



**Documenting Deforestation at Sadd al-Ahmar**  
**Petra Region, Jordan**  
Sadd al-Ahmar, 1924-2011

*by Erin Addison, PhD., MLA*

**Note:** This is the author's version of the book by the same title published by Lambert Academic Publishing. This version of the paper includes some photos which are not in the published version and affords the reader an opportunity to look at graphs, maps and photographs at higher resolution. This version is for personal/scholarly use only, and not for reproduction and circulation.

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Again, and always –

Bridget: many thanks for accompanying me everywhere, literally and figuratively.

And Sami:

*on an ordinary day*

*the extraordinary way*

*you turn to me and say --*

*I believe in this.*

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## LIST OF ABBREVIATIONS

BRDC	Badia Research and Development Center
CDM	an international consulting, construction, engineering and operations corporation
DoSJ	Department of Statistics, Jordan
GCEP	General Corporation for Environmental Protection, Jordan
HDR	Human Development Report
IALC	International Arid Lands Consortium
JD	Jordanian Dinar
JIT	Jordan Inspiration Tours
JPFH	Jordan Population and Family Health Survey
PAP	Petra Archaeological Park
PRA	Petra Regional Authority
PDTRA	Petra Development and Tourism Authority
PAPOP	Petra Archaeological Park Operating Plan
SMP	Strategic Master Plan for Petra Region
UNESCO	United Nations Educational, Scientific and Cultural Organization
USAID	United States Agency for International Development
WAJ	Water Authority of Jordan
WAP	Wadi Arabah Project

Table 1: of Arabic-English Transliteration

ا	aa	ض	<u>dh</u>
ب	b	ط	<u>t</u>
ت	t	ظ	<u>zh</u>
ث	th	ع	'
ج	j	غ	gh
ح	<u>h</u>	ف	f
خ	kh	ق	q
د	d	ك	k
ذ	<u>th</u>	ل	l
ر	r	م	m
ز	z	ن	n
س	s	ه	h
ش	sh	و	w or ou (see note)
ص	s	ي	y or ii (see note)
ع	a	'	u
ي	i	ة	ah
(double consonant)		ء	'

note: when w and y appear, letter is used as consonant; when ou or ii appears, letter is used as long vowel.



## 1. INTRODUCTION

The impetus for this study arose from a need to document the seriousness of the impact of firewood gathering on the remaining forests of the southern mountain ranges of the Jordanian plateau in general and the Petra Region in particular. The need to document the impact of firewood gathering on the Petra Region became apparent in the course of discussions which took place during 2004-2005 between a variety of international and Jordanian government agencies regarding the permitting of reforestation, landscape design and land use within the Petra Archaeological Park.<sup>1</sup> During these discussions amongst the many stakeholders,<sup>2</sup> who often have conflicting interests in land use, it became evident that decision-making about this critically valuable region is hampered by a grave lack of hard data on the environment or existing land use.

The natural landscape in the Petra Region<sup>3</sup> is already profoundly stressed by the combined forces of population growth, grazing, clearing of forests for agriculture, lumber and fuelwood needs, drought and the concomitant erosion and desertification which accompany these processes. Petra's once flourishing forests – not to mention the rich biodiversity they once sheltered – are so threatened as to be nearly invisible today. During the site analysis for an interpretive landscape masterplan for the Wadi Musa Wastewater Re-Use Implementation Project at Sadd al-Ahmar,<sup>4</sup> firewood gathering – mainly for tourism – emerged as one of the most widespread and damaging activities affecting the local vegetation. This study was an attempt, first, to document the historic

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<sup>1</sup> The famous Nabataean antiquities site of "Petra" is a UNESCO World Heritage Site, recently voted in an international promotional campaign to be one of the "New Seven Wonders of the World." Its name in English is Petra Archaeological Park; the Arabic name is *mahmiyya athariyya al-batra*. The implications of the term *mahmiyya* are discussed below. In what follows I will, for the sake of consistency, refer to it as the "Park" or "PAP" as is customary in Jordanian documents.

<sup>2</sup> During this period representatives from USAID, the Department of Antiquities, CDM International, the Petra Archaeological Park, UNESCO, Petra National Trust, Petra Regional Authority, Jam'iyyah Sadd al-Ahmar, International Arid Lands Consortium (IALC) and Badia Research and Development Center (BRDC) were convened on four occasions. The expansion of farming activities and a phased landscape design were permitted on March 17, 2005.

<sup>3</sup> The Petra Region is a distinct administrative unit in Jordan. At the time this study was begun the Region was governed by the *sultat al-iqliim al-batra'* or Petra Regional Authority (PRA). Jordan is divided into seven administrative units called Directorates (*muhafazhaat*). Although the Petra Region falls within the Ma'an Directorate, the Director General of PRA (now the High Commissioner of PDTRA) is answerable directly to the Prime Minister, which places him at the same administrative level as a Cabinet member. In September 2009 a new administrative body, the Petra Development and Tourism Regional Authority (PDTRA), was created, reflecting the awareness of Petra's economic value to the Kingdom.

<sup>4</sup> The Wadi Musa Wastewater Re-Use Project is funded by the United States Agency for International Development (USAID) in cooperation with the Water Authority of Jordan (WAJ). The legal landowner was, until September 2009, the Jordanian Department of Antiquities, and the use of the land is the right of the Jam'iyyah Sadd al-Ahmar, a farming cooperative. The matter of ownership has been muddled by the creation of PDTRA.

changes in the biotic community for one area within the Park; secondly, to document the severity of continuing firewood gathering in the same area.

Remarkably, given the significance of Petra to Jordan's economy, five years after the completion of the original study it remains the sole study tracking vegetation change over either the short or long term within the Petra Region. When the most recent incarnation of local governance, the Petra Development and Tourism Region Authority, commissioned in 2010 a Strategic Master Plan for Petra Region<sup>5</sup> the existing environmental data was still sorely inadequate for long-term land use planning. This situation motivated the researcher to repeat the survey in order to assess the ongoing dynamics affecting the forest in the study area.

This study employs biogeographical and anthropological methods to address the following questions:

- (1) What is the history of the forests of the Petra Region, as represented by the study area (Fig. 6)?
- (2) How can we attempt to quantify environmental change in a situation where data is scarce?
- (3) What is the present condition of the forest at Sadd al-Ahmar?
- (4) What are the significant current impacts on the landscape at Sadd al-Ahmar?
- (5) What are the implications of the study for environmental conservation and land-use planning in the Petra Region?

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<sup>5</sup> For which the present author served as the Environmental Expert.

## 2. RELEVANT STUDIES

### **Biogeographical approaches**

The present study of the biogeography of the forest at Sadd al-Ahmar focuses on tracking vegetation change using archival resources, maps, ground-truthing and narrative accounts. Biogeographical studies conducted in the Santa Rita Experimental Range in Arizona, on the Borana Plateau in Ethiopia and the Desert Laboratory at Tumamoc Hill, Arizona, provide the basis for the approaches employed in the present work.

**Santa Rita Experimental Range.** The Santa Rita Experimental Range (SRER) is comprised of 20,000 hectares of rangelands in southeastern Arizona, where vegetation change has been tracked since 1903 using repeat photography, repeat mapping and line intercept transects. Repeat photography documents vegetation change by using landscape photographs from a broad scope of locations repeatedly over a century. Repeated, detailed and systematic mapping of small plots over time was conducted at SRER for approximately twenty years in the early 1900's (McClaran 2003:19), providing data at a finer scale. The line intercept transect method for estimating herbaceous and woody plant cover eventually replaced mapping because it was more efficient for the large area of study. Approximately 200 permanent transects were established in 1957. A series of studies focused on repeated inventories along at least 130 of these transects over the ensuing decades and continue at the time of writing (McClaran 2003:19). McClaran emphasizes that what makes any of these methods productive is their duration, scope, and frequent application.

Complemented by "a 100-year record of experiments and systematic observations" (McClaran 2003:16), the record from SRER is arguably the most exhaustive documentation of vegetation in the world. This work was pivotal in the development of the discipline of range science (Sayre 2003: 2ff). The importance of analyzing the changes in the landscape over time and considering a wide range of variables as agents of change is summed up by McClaran as follows:

The most incontestable conclusion from this century of vegetation change is that future changes cannot be conceived and understood if there are no records of previous conditions. An equally important conclusion is that the response of vegetation to management practices will be contingent on past and future precipitation patterns, elevation and soils at the location, and the current mix and vigor of the plant species (2003: 31).

Nathan Sayre, in his meta-narrative about SRER, adds another layer of analysis by situating the genesis of the project, the construction of its research questions and the archiving, editing and implementation of the results within their social and political contexts (Sayre 2003). The work at SRER establishes the importance of physical historiography of the landscape, taking into consideration a diverse range of causal factors. Sayre's situation of SRER within its socio-political context underscores the need to consider the broader discourses which shape land-use.

Its geographical remoteness and the fact that apart from research it has been closed to commercial use for over a century renders SRER quite different in nature from the Sherah Mountain range of which Petra and Sadd al-Ahmar are part. While the research at SRER initially responded to issues created by human disturbance, namely overgrazing, the duration of

this activity was relatively short, human intervention preceding the activity was very low-impact, and then the Range was closed to the activity except for research purposes. Sadd al-Ahmar is cradled within the remains of significant neolithic urban centers (Fig. 1) and shows evidence of over 9,000 years of nearly continuous human use (Gebel 1984). Equally significant to the research problem is the fact that intensive human use of the land continues and is unlikely to abate in the foreseeable future. For this reason it is important also to refer to projects in which long-term human impact -- over millennia -- and continuing human disturbance are factors.



**Figure 1:** Neolithic Ba'aja 1, pictured above, is one of a network of Neolithic settlements that is woven throughout the Petra Region. A related settlement is located 750m downstream within the study area. Consideration of impacts from up to ten millennia of continuous, intensive human use is characteristic of research conditions in Old World sites.

**The Borana Plateau, Ethiopia.** In the mid-1980's a group of projects on the Borana Plateau in Ethiopia compared trends in the environment by mapping and photographing vegetation change over two decades (1965-1986). Analysis of 15,475 km<sup>2</sup> compared grazing patterns, erosion, vegetation cover, and forest density and age. Although the study area at Borana is much larger than Sadd al-Ahmar, the Borana project is relevant because four of its 20 km<sup>2</sup> mapping blocks were comprised of semi-arid mountainous rangeland used, like Sadd al-Ahmar, for many centuries by nomadic pastoralists and still in use both for cultivation and grazing. Also

similar to Sadd al-Ahmar, parts of these regions have experienced a high degree of recent sedentarization due to the development of new, permanent water sources. As in the Petra Region, today's pastoralists are only the most recent residents, following upon millennia of habitation (Coppock 3.2.2). Although the Borana Plateau study conducted close documentation of vegetation change only over a short time span, researchers employed historical analysis (3.2.2.) and interviews as part of their efforts to understand the broader context of the landscape (3.2.5.2). The Borana project used a combination of satellite images, archived aerial photographs, ground-truthing and mapping to establish vegetation trends. Interviews with local population complemented and enhanced the identification of native plant species and human pressures on plant populations (3.2.2).

Although broader in physical scope, the Borana project informs the research at Sadd al-Ahmar because it addresses problems which confront most researchers working in the developing world: a paucity of records, intense economic pressure on the landscape, the relative unlikelihood that these pressures will abate, and consequent inability to control experiments or research conditions. The multivalent research methods used for the Borana, combining oral narratives, archival materials, modern image-production such as satellite photography, traditional mapping and ground-truthing in the field, are more applicable to research in south Jordan than the well-controlled methods employed at SRER.

**The Desert Laboratory, Arizona.** The Desert Laboratory at Tumamoc Hill in Arizona documents long-term vegetation in a high-desert environment, where largely undisturbed plots of native vegetation have been mapped every decade for nearly a century (Guo 2004: 758). Qinfeng Guo's 2004 article explicitly considers a temporal framework more analogous to that affecting Sadd al-Ahmar. Tumamoc Hill shows agricultural remains dating back to 700 B.C. and evidence of continuous habitation and human intervention for economic purposes until 1907, when the site was enclosed and dedicated to research activities (758). Thus anthropogenic impacts are measured at Tumamoc Hill in terms of millennia rather than centuries or decades. Guo argues that the slow recovery of the native, perennial desert vegetation is attributable to *prehistoric* as well as recent human impacts (761). His conclusions illustrate the significance of archaeological data to link the deep past to present-day range management and environmental restoration.

### **Anthropological approaches**

Methods drawn from the field of anthropology were employed in order to explicate the present-day context of human pressures on the environment at Sadd al-Ahmar. The effectiveness of such an interdisciplinary approach to environmental issues has been best illustrated to this author by the analyses yielded up from the Madaba Plains Project, Jordan, and participation in an ongoing seminar project in ethnoarchaeological perspectives on nomadic pastoralism.

**Madaba Plains Project.** Founded initially as a Biblical archaeology project, the Madaba Plains Project (MPP) of Andrews University is now a wide-ranging, loosely related set of research projects which has yielded a substantial body of information about pastoral society from the Iron Age to the present. Participating scholar Oystein LaBianca (1990) has developed a complex and extremely useful template for understanding Bedouin society in the eastern Mediterranean based on the notion of "food systems,"



a dynamic and complex unity consisting of all of the purposive, patterned, and interdependent symbolic and instrumental activities carried out by people in order to procure, process, distribute, store, prepare, consume, metabolize, and waste food (Dyson-Hudson & McCabe 1985; Pimentel 1979).

By layering bodies of evidence from cultural remains, natural history, textual sources, and serious scholarship on the current population of the Madaba plateau, LaBianca and his colleagues have crafted a theory with explanatory power for both present and past uses of the landscape (LaBianca 1990). The food systems template avoids traditional and over-simplistic dichotomies between "Bedouin" and "settled" society and "the desert and the sown," recognizing that in the Jordanian context nomadic pastoralists are not, as so often characterized, marginal to the social structure, but rather form the enduring core of the social and political structures even today. Surprisingly, perhaps, for what began as a fundamentally a theological enterprise, MPP methodologies also avoid dichotomizing modern Jordan and an idealized "classical" past.

MPP's work is relevant to the present research because it includes a successful interdisciplinary attempt to understand landscape dynamics over the *longue duree*. MPP combines anthropological method and ethnobiology with historiography and the life-sciences to understand the interaction of nomadic pastoralism, sedentarization, food systems, and cultural patterns in an arid ecosystem. As this author has argued elsewhere, sufficiently complex and sensitive description of the landscape and identities of those who inhabit it depend on balanced investigation both of the physical terrain and the historical *longue duree* that shapes the use of the land and resources in a given locale (Addison 2004).

**On the Fringe of Society.** A second example of successful interdisciplinarity using the past to understand the dynamics of present-day nomadic-pastoralist society is the loosely affiliated group of scholars who participated in the 2004 symposium in Jerusalem entitled (perhaps ironically) "On the Fringe of Society: archaeological and ethno-archaeological perspectives on pastoral and agricultural societies" and its follow-up at Eastern Carolina University, Greenville, in the fall of 2005. In these symposia scholars from the sciences and anthropology shared applied academic work from Israel and Jordan in an effort to advance understanding of modern Levantine nomadic-pastoralist society. In some sense extending the methods of MPP to their logical conclusion, several scholars actually working in the development sector in the deserts and steppes of Israel and Jordan translated their work basically in the form of participant observation back into academic discourse.

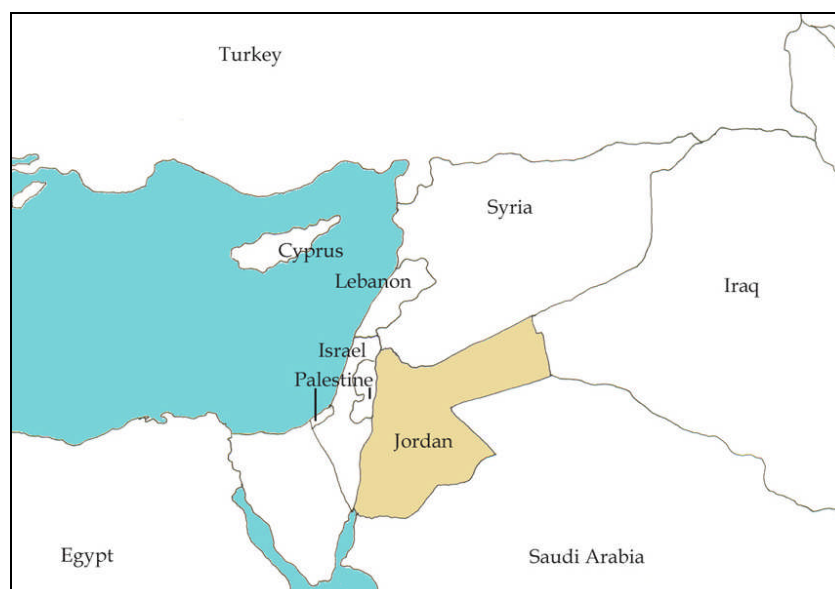
**Participant observation.** As an accepted method of data-gathering participant observation was pioneered in the 19<sup>th</sup> century by Frank Hamilton Cushing in his studies of Native American tribal societies. The method became (in)famous as applied to non-western cultures by Bronislaw Malinowski and Margaret Mead, but eventually was applied usefully to modern Euro-American subjects as well by Victor and Edith Turner and others. Valuable experience gained by scholars working on applied projects in the field is a type of participant observation which informed much of the work presented at the symposium, and served as an important source of data for the work at Sadd al-Ahmar. The discussion below aspires to "thick description," in the sense best articulated by anthropologist and ethnographer Clifford Geertz in

his work by the same title (Geertz 1973). Though Geertz is describing culture, much of what he has to say about description is equally applicable to the landscape. To paraphrase a famous quote from the eponymous essay, *biogeography is (also) thick description. One is faced with a multiplicity of complex historical – natural and cultural – processes which must be first grasped and then rendered.* We encounter landscape, like culture, as a complex set of interwoven signs that, in some sense, must be interpreted semiotically, its symbology rendered into narrative. After only eight years as a “participant observer” in the life of Sadd al-Ahmar, this author’s interpretation of the discourse of the landscape changed dramatically.

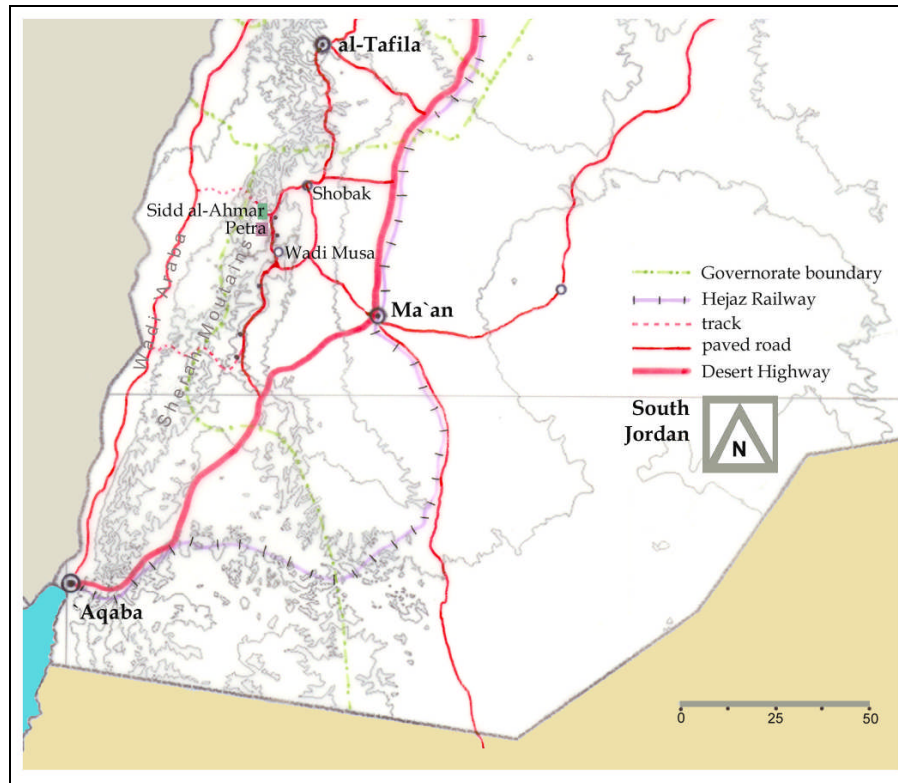
In sum, the research methods employed in this study aspire to genuine interdisciplinarity. The understanding of the physical terrain combines field data, archival material, repeat photography, mapping and ground-truthing. Historiographical research and anthropological methods of interviewing primary informants and users of the site were required to understand the complex socio-political dynamics affecting the landscape. Where field observation, interviews and historical sources were unrevealing, participant observation was employed as a method of entering into local dynamics in a critical way.

