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## **Terrace Cultivation in the Jabal Hārūn Area and its Relationship to the City of Petra in Southern Jordan**

### **Introduction**

The Finnish Jabal Hārūn Project (FJHP) comprises the excavation of a monastic complex on the top plateau of Jabal an-Nabī Hārūn and an intensive archaeological survey around the mountain. The Jabal Hārūn area is located approximately 5km southwest of Petra, at an elevation of 800-1000m asl, on the eastern edge of the Wādī ‘Araba. The semi-arid environmental setting, with a mean annual rainfall of ca 150mm, means that the area offers only limited possibilities for humans to utilize the land. Most of the rainfall comes during heavy storms, which cause flash floods in the wadis. Despite these climatic restrictions, dry cultivation of cereals can be practised on the upland plateau, but not without special techniques. Due to the aridity and sparse vegetation in the area, herding is most profitable way for people to make their living.

This paper aims to discuss changes in cultivation practices in the Jabal Hārūn area since ancient times to the present day. It is assumed that conclusions about cultivation practices can be drawn from the study of hydraulic structures related to different archaeological periods. In addition to the numerous barrages around Jabal Hārūn, there are datable finds and various other structures, which may be related to agriculture or habitation in the area. We should also take into account the possible significance of the roads running through the Jabal Hārūn area between Wādī ‘Araba and Petra. Travellers would have needed food and water supplies, and the agricultural activities may have been related to the active caravan routes crossing the area.

Three basic hypotheses can be postulated for explaining the correspondence between archaeological evidence and land use in the past. Firstly, environmental conditions and changes have been the crucial factor in bringing about changes in ag-

ricultural practices. Secondly, changes in cultivation practices most importantly reflect changes in societies. Finally, a complex combination of both factors may have been at work.

The general objectives, research questions, methodology and central results of the FJHP survey have been covered in many earlier articles (see Frösén *et al.* 1998, 1999, 2000; Lavento *et al.* 2004a, *forth.*). These issues are therefore not included in this discussion.

### **Cultivation in Dry lands**

Ancient agricultural installations in the Negev desert have been studied extensively from as early as the 1950s (for example Bruins 1986; Evenari *et al.* 1961; Glueck 1968; Mayerson 1962; Morris 1961; Rubin 1988; Zohary 1954). There are indications that run-off farming began during the Chalcolithic and was practiced through the Bronze and Iron Ages in the Negev (Bruins 1986: 36-38). After a millennium, the next signs of run-off farming are from the Nabataean period, from the first century AD (Bruins 1986: 36-38). The rain-fed agriculture practiced by the Nabataeans relied on a complex system consisting of barrages in the wadis and terraced fields on the slopes. Such installations are known throughout the Nabataean kingdom and have been studied extensively especially in the Negev (e.g. Bruins 1986; Evenari 1997; Mayerson 1962). In the central Negev hills, where these systems are common, they are dated to the Nabataean-Byzantine period. In the Negev, the technology for run-off farming peaked during the Byzantine period. Cultivation as a large-scale enterprise was apparently abandoned during the latter part of the Early Islamic period (Haiman 1995: 34).

Many authors discussing Petra and other nearby Nabataean sites mention the existence of hydrau-

