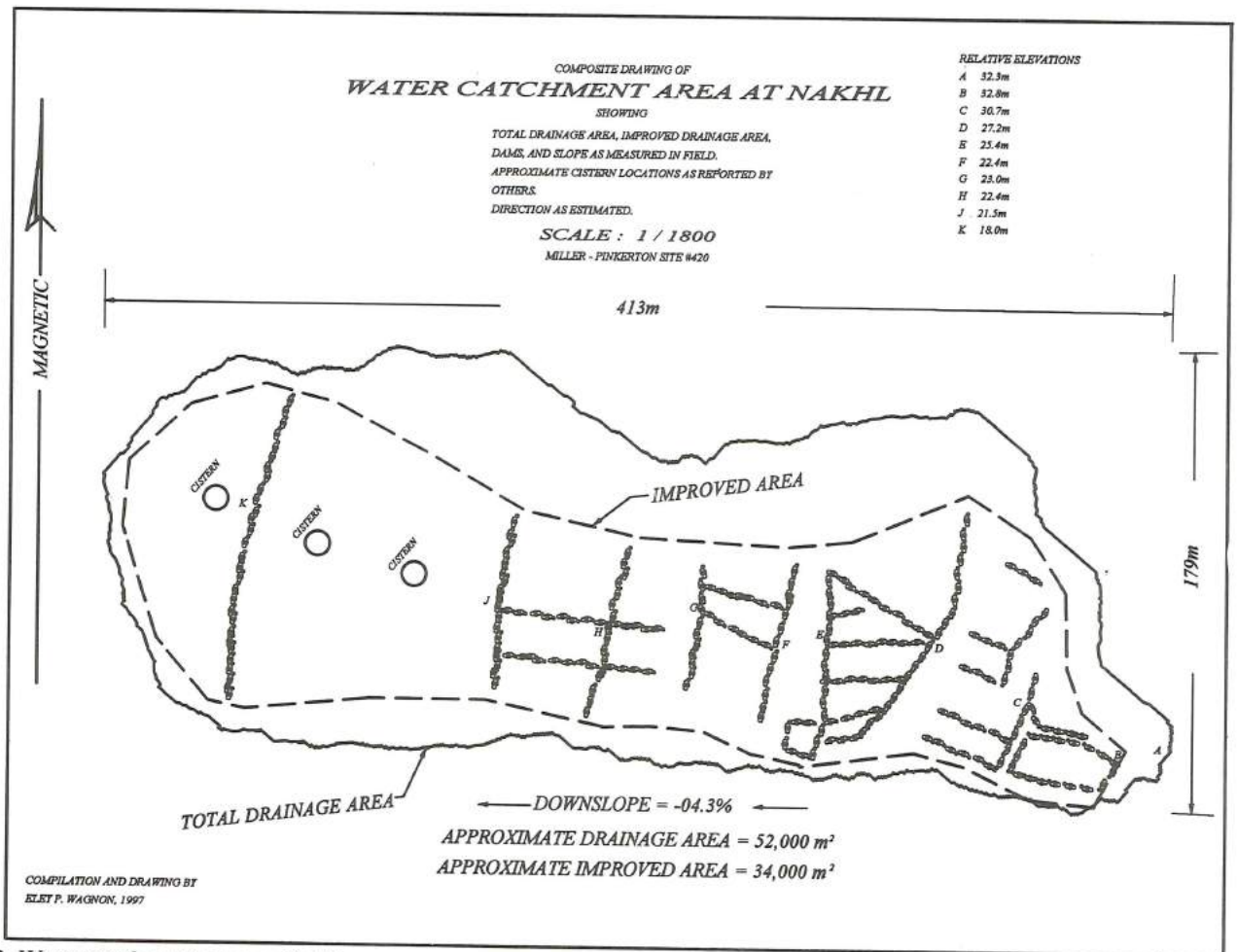
the winter months. Consequently, for centuries the inhabitants have sought a variety of ways to store water for the dry period during the summer when the temperatures and evapotranspiration achieves the highest levels.¹ Wells or cisterns were preferred more than surface water storage as their water loss by evaporation was considerably less. In the case of Nakhl, it is believed that the headwaters of the Wādī Nakhl were used in several ways (Figs. 2 and 3): (1) several lowlying dams were built to store water, usually filling the highest dam first, and then allowing the overflow to fill the next lower dam downstream; (2) several cisterns were strategically located and constructed to allow for subsurface storage of water from the surface run-off of streets and building; (3) several wells were constructed which allowed for groundwater inflow as well as overland flow for replenishment; and (4) lateral walls were constructed in the catchment area to retain moisture for crops or animals use.