### 3. RESEARCH METHODS

As suggested above, two broad methodologies are employed in the research: biogeographical documentation to establish long-term changes in the forest, and an anthropological approach to understanding its present context. The data for the study was gathered between December, 2003 and March, 2006, at Sadd al-Ahmar in the Petra Region of Jordan (Figs.2-3). The methods used



**Figure 2:** Jordan in geographical context



**Figure 3: South Jordan**

for gathering and analysis of data include archival research, field observation of both firewood gathering and the use patterns associated with traditional grill-picnics (*Ar. hash ou nash*), interviews with users and tourist operators and, finally, a five-month internship with a local tour operator.

Combining methods used in the foregoing projects as well as others conducted in the Centennial Mountain Range (Hendrickson et al.: 2004), Jornada Experimental Range (USDA: 2004), Australian Alps (Coyne 2001: 19), this study used vegetation inventory and mapping to establish the history of the forest at Sadd al-Ahmar, as well as archival materials and oral narratives. The first perception of the study problem itself was gained in the process of the site analysis for a landscape design which required an initial vegetation inventory. In an effort to understand the vegetation and environmental processes at Sadd al-Ahmar, the author inventoried and mapped all of the mature trees onsite in the winter of 2003-4. The initial assumption that overgrazing would be the primary anthropogenic impact on the environment was quickly corrected by the evidence of fuelwood harvesting.

In the winter of 2005-6 the site was re-inventoried to include visible remains of mature trees which have been harvested for lumber and firewood and visible evidence of firewood harvesting from remaining trees. The latter survey includes an assessment of damage incurred within six months prior to the final mapping (November 2005-March 2006). Recent damage can be easily assessed for junipers, which are the dominant tree onsite, by the color and fragrance of exposed bark. Vegetation mapping and field observations of the site – particularly the observation of picnicking and firewood gathering – shaped the research question and also furnished quantitative

information to assess the problem and its impacts. Archival sources include maps, photographs, written narratives, archaeological and other field reports. In an attempt to simulate the repeat photography at SRER, early aerial photographs from archaeological surveys were justified with satellite imagery from the archives of the Petra Regional Authority (PRA), the Royal Jordanian Geographic Society and Google Earth.

Material antedating photography includes the travel accounts of pilgrims and explorers as well as geographers. One important source of such narratives is the body of literature produced by European Christian travelers to the “Holy Land,” many of whom describe the landscape in detail and even provide drawings or photographs. Their accounts are often especially rich, because their interest in capturing the atmosphere of the actual landscape is inspired by the conviction that they are experiencing the sacred landscape where their primary prophet lived and preached.<sup>6</sup> Reports of naturalists and development agencies such as United Nations Food and Agriculture Organization (FAO), International Council of Scientific Unions (ICSU) and others give scientific reports of the region’s recent past. Archaeological reports allow us to look even deeper into the past to understand the natural history of Petra’s forests.

Oral narratives have also been significant in establishing the use patterns which affect the forests of the Petra Region. Interviews were conducted with both individuals and groups of farmers and picnickers. Sixteen adults, ranging in age from 25-75, who have lived their whole lives in the region were interviewed about their memories of the landscape, about wildlife, construction traditions, picnicking and firewood gathering in general. All of the interviewees belong to the Laythneh and `Amariin tribes who have inhabited the Petra Region for many generations,<sup>7</sup> and all interviewees have farmed and herded in the Petra Region for part or all of their lives. Two interviews were conducted with staff of the Office of the Jordan Hijaz Railway, regarding the route of the `Unayzah-Shaubak logging spur and harvesting of the Hishah forest.

### **Definition of the study area**

The study area, known as Sadd al-Ahmar,<sup>8</sup> is a 10.7 ha. *wadi* (seasonal wash) system located at the northern end of PAP in the *Jibal al-Sherah*, or Sherah Mountains of southern Jordan east of

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<sup>6</sup> See the discussion in Douglas Nickel (2003), Francis Frith in Egypt and Palestine: A Victorian Photographer Abroad, or Robinson and Smith (1841) Biblical Researches in Palestine, Mount Sinai and Arabia Petraea, a journal of travels in the year 1838, whom we will discuss further below. Note the tendency to refer to the area not by its local, Arabic name, but by the biblical name “Edom.”

<sup>7</sup> The debate over which of the present tribes arrived in the area first and who has been there longest is fraught with political tension because of its possible relevance to land claims. It is beyond the scope of (and largely irrelevant to) this research even to begin to summarize this argument.

<sup>8</sup> Sadd al-Ahmar means “red dam,” so-called because of the network of dams and check dams, many of them typical Nabataean constructions of local red stone, which crisscrosses the entire area. It is also known as “Ba`aja,” which is the name of the conical mountain landmark at the northeast end of the plateau and the deepest of the three wash systems. Because of the famous Neolithic archaeological sites excavated there by Hans Gebel and his associates, much of the literature on the area is to found under Baga, the German transliteration of this name, as well as

Wadi `Araba. Sadd al-Ahmar is bound on the south and east by steep, 150-200m bluffs of sandstone scored by siqs (Ar. pl. *asyaaq*), which are deep, narrow, nearly vertical-sided chasms in the sandstone mountains. The north end of Sadd al-Ahmar leads into the rugged sandstone and red granite mountains above Naqab Namala. In the west the plateau drops steeply away into Wadi Umm al-Hairan and the successive escarpments descending to the Jordan Valley.



**Figure 4:** Sadd al-Ahmar and WMWWTP, 2002: the finishing pools of the wastewater treatment plant are visible bottom, center; the black line indicates the eastern boundary of Petra Archaeological Park. (Image courtesy of Petra Regional Authority)

The phytogeographical classification of Sadd al-Ahmar is described by botanist Sawsan Oran (2003: 2) as a transitional area between the cool semi-arid Mediterranean and Irano-Turanian zones of the Jordanian highlands. Soils are yellow to gray clay soils overlaid by pink sandy soils deposited by weathering of the surrounding sandstone rock formations. The mountains of south Jordan are Paleozoic sandstones and Precambrian basement (Qudah 2006) punctuated by basalt extrusions, transitioning into the pink and red sandstones, limestone and chert of the extremely

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Ba'ja. Locals also refer to the whole northern end of the Petra Region, including Sadd al-Ahmar, as "Baidha."

arid Saharo-Arabian deserts of the southern Badia. On the rainfall maps most widely used in publications about Jordan the Petra Region is said to receive approximately 200 mm annual rainfall. Rainfall records for the demonstration farm at the WMWWTP, however, indicate that in fact 1994 was the last time Sadd al-Ahmar received this much precipitation. The International Water Management Institutes Online Climate Summary Model cites Sadd al-Ahmar's average rainfall to be a mere 42.34mm p.a. Rainfall events in Jordan are, however, extremely localized and vary widely even within the Region, and runoff from the steep slopes is a significant source of additional water.

At Sadd al-Ahmar the most conspicuous visible remains of past human habitation date to the Nabataean period, during which the famous city of Petra itself was built. Only slightly less striking are remains from prehistory. The Neolithic village of Ba'aja 1 overlooks Sadd al-Ahmar from the bluffs above (Fig.1, above), and Ba'aja 2 lies within the study area. There are pottery and structural remains of almost continuous human habitation since approximately 7,500 BC.

The four clans (*hamaayil*) of Bani Laith (al-Layathnah) as well as the clans of al-Bidoul, al-`Amariin, Bani `Atiyya, and al-Sa`idiyiin, the semi-nomadic tribes which have inhabited the Petra Region for the past many centuries, have historically combined nomadic pastoralism with the cultivation of barley, wheat, olives, figs, pomegranates, grapes and other food and forage crops (Fig. 5). Until the 1960s extended family groups lived parts of the year in stone-built villages located at water sources; and other parts of the year traveled with their herds of goats, sheep and camels searching for pasture. Tourism, in the form of guiding foreigners, became part of the region's economy in the 19<sup>th</sup> century. By the 1980s commerce and public services had coalesced around the police station, established during the late Ottoman period at Wadi Musa. Today Wadi Musa, with some 26,000 inhabitants, is by far the largest town in Petra Region and serves as the commercial, administrative and transportation hub for the area. Many of the old nomadic pastoralist lifeways exist, but the fortunes of the entire Region rise and fall around the tourism market. Rapidly increasing population also exerts pressure to find new fuel and water sources and sources of income generation, forage, and food for humans.

Sadd al-Ahmar was chosen for study because of the discussions surrounding land use on the WWTP site, which catalyzed debate on landscape intervention in the Petra Archaeological Park (Palumbo and Cavazza 2004). During the year-long debate over whether to permit retroactively the Re-Use Project and its associated interpretive center and landscape design arguments raged on, supported by only the most impressionistic "data." Because of the permitting debate, there was a felt need for a scholarly examination of the existing vegetation and land use as well as an assessment of past impacts for this specific area. It should be said, however, that initially the contractors' policy was not to disturb existing trees, owing to Jordan's GCEP 1995 Environmental Protection Law No.12 and its temporary amendment in 1999-2000 (GCEP 2001), which forbids the removal of any trees without written permission from the Forestry Department.

While the recent introduction of treated wastewater and associated drip irrigation is a new development, Sadd al-Ahmar was, in 2003, otherwise typical of agricultural areas throughout the Petra Region and the Jordanian highlands in general. It hosts nomadic pastoralists' tents during certain seasons, and until recently some Bedouin also kept stone-built and cave dwellings,



storage rooms and stables there. Because of the wadi system and runoff from adjacent bluffs into siqs which are still dammed, there is water available there much of the year, and so there has been agricultural and livestock husbandry there as long as we have traces of human settlement. Also typical is the intricate network of Nabataean water management remains, much of which – especially the refurbished dams and agricultural terracing – is still useful. Agricultural activity has flourished with the extension of the Re-Use Project's drip network, and traditional dry-farming of barley continues as well. As we will discuss in some detail below, however, Sadd al-Ahmar has been intensely cultivated for at least 2,000 years and probably much longer. Like the rest of Petra Region, Sadd al-Ahmar is also starkly overgrazed. Typical also, as we will see presently, are the environmental impacts associated with the construction of a paved road though Sadd al-Ahmar.

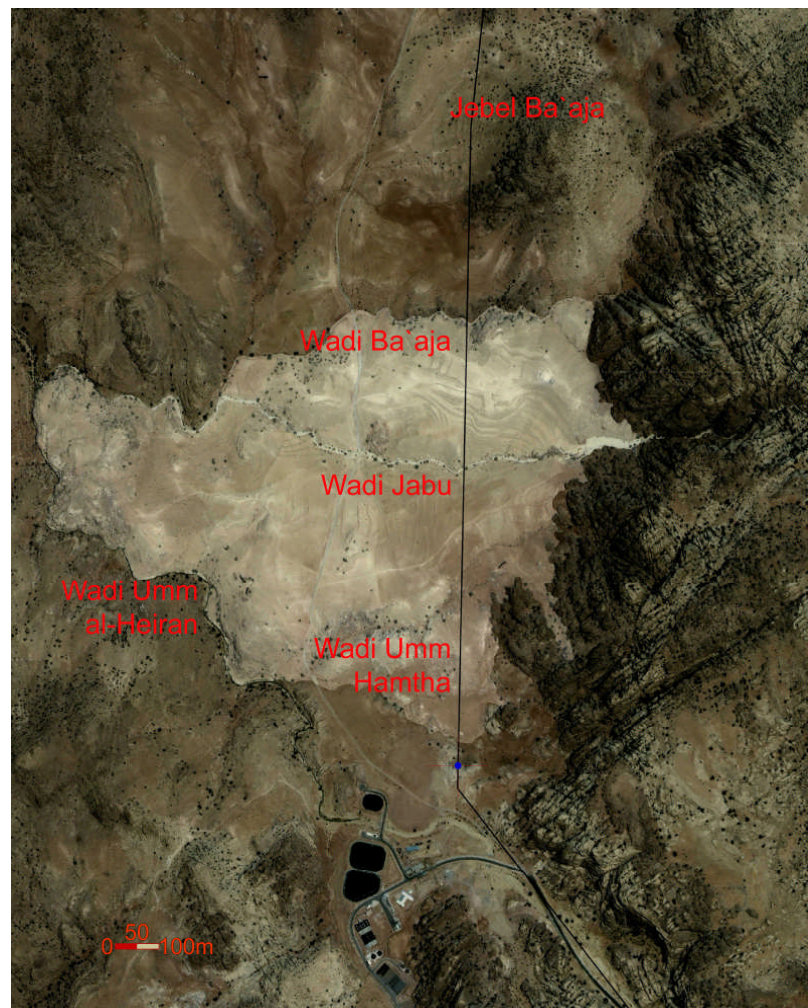


**Figure 5:** Sa`idiyyin Bedouin tent at Sadd al-Ahmar; dry-farmed barley, goats and goats-hair tent encampment on the western face of Ba`boul Ba'aja, summer 2004.

Located within the extreme northeastern corner of the Park, Sadd al-Ahmar is adjacent to the Hishah oak forest and Namala, the steep pass which leads west down to the Jordan Valley floor. The whole area is a popular venue for traditional family grill picnics, or "*hash ou nash*," in Arabic, which officially disallowed by Park guidelines, but these guidelines are almost entirely unenforced outside the immediate environs of the main tourist site. A project to interpret the activities of the wastewater treatment plant and the Re-Use Project included an interpretive masterplan and landscape design which occasioned this research. The construction of the demonstration farm also required the production of detailed contour maps which are unavailable

for other parts of the Park, and which facilitate the mapping of vegetation onsite. Finally, the existence of the Re-Use Project (and its associated budget) offers an opportunity actually to implement measures to address some of the challenges which will be discussed forthwith.

The boundaries of the study area within Sadd al-Ahmar are defined by the small wash systems that drain from the eastern bluffs into Wadi Umm al-Hairan. These are, from north to south, Wadi Ba'aja, Wadi Jabu, and Wadi Umm Hamtha.<sup>9</sup> The trees mapped for this study occurred within the bounds of this wash system. The area south of Wadi Umm Hamtha has been altered entirely by massive earth-moving associated with the construction of the WWTP and



**Figure 6:** The study area in geographical context. Wadi Umm al-Hairan is often bound on the opposite side by cliffs and thus the study boundary was drawn down the center of the streambed.

<sup>9</sup> These are the names used on maps produced by the Royal Jordanian Geographic Society. It should be noted that local usage is rather different. The deep siq which penetrates the eastern bluffs all the way through to the Hishah Mountains is known as Siq Ba`aja. The name "Jabu" is unknown to locals.



demonstration farm and so has not been included in the study. The eastern boundary is defined by the foot of the sandstone bluffs, which rise abruptly 100-200m above Sadd al-Ahmar. A few hundred meters westward beyond Wadi Umm al-Hairan, which wraps around the western half of the study area, the landscape drops abruptly away again in a series of escarpments descending a thousand meters and more into Wadi `Araba.

### Biogeographical data collection & analysis

In 2003, at the outset of the site analysis for the landscape design, the author conducted a survey of the trees at Sadd al-Ahmar as part of the process of learning the native species onsite and to grasp exactly what resources were at hand for landscape design. The vegetation inventoried for the purposes of this research was restricted to eight native tree species found onsite:<sup>10</sup> *Amygdalus korschinskyii* (Fig.7),<sup>11</sup> *Ceratonia siliqua*, *Rhamnus disperma* (Fig.8), *Juniperus phoenicea* (Fig.9), *Nerium oleander* (Fig. 10), *Pistacia atlantica* (Fig. 11), *Pistacia palestina* (Fig. 12) and *Quercus coccifera* (Fig. 13). There are several reasons for restricting the inventory to trees. First, it would be very difficult to produce an accurate quantitative estimate of understory species from the photographs available. Second, the debate which occasioned this research centered around the use of native trees as landscape plants onsite, and it was the matter of reforestation which elicited the discussion of "landscape integrity." The Petra Archaeological Park Operating Plan (PAPOP) specifically encourages reforestation with native species propagated from local seed stock (PAPOP II:2:4.4.6-8, 10). In addition, *Quercus coccifera*, *Juniperus phoenicea* and *Pistacia atlantica* are officially listed as endangered species in Jordan (Oran 2003: 10), and this fact was voiced repeatedly as a matter of concern in the debate surrounding the permitting of the

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<sup>10</sup> *Rhamnus disperma* (common name *zarour*) is so consistently grazed down that it usually appears as a very low, spreading shrub clinging to rock faces. The reason it is virtually unrecognizable is that its young, thornless shoots are preferred forage for goats. Only the few of hundreds of specimens of *R.* that have reached  $\pm 2$ m in height and achieved arboriform appearance appear on the vegetation maps. *Zarour* is also the common Arabic name for *Crataegus aronia*, of which only one specimen is found onsite.

It should also be noted that *Nerium oleander* almost always appears as a large shrub, and appears nowhere but the bottoms of streambeds. It is not used for firewood nor is it grazed, because it is poisonous. It is included in the maps because it would have appeared as a tree in the aerial photographs and it serves as wildlife habitat, as well as inhibiting soil erosion.

Four examples of *Retama raetam* were included on the vegetation map because they have reached over 2m in height and have enough canopy that they appear on aerial surveys as trees.

<sup>11</sup> Oran 2003:24. I am not convinced of this identification, though it is certainly an *Amygdalus* sp.; Oran (2003:10) lists *Amygdalus korschinskyii* as an endangered species. Isabelle Ruben, whose book I have found to be most reliable, does not list *A. korschinskyii* as occurring within the Region (Ruben 2006). There is a complex debate over whether *Q. coccifera* is a subspecies of *Q. calliprinos* or vice versa, but I will adhere to Oran's identification of the local oak as *Q. coccifera*.

landscape design and extension of the farming activities.<sup>12</sup> A move to permit reforestation is likely to center on these species.



**Figure 7:** *Amygdalus korschinskyi* (Eng. wild almond; Ar. *louz*). See n.12, above.



**Figure 8:** (Left) *Ceratonia siliqua* (Eng. carob; Ar. *kharoub*) climbing along the opening of a siq; (right) *Rhamnus disperma* (Ar. *zarour*) in tree form; see n.11, above, also Fig.16, below.

<sup>12</sup> Eventually it was concluded all off-farm planting (i.e., windbreaks and a demonstration garden at the interpretive center) should use only *Ceratonia siliqua*, *Juniperus phoenicea*, *Pistacia atlantica*, *Pistacia palestina* and *Quercus coccifera*.





**Figure 9:** *Juniperus phoenicea* (Eng. Phoenician juniper; Ar. `ar`ar)



**Figure 10:** *Nerium oleander* (Eng. oleander; Ar. *diflah*) in the streambed of Siq Ba'aja, August 2004.





**Figure 11:** The deciduous *Pistacia atlantica* (Eng. Mt. Atlas pistachio; Ar. *butm atlantii*) during winter (left), in late winter/ early spring bloom (center), in full leaf during summer (right).



**Figure 12:** *Pistacia palestina* (Eng. Palestinian pistachio; Ar. *butm filistīinii*); the shrub around the base of the tree on left is *Rhamnus disperma* as it normally appears onsite. *P. palestina* has a rounder, glossier light green leaf, compared to *P. atlantica*, and its bark is smooth silvery grey.





**Figure 13:** *Quercus coccifera* (Eng. Kermes oak, Ar. balout).

It is also arguable that the trees themselves, as well as their health condition, are crucial to the survival of the understory: that each tree creates a "fertility island" (MacLaren 2003; Reyes-Reyes, et al 2003; Frias-Hernandez, et al. 2003, Tiessen et al. 2003; but Corrigan 2004) under its canopy, under ideal conditions providing shade and organic matter and inhibiting soil erosion. In 1963 a British soils survey team conducted an experiment in Hishah forest in which soil samples were taken representing the area covered by the canopies of two old-growth *P. atlantica*. They report that:

In each case these data show a clear gradation of increasing content of organic matter from the outer zone to that contiguous to the trunk of the tree. This gradation is reflected in the values for colour, reaction, per cent calcium carbonate, and especially in the per cent humus and the cationic exchange capacity... There is little doubt that the major contribution to the organic matter of the soil was made by the leaf-fall and seeds of the trees themselves" (Willimott, et al., 1964).