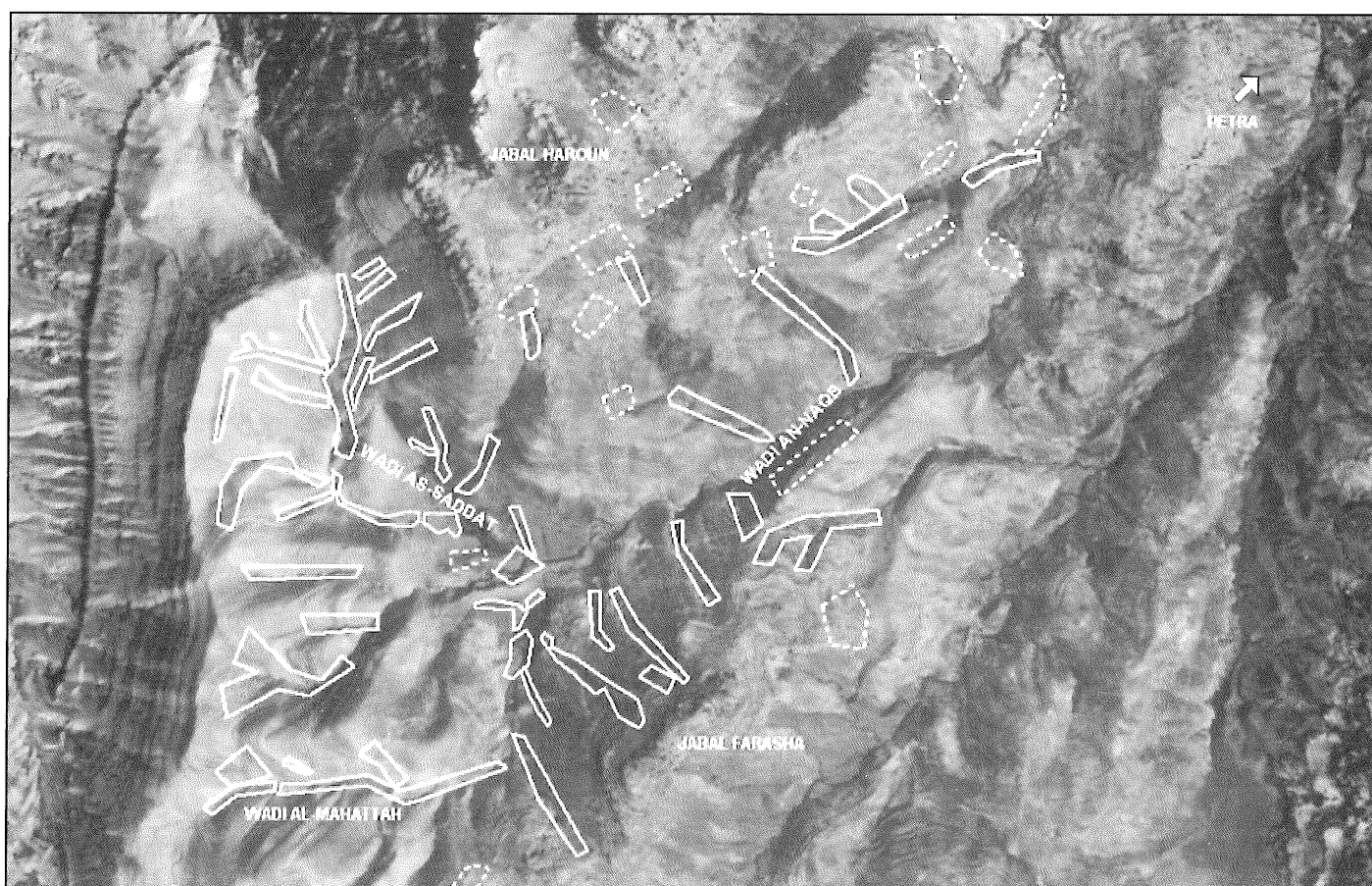
lic installations in the surrounding landscape (e.g. Lindner *et al.* 1996a: 111-113; Lindner *et al.* 2000: 553; 'Amr *et al.* 1998: 504, 516, 532, 539; Tholbecq 2001: 403-404). However, a more detailed study of these systems seems to have received less attention near the Nabataean capital than in other areas of Jordan, where surveys have focused on rural areas (e.g. Mattingly *et al.* 1998; Oleson 1988).

In addition to the hydraulic installations, water channels and cisterns have also been constructed at least since the Iron Age. Starting in the Nabataean period, water was conducted from springs to settlements in the modern Wādī Mūsā area and eventually down to Petra (see e.g. 'Amr and al-Momani 2001: 259, 267, 270). Although water conduits and cisterns have been used also on the top plateau of Jabal Hārūn (Frösén *et al.* 2003: 309-310), unambiguous evidence of cisterns or water channels has not been found in the area surrounding the mountain.