Early Observations

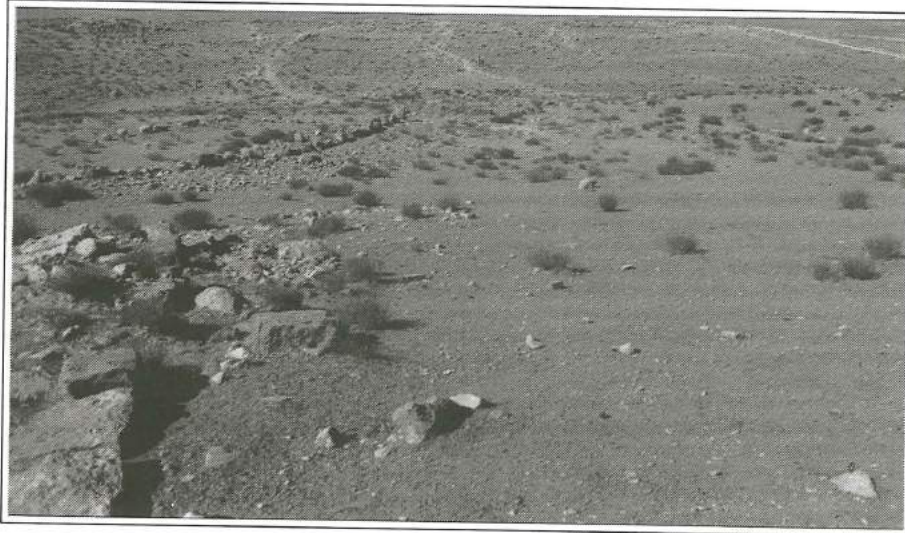
Alois Musil, who explored this area in 1896 and 1902, described Nakhl as "one of the most extensive ruins in the area" (1907: 324). Musil noted a wadi on the west side of the site with dams across it forming reservoirs. While commenting on the numerous cisterns in the area, he was most impressed by the masonry of the temple and fortifications on the east, which he compared to the pyramids of Egypt (1907: 324). In the thirties, Nelson Glueck observed numerous cisterns and walls on the site, and he dated them to Nabataean times. Like Musil, however, he was attracted to the large stone structures on the site. He wrote about seeing "a large building made of evenly cut limestone blocks, similar in the style of construction to the temple at Qasr Rabbah" inside of which a church had been

1. For recent research on the water catchment system in Wadi Faynan in southern Jordan, see Barker *et*

al., 1998: esp. 9-17.



2. Water catchment area at Nakhl.



3. The Nakhl catchment area from the north. The lighter areas are the walls across the wadi (Photo by Reuben G. Bullard, Jr.).

built (1934: 66). Miller's survey confirmed the presence of two major buildings, a Nabataean temple and nearby, a Nabataean/ Roman building with a Byzantine church inside (1991:155). The pottery that he collected there dated from EB 1 to modern times,

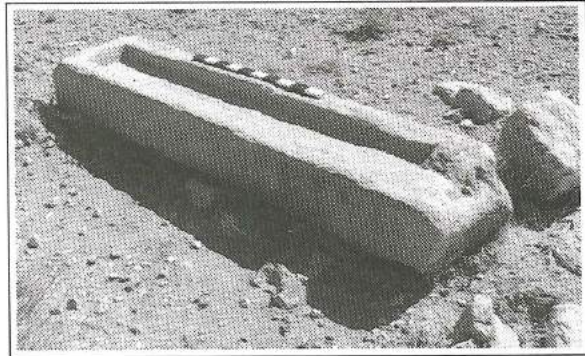
but the concentration was clearly Nabataean and Late Islamic (1991:154).