Precisely the same phenomenon can be observed under healthy trees at Sidd al-Ahmar. Thus it appears that along with severe historic overgrazing (also reported in Willimott, *passim*), it is not only the removal of trees, but the diminishment of tree canopy that is denuding the landscape. Increased humidity and lower soil temperatures beneath healthy tree canopies were also documented by Willimott and his teammates. It will be seen that in areas less accessible to human intervention trees are healthier, and several levels of understory survive beneath them.<sup>13</sup>

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<sup>13</sup> There is considerable evidence to suggest that in many cases tree cover creates such fertility islands. Corrigan's interesting research note, however, suggests that under western junipers the effect is the opposite. Field observation at Sadd al-Ahmar would suggest that healthy *Juniperus phoenicea* do create such an effect, but several factors are at work here, including water

It was observed in the field that the most frequent tree onsite, the *Juniperus phoenicea* (Ar. `ar`ar), is failing to re-seed itself. Its germination rates vary widely under cultivation (n.45, below), but in the entire study area only *one* seedling was observed. That seedling occurred in a grove of mature trees, where soil and organic matter had been trapped in a relatively healthy understory. As the trees and understory also serve as shelter and nourishment for fauna, their decline diminishes animal habitat and thus biodiversity. In sum, the presence of trees and the health of their canopies is used in this research as an indicator of forest health in general. Put another way, the decline of the quantity and quality of tree cover indicates a decline in the ecosystem as a whole.

In order to generate a quantitative assessment of the current impacts on the forest two sets of aerial photographs (from 1924 and 2002, respectively) were compared, followed by comparison of the two vegetation maps produced by the on-site inventory. The area of the tree cover shown in the 1924 photo was estimated in order to establish a baseline for comparison. Circular polygons were used to represent area of woody cover. Polygons representing 4m<sup>2</sup> were overlaid onto the 1924 image, and the resulting image was then abstracted to give a graphic representation of tree cover in 1924. The same technique was applied to a satellite image from 2002 to establish a quantitative measure for the rate of the decline of the forest between 1924 and 2002.

In absence of aerial photos since 2002 the researcher surveyed the site on foot during winter 2003-4 and winter 2005-6 to generate two vegetation maps. An inventory of species was made and every tree entered on the map with a polygon color-coded by species. These maps yielded a precise count of the indicator species and changes in the forest since 2003. In 2004-2005 the inventory also noted whether or not each tree had been subject to firewood stripping, in order to assess the level of current and continuing pressure from fuelwood demands. Finally, an inventory of remaining tree stumps elucidated the recent decline of the forest. Comparison of the two inventory maps yielded a quantitative assessment of the diminishing forest since 2003, indicated which species are under the most severe pressure, and yielded a quantitative assessment of continuing pressure on remaining trees.

In 2010 the ground survey was repeated. At the time of writing (2011) there are no satellite maps available at adequate resolution to repeat the forest cover estimate. Images from Google Earth, however, are of ample resolution to illustrate changes in land use between 2002 and 2009.

For analysis of the aerial photography the boundary of the study area was drawn at the point where the shadows become impenetrable at the base of the nearly vertical cliffs east of the site. The size of the polygons was calculated both by using an engineer's scale and estimating pixels. Care was taken not to overlap polygons or to place polygons which exceeded the outlines of a given tree in the images, and indeed to position polygons within the edges of the photographed vegetation cover. This strategy yields a very conservative estimate of the cover pictured in both photos, and also compensates for shadow.

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availability and grazing access, and a thorough discussion of this observation is beyond the scope of this research.

The historic causes of the forest's decline were gathered largely from archival sources. Current, ongoing impacts were investigated through field observation, in-depth interviews of long-term residents, interviews with 152 picnic groups in 2004-2005 and participant observation as a tour operator. Recent damage to the remaining trees within the study area was measured in the final mapping exercise in 2005-06, which includes a count of remaining trees which exhibit damage by anthropogenic stripping within the last six months. [2010-11] Since 2005 the author has maintained a residence in Wadi Musa and since 2009 has stabled horses in Sadd al-Ahmar. She has thus visited the study site literally hundreds of times and developed personal relationships with many of the farmers and other users of the site. Remarks at the close of the conclusions draw upon this more intimate relationship with the landscape.

### **Anthropological data collection and analysis**

Data gathered in the form of participant observation formed the core of the research on current uses of the landscape at Sadd al-Ahmar. Many of the individual interviews were conducted very informally in the course of working on related projects at Sadd al-Ahmar and in other communities in the Petra Region. Where archival material does not exist and interviews are unreliable, participant observation was employed to understand the social and economic processes which form the background for the research problem.

One of the key areas in which participant observation was useful has been the tourism economy. An important contributor to the demand for firewood is the tourist picnic "industry." Local and corporate tour operators stage elaborate "Bedouin picnics" for Petra tourists, and these picnics are one of the most lucrative business niches for local operators. Because of the controversies associated with picnicking in the Park, however, most tourist operators are less than forthcoming with information on this activity. For this reason, and so as better to understand the local economy of the Petra Region, the author worked for five months as an intern for a local tourist operator who specializes in events commonly known as "Bedouin picnics," though they bear only slight resemblance to Bedouin life. As an intern for Jordan Inspiration Tours (JIT) from June-November, 2004, the author participated in the staging of six such picnics for guests from the U.S., Jordan, Scotland, England, Israel, and Norway, ranging in size from 4-50 guests. The researcher has observed or attended as a guest several dozen more such events. Many of the workers and musicians who work for JIT cook or perform regularly for other operators, as well, and contributed to this research by discussing their experiences. Participant observation allowed the researcher to comprehend more fully the socio-economic and cultural processes which influence user behaviors.

Family picnic groups constitute another critical pressure on the forest at Sadd al-Ahmar (Fig. 29). As part of a larger project to determine user patterns and needs for the above-mentioned landscape design, as well as to gather for IALC information on attitudes toward the use of reclaimed water, the author and a colleague from the Jordan Badia Research and Development Center<sup>14</sup> (BRDC) conducted interviews with 152 picnic groups and other users of the site.

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<sup>14</sup> *Badia* means "desert" in Arabic, more or less -- empty desert. BRDC is a government-funded and supported research unit of Jordan's Higher Council of Science and Technology (*al-majlis al-'ala lil-'alimiyyah wa-taknulujiyyah*)

Interviews were conducted on seven different weekends during the spring and summer of 2004 and the late spring of 2005. Interviews were questionnaire-based (see Table 2). Interviewees were picnic groups along the Wadi `Araba Road between the opening to Sadd al-Nimr and the intersection with the northern boundary of the Park. The BRDC colleague is a member of a local tribe based in Rajif, one of the seven communities of the Petra Region. This tribal affiliation, along with the fact that the team included both a man and a woman, was key in the success of the picnic interviews, as local family groups are often quite wary of “outsiders.”<sup>15</sup> A man interviewing alone would have had limited access to the views of female family members.



**Figure 14:** A family picnicking at Sadd al-Ahmar on a spring afternoon in 2006 when over 200 vehicles were counted onsite. Averaging five people per vehicle (11 persons are pictured here), over a thousand people barbecued on that afternoon, virtually all of whom would have gathered firewood in the area.

In sum, several research methods were employed to address the study questions. The history of the forests of the Petra Region, as represented by the study area (Fig. 6) was determined by examining archival sources and conducting interviews. The present condition of the forest at Sadd al-Ahmar was established by repeated mapping of trees and quantification of damage to

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<sup>15</sup> “Outsiders” include Jordanians from anywhere north of Tafilah. As one colleague, a European-educated architect from an old and distinguished Jordanian family based near Amman once put it, “I introduce myself and these people smile politely and say, ‘oh, that’s nice, and where are you from?’ They don’t even consider me really Jordanian.” This wariness extends especially to photographing family members – often considered an invasion of religiously prescribed boundaries of propriety.



trees between 2003 and 2006. Significant current impacts on the landscape at Sadd al-Ahmar were determined through field observation and participant observation.

## **Table 2: Picnic Questionnaire**

Interviewers: Ahmad al-Rawajfeh, Erin Addison

Interviews were conducted on seven different weekends during the spring and summer of 2004 and the late spring of 2005. Interviewees were picnic groups along the Wadi `Araba Road between the opening to Sadd an-Nimr and the intersection of the road with the northern boundary of the Petra Archaeological Park.

Interviewers introduced themselves and ask if they may interview the group. Interviewers encountered no refusals. Usually some conversation took place about BRDC and the Rawajfeh family name, because it is a southern tribal name. Interviewers then asked the following questions:

1. Where are you from?
2. How many are in your party
3. Why did you choose this spot to picnic?
4. If you could do anything to this area to make it more attractive, what would it be?
5. Would you be willing to pay for a picnic site if there were services? (if the interviewee did not mention an amount --) How much would you be willing to pay?
6. Where is your firewood from?
7. What kind of firewood do you prefer?
8. What do you think about using charcoal? Why?

Usually at this point, if there was a separate women's group, Addison would excuse herself and greet the women, ask the same questions.

### 152 groups:

92 groups from within Petra Region

48 groups from outside Petra Region

12 of the 48 from outside Ma'an District

Groups who drove farthest were a group from Tafileh and a group from `Aqaba

Groups ranged in size from 8 persons to 42 persons, and averaged 16.

Every group included shade and scenery as reasons for coming to this area.

33 groups stated that their families had traditionally picnicked here. All of these 33 were from the Petra Region.

The suggestions for improvements ranged from swimming pools, shopping and an amusement park to drinking water and trash pickup. The most common suggestions were:

147 groups requested bathrooms

142 groups requested trash facilities (trash cans, trash pickup)  
 124 groups requested tables, benches and firepits (interestingly, the request for firepits mostly came from women)  
 113 groups requested fresh drinking water  
 111 groups requested more trees  
 97 groups requested lawn  
 93 groups requested playground equipment

Every group stated willingness to pay a small amount to picnic if services were provided. The most common amounts suggested were half a Jordanian dinar (US\$.70) or one JD (US\$1.40) per car.

45 groups brought firewood with them; of those 45, 27 gathered the firewood on the way; of the 18 who brought firewood from home, 3 had gathered it in the countryside near home, 15 were using orchard cuttings.

127 groups gathered firewood onsite or on the Wadi `Araba road after turning from Baidha (within 3km of the site).

No groups used charcoal.

The most-used firewoods were oak (143), `ar`ar (142) and rattam (123). Most groups mentioned more than one kind of wood, and many groups who were using orchard cuttings mentioned these three.

No group preferred charcoal. The most common answer (unfortunately unquantified) as to why charcoal was not used was that it affected adversely the taste of the meat being grilled. Many groups answered that firewood gathering was part of the recreational aspect of the picnic. Many groups answered that the meat should "taste like the place it is cooked," or a similar comment. Most interviewees seemed a little perplexed by the question in the first place.

#### 4. RESULTS

##### **Establishing the history of the forest at Sadd al-Ahmar**

Sadd al-Ahmar, like the rest of the Petra Region, has hosted continuous human settlement since the Mesolithic period. The prehistoric settlement at Baidha (3.5 km south-southwest of Sadd al-Ahmar) dates back at least to the early Neolithic (pre-pottery Neolithic B) period, placing it as one of the world's oldest year-round human settlements, contemporary with Ariha/ Jericho in Palestine and Ganj Dera in Iraq. All of these settlements are sites which bear evidence of the earliest agriculture and domestication of goats (Horwitz, et al. 2005: 210, 216-17; Wright 1971:119). The Neolithic remains on and adjacent to the study site include three significant villages known to archaeologists as Ba'aja 1, 2, and 3, which overlap the later periods of settlement at Baidha (Gebel 1985: 9). Thus humans have been part of the region's ecosystem for some 10,000 years. It is probably only recently, however, that human activities have come to *dominate* the processes which have shaped the natural landscape of Petra.

In this section we will first summarize the archaeological and historical narratives which bear on the history of the forests in the study area. This picture will then be fleshed out with information from interviews and material remains onsite. Once a picture of the deeper history of the forest has been sketched out, we will turn to photographic documentation and vegetation maps to establish the dynamics of the more recent past at Sadd al-Ahmar. Research results establish that the forest experienced radical degradation in the first decades of the twentieth century and has been declining ever since. Quantitative assessment suggests that in recent years the rate of decline is increasing. Evaluation of the causes for the decline, i.e., the current pressures on the forest, allow us to suggest the implications of a non-interventionist management approach, as well as to suggest means to address these pressures and protect what remains of the forests of the Petra Region.

**The history of the forest until 1924.** As noted above, the Petra region hosts some of the earliest known human settlements. Archaeological evidence attests to several thousand years of human history which predate written sources. Human use of wood products for construction is hypothesized at the excavations of Neolithic Baidha (Dennis 2003), where timber beams reinforce the reconstructions of conical, teepee-like roofs on round residential structures.

Copper mining was probably pivotal in the process of state formation in the Edomite period, dated variously from 11<sup>th</sup>-6<sup>th</sup> century BC. Mining and smelting were crucial industries in the region from the Neolithic period through the Early Bronze age and Edomite period all the way to the 12<sup>th</sup> century AD (WAP 2006). One study reports that

Copper smelting was the first pyrotechnical industry to require charcoal... According to the few estimates available the charcoal to copper ration for smelted oxide ores is at least 20 to 1... and perhaps as much as 40 to 1...A five kg. smelt, therefore, would use 100 kg. of charcoal (to be conservative)... and would use 700kg of wood (Horne 1982).

It is difficult to estimate the amount of wood which would have been required to fuel smelting operations for twenty-two centuries, but such smelting operations – over such an enormous timespan – suggest that fuelwood was available, indeed plentiful. Analysis of charcoal remains

from mines in southern Jordan reveal that local species, including *Retama raetam*, *Juniperus phoenicia*, and *Quercus calliprinos* (= *Q. coccifera*) were used as fuelwood for smelting fires (Engel 1993).

New textual description of Petra's landscapes during the Roman and Nabataean periods will no doubt be yielded by the Petra Papyri currently under analysis at the University of Michigan, but archaeology has already yielded evidence that wood was used extensively by the Nabataeans in the construction of Petra, and residential complexes from Roman and Byzantine periods continued this use (Shaher 2005).

Paleobotanical analysis of hyrax middens reveal that there was a sharp decline in the forests of Petra and vicinity following the Byzantine period (Fall 1990). Paula Kouki, in her dissertation analysing environmental change in the Jabal Haroun area of Petra Region, reports that pollen remains from *Artemisia* and *Ephedra* spp. also declined,

while pollen from taxa indicating disturbance increases, which Fall considers to be the result of foraging by livestock. The pollen composition of the midden dated to the Early Islamic period strongly resembles that of the present day (Kouki 2006).

There is little archaeological evidence for the early Ottoman period, and by the time we move into the later Ottoman European travel accounts begin to appear. The Petra region has been relatively well-documented in European sources since 1812, when Swiss traveler Johann Burckhardt wrote of his exploits hunting for the "rose-red city." In 1812 Burckhardt gained entry to Petra disguised as a Muslim trader, and Petra became a destination for European tourists and pilgrims. Although most travelers' accounts focus on the archaeological remains of the main city, the scenery is so overwhelming that many comment on the landscape as well. Most of these travelers were essentially pilgrims: they imagined the Sherah mountains and surround as "Edom," the region beyond the Jordan River described in the Old Testament. Many came to the Transjordan<sup>16</sup> from what was then Palestine, usually from Jerusalem, and so approached our study area from Ras al-Namala, an age-old pass which ascends from Wadi Feinan through Sadd al-Ahmar and Siq Umm al-Hairan into Petra. Others came from Shaubak or Ma'an through the Sherah and then descended through Baidha, crossing the hillsides above Sadd al-Ahmar. Thus we have travelers' accounts of precisely our study area, as they approached the famed ancient city.

Charles Irby and Leonard Mangles were neither pilgrims nor adventurers, but naturalists who visited Jordan in 1817-1818. They comment on the "barren state of the country" around Petra itself (1823: 439), but of the slopes above Sadd al-Ahmar, the Hishah mountains of the Sherah between Bedebdeh and Shammakh, they remark that their guide, "conducted us to a valley with the sides prettily studded with turpentine<sup>17</sup> trees, so clustered and grouped together, as to give it a very parkish appearance..." (386). They also note that some of the local Bedouin migrated

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<sup>16</sup> Today's Hashemite Kingdom of Jordan was founded in 1946, before which it was called by the British the "Transjordan" (i.e., across the Jordan River from Palestine).

<sup>17</sup> "Turpentine" and "terebinth" both refer to pistachio trees, though it is unclear whether they refer to *Pistacia atlantica* or *Pistacia palestina*.

annually to Cairo and Suez to sell charcoal, suggesting that wood was plentiful enough for it to be economically viable to transport it some distance to market.

Christian pilgrim-scholars E. Robinson and E. Smith, in the year 1838, entered the Petra region through “Nemela” pass (1841: 504), and wrote in their journal that  
 in the vallies (sic) were various trees and shrubs, the Seyal, Butm, and the like,  
 and also the Retem in great quantity, all very large. On the rocks above,  
 we found the juniper-tree, Arabic ‘*Ar`ar*’; its berries have the appearance  
 and taste of the common juniper, except that there is more of the aroma of  
 the pine. These trees were ten or fifteen feet in height (506).<sup>18</sup>

Of the Sadd al-Ahmar area they noted,

The shrubs, studding the mountains to their very top, continued green;  
 and large trees of the juniper became quite common in the Wadys and  
 on the rocks...Looking down into [the siq] we perceived its bed  
 full of the Difleh or Oleander in full bloom...We here turned up a side-  
 valley S.E. still called Nemela; the oleanders and junipers continuing  
 all the way...(509-510)

The famous Charles M. Doughty, whose books were fodder for such as T.E. Lawrence, wrote in the 1880’s of the slopes above Baidha,

This limestone moorland, of so great altitude, resembles Europe, and  
 there are hollow-parklike grounds with evergreen oak timber... we began  
 to descend over a cragged lime-rock, beset with juniper (1921:78)

A series of photos from William Libby and Franklin Hoskins’ 1905 account tell little about the mountainsides, because the background landscapes are blurry, but it is interesting that in the foregrounds there is plentiful low shrub cover on hillsides and in the wadis (1905: 45-129, *passim*).

As always, the Czech geographer Alois Musil offers us more nuanced information. In Volume II of his famous work, *Arabia Petraea*, he gives us careful accounts of his rides through Hishah and Namala in 1896 and 1902, respectively:

At this point the region belongs to the Jabal ash-Sherah and now grew  
 beautifully picturesque. We rode through high *durrgras* past very  
 stout terebinth trees and dense shrubbery, and it seemed to me as though  
 we were transported suddenly into a European wood.

The butm-terebinth bore red berries, which the thirsty population were enjoying happily.  
 Here and there stand quite dark, indeed almost black cypresses, `ar`ar, luzzab, which  
 have real, solid timber which is sold in Kerak or Ma'an at a rather

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<sup>18</sup> *Seyal* (Ar.) is *Acacia tortilis* (al-Eisawi 1998: 177); *butm* is pistachio (again, either *P. atlantica* or *P. palestina*); *retem* is *Retama raetam*, `ar`ar is *Juniperus phoenicea*. *Seyal* does not occur at elevations as high as Sadd al-Ahmar, but lower on the Namala pass.

dear price. Their black, oblong fruit is cooked, pressed, and the thick mass, *al-bawrash* (sic), is eaten as a delicacy. A sought-after commodity is also borne by the mahaleb cherry (morello, *keraz*), from whose branches are manufactured the best flutes... (37-38).

Of his journey from the Jordan Valley floor up Namala pass through “sik al-Beda” (upper Siq Umm al-Hairan), a route which necessarily passes through Sadd al-Ahmar, and on into Hishah (1905: 220) Musil writes, “... The butm-trees, which begin at an elevation of about 400m, diminished by 600m further on and the dark luzzab, or `ar`ar, appeared (217) <sup>19</sup> He provides a striking photograph looking up the Namala siq from the south – the siq is crowded with mature trees (1907: 218).