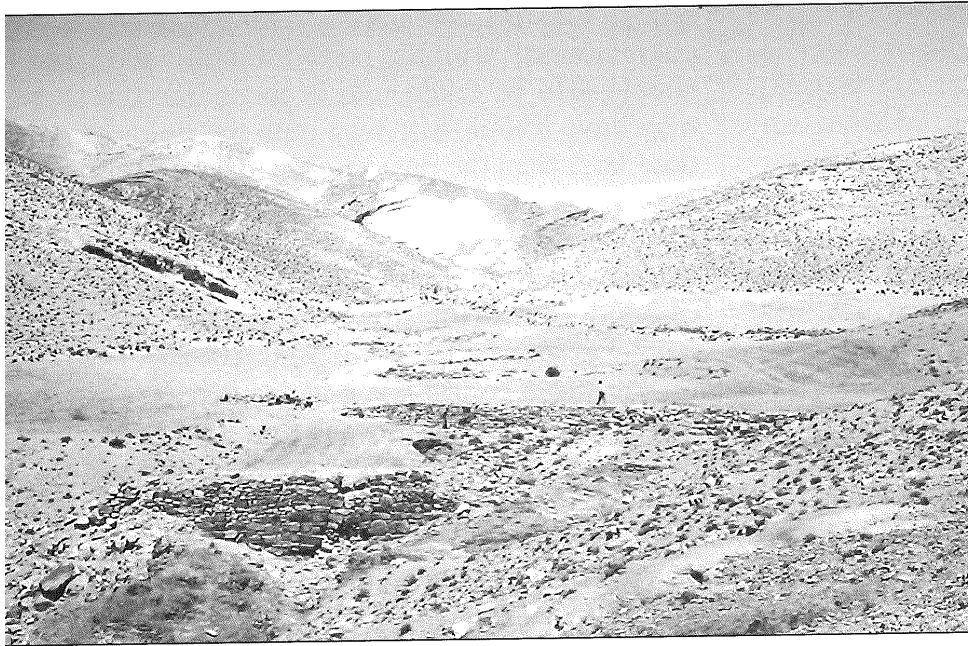
The part of the FJHP survey area to the west and south of Jabal Hārūn is characterized by several wadis and their numerous tributaries. Hydraulic in-

stallations, i.e. barrages (dams) and terrace walls, have been built all over the area, forming an extensive run-off farming system (FIGS. 1, 2). Remains of terraces and barrages have also been recorded in the area between Šabrā and Jabal Hārūn (Lindner 1986: 137-138), and similar constructions are known everywhere in the Petra region ('Amr *et al.* 1998: 504, 516, 532, 539; Tholbecq 2001: 403-404). However, the installations in the Jabal Hārūn area are exceptional because they are concentrated in a small area and display a high level of technology and functional interdependence. This suggests a large project under common administration and management (Frösén *et al.* 1998: 495-498).

Even though the valley where the city of Petra is located is not suitable for agriculture, the sandstone and limestone hills around the city are suitable for cultivation on terraced fields (Al-Muheisen 1990: 206-209). The Wādī Mūsā Water Supply and Wastewater Project Survey has documented several agricultural terraces and wadi barrages dated to Nabataean times ('Amr *et al.* 1998). Agricultural fields ("gardens") irrigated by run-off systems have



1. The main part of the run-off farming system in the Jabal Hārūn area presented on an air photograph. Lines: barrage systems, dotted lines: areas with terrace walls.



2. Well-preserved barrages and barrage-terraces at the foot of Jabal Hārūn.

been observed at Umm Rattām (Lindner *et al.* 2000: 553-554). The region of Ba'ja was an important agricultural provider in the Nabataean period. This area is also currently under cultivation using dry farming techniques, and seemingly the rainfall is sufficient for watering the cereals and olives grown there (Al-Muheisen 1990: 209-210; 1992: 215).

Somewhat farther away in Wādī Faynān, about 40km north of Petra, there is an extensive field system indicating planned agriculture and water management, dated mainly to the Roman and Byzantine periods. In Wādī Faynān, the construction and management of the field system during the Roman and Byzantine periods was an imperial enterprise, related to the industrial-scale mining of copper in the area (Barker *et al.* 1997: 27-32, 1998: 9-17, 1999: 269-281, 2000: 42-44). The structure of the Wādī Faynān farming system resembles the system in the Jabal Hārūn area. Two examples of stepped water control structures (i.e. spillways) in barrages were also observed in Wādī Faynān, similar to those at the FJHP Site 33 (FIG. 3) (Ruben *et al.* 1997: 433, 443-444).

In the FJHP survey area, two basic methods of cultivation by runoff irrigation can be separated, namely the main and tributary wadi cultivation and cultivation on the slopes (see Lavento *et al.* 2004b). Also the differences in topography and bedrock have resulted in considerable variations in the hydraulic installations (Lavento and Huotari 2002; Lavento *et al.* 2004b). Similar observations have been made in the Negev by Evenari (1997), Bruins (1986; 1990), and Mayerson (1962). Be-



3. A stepped structure in a barrage at FJHP Site 33. Similar structures have been recorded in Wādī Faynān.

cause rains come seasonally, during a short period of time, water needs to be preserved in cisterns or

pools or absorbed into the soil to prevent evaporation. The most effective way to retain water is to build barrages across wadis. Water can then be stored in small pools (or cisterns) from which it can later be directed to the areas under cultivation. As water runs into pools, it also transports the fertile fine sediments that are deposited behind barrages. Erosion can be reduced by building terrace walls across slopes. The walls retain fine sediments, which would otherwise be washed away by rainwater, and increase the infiltration of water into the soil. Sometimes it is necessary to use channels to conduct water into areas with more even topography where it may infiltrate more easily (Frösén *et al.* 1999: 398). Small fields can also be farmed on the slopes.