The Walls of the Western Slope of Nakhl

Miller's plea for closer examination of Nakhl was acknowledged by Robert Schick

and Mu'ta University, who recently conducted excavations of the impressive Nabataean buildings on the site. To date, however, no attention has been given to the walls across the wadi on the western side of Nakhl, beyond Musil's and Miller's acknowledgment that they are there (Fig. 4). For that reason, KRP spent a large portion of the two days of its 1995 season at Nakhl measuring, drawing, and photographing these walls. Additional data was gathered on a return visit in 1997.

The low walls were constructed perpendicularly across a wadi that forms a trough down the western side of the ruins, sloping in a southeast to northwesterly direction at a -04.3% grade (see Fig. 2). The total catchment area is about 52,000 m², while the walls themselves span an area of 34,000 m². They are 115 m to 70 m long, depending on the breadth of the depression at the point where they cross it (see Figs. 3 and 4). The width of each wall is about 4 m. Three cisterns (or wells) lie at the western end or bottom of the slope (Fig. 5). Adding to the complexity of this system are the low walls constructed perpendicular to the series of walls across the wadi, dividing the areas between the walls into smaller sections that may have been pools or reservoirs. Founda-



5. Stone watering trough near one of the cisterns at the lower end of the catchment area (Photo by Reuben G. Bullard, Jr.).

tions of buildings surround the wadi on all sides but the northwest, which is open and fans out to the cultivated land beyond. Thus the system of walls is remarkably close to the city itself, apparently part of it. Because the stones of the buildings along the perimeter of the wadi are more carefully worked, they stand in marked contrast to the building material of the walls in the wadi, which appear to be constructed of small unquarried stones that lay naturally in the area. In their present condition, the walls appear to be low dams that would retain run-off from rainfall and yet allow excess water to flow over into the area behind the next wall below. While soil may have been retained behind the walls at one time, there is none today; only depressions that



4. The Nakhl catchment area from the northwest (Photo by Reuben J. Bullard, Jr.).

look like pools or reservoirs lie behind the walls today. Each wall is a rather crude line of rubble clearly higher than the land behind and in front of it.

Similar Systems of Walls in the Levant

Walls across wadis have been observed on both sides of the Jordan Rift and are understood to be systems for harvesting water in areas so arid that agriculture would not be possible without them. They are praised as examples of ancient ingenuity as well as models for the future development of land dependent solely on water provided by the run-off of seasonal rains (Shanks 1988: 40-42). The classic study of the use of walls in water catchment systems can be found in Evenari, Shanan, and Tadmor's interdisciplinary study of the an-Naqab. Using aerial photographs, they were able to locate a "dense network of ancient fields, farms, terraced wadis, and floodplains" associated with the six desert cities of Avdat, Shivta, Nitzana, Kurnub, Khalutza, and Rukheibe (1982: 97). The walls, which were all associated with agriculture, can be classified into three categories: (1) individual terraced narrow wadis, (2) groups of terraced fields found in conjunction with farmsteads, and (3) extensive water diversion systems on the floodplains of large wadis (1982: 97).

The "individual terraced wadis" look like ladders from the air. They are terraces formed by walls at right angles to the wadi. Concerning the function of these terraces the authors make the following observation:

The agricultural function of the terraced wadis may be deduced from their structure and from observations of flash floods. In these terraced wadis, floodwater cascades gently down from terrace to terrace. During the flow some water sinks directly into the terrace soil, and some is ponded behind the terrace wall and later penetrates into the ground. These terraces are therefore ancient erosion and flood-control structures. The wetting of the terrace soils enables them to be put to agricultural use. Even

today some enterprising Bedouins sow some of these areas to barley after an early winter flood. In many cases yields can be considered good by the standards of the Bedouin (1982: 97).