George E. Post, who taught at the American University in Beirut and worked in Jordan for decades, contributed a short chapter on “The Botany of Edom and Moab,” to George Livingston Robinson’s work on Petra. He writes, in 1930,

...The western edge of the plateau of Edom and Moab rolls up into a crest, from four thousand to five thousand feet above the Mediterranean. This crest was once heavily wooded with oaks, terebinths, and, especially on its western aspect, with junipers. In a recent journey northward from Petra, as soon as we had cleared the valley, we came into a rolling parklike country, studded with treelets of hawthorn or *Bratalgus agarolus*.<sup>20</sup> Crossing a promontory of the table-land, we entered a grove of oaks, and, a little farther on, a region of mushroom-shaped terebinths, with dense semispherical tops, on very thick trunks... Notwithstanding these remnants of the ancient forests, the table-land is now mostly denuded of its trees...(222)

The impression from these accounts is that the forests of the Petra Region, and Hishah/ Sadd al-Ahmar specifically, diminished significantly between the late nineteenth century and the early twentieth. Once a parklike forest resembling Europe (1880, 1902), by 1930 we find a “table-land mostly denuded of its trees.”

It was during precisely this period that the Ottoman Sultan Abdul Hamid II conceived of the great Hijaz<sup>21</sup> railway, intended to consolidate Ottoman control over the Arab territories and to convey Muslim pilgrims from Damascus to Mecca for the hajj. The railway reached Amman in 1902, Ma’an in 1904, and finally Madina in 1908 (Abujaber 40). It is interesting that in the Cambridge *Economic and social history of the Ottoman Empire*, there is a chapter devoted specifically to the Hijaz Railway, even a section entitled “impact of the railroads, an assessment,” which discusses the enormous labor and financial resources required to construct the railway. Nowhere is the issue of construction materials addressed, and the environmental consequences of this massive endeavor are not considered under “impacts” (Faroghi et al.:1997). In fact the impact on Jordan’s forest was devastating.

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<sup>19</sup> (Author translation)

<sup>20</sup> Probably *Crataegus aronia*, Ar. *zarour*, wild hawthorn.

<sup>21</sup> As elsewhere, the spelling of Hijaz/Hijaz varies, due to the perceived ambiguity and variation of short vowels in spoken Arabic. Except where the word is used in a title, it is here spelled to match the Table of Arabic Translation, above.

Archival sources from the Ottoman period in Jordan report the confiscation of property and expropriation of land for timber and construction of the railway. Records of an estate near Amman indicate that in 1899 the Ottoman government levied a “wood aid” tax to fuel the steam engines (Abujaber 1989:117). There is a common misconception that the forests of Jordan were depleted to supply the Hijaz railroad ties (or “sleepers,” in British parlance). A local Hijaz Railway enthusiast, Sami Sabat, who has researched the length of the railway and collected rails and ties for analysis reports that the rails were built of imported Turkish and Macedonian oak or, farther south, steel.<sup>22</sup> The stacks of wooden ties that remain visible at some of the stations now are left over from a restoration project sponsored by the U.S. in the 1950’s (Sabat, personal communication). The demand for firewood to fuel the steam engines was pressing enough that in 1915 a 36 kilometer spur line was laid from the `Unaizah station just north of Ma’an into the Hishah forest southwest of Shaubak (Nicholson 2005: 57f.; Peake 1958: 97). Frederick G. Peake “Pasha,” who served in Jordan in the early 20<sup>th</sup> century and whose narrative of his career in south Jordan remains one of the standard works on the region and its tribes in WWI and post-WW Jordan, writes of the “Hish forest,”

It was from this forest that the Turks had obtained the wood which they used as fuel for the engines on the Hijaz railway. By January, 1918, most of the trees had been cut down and removed (138 n.1).

This project would most likely have included timber from our study area. Today the “Hishah forest” describes an area above – north and east of -- Sadd al-Ahmar. Kennedy, however, in 1925 describes the area including Sadd al-Ahmar as “the western edge of the Hishah Forest” (B 18-19). Now Hishah is a hilly wooded region covered with oaks and very little else. Irby and Mangles described their 1817 route from Shammakh to Bedebdeh, a route passing just above Sadd al-Ahmar (in what is now called Hishah), as “a valley with the sides prettily studded with turpentine trees... clustered and grouped together” (386). One is hard-pressed now to locate even a few isolated specimens of “turpentine” (*Pistacia atlantica* or *Pistacia palestina*) between Shammakh and Badabdah.<sup>23</sup>

The author was fortunate to be able to interview the elderly Muhammad Ibrahim Qassim Kreishan, for over 40 years General Supervisor of Line Maintenance for the Hijaz Railway in Ma’an, and whose father also worked on the railway. Mr. Kreishan explained that pistachio was the preferred fuelwood for the steam engines, with oaks a distant second choice. Mr. Kreishan’s explanation confirmed the anecdotal report that we heard repeatedly in interviews in the Petra region regarding the disappearance of the pistachios.

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<sup>22</sup> Only in the last segment laid before Medina were wooden ties used south of the Jordan-Saudi border (Peake 1958: 96, 138 n.41). There is some irony to the reports that the wooden ties were eventually torn out of the tracks by the Bedouin to use for firewood.

<sup>23</sup> In fact several remaining gigantic specimens of *Pistacia atlantica* on the edge of Hishah and near Wadi Musa are now marked with signs and protected by the Jordan River Foundation’s Historic Trees Project. One of these, south of Wadi Musa in Wadi Dhaha, is estimated to be nearly a thousand years old.

Although the spur line to Hishah was torn out in 1922-23, rails are still reported to be visible in the forest outside Shaubak.<sup>24</sup> The village of Hawwala, still known locally to older people as *ras al-hadiid* (“the head of the iron,” i.e., the head of the *khatt al-hadiid*, or tracks), lies near the edge of region clearcut for the Railway (Fig. 15). The 36 kilometers from the edge of the forest to `Unayzah station look like the left half of Figure 16. The oak forest on the right covers some 25km<sup>2</sup>, thinning rapidly on the edges which approach old settled (or once-settled) towns and roads: Shammakh, Baidha, Wadi Musa, Ras al-Namala. What remains exists by virtue of the area having been declared a private reserve by King Hussein in the 1960’s. Today the Hishah forest consists almost entirely of rather stunted oaks, which appears to corroborate local narratives which say that the residents used to harvest the pistachios selectively for the market in Ma’an, and that the large oaks were preferred by locals for constructing doors and furniture.



**Figure 15:** Northern edge of the remains of the Hishah forest from the Shammakh road looking southeast.

Another indirect pressure exerted on the forests by the construction of the Hijaz railway was the existence, by 1904, of a giant camp that moved slowly south accompanying the extension of the line. At some points as many as 7,500 people inhabited the Ottoman construction camps (Nicholson 2005), bringing with them a village-sized demand for fuelwood for heating and cooking. Ma’an served as the base for the construction of the entire southern line, completed in

<sup>24</sup> This author has failed to locate them, but locals insist they are there.



1908 – so this provisional community's needs would have presented a significant added pressure on the fuelwood supply of the area for more than half a decade.

Taken together, the pressures associated with the construction of the Hijaz railway constitute a significant, perhaps cataclysmic impact on the forests of the northern Petra-Shaubak region, which includes our study area. This conclusion was likewise reached by Willimott, et al., (1964). From 1904 at the latest, until at least 1918 and perhaps later, these forests were systematically ransacked to serve the Ottoman effort. This reinforces the sense we gain from the narratives above that the sharpest decline in the area's forests occurred in the early 20<sup>th</sup> century.

This impression is supported still further by interviews with older members of the communities of Baidha and Qurayqra.<sup>25</sup> They report of their fathers telling stories of the Bedouin wars and conflicts with the Ottoman army when close-range gunfights were carried on between opponents hiding in groves of trees. Sheikh Salim Abu Shusheh recalls his father's stories of Turkish soldiers shooting at the `Amariin from the bluffs overlooking Sadd al-Ahmar, where his family hid in the pistachio trees.<sup>26</sup> There are today no "groves" of pistachios – only isolated specimens. Indeed "hiding" in "groves" of any tree species in Sadd al-Ahmar would be poor cover in a gunfight. Sources also remember the charcoal trade (both local and foreign) and harvesting for lumber. The photographic evidence also suggests that the "turpentine" trees of Irby and Mangles' "parklike" landscape of 1818 have largely vanished by 1924.

Even after the forests were far depleted by the railway project, the demand for lumber for local construction continued. Local homes were built using tree-trunks or large limbs, preferably from the *balout* (*Quercus coccifera*) or `arar (juniper, *Juniperus phoenicea*) for roofs, doorways and columns.

The decimation of the forest cover, not to mention the understory it protected and nourished, did not cease with the demise of the Hijaz railway in the famous campaigns of T.E. Lawrence during World War II. The war years yielded detailed aerial surveys of much of west Asia, which have been a great boon to archaeology and historiography. Alexander Kennedy's monumental work on Petra (1925) includes an aerial survey of the entire watershed, including Sadd al-Ahmar, completed in 1924. Comparing Kennedy's survey to the satellite image of Sadd al-Ahmar taken in 2002 upon the completion of the water treatment plant affords us a visual resource for examining the changes in the forest.

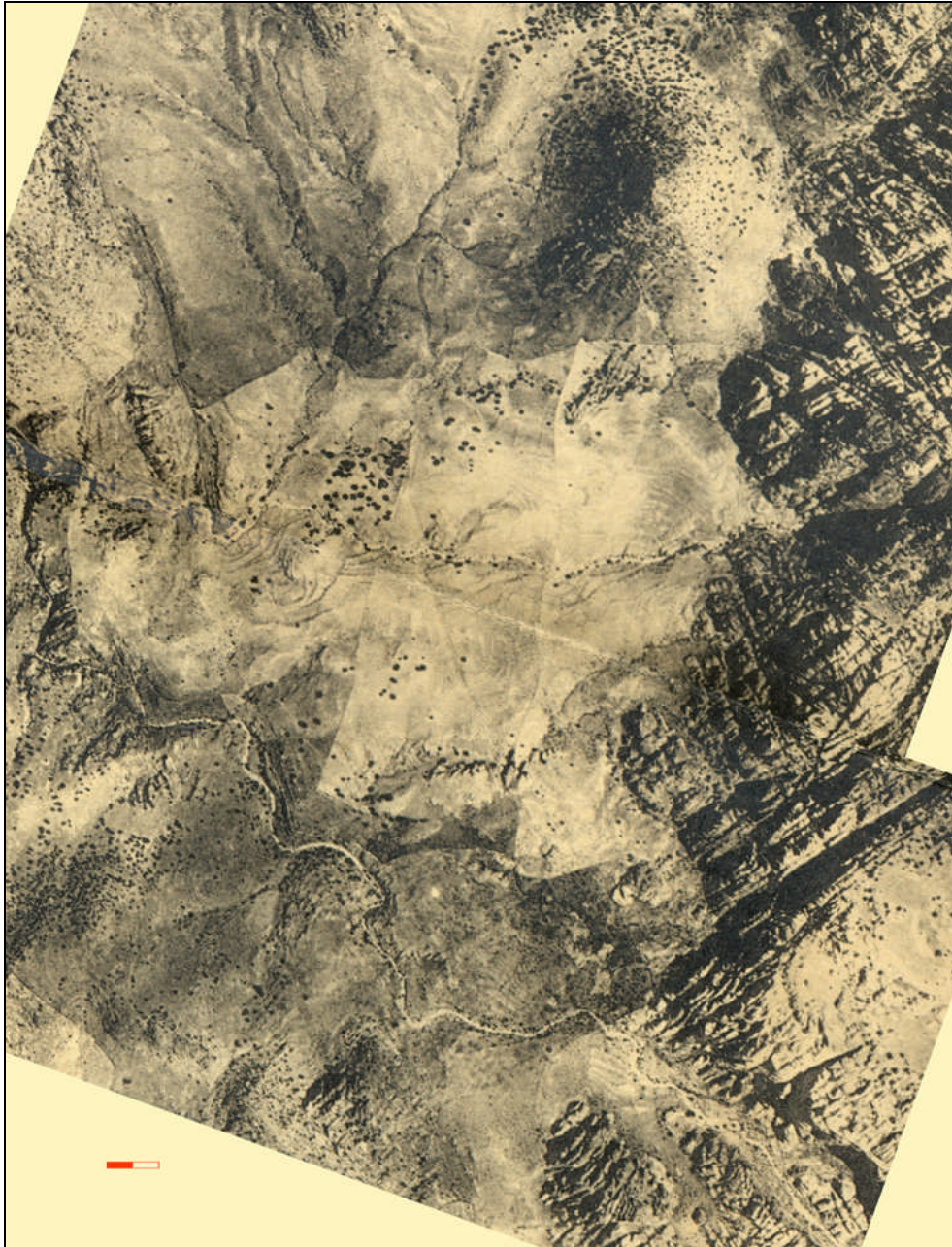
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<sup>25</sup> The `Amariin tribe, who summered in Sadd al-Ahmar before it was annexed as part of the Petra Archaeological Park, spent winters in Qurayqra and still do. I am especially indebted to Sheikh Salim Saliim Abu Shusheh al-`Amaariin of Qurayqra and Namala; Isma'il al-Twaissi of Wadi Musa, whose father built the first school in Baidha in the 1930's and told Isma'il of forests and wildlife there; and Abu Muhammad al-`Amaariin from Baidha and his nonogenarian father, who have reminisced for me about the past in Sadd al-Ahmar and Baidha.

<sup>26</sup> Other researchers report similar testimonies (Willimott 1964).

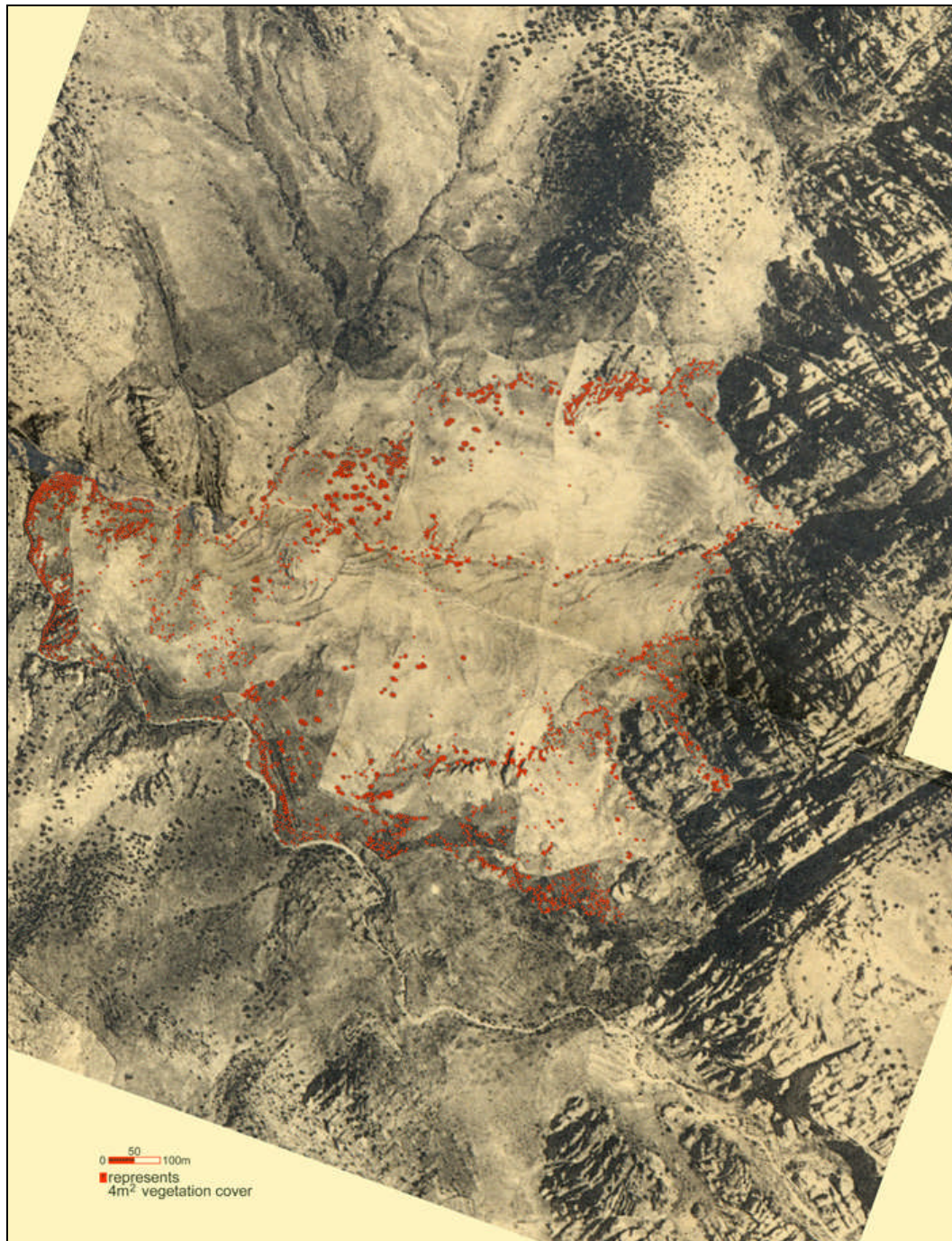
### The forest from 1924-2002

Alexander Kennedy's aerial survey of the Petra area was originally published in his enormous work, *Petra: its history and monuments* (1925: plates follow text - Fig. 17). Though the purpose of the Petra survey was to identify the many layers of built remains, it serves splendidly to

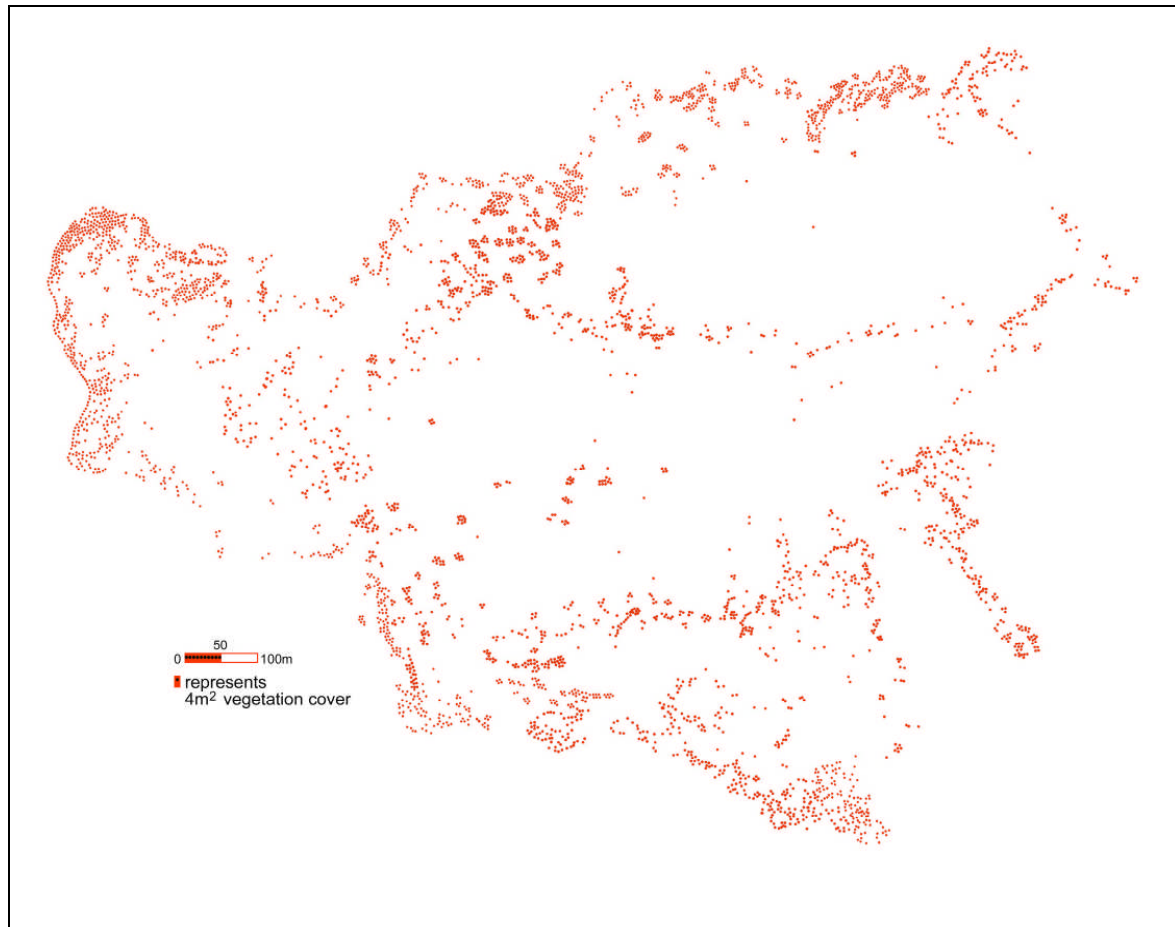


**Figure 16:** Sadd al-Ahmar, 1924. Composite of six sections from Alexander B. W. Kennedy's aerial survey of the Petra region. Conical Ba'boul in the northeast and the deep clefts of Siq Ba'aja and Siq Umm al-Hairan to the west and south make it easy to locate Sadd al-Ahmar in the map series





**Figure 17:** Forest cover in study area, 1924, indicated by red polygons, each representing  $4\text{m}^2$ . illustrate the condition of the forest cover in 1924, when it was composed. In order to generate a quantitative assessment of the forest cover the 1924 image was overlain with graphic polygons, each of which represents  $4\text{m}^2$  in area, yielding Figure 17. The resulting estimate of forest cover can then be abstracted (Fig.18) to give a graphic representation of tree canopy in 1924 and serve as a baseline for comparison.