### Dating the Run-off Farming System

The dating of terrace walls and barrages is problematic due to their long history and usually simple construction. In the Wādī Faynān, there is evidence that some of the field walls may date to the Bronze Age (Barker *et al.* 1997: 35-36). An Iron Age date has been suggested for some of the terrace walls in the Petra area (Lindner *et al.* 1996b: 150), but most of the barrages and terrace walls have been attributed to the Nabataeans (Lindner *et al.* 1996a: 114; 'Amr *et al.* 1998; Tholbecq 2001: 403-404).

Small soundings excavated in several barrages in the Jabal Hārūn area have revealed that the structures have clearly been used, repaired and remodeled at several stages over a long period of time. However, attempts to date the structures via scientific means have not produced satisfactory results. C14 dating of macrofossiles gave recent dates and OSL dating of sediments did not yield dates accurate enough for establishing a chronology for the phases of barrage construction and abandonment.

For the dating of the hydraulic installations we should also take a look at other archaeological materials. The analysis of Nabataean fine ware pottery from the FJHP excavation and survey indicates that the first century AD was the period of the most intensive Nabataean presence in the FJHP area (Lavento *et al.* 2004a: 232). The fairly even off-site distribution of pottery could be the result of the practice of intensive manuring in the fields in Nabataean times (e.g. Alcock *et al.* 1994: 138; Bintliff 2000: 209; Wilkinson 1989: 41). However, even if manuring explains how the background scatter of sherds was formed, the problem of chrono-

nology remains. The pottery dating may be entirely contemporary with the period of cultivation, but it should also be taken into account that the sherds may have found their way onto the fields at some time later than the date attributed to them on typological grounds. However, pottery finds in the Jabal Hārūn area, seem to decline around the time of the Roman annexation in 106AD. Also the majority of building structures, including a farm or a small hamlet (Frösén *et al.* 2003: 309-310) appear to date to Nabataean period, the first and early second centuries AD, although often their chronology cannot be securely fixed (comp. 'Amr *et al.* 2000: 233).

### Environmental Impact

The minimum mean annual rainfall for dry cultivation is considered to be ca. 200mm (van der Veen *et al.* 1996: 254), which is met on the slopes of the ash-Sharā range and the western parts of the Jordanian highlands. However, the minimum amount of rainfall required by olive, vines and fruit trees is 300 mm (van der Veen *et al.*: 255), which at present day is only reached in the Ash-Shawbak area to the north of Petra (Shehadeh 1985: 30-31). This indicates that floodwater or run-off farming systems or irrigation were needed for successful cultivation in much of the Petra area. The data from Byzantine-period Negev and later reconstructions have shown that the annual rainfall of 100mm could be transformed into more than 400mm of effective rainfall by the collection of run-off, which would be sufficient not only for cereals, but also for vines, olive and fruit trees (Rosen 2000: 50-51). Results of remarkably high yields for both wheat and barley under run-off cultivation have been reported in ethnoarchaeological studies of traditional agriculture in the Petra area (Russell 1995: 696-698).

The climate of the Near East has generally resembled that of the present for the last 7000 years, although there have been fluctuations between more humid and more arid phases within the semi-arid climatic regime (Bar-Matthews *et al.* 1997: 161-166). Based on Dead Sea levels, the climate was relatively more humid during the Nabataean-Roman period from the first century BC to the third century AD, but following it between ca. 300-850AD there was a more arid phase (Bruins 1994: 307-308). There is evidence in the Petra papyri that the fields owned by one person were distributed among different geographical areas, perhaps as a response to the variability of the rainfall and to ascertain that at



least some of the fields received enough rainfall for cultivation from year to year (Koenen 1996: 184). On the other hand, despite the apparently adverse climatic conditions, desert agriculture reached its widest extent in the Negev during the Byzantine period (Rosen 2000: 45-51).

On the basis of this information we can expect that changes in humidity have also taken place within the range of centuries in southern Jordan. It seems that the more humid period around the turn of the Christian era witnessed also the most intensive agricultural activity in the Jabal Hārūn area. Likewise it is possible to connect the more arid phase during the Byzantine and Early Islamic period with the apparent decrease of cultivation and human activity. The adverse climatic setting might explain why the monastic complex on Jabal Hārūn did not utilize the surrounding area as much as might have been expected.