The authors speculate that the terraced wadis date to Middle Bronze 1 since sites dating to that period were found on the nearby Ramat Matred (1982:99). Thomas Levy has found terracing at Shiqmim and along the Nahal Beersheba drainage basin dating to the Chalcolithic period (1990: 25).

A more common occurrence in the an-Naqab is the second category, groups of terraced fields surrounded by a stone fence which also often encloses a farmhouse or watch-tower. These farms, called "run-off farms" by Evenari, Shanan, and Tadmor, all exhibit two basic features: cultivated terraces in the wadi bottom and water conduits directing water from the hillsides in the area. It is estimated that during the Byzantine period run-off farming supported "tens of thousands of people and encompassed practically all of the usable bottomlands (the vales and wadi beds) in the northern Negev" (Hillel 1994: 68).

To the north, in the Buqe'ah, a small isolated basin in the northeastern Judean desert, Lawrence Stager has noted similar structures used by ancient farmers (Stager 1976). He describes a farm consisting of seven terrace dams across the wadi 150 m south of Khirbat Abū Ṭabaq. The seventh century BC pottery found at Khirbat Abū Ṭabaq led Stager to date the adjacent fields and dams to the Iron Age. He claims that this area became part of the political and economic sphere of Judah during in the seventh century BC because it allowed access to the mineral rich Dead Sea and its western littoral plantations stretching from Khirbat Qumrān to En Gedi. Khirbat Abū Ṭabaq, along with Khirbat as-Samrā' and Khirbat al-Maqari formed a line of "paramilitary outposts" to protect the Buqe'ah route from robbers. Farms such as the one near Khirbat Abū Ṭabaq were established in

connection with these outposts. All of this was abandoned with the Babylonian conquest early in the sixth century BC (1976: 145). He rejects the dating of the farms in the an-Naqab to the Middle Bronze Age, maintaining that the earliest farms at Ramat Matred date to the late tenth and early ninth century BC (1976: 157).

Regardless of the time of its inception, water harvesting by networks of terraced wadis, most likely reusing older structures, continued and reached peak usage in the Byzantine and Umayyad Periods (Haiman 1996: 34; Hillel 1994: 72). Abandonment of the farms coincided with the move of the Abassids to Baghdad. This pattern indicates that the ebb and flow of agricultural settlements in the an-Naqab highlands represents deliberate incentive programs of strong central governments with invested interests in the frontier. Hence Mordechai Haiman concludes that "nomadism and sedentarism were affected more by geopolitical conditions than by natural environment" (Haiman 1996: 47; Abujaber 1995: 740).

An example of Evenari's third category of agricultural water systems is found near Kurnub (Glueck 1959: 207-213). At the point where the Wādī Kurnub enters the Tureibe plain, ancient settlers built a large channel to divert water into a series of terraced fields. These diversion systems in wadis differ from the farm units in size. Whereas the small farm units rarely exceed five hectares, the diversion units cover tens and even hundreds of hectares (1982: 110). The Kurnub system was found to have been constructed in three stages (1982: 112). Similar diversion systems can be found in Nahal Avdat (Wādī Ramliye) and in Nahal Lavan (Wādī Abiad). On the basis of pottery sherds found in the vicinity, these systems can be dated from the Middle Bronze 1 to the Nabataean-Roman-Early Byzantine period, with the complex wall systems dating most likely to the latter. An inscription was found *in situ* in the Ramliye area say-

ing: "This is the dam which Garmo and his friends built in the 18th year of our Lord Rabbel who brought life and deliverance to his people." This is Rabbel II, who ruled in AD 88-89 (Evanari, Shanan, and Tadmor 1982: 119).