**Figure 18:** Abstract representation of the forest cover in the study area in 1924.

The 3,922 dots which compose the image in Figure 18 represent the estimated 15,688m<sup>2</sup> of forest cover which existed at Sadd al-Ahmar in 1924. The results produced a graphic comparison between the 1924 image and Petra Regional Authority's 2002 satellite image (Fig. 22, below).





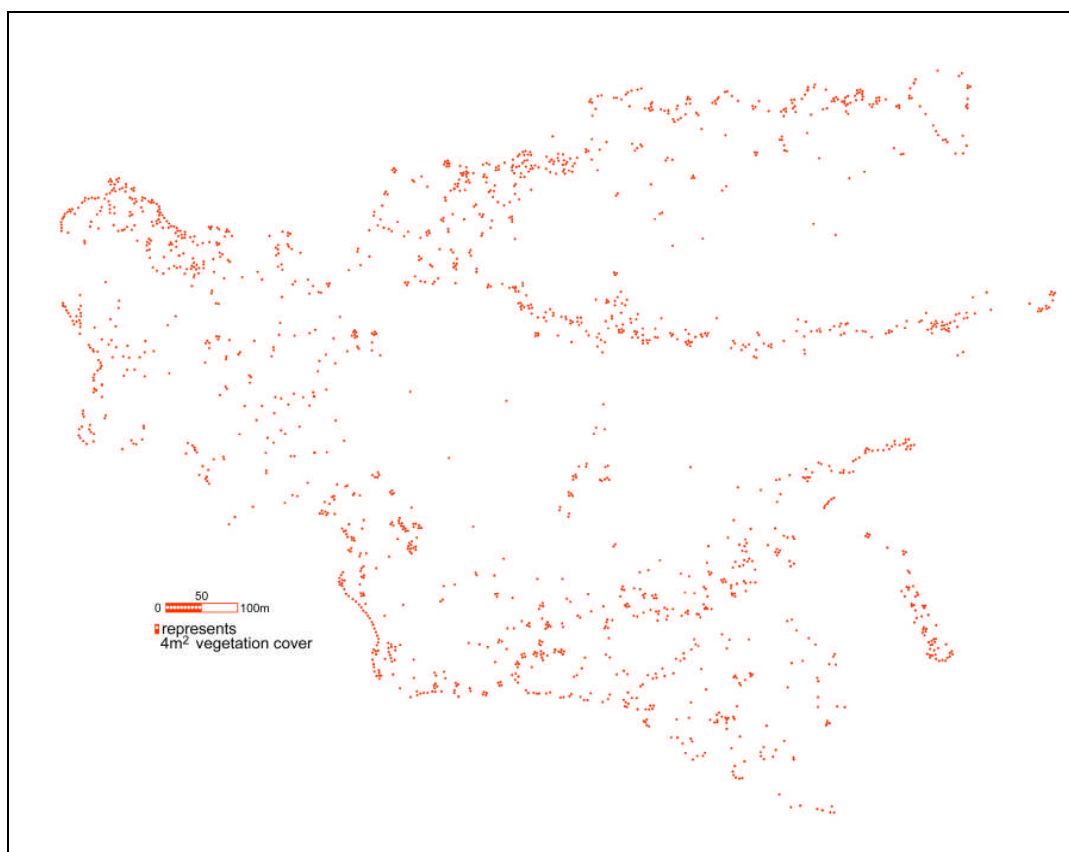
**Figure 19:** Sadd al-Ahmar, 2002. In this image the finishing ponds of the wastewater treatment plant are also clearly visible in the bottom center (courtesy of the Petra Regional Authority).





**Figure 20:** Forest cover in study area, 2002, indicated by red polygons, each representing  $4\text{m}^2$ .

Again the image was overlain with polygons (Fig.20) and the graphic abstracted to represent the tree canopy in 2002 (Fig.21).



**Figure 21:** Graphic from the 2002 image abstracted to represent tree canopy in 2002.

The 1,650 dots which compose the image in Figure 21, each of which depicts  $4\text{m}^2$ , depict the estimated  $6,600\text{m}^2$  of forest cover which existed in 2002. This figure represents a decline of 58% since 1924. Even if we concede that the greatest single impact on the forest at Sadd al-Ahmar probably occurred between 1915-1918, Figure 22 demonstrates a marked decline between 1924 and 2002.

In absence of aerial photographs or written narratives dating between 1924 and 2002, oral narratives and material remains were used to assess the reasons for the decline indicated in Figure 22. The other method used to assess recent changes in the forest cover involved mapping the stumps of trees which have been cut (see Figs. 34-35, below). Some general observations made during this mapping process help to elucidate changes in the forest between 1924-2002.

The survey suggests that many stumps must have been removed during clearing for agriculture. Agriculture has been practiced at Sadd al-Ahmar for at least 2,000 years, and the region hosted some of the world's first agricultural villages. The entire valley, and the steep hillsides as well, are laced with handsome terraces and the remains of an intricate water harvesting network from the Nabataean period (ca. III BC-III AD) (Fig. 23). In the 1924 photo it is possible to





**Figure 22:** Forest cover in 1924, 2002. The graphic derived from the 1924 image (left) represents 15,688m<sup>2</sup> of forest cover; the graphic derived from the 2002 image (right) represents 6,600m<sup>2</sup> of forest cover, a 58% decline.



**Figure 23:** Nabataean period cistern opposite Ba`boul Ba`aja.

discern terraces and fields which are still evident in the image from 2002 and which function now on the Re-Use Project farm plots. Where the ground becomes too steep or rocky for



cultivation the number of stumps increases. One explanation of this might be that these tree species simply preferred steep, rocky, sheltered areas and did not grow on the open hillsides. Three observations, however, suggest that this is not the case.

First, whereas pistachio and carob prefer sheltered areas in the siqs and wadis, the *`ar`ar* juniper generally thrives in small groves on the open slopes.<sup>27</sup> There are still several remaining stands of old *`ar`ar* onsite on hilltops fully exposed to the sun and wind. One of the few remaining oak forests in the area covers the exposed western slopes of the Jabal Sharah below Hishah.

Two other observations suggest why the remaining stumps are presently concentrated in steeper areas and not on the farm plots. When we observe the ongoing damage to trees at present, harvesting decreases as we move away from roads and farms, i.e., as the trees become less accessible, and firewood more difficult to transport. Thus the easily accessible valley farmland is likely to have been harvested first. Some of the largest stumps were encountered on the table-land areas along terraces or in fields where property lines join. These terraced areas are often not particularly steep – they are conserved for erosion control, and water and soil "pool" behind them: the stone terrace walls provide more positive soil and water conditions – i.e., the opposite of a steep, rocky habitat. Because plowing veers short of the terraces to avoid damaging them and rarely actually reaches the very property line of a farm plot, these terraces and property lines create narrow corridors from which stumps were never cleared. It is likely that there were, once, trees on the flatter lands, but the stumps were cleared for agriculture.

In examining the Kennedy and PRA aerial photos, it is important to notice that not only have trees disappeared entirely, but *cover* is diminished. Based on field observations, there appears to be a dramatic contrast between the shade cover and the humus accumulated beneath a healthy mature tree and the arid micro-habitat under a stripped one. Each of these micro-habitats potentially shelters various plant growth forms and the structural diversity which potentially serves as an effective habitat for wild fauna. Firewood stripping of trees which are still standing exacts a toll on this precious shade cover and appears to remove valuable nurse-plants for the understory. Even gathering deadfall wood robs the starved soil of much-needed organic matter.

On open hillsides the low chaparral of *sheeh* (*Artemisia sieberi*, Ruben 62; = *A. herba alba* Asso, al-Eisawi 1998:79) and *gaysoum* (*Achillea fragrantissima*) has been almost entirely destroyed by grazing and human pressure. Both are important medicinal plants still used throughout Jordan and under pressure from wild-gathering. *Sheeh* is stockpiled at the end of the winter for cooking fuel (Figs. 24-25). Grazing also stresses the tree cover. *Rhamnus disperma* virtually never appears in tree form – it is so continually grazed down that it takes a bizarre, carpet-like

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<sup>27</sup> It is unclear at the time of writing whether or not the Kermes oak (*Quercus coccifera*) thrives on the open slopes. They never appear in exposed areas at Sadd al-Ahmar. There is no other oak attested for the Petra Region by Oran or al-Eisawi. The Kermes oaks of the Hishah forest, however, grow completely exposed to harsh western sun and wind. Though they appear very different in growth habit and the foliage is stunted by comparison with those at Sadd al-Ahmar, this may result from constant coppicing and from the harsh exposure itself.



**Figure 24:** Sheeh (*Artemisia herba-alba*) stockpiled for firewood in Rajif, March 2006.

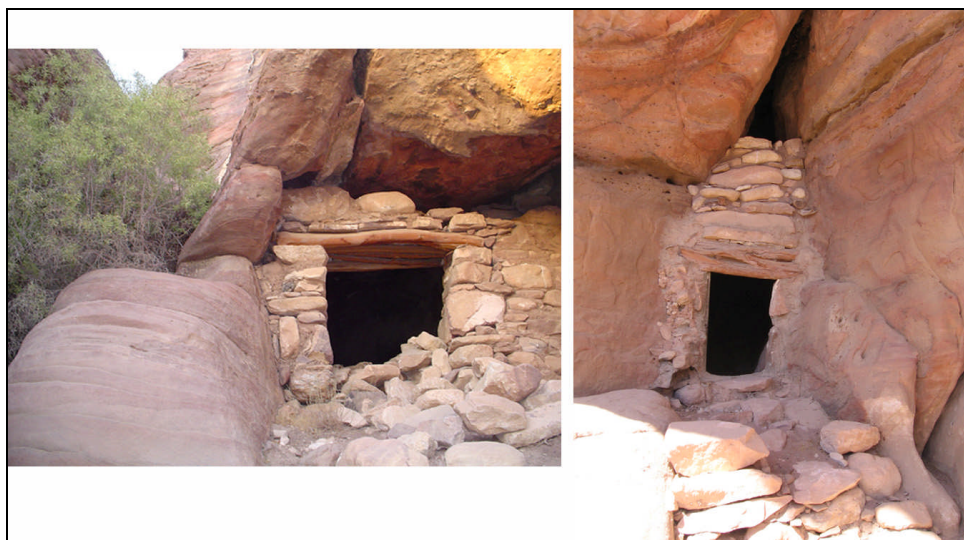


**Figure 25:** A family gathers sheeh (*Artemisia herba-alba*) for firewood, March 2006, Shaubak-Wadi Musa road.

appearance – almost like a bonsai tree. All of the trees in Sadd al-Ahmar are heavily grazed to about two meters, resulting in the typical thick, burlled trunks and stunted foliage. Indeed, part of the “parklike” appearance of Jordan’s forests results from the “pruning” the lower foliage receives when goats browse them – each tree is evenly “trimmed” beneath to about two meters above the ground -- the height of a goat's out-stretched neck.

Another significant use of timber in the Petra Region was, until quite recently, local construction. While the population of southern Jordan is historically nomadic pastoralist, i.e., "Bedouin," in

the twenty-first century that is a complex identity (Addison 2004). For at least three generations a significant share of the population has spent part or even most of the year at fixed locations in "hard" dwellings of some kind, as opposed to tents. Now most Jordanians occupy hard



**Figure 26:** Shepherds' shelters on the north bank of Wadi Ba'aja (left) and the north bank of Wadi Umm al-Hairan (right). The Ba'aja shelter has a handsome finished-cypress ceiling; both shelters use cypress beams for the lintels over the openings to the caves.

dwellings, even if they still own traditional goats' hair tents. In Kennedy's 1924 survey, for example, it is easy to discern the established, stone-built village of al-Jiy (Elji, Elgy, Al-Jee), the village which eventually became Wadi Musa, suggesting that hard construction has been a part of "Bedouin" life in the area at least a century. Furthermore, the landscape is riddled with small shelters used by shepherds or for seasonal storage (Fig. 26).

The connection between the stone dwellings and deforestation is direct: before the advent of reinforced concrete, timber -- especially the tough, fragrant, insect-resistant `ar`ar juniper, was used for lintels, doorframes, doors, roofs and support columns (Fig. 27). Indeed, `ar`ar was the wood preferred by Bedouin for tent poles as well.<sup>28</sup> Concrete construction became the norm in Petra in the 1960's, so wood construction was a significant environmental pressure for at least four generations and probably much longer. It is worth noting that the four freestanding vernacular stone structures in the study area were built after 1924, and all incorporate wood in roofs and doors.

Population growth and economic development have exacerbated pressures on the local forests. Jordan's Human Development Report 2004 reported that 69% of Jordan's total population falls under the age of 29; 38% was under the age of 15 (HDR 2004: 18). Jordan Dept. of Statistics reports that in 2010 over 27% of Jordan's population was between the ages of 20-34. A staggering 48.3% is under the age of 20 (DoSJ 2011). In the past population growth occasioned a demand for timber for dwellings; at this point most of the land within the *tanzhiim* -- the utilities networks -- has already been deforested and dwellings are mainly concrete.

<sup>28</sup> Salim Saliim Abu Shusheh, Majed Nasr al-Hasanat, et al., personal communications.





**Figure 27:** Timber from *Juniperus phoenicea* used for lintel, door and ceiling construction in structures at Sadd al-Ahmar.

Another significant pressure on the forests throughout the region has been, until recently, the traditional wedding party. Wedding parties are virtually always the same, and involve the slaughter of many head of sheep, goats and camels which are then cooked in huge steel cauldrons over open fires for the requisite celebratory *mansaf*. Each wedding party requires



**Figure 28:** Cauldrons of *mansaf* boil over wood fires.

approximately 600kg firewood and one ton (one dump-truck load) costs, at the time of writing, JD160-250 (US\$227-355), depending on the kind of wood and not including the price of transportation. Although the tradition continues, it is abating due to economic pressure and the wide availability and relative inexpensiveness of gas. At the same time, if we consider that the average household income in the Ma'an Governorate (where Petra is located) in 2008 was JD 3,383 (\$4,803), or JD 282/ US\$400 per month, it is clear that firewood is a valuable commodity. As the wedding ritual is adapted to new technologies, however, a greater threat to Petra's forests is development associated with growing tourism.

Petra has hosted tourists in the modern sense of the word<sup>29</sup> since Jacob Burkhardt arrived in 1812. A quantitative and qualitative transformation in the tourist market took place, however, in 1994 with the signing of the Jordan-Israeli Peace Treaty. In 1994 there were no five-star hotels in the Petra Region; by 1997 there were five, and dozens more two-, three- and four-star establishments. Petra and the lodgings associated with it are Jordan's single most important generator of tourism revenues. Petra is overwhelmingly the primary tourist destination in Jordan: 90% of all international tourists spend at least one night in Wadi Musa. In 2004 tourism was Jordan's largest export sector, its second-largest producer of foreign exchange (at 11%), its second-largest private-sector employer, and accounted for 10-11% of Jordan's GDP. Tourism was Jordan's fastest-growing development sector, and Petra accounted for over 90% of the total income from tourism in Jordan (JTB 2004).

One salient activity of both domestic and international tourism and local residents exerts ongoing pressure on the forests of the Petra Region: demand for firewood for cooking, and particularly for outdoor grilling. Historically the Bedouin population has relied on firewood for cooking and heating; though the population of tent Bedouin is dwindling, their firewood needs persist and many settled Bedouin retain traditional firewood use-patterns. Electricity was introduced to Wadi Musa in the 1970s and to the other villages of the Region soon thereafter. Until the '70s, however, firewood was harvested for these purposes and constituted a demand which increased with the population. Even with the settling of most Bedouin in fixed dwellings and the advent of alternative cooking and heating fuels, however, outdoor grilling -- *hash ou nash* -- continues to be a premiere recreational activity. Throughout Jordan, on most sunny afternoons and especially Thursdays and Fridays in the warmer months, any place with mature trees is likely to host picnickers grilling meat over wood fires. As this study suggests, these fires are most likely to be built from locally gathered wood. Scripting on the *hash ou nash* tradition, local and corporate tour operators have developed a highly lucrative commercial picnic product for tourists to Petra, which also depends on a supply of firewood.

So far we have surveyed the historic pressures on the forests of the region and Sadd al-Ahmar in particular, and we have documented some of the processes involved in their decline over the past two centuries. In sum, there seems to have been a marked decline in vegetation cover in the late 19<sup>th</sup> and early 20<sup>th</sup> centuries, largely – though not solely – due to the harvesting of wood to supply the construction and operation of the Hijaz railway. Concomitant and continuing

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<sup>29</sup> The history and definition of tourism is a field unto itself; cf. especially Erik Cohen's *Contemporary Tourism: diversity and change* (Tourism Social Science Series, 2004). Also al-Hasanat, 2011.

pressures on the forests include harvesting of wood for charcoal for domestic use, sale and international trade, firewood for domestic use and for trade, lumber for the construction of roofs, doors, furniture and farm implements, and clearing of forests for agriculture, building and tourist development.

Today at Sadd al-Ahmar many of these pressures are matters of historical interest only. The Hijaz railway met its demise in 1918.<sup>30</sup> Consumption for charcoal is minimal as there is negligible domestic and no foreign market for it any more. Within the Park boundaries clearing for agriculture is prohibited.<sup>31</sup> Clearing for tourism development is also prohibited, though some abuses still occur. For over a generation now most construction uses reinforced concrete, and most lumber is imported from Turkey and the former Soviet Union. Grazing, though still evident on the margins of the study area, is illegal and severely regulated. Yet the main pressure on remaining trees of the Petra Region's forests is the demand for firewood, with picnicking remaining the single most severe pressure on the survival of these native forests. At this point the remainder of the discussion will focus on the documentation of current and ongoing damage to the remaining "forest" at Sadd al-Ahmar from 2003-2006, and assess the predominant pressures which threaten to worsen its prospects for survival.

**Sadd al-Ahmar, 2002-2006.** This section of the study focuses on current and continuing sources of stress on the forest at Sadd al-Ahmar and the Petra Region in general. At the outset of this research the author assumed that overgrazing would be the most significant pressure on the landscape, and indeed grazing has exacted a profound toll on the ecosystem over the 10,000 or so years it has been practiced in the study area. Better acquaintance with the area indicated that there are still families who spend all or part of every year at Sadd al-Ahmar living in tents, who rely to a great extent on firewood gathering for heating and cooking. During the three years the author worked on the Re-Use Project, however, it has become abundantly clear that the profoundest single pressure is firewood gathering for recreational picnics and the picnics associated with international tourism to Jordan.