The core of this hypothesis is that the Jabal Hārūn area is very sensitive even to small changes in climate. This hypothesis assumes that already a few dry years could have changed the sensitive environment essentially and made run-off cultivation unproductive for a long period afterwards. The problem with brief climatic changes is that they are almost impossible to observe in the archaeological data or in the sedimentary record around Jabal Hārūn. Nevertheless, they may have played an important role in the cultivation history of the area.

### Human History and Agriculture in the Jabal Hārūn Area

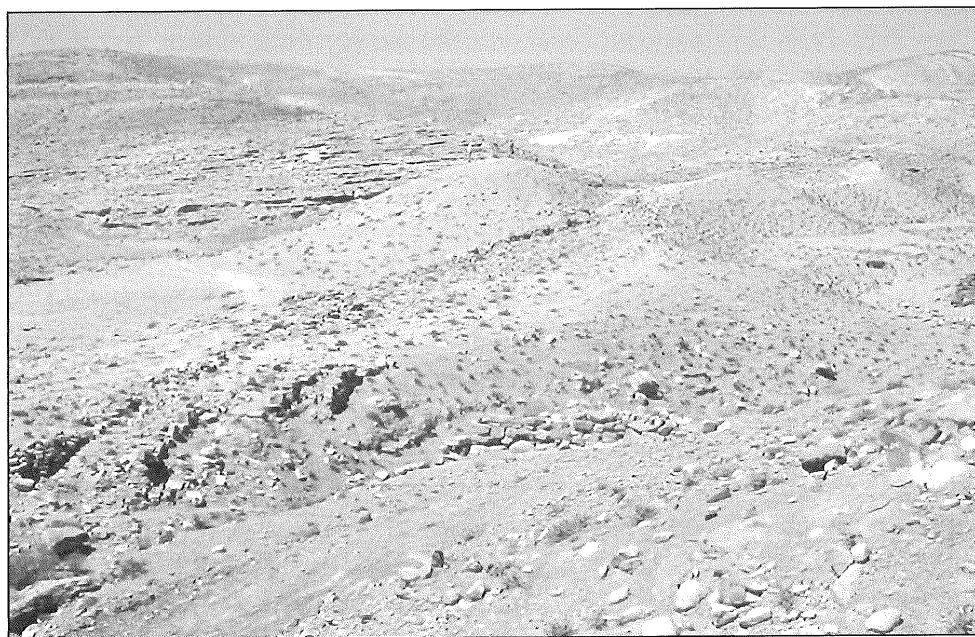
The Nabataean capital of Petra was established in the first century BC at the crossroads of several caravan routes and experienced its heyday during the first-third centuries AD. In 106AD Nabataean was annexed by Rome. As the capital of the Roman province of Arabia, Petra continued to be a prominent urban centre also under Roman rule (Fiema 2002a: 1).

It has been postulated that during the Nabataean period the need for arable land grew as a result of the growth of the city of Petra (Lindner 1986: 153, 172; Lindner *et al.* 1996a: 114). It can be suggested that after the most productive areas were already taken into cultivation, the areas less suitable for agriculture were also needed. The area surrounding Jabal Hārūn represents this type of marginal environment for agriculture. Cultivation in the area is not possible without some form of artificial ir-

rigation. The large amount of Nabataean fine ware ceramics all over the survey area, dating to the first and the early second century AD (Schmid 1996), may indicate the importance of the Jabal Hārūn area during this period.

The spread of pottery not related to settled activities is most often explained by manuring, which creates relatively even spreads of sherds over the fertilized fields (Alcock 1993: 84). Manuring is thought to be connected with intensive agricultural practices such as horticulture and relatively small field size (*ibid.*). In addition to water management installations, there are other structures of different types in the survey area. Some of these may have been related to agricultural activities while others are probably connected to the ancient road running through the Jabal Hārūn area from Petra to Wādī ‘Araba. The overall picture of the surroundings of Jabal Hārūn during the Nabataean period is that of a largely rural area servicing Petra. The population of the area may have lived in the smallish buildings that are now in ruins, or they could have led a semi-nomadic lifestyle, living in tents while farming the fields.