Systems of dams occur at numerous sites in Jordan. An earthen dam that may have been constructed to slow run-off and increase infiltration was found in the al-'Umayrī region by the Mādabā Plains Project (Cole 1984: 42). Likewise, ancient looking terracing at irrigated areas near springs like 'Ayn Ḥisbān and 'Ayn Mūsā have been observed in the Tall Ḥisbān area (Lacelle 1986: 64).

Nelson Glueck recorded both dams and terraces in the area south of the al-Karak Plateau. He found Early Bronze 1, Early Bronze 3 and Middle Bronze 1 sherds on the terraces on the north slope of the western part of the Wādī al-Ḥasa at Khirbat Umm as-Sedeirah. He claimed that "the presence of this site on the slope of the Wādī al-Ḥasa was made possible so far as the practice of agriculture by its inhabitants is concerned first of all through careful terracing, laboriously carried out throughout many generations and centuries" (1970: 145). Glueck described similar systems of walls at aṭ-Ṭilāḥ and dams at Sela' near Buṣayra and at Rukhemtein in the Wādī Ramm (1970: 61, 197, 195).

John Peter Oleson describes dams across wadis in the area of al-Ḥumayma, ancient Auara, a Nabataean and Roman site in southern Jordan:

Although the Bedouin around Humeima now commonly make use of earth and stone wadi barriers to slow the progress of erosion and foster the infiltration of run-off water into the fields during the winter, only two possibly ancient structures of this type were catalogued. By their very nature, such barriers are vulnerable to complete destruction, and in the immediate vicinity of Humeima the recent use of tractor-drawn ploughs in the ancient fields has obliterated any

traces. One of the two sets of barriers tentatively accepted as ancient differs from the modern examples in being constructed of large boulders rather than of earth or small stones. The antiquity of the other is suggested by the presence nearby of ancient architectural remains (Oleson 1991: 49-50).

He distinguished the dams across wadis from the terracing of slopes, which also served the purpose of holding back rain water to increase absorption and, at the same time, created level surfaces for planting crops (Oleson 1991: 50; 1992: 890; 1995: 709, 713). Oleson recorded six sets of terraces in the al-Humayma region (1991: 48).

Conclusion

The walls across the depression on the eastern slope of Nakhl bear all of the markings of being another example of water management by the ingenious inhabitants of arid lands. At present we can surmise that they are similar in function to those at al-Humayma in southern Jordan. The factors common to both sites are the presence of the Nabataeans, low dams across the wadi, walled terraces on the slopes of the wadi, and additional cisterns in the area. The catchment facility at Nakhl, however, is unusual in that it penetrates the city itself.

Several questions remain, however. The first concerns the dating of the system. While it is enticing to date the structures in the wadi to the Nabataean period, there is no evidence to do so positively. The walls could have been built at any period. Regardless of when they were constructed, it is very likely that they were reused by the inhabitants of the area, possibly even after the city ceased to be occupied. This may account for the location of the series of walls so close to the city ruins. Possible modification of the walls as sheepfolds in recent times also confuses the matter.

A second question concerns the purpose of the system of walls. In light of other examples of runoff farming in similar adjacent areas, the walls most likely functioned as low dams for agricultural terraces. Water would be retained by the wall, which served as a low dam, allowing it to percolate into the soil. Excess water would flow over the dam to the next terrace downslope. Such a water management system would provide enough moisture for crops or orchards to grow close to the city. Also possible, but less probable, is that the walls simply held rainwater in pools or reservoirs for watering animals and for non-drinking purposes of the humans occupying the site.

The answer to these questions must await excavation and the analysis of soil samples from the area of the wall complex. Regardless, Nakhl is one of the most spectacular ruins on the al-Karak Plateau. Its natural location provided numerous opportunities for water resources development. That the ancient inhabitants of Nakhl were skillful in exploiting their natural environment to supply their water needs is attested by the numerous cisterns and wells that can be found there. It stands to reason that the water catchment system on the western slopes of Nakhl was another example of their ingenuity.

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