After noting briefly matters of grazing and nomadic-pastoralism -- significant pressures for the Region as a whole -- the focus of the remaining discussion then turns to *hash ou nash*: grill picnics. A venerable tradition amongst Jordanians, *hash ou nash* has also become a commodity on the international tourist market, and both the tradition and the commodity affect the forests. These remarks are followed by an examination of vegetation maps composed at Sadd al-Ahmar in 2003-4 and 2005-6, and the processes elucidated in the maps. Finally we will look at the period of expansion of the Re-Use Project, 2006-2011.

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<sup>30</sup> The Railway was destroyed in WWI by the troops of the Arab Army under Sheikh `Awdah Abu Tayyeh and T.E. Lawrence "of Arabia" (Peake 1958:98) The Jordanian section was reconstructed in the 1930's (Nicholson 2005) and the section from al-Hasa to `Aqaba is still used for the transport of phosphates.

<sup>31</sup> Some clearing still takes place, but because agricultural activities cannot be carried out surreptitiously, this impact has been minimized. Nocturnal logging by tourist operators is a much more serious threat. In March 2006, as this report was being written, over twenty mature `ar`ar were felled with chainsaws in Ras al-Namala on one Friday night (Majed al-Hasanat, personal communication).

**Nomadic pastoralism.** As noted earlier, nomadic pastoralism has been an integral element of the Petra Region's culture and civilization for as long as 10,000 years. Caprine remains are found at Baidha as early as the 9,300-8,500 BC (Horwitz, et al. 2005: 210, 216-17; Wright 1971:119) and many of the `Amariin who live at *iskaan* Baidha, scarcely a kilometer northeast of neolithic Baidha, are still pastoralists. Typically, however, most of the Baidha `Amariin are now settled in concrete block homes most of the year, moving outside into goats'-hair tents in their front yards or on their own farmland during the hot summer months. Tent groups from other Sa`idiyyiin Bedouin families and from the Bidoul tribe based at Umm Sayhoun are also found within the study area seasonally. These families graze hundreds – and in certain seasons upwards of two thousand – head of goats, sheep, donkeys, horses and camels on the study site and its surrounding mountains. Grazing exerts intense pressure on the local environment and the entire Region is severely overgrazed. The resulting devegetation leads to topsoil loss and erosion and a general degeneration of the Region's biomass.<sup>32</sup>

Grazing is not a grave threat to mature trees. Grazing threatens the tree population because seedlings are grazed off almost as soon as they sprout, and saplings are constantly grazed down so that even decades-old trees are deformed into carpet-like dwarves, less than knee-high, spreading over the rocks. By far the most damaging pressure exerted directly on mature trees by nomadic pastoralists and the rest of the permanent and transient population of the Region is fuelwood gathering for cooking and heating purposes.

**Domestic tourism: *hash ou nash*.** The author began her study of Sadd al-Ahmar in the winter of 2003, mapping the mature trees of the area with an eye toward developing an interpretive landscape masterplan for the site. On the first mild spring weekend of 2004, an entirely unexpected phenomenon greeted the eye: literally *hundreds* of picnickers dotted the landscape, busily gathering firewood and building campfires for *hash ou nash*, the traditional Jordanian<sup>33</sup> outdoor grill picnic.

Typical *hash ou nash* involves one or more households loaded into several vehicles, ideally accompanied by several square meters of plastic *hasira* mats, upholstered foam pads for lounging, plastic chairs and tables, ten-gallon water jugs, towels, tubs and dishsoap, marinated meats and salads, prepared *qahwah saadah* (Bedouin coffee), tea paraphernalia, soft drinks, and often toys, bicycles and balls and goal-post for football. *Hash ou nash* generally occupies the part of the day between *dhuhur* prayer (around noon), when the men come home from mosque, and sundown. In its most extreme form it includes livestock and butchering implements, with trailer rigs and buses full of people and equipment, and even tractors dragging water tanks. Part

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<sup>32</sup> Sadly no vegetation map or comprehensive vegetation survey exists for Petra Region or even for PAP, much less a program for long-term vegetation monitoring and evaluation. For the 2011 Strategic Master Plan for Petra Region the present author composed the most comprehensive existing species list by combining partial surveys conducted over the past decade (SMP 2010). It is still far from complete.

<sup>33</sup> *Hash ou nash* is not strictly a Jordanian phenomenon: the author has observed it in Palestine and Syria as well; but the evidence under discussion is Jordanian and so it will be referred to in its Jordanian context. The expression *hash ou nash* refers to the fanning/venting of charcoal for grilling.



of the fun of *hash ou nash* is the full-scale "project" it involves, and part of that project is firewood gathering.

It is a common occurrence to count over one hundred vehicles on the Wadi `Araba road between Baidha and the top of Sadd al-Ahmar, a five kilometer stretch of road. The author has spent at least two weeks a month in the Petra Region from July 2004 until the present, and it has become a habit to do a "picnic count" whenever onsite at Sadd al-Ahmar. It is not uncommon, on a beautiful day, to count over 200 vehicles. Although weekends, especially Fridays (the day of congregational prayer service at the mosques), are by far the most popular days for *hash ou nash*, groups can be found picnicking any day of the week, throughout the year.<sup>34</sup> Although rain keeps people indoors, a sunny snow day will bring people out in droves. *Hash ou nash* is an extremely popular activity.

It is important for our discussion to place *hash ou nash* in its social context. Jordanian society outside of Amman is still very rural, conservative Sunni Muslim. In the communities of the Petra Region people do not date, they do not dine out, they do not go to bars, they do not dance in public; there is no movie theatre, no game arcades, no mall, no beach, no town square/ piazza/ zocalo. Although men convene in cafes and shops to drink tea and coffee and smoke argileh, and young men increasingly convene in the internet cafes and snooker halls in Wadi Musa, local women are rarely seen in public after sundown, and it is considered wildly improper for them to go to the cafes or hotels.<sup>35</sup> Recreation tends to be intensely family centered, and usually focuses on a family event such as a wedding, engagement, funeral or graduation. "Families," on the other hand, are -- quite literally -- tribes, and may include just about anyone with the same surname. Outdoor picnics are inexpensive and they offer an opportunity for the women to get out of the kitchen, especially on a hot day, and to socialize. In settings along the roadsides women are often able to socialize with other family groups and groups from outside their own neighborhoods. Perhaps most importantly *hash ou nash* offers easy, safe entertainment for the squadrons of children -- as noted earlier, two out of five Jordanians is under the age of fifteen. *Hash ou nash* has little competition from other activities. Because picnicking without an (expensive) permit is officially forbidden within the Park, the load has increased in other accessible, scenic areas.

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<sup>34</sup> Petra enjoys over 300 sunny days a year and few of the remaining, overcast days actually result in precipitation.

<sup>35</sup> Wadi Musa is unusual because of the hotels and bars that serve the Petra tourist clientele. No liquor is served or sold in the Petra Region except in hotels. For this and related reasons, hotels are considered socially questionable terrain for the local population. Tour guides and the occasional upper-level official might be seen in the high-end hotels, and it is acceptable for men to do business over tea in the public areas. Social intercourse at the hotels, however, is considered suspect -- even moderately religious tour guides are unlikely to join their guests for more than a polite coffee before returning to more socially sanctioned venues. The same ethic that socially proscribes women's appearance in public amongst strangers renders impolite to take pictures of family picnic groups.



**Figure 29:** An early spring picnic afternoon at Sadd al-Ahmar, 2006. By the end of this afternoon the author counted over 200 vehicles onsite and in adjacent Siq Umm al-Hairan, a 4.5km stretch of road.

Interviews yielded the following relevant information:<sup>36</sup> all of the picnickers were Jordanians, most from the Petra Region, and all but 12 groups were from the Ma'an Governorate. Many groups had travelled over 25 kilometers to picnic in this area, which is generally referred to as "Baidha," and one group had traveled from `Aqaba (approximately 125 km). Groups ranged in size from 8-42 persons, and the average size was 16 persons. Every group included shade and scenery as reasons for coming to this area. While a great deal of useful information was gleaned from the questionnaire, the material most relevant the present study regarded firewood use:

Of 152 groups, 127 groups gathered firewood onsite or on the Wadi `Araba road after turning from the Baidha intersection (within 3km of the site). 45 groups brought firewood with them; of those 45, 27 gathered the firewood on the way; of the 18 who brought firewood from home, 3 had gathered it in the countryside near home, 15 were using orchard cuttings. No groups used charcoal. The preferred firewoods were *Quercus coccifera* (143), *Juniperus phoenicia* (142) and *Retama raetam* (123). Most groups mentioned more than one kind of wood, and many groups who were using orchard cuttings mentioned these three. No group preferred charcoal. The common answer as to why charcoal was not used was that it affected adversely the taste of the meat being grilled. Many groups answered that firewood gathering was part of the recreational aspect of the picnic. Many groups answered that the meat should "taste like the place it is cooked," or a similar comment. Given the popularity of *hash ou nash* as a recreational activity, the lack of affordable and socially approved competition from other activities, and the sheer numbers of people involved in the activity throughout the year, these results are sobering. As evident from the vegetation maps below, the pressure exerted by local picnickers on the Region's forests is profound.

***Hash ou nash* as an international tourism commodity.** As discussed earlier, tourism is Petra's most valuable commodity. Since this study was initiated in 2002 the number of tourists has increased exponentially to a recent high of 813,264 in 2008 (PAP 2009). From this it seems safe to conclude that tourism is not going to disappear from the screen as a major impact on the

<sup>36</sup> Questionnaire and detailed results are located in Table 2: Picnic Questionnaire, above.

environment of the Region. Indeed, in 2004 USAID had already identified tourism as Jordan's most important development sector and earmarked significant funding for sector development.<sup>37</sup>

Very little of the profits from tourism remain in the Petra Region, however. Each year lengthening visitor stays and making Jordan a destination (rather than an "add-on" day trip to Israel tourism) have been slated as goals in the development sector. The master planning exercise which took place in 2010-2011 was tasked with precisely this goal, as part of the larger ambition to make Petra a "world class tourism destination." At the time of writing (2011) tourists are typically bused in to stay a night or two in between Amman/Jerash and Wadi Rum/Aqaba. The average visitor stay is 1.93 nights (Mustafa 2011). There is not a single independently-owned five-star hotel in the Region: the corporate-owned Marriott, Movenpick and Sofitel's Taybet Zaman are the three luxury hotels – all foreign. As noted above there is little "night life," in the western sense of the word. Alcohol – a high profit commodity -- is available only in hotels, and not all the hotels. Only the Marriott, Movenpick and Crown Plaza have western-style bars and western music – but there are no discotheques in the Petra Region (despite what signs say on a few of the local hotels). During high season the luxury hotels sometimes organize special events, but these are limited to their in-house guests. While some of us may think this an ideal state of affairs in such a spectacular natural setting, it is generally agreed at every level of the tourist industry that "the night-life problem" is a major obstacle to lengthening visitor stays. Night-life is also a high-profit commodity, and presently most of that profit in Wadi Musa remains in the hands of foreign corporations. Thus tour operators are challenged to devise their own entertainment for the groups they host. One of the most consistently popular and highest profit activities that local tour operators can offer is the "Bedouin picnic" -- a glamorous version of *hash ou nash*.

Local tour operators typically host small groups – families and small bus tours – though luxury picnics are also staged for larger groups. Luxury picnics are staged outdoors, and there are perhaps half a dozen preferred venues around Petra. One of these is just a few hundred meters from the entrance to Sadd al-Ahmar. These venues feature spectacular natural scenery and privacy afforded by caves or siqs invisible from the road. The path to the campfire and the surrounding rock formations are lit subtly with luminarias, and the short walk in is accompanied by a traditional solo flute player. Large groups – 25 or more – are often entertained at established "camps" with a generator and some kitchen, bathroom and seating facilities – usually a *bait sha'r* – a Bedouin goats' hair tent with *farshat*, the traditional upholstered pads for lounging. These camps are also tucked away in the rock formations, which are lit (rather less subtly) with strings of white lights. Traditional Arabic music on *rababa*, *`oud* and flute is usually part of the evening's offerings, and sometimes a local band and *debka* group.

The typical luxury picnic serves an adaptation of *zarb* or *mansaf*, the traditional celebration dishes of south Jordan, or mixed grill. *Zarb* and *mansaf* are dishes served on giant platters from which a group of five people eat in common. Usually salads are served as side-dishes. For large

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<sup>37</sup> See the following recent links, amongst many others:  
<http://www.siyaha.org/email/issue1/grants.htm>,  
[http://www.usaidjordan.org/press\\_display.cfm?id=771](http://www.usaidjordan.org/press_display.cfm?id=771),  
[http://www.usaid.gov/stories/jordan/cs\\_jordan\\_petra.html](http://www.usaid.gov/stories/jordan/cs_jordan_petra.html)

groups the food is sometimes served buffet-style. Zarb requires, however, several hours to prepare,<sup>38</sup> and mansaf at least two hours and some 20kg of wood for each giant steel pot.<sup>39</sup> An integral part of these “luxury *hash ou nash*” endeavours is the campfire -- usually ready when guests arrive so that tea can be served immediately, and then stoked and maintained through the meal and entertainment. Picnics rarely last less than three hours: thus the amount of firewood needed is considerable -- and obviously the less money spent on the firewood, the higher the final profit margin for the evening.

In general, the picnics are relatively low-overhead, high-profit endeavors. JIT -- as is typical for Wadi Musa tourism providers -- is a family operation. Even the musicians are usually relatives, and in any case charge local prices to local operators. There is virtually no overhead cost for the venues: the labor of clearing trash before using a site is probably the single largest input. Though a modest fee is charged for an evening's use of an established camp, the larger groups yield higher profit and the camp fee is thus absorbed. The food is prepared onsite and there are relatively few dishes required for serving. Animals are purchased and butchered for the specific occasion, so there is no “middleman” absorbing the main food costs. Salad materials are simple and purchased at the central vegetable market and transported directly to the picnic site. At JIT only soft drinks and tea are served, limiting investment in glassware and alcoholic beverages (and shortening the length of the picnic).<sup>40</sup> In 2005 the cost of a luxury picnic for 4 people was JD 120 (US\$168), and JIT charged JD40 per person, yielding a profit of JD 10 per person, or 25%. For a group of 20 JIT's cost would be about JD 500, and the charge per person would be JD 35, yielding JD 200 (40%) profit for the evening. When one reckons that JD 200 is more than a month's salary for a full-time front desk receptionist at a five-star hotel, the profitability of the picnic industry begins to come into focus.

The foregoing describes an important “value-added” tourism commodity. There is a high profit margin attached to the activity, and virtually every *girsh* earned remains in the locality. As noted earlier, there are very few activities that yield this kind of profit to local providers. Unfortunately, given what we already know of pressures on the forests of the Petra Region, the activity also requires a significant fuelwood input. To compound the problem, many of these same local providers must haul their own firewood for camping groups in nearby Wadi Rum. As efforts are strengthened to promote tourism in Jordan, and specifically to lengthen stays in the Petra Region and Wadi Rum,<sup>41</sup> the demand for firewood will inevitably increase.

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<sup>38</sup> Zarb is a traditional Bedouin method of slow-roasting food underground. A small oven is built of flat bricks or stones, well-caulked and sealed with mud. The stones are heated through by banking a slow- and hot-burning wood such as oak or rattam. Once the wood has turned to coal the meat is sealed very quickly into the stone oven and cooked for about two hours.

<sup>39</sup> Mansaf is Jordan's national dish, traditionally a whole sheep cooked in one giant pot of rich, aromatic sauce made from dried and reconstituted sheep's yogurt, and served over seasoned pilaf.

<sup>40</sup> A Norwegian group hosted by JIT was, for a variety of reasons, permitted to bring their own coolers and alcoholic drinks, and the difference in the progress and overall length of the picnic was profound.

<sup>41</sup> Regarding new tourism initiatives for Wadi Rum see <http://www.siyaha.org/email/issue1/headlines2.htm>. Regarding the issue of sustainable tourism development, it should also be noted that JIT is an advocate of environmentally sustainable





**Figure 30:** Staff members retrieve dinner from the coals of a *zarb* oven at a tourist camp.



**Figure 31:** A zarb oven stoked with locally gathered wood.

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tourism practices, including limiting off-road trekking and harvesting of firewood from native trees. All JIT grilling is done over “logs” of recycled olive press waste called *jift*. Unfortunately environmentally conscious tourism providers still number in the minority in Jordan.



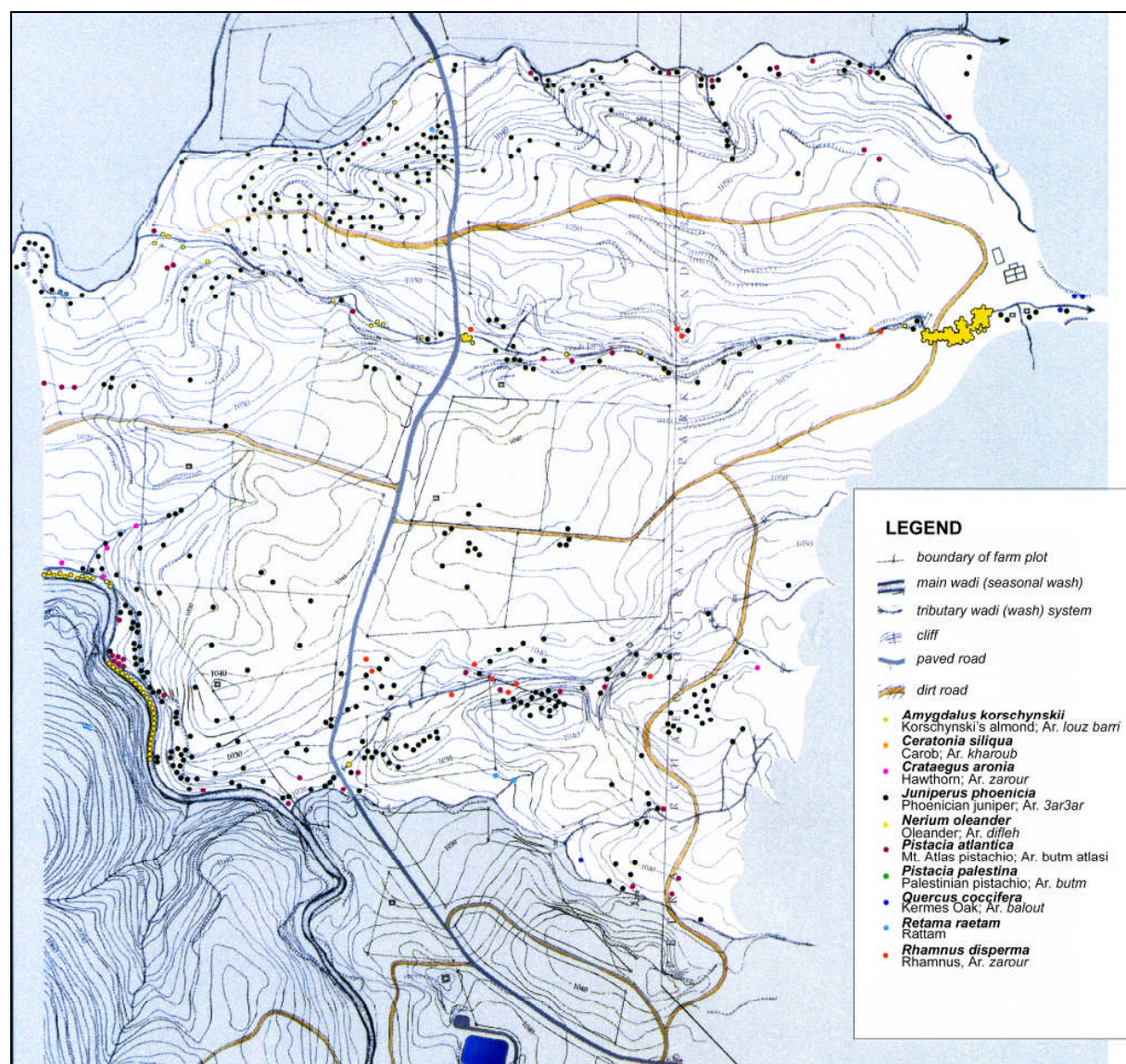


**Figure 32:** Preparing a camp for a large tourist group in Wadi Rum.

Together domestic and international *hash ou nash* present a profound stress on forests all over Jordan, and on the Petra Region in particular. On the first sunny, warm weekend of 2006, over twenty mature *Juniperus phoenicea* trees were chainsawed in Sadd an-Nimr and Wadi Namala, which respectively flank the north and south ends of Sadd al-Ahmar. The widespread assumption is that the trees were taken for tourism-related firewood by local, independent tour operators.<sup>42</sup> Within the study area most of the pressure is from local picnickers, who tear down tree branches and “strip” the junipers, whose naturally shredded bark facilitates stripping. This practice also makes it very easy to recognize whether or not a tree has been damaged within the past 3-6 months, for, depending on weather, the inner bark and wood retain a distinctive red-gold color for many weeks. Results from observations relating to this damage and other vegetation characteristics are presented below, in order to gain a quantitative sense of continuing pressure on the forest at Sadd al-Ahmar.