The intensification of the use of the Jabal Hārūn area during the Nabataean period was probably encouraged by growing traffic on the caravan route, traces of which can be seen in the southwestern part of the FJHP survey area (FIG. 4). The road seems to split in two at the foothills of the mountain: one stretch continued east to Petra and the other one curved north to Umm Rattām via Naqb ar-Rubā‘ī. The remains of the separate branches cannot be seen in the survey area. This probably results from the recent construction of a modern road, which most likely follows the pre-existing route. Although the remains of the road to Petra end by the southwestern foothills of Jabal Hārūn, structures that can be tentatively related to the continuation of the road have been found. Some stone tumbles, probably the remains of small buildings, have been located also by both stretches of the existing road. In addition, there are the remains of a watchtower (FJHP Site 54) with a view to the Wādī ‘Araba as well as to the direction of Petra. A larger multi-room structure (FJHP Site 49) close to the watchtower may indicate that the caravans were staying overnight in the area (Frösén *et al.* 2000: 415-418). An open camping ground with no built structures (FJHP Site 25) has also been tentatively identified. The locals still know the place as a caravan camping site (Lindner



4. The ancient road on- the southern foothills of Jabal Hārūn.

*et al.* 2000: 539). However, modern land use may have altered the appearance of the structures and perhaps some of the remains are entirely modern.

Caravan camping grounds are also found elsewhere around Petra. A good example has been studied by Kloner (1996) along the road between Naqb Sulaysil and al-Bayḍā to the northwest of Petra. The site includes cisterns and camping grounds. According to Kloner (1996: 132) it was the centre of caravans proceeding mainly to the east and south, passing Petra at some distance to avoid its taxation. Zayadine and Farajat (1991: 281) highlight Bayda as an ideal place to halt due to its water reservoirs and more open terrain compared to the narrow valley in Petra, accessible only with difficulty. Structures of similar character are found also in Ṣabrā (see e.g. Lindner 1997/1998: 563).

The caravan routes through the Jabal Hārūn area share similar characteristics with those via Wādī Ṣabrā and Bīr Madhkūr, although they were not as popular and widely used. The caravans needed water and food supplies, as well as open terrain with good visibility of the surroundings for safer sleep when stopping for the night. All the sites presented here were able to meet these requirements. At the time when the Roman Empire took over the territory and concentrated the traffic to run south to north along *Via Nova Traiana*, the number of small farming communities and amount of agricultural production declined considerably (Graf 1992: 260; Lindner 1992: 266).

Long-distance caravan trade may have diminished in the third century, affecting also Petra (Fie-

ma 2002a: 1-2). During the fourth century geopolitical changes in the province of Arabia altered the status of Petra and the surrounding areas. Earlier it was believed that Petra declined seriously during the fourth century and was finally wiped out by an earthquake in 551AD. However, the finding of the Petra Papyri has changed this picture. The papyrus archives span almost the whole of the sixth century and have provided evidence of a provincial town that continued its life through the supposed destruction much as before (Koenen 1996; Fiema 2002b). There are some changes, however: trade no longer seems to be very important, as evidenced also by the archaeological finds in Petra itself, which include very few imported items (Fiema 2002b: 225), and land holdings seem to have become the main source of income for the wealthy citizens of Petra. Much of this property appears to have been agricultural land (Koenen 1996: 179-180).

Changes in land ownership and estate size may have influenced the land use practices from the Nabataean and Roman to the Byzantine times. Alcock (1993) has convincingly argued with data from Classical and Late Classical Greece that larger estates and the concentration of land-ownership into fewer hands result in the nucleation of rural settlement and more extensive agricultural practices. The Petra Papyri indicate that there were a few families owning large areas of agricultural land in Byzantine Petra (Koenen 1996: 183-184, 187-188). The decreasing number of settlement sites from the Nabataean to the Byzantine times has been noticed in many surveys ('Amr *et al.* 1998; Tholbecq 2001).

Especially the abandonment of small sites which might be considered single farmsteads, around the Late Roman – Early Byzantine period, could be taken as evidence of the nucleation of settlement, although the survey data from the Petra region is not yet sufficient to prove this conclusively.

Whether the monastery on Jabal Hārūn also owned land is an open question. The monasteries in Palestine usually practised agriculture, including olive culture and viticulture (Hirschfeld 1992: 105), and the monastery of Mount Nebo on the edge of the Jordanian highlands, near the Dead Sea, apparently had extensive terraced fields and was involved in the production of wine and olive oil (Piccirillo 1985: 259). It would be tempting to connect the monastic complex with the development of the large system of hydraulic installations surrounding Jabal Hārūn, but the small amount of Byzantine finds in the survey area does not support this interpretation (Lavento *et al.* 2004b). On the other hand, the lack of ceramics cannot be used as a solid argument for the opposite interpretation either. It may simply reflect a change of the cultivation and manuring practices, perhaps to less demanding plants and a more extensive form of agriculture. Even if the monastery owned the land around Jabal Hārūn, it probably leased it to tenant farmers like the papyri prove other large landowners in Petra commonly did (Koenen 1996: 184). The area is close enough to Petra so that it could have been easily farmed by people living closer to Petra or even in Petra itself, and perhaps staying in the area only temporarily during the sowing and harvest time, which would leave few archaeologically visible traces.