<sup>42</sup> Majed al-Hasanat, Sami Hasanat, Salim Abu Shusheh, personal communications.

**Mapping short-term changes in the forest at Sadd al-Ahmar.** In the winter of 2003-2004 a tree survey was prepared as part of the site analysis for the landscape design. The map was not initially intended to be part of a long term study – it was strictly a tool for understanding the existing vegetation and landscape dynamics of the site.

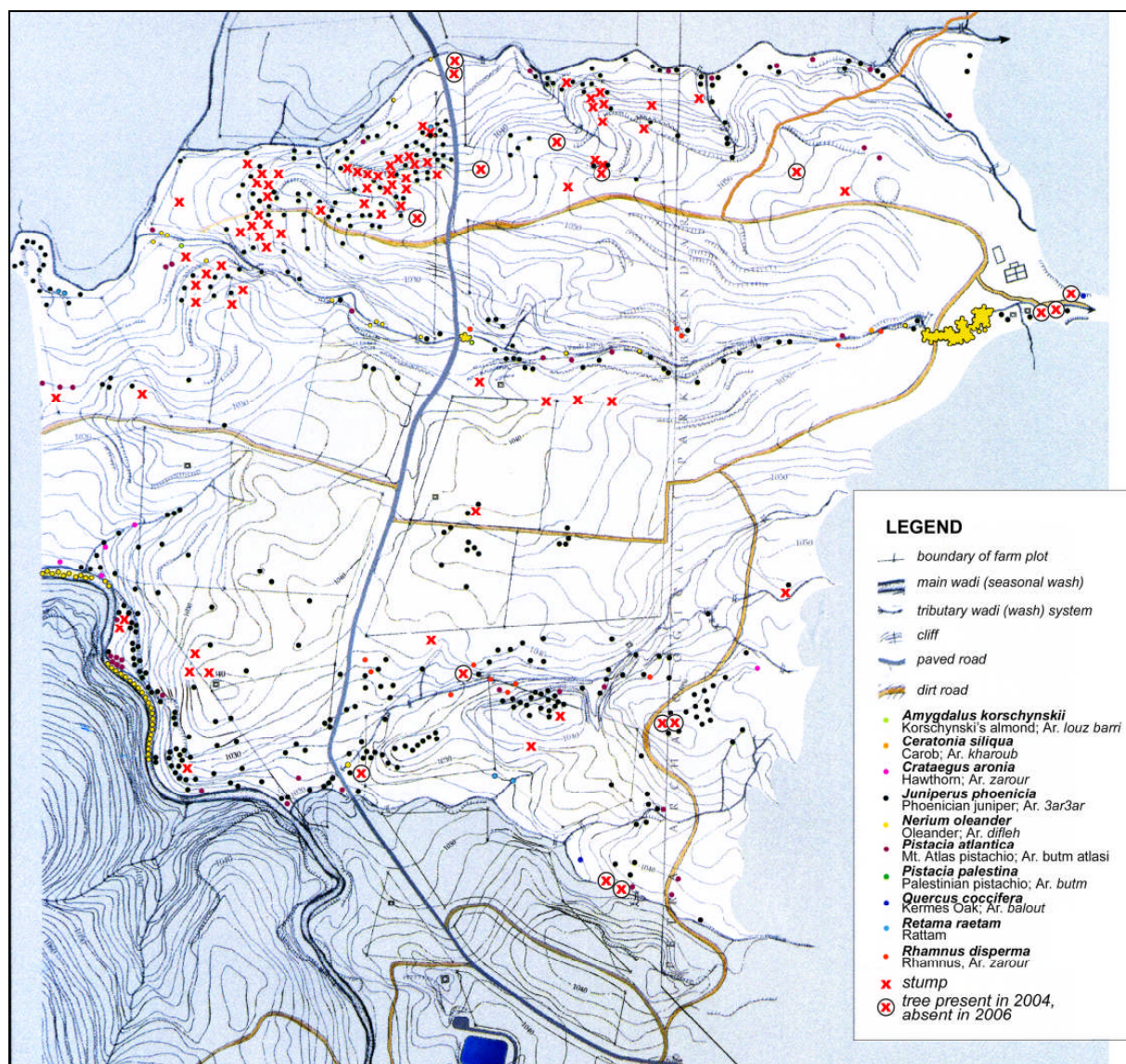


**Figure 33:** Tree survey, 2003-04.

Trees were mapped and species identified by color-coded dots on a contour map. Unlike the vegetation cover images above (Figs. 17-22) there was no attempt to draft the dots to scale. In connection with the events related to the permitting dispute described in the prologue the author endeavored to find ways to document the existing pressures, anecdotally observed while working onsite, on the landscape. Thus a second inventory was made during the winter of 2005-2006 (Fig. 34). To the 2005-06 map certain additional information was included: tree stumps observed onsite and damage from fuelwood stripping within the previous 3-6 months. From the



second map it was possible to determine the number of trees removed between March 2003 and April 2006



**Figure 34:** Tree survey, 2005-06. Stumps are indicated by red “x’s;” trees which disappeared between 2003 and 2006 are indicated by circled red “x’s.”

At the time the surveys were done the only available contour map of the site was the relatively coarse scaled survey conducted for the establishment of the Re-Use Project.<sup>43</sup> This map does not extend to the western extremity of the study area nor to the base of the cliffs on the eastern perimeter of the site.

<sup>43</sup> AutoCAD map of Re-Use Project site provided courtesy of Badia Resarch & Development Center (BRDC).

474 trees were counted onsite in 2003-2004, not including oleanders.<sup>44</sup> Three years later 17 of these trees have been lost. At least three of the *Juniperus phoenicea* were cleared for farming; ten have been sawed or torn down, presumably for firewood. Two *Q. coccifera* in Wadi Jabu were bulldozed by the Department of Transportation during a gravel-sifting operation. Both *P. atlantica* were pulled down on picnic weekends, again, presumably for firewood.

While the difference between the two vegetation maps is not as striking as the graphic produced from the aerial photos, the information is more precise, and the results are sobering. 17 trees have disappeared in two years, representing a 3.58% decline: even without factoring in the increasing population and the increasing demand for fuelwood, the landscape will be entirely denuded in less than fifty years. Put in more human terms, by the time the children of many of my colleagues in the tourist industry are their parents' age, not a tree will remain at Sadd al-Ahmar.

Merely quantifying the number of which have been removed does not adequately assess the continual assault on the health of the "forest." As discussed earlier, the health of the existing forest canopy -- and thus the amount of shade and organic matter it provides for the understory -- may be crucial to the survival of both understory and the forest itself. The 2005-06 vegetation survey not only inventoried the trees, but assessed evidence of firewood stripping within the preceding three to six months. *Every single tree at Sadd al-Ahmar showed evidence of recent stripping for firewood.* This evidence is not subtle: the images in Figure 33, above, are entirely typical. At the most basic level, firewood stripping of this severity damages the health of the trees themselves and makes them vulnerable to attack from insects and disease. Diminishing the tree canopy also directly diminishes habitat for birds, not to mention habitat for humans: the attraction of shade and scenery universally mentioned in the *hash ou nash* survey is threatened by stripping firewood -- largely for *hash ou nash*.

Another set of ecosystem impacts results from damage to the tree canopy as a whole: each tree, and especially groves of trees, creates a "fertility island" (MacLaren 2003; Reyes-Reyes, et al 2003; Frias-Hernandez, et al. 2003, Tiessen et al. 2003, Willimott, et al., 1964; but Corrigan 2004) under its canopy, providing shade and organic matter and inhibiting soil erosion. As noted earlier, there are several factors influencing the understory at present: grazing, firewood gathering of shrubs (see above, Figs. 24-25), and human use. The latter includes not only "hash ou nashers," but shepherds and farmers who sit under the trees in the shade to make tea and clear the area both for comfort and for kindling for tea fires.<sup>45</sup> These uses are related -- picnickers and laborers are also likely to strip the trees -- and together deplete both the understory vegetation and

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<sup>44</sup> Oleanders were included in the survey for the sake of comparison with the aerial photos, in which it is impossible to distinguish between different plant species. They were not counted in the short-term survey. They are not threatened either by firewood demand or grazing because they are poisonous. Oleanders grow only in along watercourses; they serve as shelter for wildlife and inhibit channelization of wadi beds, but have little impact on upslope vegetation dynamics.

<sup>45</sup> *Shay `ala an-naar* -- "tea on the fire" -- is widely believed to taste better than tea heated on a gas flame, and to taste like the aromatic smoke of the herbs over which it is boiled.





**Figure 35:** A healthy grove of *Pistacia atlantica* and *Juniperus phoenicia* with medium and low shrubs and grasses beneath -- south bank of Wadi Umm al-Hairan. The deciduous *P. atlantica*, left, is just beginning to bloom.

soil. This set of dynamics in turn diminishes habitat for wildlife.

The degradation of the canopy thus has a constellation of consequences, ultimately threatening the forest's ability to regenerate itself. Germination rates for *Juniperus phoenicea*, the most common tree at Sadd al-Ahmar, vary widely under cultivation), but one farmer has achieved a success rate of over 90%.<sup>46</sup> Under natural conditions, however, in the entire study area only *one* seedling was observed in the entire study area.<sup>47</sup> This seedling appears to be thriving in a grove of mature trees, where soil and organic matter had been trapped in a relatively healthy understory. The fact that the *Juniperus phoenicea* seeds do germinate under cultivation suggests that the problem lies in the environmental context. The fact that the one observed instance of successful germination in the natural habitat occurs where there is healthy canopy, understory and soil at least begins to suggest that the opposite and prevailing conditions threaten germination.

In sum, the condition of the forest at Sadd al-Ahmar was in 2006 demonstrably worsening at a rapid rate. Nomadic pastoralists harvesting fuel for heating and cooking represent one pressure on the forest. Grazing, even within the Park boundaries, is a significant pressure on understory shrubs and herbaceous species. Given the economic importance of sheep- and goat-herding in Jordan and the ten-thousand-year tradition of nomadic pastoralism, these are not pressures which

<sup>46</sup> Majed al-Hasanat, assistant manager of the demonstration farm on the Re-Use Project, personal communication.

<sup>47</sup> This seedling is the single specimen observed within a one-kilometer radius of the study area.



are likely to vanish in the near future. Approximately 144 tent groups are resident within the Petra Region (JPFH 2010: xiii). At least three tents, inhabitants fluctuating between 20 and 32 persons -- are located on or near the study area year-round. During the harvest season there may be as many as four more tents. Identifying tents onsite, however, does not accurately assess the number of tents which may be gathering firewood onsite, as the scarcity of firewood requires tent-dwellers to range far and wide, with trucks or donkeys, to gather fuel. Today, even in Bedouin tents, a variety of fuels -- including propane, electricity, and kerosene -- are now used for lighting, cooking and heating, but the direct impact of nomadic groups' on Petra's forests should not be underestimated.<sup>48</sup>

Domestic tourism, involving as it does a deep-rooted cultural tradition of firewood-gathering for picnics, represents a second and very severe, year-round pressure on the forest. Given the rate of population growth in Jordan and the lack of competing recreational options, the stress of the *hash ou nash* tradition promises to endure and most likely increase. Pressure from the international tourism trade constitutes yet a third -- also increasing -- threat to the forest.

Vegetation surveys from 2002-2006 demonstrated that trees are declining in population and in health. Seventeen trees were removed in three years, and every tree onsite bore evidence of firewood stripping within the six months prior to the second survey. Meanwhile the damage to the canopy threatens the ecosystem as a whole.

### **Sadd al-Ahmar, 2006-2011**

The Re-Use Project has expanded considerably since 2006 (see Fig. 37, below) and at the time of writing stands poised to expand even further in a third project phase. Several structures have been built both within the PAP boundary and outside (east). Within PAP these structures include shelters for farm equipment and shade structures for post-harvest processing; outside the PAP boundary are stables, a tourist camp with permanent kitchen, bathroom and office structure, a prefab farm trailer and an unfinished concrete block structure of shifting identity.<sup>49</sup> Perhaps the most striking change on the site is the hundreds of exotic trees which have been planted as windbreaks. These are primarily *Acacia cyanophylla*, *Eucalyptus sp.* and *Populus sp.* The new trees are growing lushly, irrigated as they are with treated wastewater. The deep shade they provide draws, if anything, even more picnickers most evenings of the week, and in droves on the weekends except in the bitterest weather.

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<sup>48</sup> The matter deserves a separate study. Many tent-dwelling families are desperately poor, and their firewood needs are not going to disappear, even if regulations are enforced. It should also be noted that during 2005-2006 the price of all petroleum-based fuels in Jordan tripled as the market was privatized. South Jordan is significantly poorer than the rest of the country, and local officials have observed that many poor families who had been using gas for some of their fuel needs have reverted to gathering firewood. If firewood harvesting is merely prohibited without investigating other fuel sources, these families will be forced to "poach" firewood in absence of income for heating and cooking fuel. The development of affordable firewood alternatives is pressing.

<sup>49</sup> The owner changes his mind constantly about the intended use.

Since the initial study international tourism to Petra has skyrocketed. In July 2007 Petra was voted to be one of the “New Seven Wonders of the World.” The publicity resulting from this international promotional exercise brought a flood of tourism. The most recent figures differ slightly depending on the source (e.g., Jordan Tourism Board [JTB], PAP or PNT). According to the PAP the October following New Seven Wonders (N7W, in local parlance) was a record high for the number of visitors in one month: 99,616 – March-May is normally high season in Jordan. There was a 236% increase in tourism between 2006 and 2008, from 359,366 to 850,318 (MOTA 2006, 2009) and there has been a parallel increase in income to Jordan from international visitors, now totalling JD 593,523,011 (\$840,802,676).<sup>50</sup> The 2008-09 figures are substantially lower than the year and a half following N7W, presumably as a result of the worldwide economic crisis, but still represent an abrupt increase over pre-2007 numbers. In 2009, due directly to the tourism revenues sketched out above, the existing Petra Region Authority was expanded, its budget increased by over 500%,<sup>51</sup> and the new Petra Development and Tourism Region Authority (PDTRA) took its place.

**Land use planning to 2011.** The *raison d'être* for the 2002-2006 study was a dispute over land use. Since the establishment of the Park construction has, in fact, taken place within its boundaries (Palumbo and Cavazza 2004) despite restrictions associated with World Heritage Site status. It was the post facto permitting of “wildcat” development within the park<sup>52</sup> which led, in part, to the Department of Antiquities' concerns about activities on the Re-Use Project at Sadd al-Ahmar. At the time of the permitting dispute no land-use plan existed for the Petra Region, and PRA was understandably hesitant to permit development for fear of offending the sensibilities of the Department of Antiquities, Petra National Trust and UNESCO (Addison 2005). Experience in other parts of Jordan, however, suggests that eventually “development” will take place one way or another. In Jerash, Jordan's second-most-famous antiquities site, the same sort of impasse finally led to local residents' candid rejection of development restrictions.

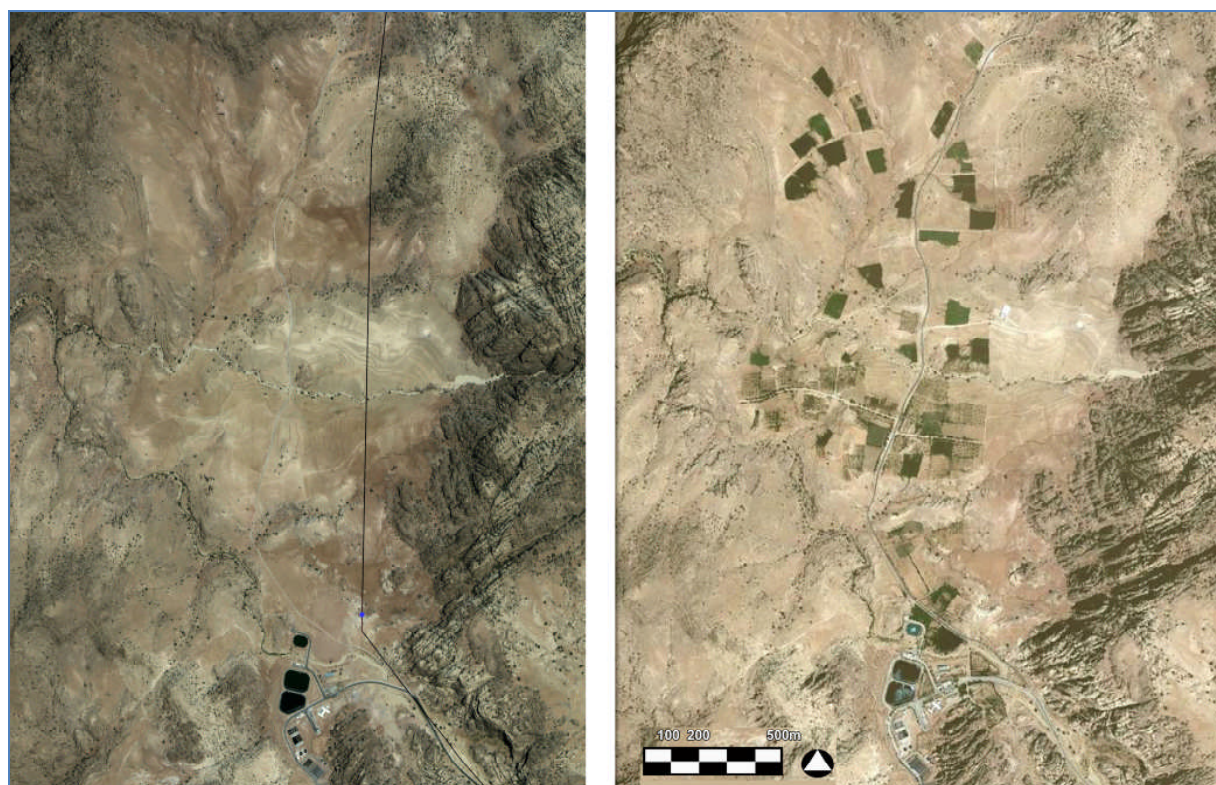
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<sup>50</sup> Establishing direct income generated by Petra is somewhat difficult. By combining figures from JTB, PAP and a recent IPSOS economic study of tourism in Jordan, the most recent year for which there are 12-month statistics, it is possible to suggest the magnitude of Petra tourism's economic significance for Jordan. The total number of visitors to Petra in 2009<sup>50</sup> 728,108-728,839. Direct income from entrance fees alone was JD 13,620,016 (US\$ 19,340,443). JTB reports that International arrivals from Jordan's “top eight” countries<sup>50</sup> totaled 306,780 in (year). Top eight expenditure in Jordan as a whole totaled JD 350,735,793 and average expenditure per visitor was JD 1,143. The 2008 IPSOS study in revealed that 73.9% of international visitors (226,710) are here for leisure purposes, of which 86.4% visit Petra (= 195,877) (PDTRA 2010). Using the 2008 IPSOS figures and applying them to the 2009 information we can conclude that a very conservative assessment of Petra's economic value can be made by multiplying the number of “top eight” visitors x JD 1,143 expenditure per visitor = JD 223,888,328 = US\$317,921,426. Jordan's 2009 GDP equals US\$21.92 billion, indicating that the tourism to Petra from only eight countries yields a direct benefit amounting to approximately 1.45% of Jordan's GDP.

<sup>51</sup> Personal communication from Sami al-Hasanat, Member of Parliament for the District of Petra.

<sup>52</sup> The `Amariin Bedouin Camp, near Baidha, was established illegally within the PAP boundary and permitted after the fact.