On the basis of the present ceramic evidence, the occupation of the monastery on Jabal Hārūn continued at least until the seventh/eighth century (Fiema 2004: 137-138). However, pottery from these periods is absent in the surroundings of the mountain. There are only a couple of structures that could be indicative of human activity in the area during the Early Islamic period. On the al-Farāsha Ridge there is a structure (Site 136), which closely resembles the open mosques known from the Negev, dated to the seventh-eighth centuries (Frösén *et al.* 2003: 310-312). A possible indication of Early Islamic agricultural activity is FJHP Site 118 (Frösén *et al.* 2003: 312), the remains of a structure, which today is not much more than a heap of stones on the lower southeastern slope of Jabal Hārūn. A couple of Nabataean sherds were found

close by, but the structure resembles the description of the watch-posts in the Negev dated to the Early Islamic period, interpreted as having been used for watching over the fields during the harvest period (Haiman 1995: 35). This idea is supported by the fact that Site 118 offers a wide view to the alluvium of Wādī as-Sāda where the most extensive arable fields of the area are located. There are also numerous terrace walls and barrages on the slopes of both Jabal Hārūn and Jabal al-Farāsha that have no associated pottery at all. The date of their construction remains open.

A large number of thick handmade pottery sherds with coarse fabric and organic temper have been found on the ledges of the northeast summit of Jabal Hārūn and at the foot of the cliffs. The sherds are sometimes painted with black or red geometric decoration or have a reddish slip. The decoration of the pottery indicates that they date to the Ayyubid-Mamluk period, possibly to its earlier part (Hendrix *et al.* 1997: 289-306; Khadija 1992: 345-356; 'Amr *et al.* 2000: 244; Brown 1988: 230-240). As this type of pottery has not been found in the area of the monastery, it seems that settlement on the mountain had moved to the heights of the northeast summit. Contemporary sources from the 10th -13th centuries indicate that the mountaintop was still in the possession of Christians (Fiema 2004: 129). During the same period, settlement reappeared also in the surroundings of the mountain. A farmstead or a small hamlet (FJHP Site 109) consisting of a few buildings is located on the northeastern slope of Jabal Hārūn (Frösén *et al.* 2001: 372-373). Pottery closely resembling the finds from the mountaintop and Site 109 can also be found in scatters on the northern and northeastern slopes of Jabal Hārūn.

The archaeological material does not help much when we are trying to understand what happened in the Jabal Hārūn area after the 11th century. The weli on top of the mountain was built in the 14th century, and pilgrimage to Jabal Hārūn has probably continued more or less without interruption through the ages. The traces associated with pilgrimage include rock carvings of footprints and short inscriptions but these did not require long-term stays in the area. Only some sporadic finds of hand-made pottery of uncertain date, but considered Ottoman, indicate the use of the area for habitation during the long period of time between the 13th and the 20th century. There are also some structures, like a lime kiln (FJHP Site 24), which

probably dates to the Ottoman period (Frösén *et al.* 1999: 399). Three threshing floors of unknown date have been found in the survey area (Frösén *et al.* 1999: 399, 2003: 312-313). There are also some stone buildings constructed in the traditional style. Apparently these were built by the Bedouin mainly during the 20th century for storing various things, including agricultural equipment.

Ethnographic evidence confirms that the area has been sporadically settled up to the present date (Simms and Russell 1996). Even if the area was used infrequently by the Bedouin we cannot tell much about its history on the grounds of archaeological finds. It seems likely that some barrages have been repaired and used also later, although dating the periods of re-use has not been possible so far.

### **Towards an Understanding of the History of Terrace Cultivation**

Previous discussions of barrages and terrace walls in agriculture have often concentrated either on the importance of cultural factors or on the determining role of the environment. It seems more useful to approach the problem as an interaction between both of these factors and by taking a look at issues not taken up so far. Although it might be convenient to discover the one factor that would explain the changes in cultivation over a long period of time, we should not forget that there is a multitude of factors, each influencing each other and sometimes taking the role of a catalyst in the change.

If ceramics can be used for reliably dating other phenomena, it is conspicuous that the end of the Nabataean fine ware in the Jabal Hārūn area may reflect the change in political situation. The interpretation is still not simple, because we do not know whether the scattered sherds are related to the habitation in the area, and their connection with the hydraulic installations is even more problematic. It seems that at some point the area was rapidly subsumed under cultivation via the construction of an extensive run-off farming system. This period of primary agricultural importance of the Jabal Hārūn area may have lasted for less than 200 years. After that the field system was probably at least partially abandoned or used only sporadically.

The most intensive period of use of the monastic complex dates between 400–800AD (Fiema 2004). However, on the basis of the archaeological evidence it may not have played as important a role in the history of the cultivation of its surroundings

as might have been expected. It is still hard to believe that no re-use of the barrages and terraces took place. It seems likely that at least parts of the run-off farming system were used also during the Byzantine period, although no settlement activity can be observed in the area. It is evident that environmental conditions in general for cultivation became less favorable after the Nabataean period. However, we should be careful not to overestimate the importance of the environmental factors.

One possible interpretation is that past human activity and its influence is not reflected through the archaeological material in the area. The structural details of the barrages seem to indicate that the same hydraulic installations were used, abandoned, repaired, reconstructed and re-used many times over a long period of time. On the basis of the archaeological material or other available data it is very difficult to estimate when these phases of use and abandonment have taken place and how long they have been. The off-site pottery found in the area is overwhelmingly Nabataean. Although there are some sites with Roman – Byzantine pottery, and Ayyubid-Mamluk pottery is found in places, the archaeological evidence does not reliably indicate agricultural activity after the Nabataean period. Evidence of later settlement has also been found, but it is very sporadic (and limited) in comparison with the settlement during the first two centuries AD.

The area continues to be used today. Every year a few families live there for some time in their Bedouin tents. This kind of habitation does not leave traces that could remain in the soil to be observed by an archaeologist visiting the area hundreds of years later. According to local informants, some of the hydraulic installations were used less than 50 years ago. In the last few years, the Bedouin from Umm Şayḥūn have attempted to recultivate the fields on the alluvium at the foot of Jabal Hārūn, but rainfall has not been sufficient to grow crops.

### **Conclusions**

It seems that run-off cultivation started during the first century AD in the area around Jabal Hārūn. The peak in the activity in the area can be connected with the heyday of the city of Petra. It is likely that there was an increased need for cultivated land related to the development of Petra as an important junction of several caravan routes. The Jabal Hārūn area may also have been used as an overnight stop



for caravans before they entered the city itself. Most intensive cultivation in the area probably took place before the Roman annexation in 106AD. Although no dramatic economic change appears to take place immediately after the annexation, the new role of the Petra region as a part of a much wider empire and its markets may have decreased the need to cultivate the more peripheral and environmentally marginal areas. The importance of several of the many western caravan routes in the Petra area also seems to have diminished after the Roman annexation, possibly as a result of the new geopolitical structure emphasized by the building of the *Via Nova Traiana* in the early second century AD. Together with the more arid climatic trend that began during the second century AD, these factors may have resulted in the abandonment of at least part of the run-off cultivation system and/or significant changes in the agricultural practices, most likely including a shift to less intensive cultivation. In addition, the monastic community that developed on Jabal Hārūn probably needed the environs of the mountain for food production. Surprisingly the archaeological material from the area does not support this view. In fact the situation appears to be the opposite: The archaeological finds indicate diminishing land use and human activity after the Nabataean period. We do not have first-hand evidence of cultivation in the area, although there are traces of at least sporadic human presence during the Byzantine, Early Islamic and Ayyubid-Mamluk periods.

The many building phases documented in the barrages give evidence of a need to keep them in shape. Although we have not been able to date these repairs so far, the many structural differences observed indicate that they were not made during one period or at several phases over a short period of time. In the light of our present knowledge it seems reasonable to assume that parts of the run-off farming system have been more or less continuously in use since the Nabataean period up to the present day. The period of its most intensive use dates to the florescence of the Nabataean kingdom, which was also a period with favorable climatic conditions. The combined effect of changes in economic and socio-politic conditions, as well as the aridification of the climate, may have diminished the agricultural use of the area during the period after the Roman annexation. After the monastic complex on Jabal Hārūn fell out of use, the area

fell into a peripheral position. As a result, after the Ayyubid-Mamluk period the Jabal Hārūn area was most probably only periodically inhabited and sporadically cultivated by semi-nomadic herders, and it has remained in similar use up to the present.

In 2002-2003, some of the barrages in Wādī an-Naqb were rebuilt and experimentally used by the locals. Interestingly, these dams were able to preserve pools of water over the whole summer — the warmest and driest period of the year. This provides practical evidence that run-off harvesting could still be applicable today. Perhaps the old traditions will gain a foothold again, after they have been proved to still work.

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