The Petra Archaeological Part Operating Plan (PAPOP) was presented in 2000, but was not ratified until 2009, under PDTRA. Developed for Petra Archaeological Park as a UNESCO World Heritage Site, PAPOP proscribed the clearing of trees for building or agriculture (PAPOP 2:2:4 passim) and laid out ground rules for natural resources management. Within the Park -- and within a buffer zone which is intended to protect viewsheds from within the Park<sup>53</sup> -- construction is technically forbidden. The pressure to develop around Petra is intense. In 2005 the Director of Planning and Organization at the Petra Regional Authority stated that even after a long slump in tourism revenues following 2001 applications for building permits in Wadi Musa alone exceeded applications for the rest of the Ma'an Directorate combined.



**Figure 36:** The Re-Use Project in 2002 (left) and in 2011 (right). The eastern boundary of PAP is visible as a black line running north-south in the 2002 image, and visibly defined as the edge of cultivation in the 2011 image. (Images courtesy of Petra Regional Authority [left] and Google Earth [right]).

Since N7W the need for land use planning has intensified with the influx of tourists and the astronomical increase in land prices. Several years ago the pressure to develop tourism and the influx of Iraqi money with war-related immigration had already dislocated the market for land: prices in attractive locations throughout the Petra Regions quadrupled between 2003 and 2005.<sup>54</sup> Prices continued to rise steadily and between 2007 and 2010, following N7W land prices outside

<sup>53</sup> Unfortunately the precise borders of this buffer zone are a matter of some debate.

<sup>54</sup> Nasr al-Hasanat, Director of the Department of Lands and Surveys for the Petra Region. Personal communication, 7 November 2005.

Wadi Musa's municipal grid rose an by average of 166%; within the residential areas of Wadi Musa by 200-400%; in the commercial tourism area by 428-625%.<sup>55</sup> One of the first actions of the new High Commissioner of PDTRA was to commission a Strategic Master Plan for Petra Region (SMP) a 20-year master plan specifically, even primarily, tasked with planning and zoning for land use.

SMP is only the most recent in a long series of planning exercises which have been inflicted on the Region<sup>56</sup> – none with the benefit of vegetation maps or even a comprehensive vegetation survey. Since the original study was completed in 2006 the author has continued to live and work in the Petra Region and she was in 2010 contracted as the environmental consultant for the SMP, only to find that existing environmental data was sorely inadequate for long-term land use planning. The present study remains the sole study tracking vegetation change over either the short or long term within the Petra Region. In 2004-05 decision-making by Petra stakeholders was severely hindered by lack of hard data on vegetation change and environmental pressures. The master planning team was met with the same difficulty in 2010. This reality was what motivated the researcher to repeat the 2002-2006 survey in order to assess the study area five years later.

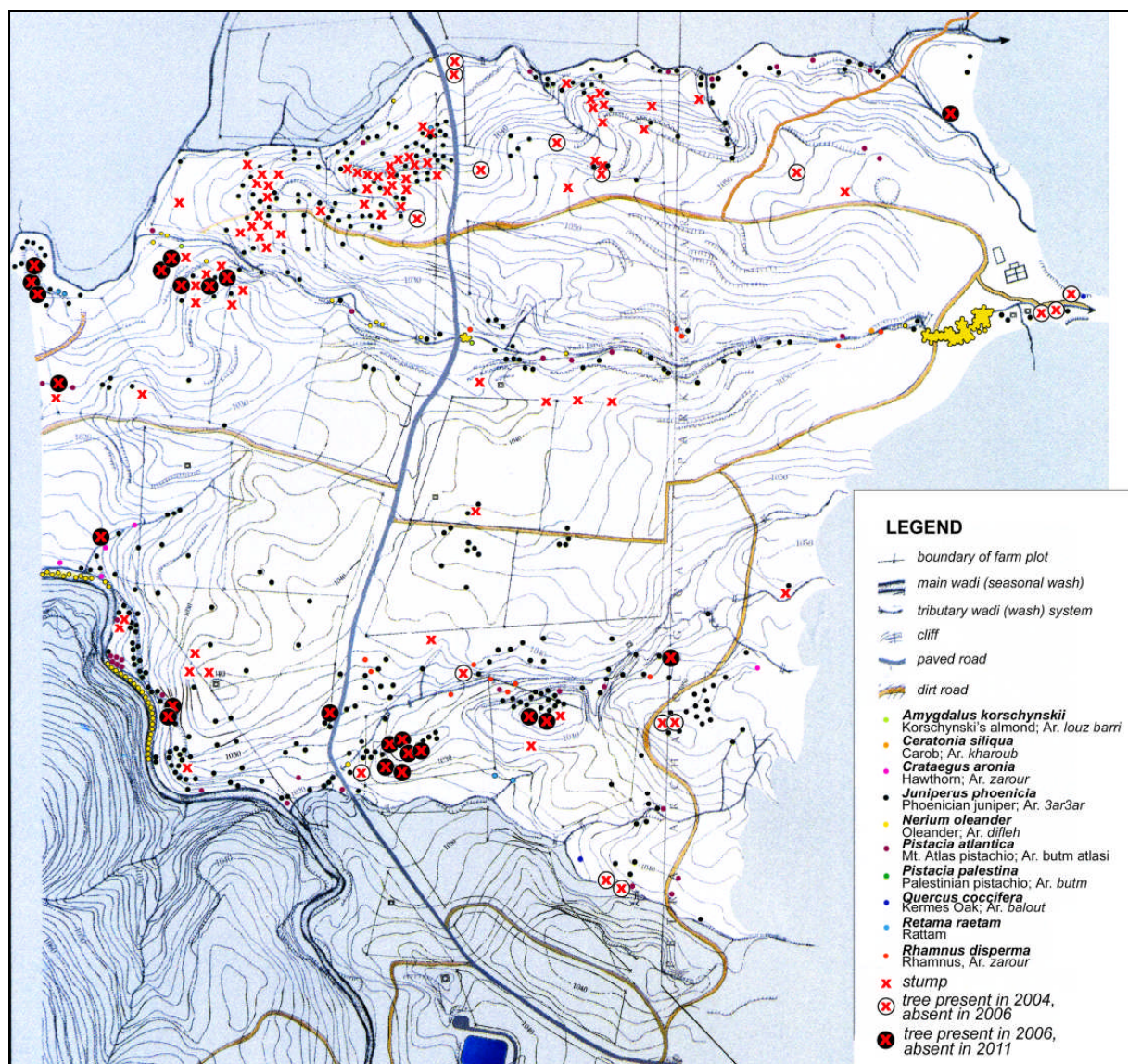
**Tree survey, 2010-2011.** In the absence of an updated satellite image such as was used in 2002-2003, it was left to the researcher to replicate the ground survey conducted in 2003-4 and 2005-06. It was found that 20 more trees had been lost since 2006, a decline of 4.37%. Interestingly,

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<sup>55</sup> Bilal al-Hasanat, real estate office owner, Wadi Musa, Jordan. Personal Communication, 28 June 2011.

<sup>56</sup> Draft Management Plan for Petra Archaeological and Natural Park, UNESCO, 1993; Petra Priority Action Plan. Dar al-Handasah/USAID, 1996; Analytical Studies, Detailed Land Use Plan and Special Regulations for the Protection of the Area along the Taybeh-Wadi Musa Scenic Way, Sigma/USAID, 2000; Petra Archaeological Park Operating Plan, United States Park Service/ USAID, 2000; The Strategic Masterplan for Petra. ATC/PDTRA, 2011.



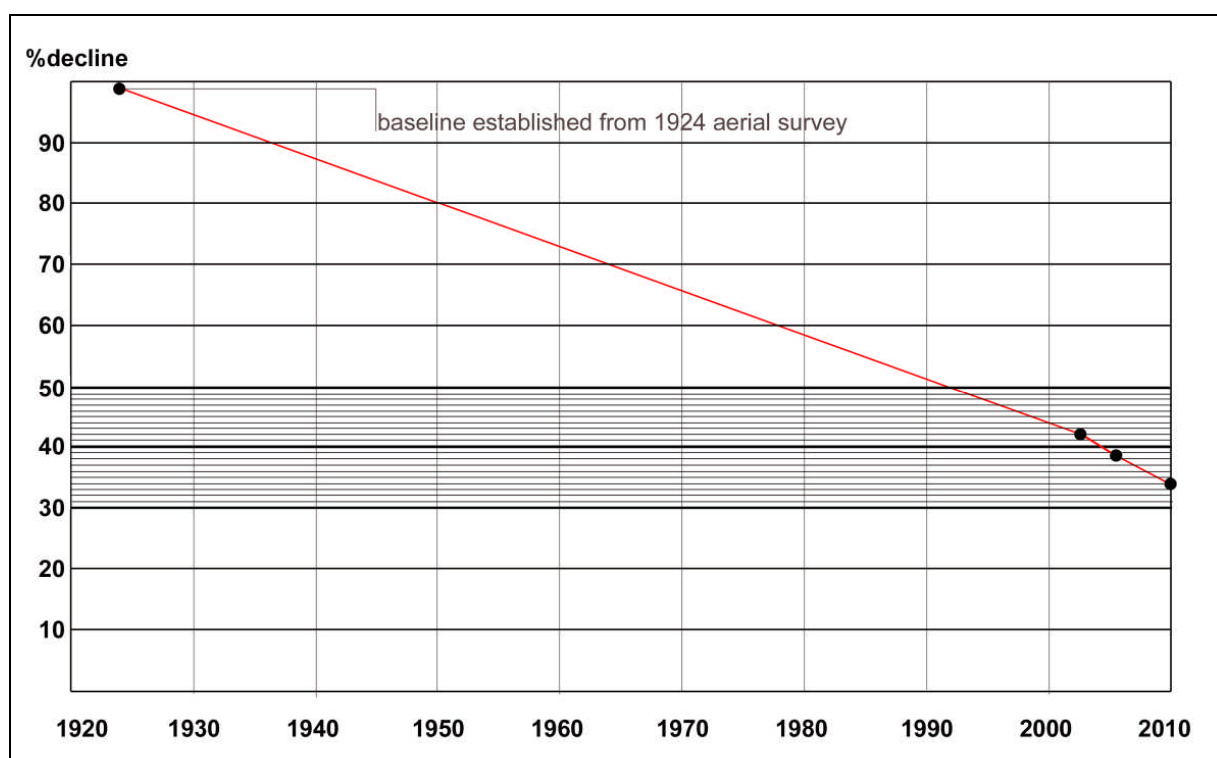


**Figure 37:** Tree survey, 2010-11. Stumps appear as red “x’s;” trees which disappeared between 2003 and 2006 are indicated by circled red “x’s;” trees which disappeared between 2006-2011 are indicated with red “x’s” on a black circle.

five of the twenty were not lost to cutting – they had died due to changed water run-off patterns attributable to earth moving related to the Re-Use Project (see Fig. 36, above).

The information gathered from the aerial photographs and ground surveys together can be presented in graph form (Fig. 38). Though we do not know for certain that the rate of decline





**Figure 38:** Forest decline at Sadd al-Ahmar, 1924-2011

was perfectly regular between 1924 and 2002, there is no indication of a cataclysmic event during that time – just a steady cutting away for a wide range of uses. What can be said with certainty is that the forest is declining rapidly and steadily, and that the rate of decline is increasing. If the forest continues to decline at its current rate the landscape will be completely barren within forty years.

## 5. DISCUSSION AND CONCLUSIONS

The genesis of this research was the site analysis for the interpretive landscape masterplan for the Wadi Musa Wastewater Re-Use Project at Sadd al-Ahmar. During the site analysis firewood gathering emerged as one of the most widespread and damaging activities affecting the local vegetation, as we have just taken some pains to demonstrate. While the observations detailed in the above are quite obvious to anyone who lives or works on the site, the need to document these activities and quantify their impact became apparent in the discussions surrounding the permitting of the Re-Use Project, including the landscape design.

During the summer of 2004 a preliminary version of the landscape masterplan was presented to stakeholder agencies in Jordan for review and feedback. This proposed design then became the catalyst for discussions amongst UNESCO, the Department of Antiquities, Petra Regional Authority and others regarding the permissibility of a range of interventions within PAP. The design put forward the following recommendations relevant to the present study:

- reforestation of areas within the Project on parcels unsuitable for farming;
- infill and salvage of existing groves of mature trees;
- extensive planting of junipers and cypress in windbreaks;
- naturalistic massing of pistachios and carobs in sheltered, uncultivable areas;
- growing firewood species as an appropriate use of reclaimed water;
- picnic infrastructure designed around interpretive trails aimed to inform site users of firewood regulations in the context of ecological conservation, and to facilitate waste management and enforcement of park regulations;
- surrounding picnic sites with preferred native firewood species, especially fast-growing *R. raetam*, with signs encouraging users to harvest the wood for *hash ou nash*.

Yet in the discussions which took place regarding the landscape design<sup>57</sup> all of these interventions – including reforestation with natives propagated from local seed – met opposition from officials. UNESCO officials voiced concern for protecting "the integrity of the Park landscape" (Palumbo and Cavazza 2003:13). Picnic infrastructure and management were disallowed because their implementation "would encourage picnicking."<sup>58</sup> In an official report UNESCO officials state that "no new constructions or modification of the landscape is admitted within Park boundaries" (Palumbo and Cavazza 2003:11). Ultimately the planting of native trees was permitted only in windbreaks. Picnic management and trail construction of any kind were deemed impermissible.

The research detailed above demonstrates that the landscape at Sadd al-Ahmar -- and the same can be said for the entire Petra Region -- has virtually *no* integrity. We explore the notion of integrity a bit further below, but it appears that what we see at Sadd al-Ahmar is a *disintegrating* landscape. It is being "modified" at an alarming rate by deforestation. This process of disintegration has been ongoing certainly for decades, probably for many centuries, but it is escalating: large-scale anthropogenic impacts on the forests of the entire region began over a century ago with the construction of the Hijaz Railway, and clearing for agriculture and firewood began long before that. As results indicated, there is a need to manage picnicking at Sadd al-Ahmar (and throughout the Region), and failure to manage this situation consigns the forest to its doom. At the time of the original study no enforceable management plan existed for Petra Archaeological Park or the Region. PAPOP was finally adopted as the official operating plan for PAP in 2009, but its jurisdiction outside the Park boundary is a matter of speculation. The Strategic Master Plan for Petra Region, which quite clearly focuses on Region-wide issues and not on PAP, was completed in the late spring of 2011. Whether it will be shelved and forgotten as have earlier plans and studies remains to be seen.

In 2004-05 the permissibility of all planting -- even the planting of regionally adapted natives propagated from local seed (permitted in PAPOP II:2:4.4.6, 4.4.8) -- was questioned for a variety of reasons. UNESCO was concerned about the transgression of PAPOP regulations and damage of cultural heritage remains by roots; the Department of Antiquities was concerned because of the irregularity of the permitting procedures in the initial phase of the Re-Use Project (Addison

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<sup>57</sup> These discussions were also directed at the agricultural activities onsite.

<sup>58</sup> This is a direct quote of arguments voiced by officials from both Petra National Trust and the Department of Antiquities at the permitting meetings.

2005) and, like UNESCO, concerned ultimately about damage to the antiquities. Petra National Trust raised the question of agricultural development within the Park, limited by Jordanian law to dry-farmed barley.

Meanwhile USAID, the PRA, BRDC, IALC, and the farmers of the Jama`iyah Sadd al-Ahmar were understandably concerned that their considerable investments of time and money into the WWTP and the Re-Use Project might be compromised by the above-mentioned questions. Finally a agreement was crafted by which the Re-Use Project would be allowed to move forward with some modifications, such as disallowing further planting of fruit trees or replacement of those already in the ground. With the exception of forage crops and existing tree crops, all exotic species were to be removed from the site.<sup>59</sup> Windbreaks would be planted with native species rather than exotics, and some existing exotics in windbreaks would be harvested for firewood after five years. The location of the interpretive center and landscape would be moved to a site which had already been graded in the construction of the WWTP, in order to “reduce further intervention in the landscape.” In short, the local, national and international authorities opted for a non-interventionist approach – no reforestation, no construction, no “modifications” of the landscape, prohibition of various activities on paper: non-management.

Since 2005, in the absence of management (of picnicking or anything else), “new constructions and modifications of the landscape” have flourished. Ironically perhaps, in our study area there has been more agricultural planting and clearing, planting of exotic species (quote PAPOP), construction, earth-moving and more trees lost *within* the Park boundary than outside it. As mentioned, the flourishing non-native windbreaks now encourage more picnicking within PAP than outside it and trash infests the entire area because there are no services, no rangers, and no regulations onsite.

To speak to the need for enforceable regulations does not mean that picnicking should be prohibited or that firewood gathering should be *merely* prohibited. In the first place, to impose prohibitions on picnicking and its associated activities within the Park would only push the activities outside the Park and increase the pressure on the surrounding watershed. There is a real and felt need in amongst the local population for recreational open space, which cannot be met by forbidding their presence on a landscape their families have inhabited for centuries. Likewise, the very real need for fuelwood for nomadic pastoralists cannot be met by forbidding it. The public perception that wild-gathered firewood is free is understandable and should be addressed through environmental education, not met with equal ignorance. The need for grazing land or an alternative source of animal fodder is urgent and will not be met by forbidding it. Not “intervening” in the landscape, failing to “modify” the existing situation, solves nothing and squanders Petra’s spectacular natural heritage.

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<sup>59</sup> At the time of writing, however – 6 years after these resolutions were signed – fruit orchards are plentiful on the Re-Use Project, windbreak species are still overwhelmingly non-native and exotic species have yet to be removed. Most of the land has come to be concentrated not in the hands of the poor farmers the Project was meant to serve, but in the hands of wealthy landowners from Wadi Musa. There is still no interpretive center.

An exhaustive prescription for what ails us at Sadd al-Ahmar would require another kind of book. The primary goal of the present study has been to document the existence of a particular problem. It would be remiss, however, to criticize the non-interventionist approach and then fail at least to suggest appropriate “interventions and modifications.” The following, very cursory list applies not only to Sadd al-Ahmar, but to Petra Region and to Jordan as a whole.<sup>60</sup>

- Enlistment of Petra Region on the World Heritage List also for UNESCO criterion (ii), natural heritage;
- Monitoring, evaluation and accountability of funding agencies for development initiatives such as the Re-Use Project;
- Development by Jordanian experts of a watershed management plan including environmental benchmarking and conservation policy;
- Reforestation with tree species propagated from locally-gathered seed;
- Establishment of a long-term vegetation monitoring and evaluation unit at PDTRA;
- Implementation of an integrated, sustainable, community-based grazing regime for the entire Region;
- Implementation of native forage projects;
- Development of environmentally dependent, sustainable income generation projects, e.g., the cultivation of native medicinal and aromatic plant species;
- Environmental education programs for all age groups;
- Establishment of managed recreational areas for locals;
- Training and equipping of rangers authorized to enforce Forestry and environmental laws;
- Strict regulation of tourism providers;
- Production of firewood alternatives, e.g., olive press waste (*jift*).

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After eight years at Sadd al-Ahmar, this researcher is moved at a wholly un-intellectual level by the strength with which the landscape does revive year after year, and equally moved by the human onslaught that depletes it. All the many species inventoried by Sawsan Oran in 2002 seem to *want* to grow at Sadd al-Ahmar -- with perhaps the exception of *Juniperus phoenicea*. But there is no question whatsoever that the human onslaught is outweighing the ecosystem's determination to regenerate itself every year. With this in mind, one might plausibly wonder why this author does *not* recommend a strict non-interventionist approach<sup>61</sup> such as that recommended by UNESCO, PNT and the Department of Antiquities for the *mahmiyyah athariyya al-Batra*’ – as PAP is called in Arabic.

On a broader level, the conclusions of this study call to account the definitions and parameters of expressions such as *mahmiyyam* “reserve,” “intervention,” and the notion of “integrity” as it is used to apply to natural landscapes and their conservation. English translation of *mahmiyyah athariyya al-Batra*’ as “Petra Archaeological Park” loses the sense of the word *mahmiyyah* -- better translated as “reserve,” a place of conservation, an off-limits place more akin to Nature

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<sup>60</sup> Unlike most of the rest of Jordan, however, these measures are eminently fundable through the community development unit at PDTRA, which is enriched by revenue from PAP.

<sup>61</sup> See PAPOP 2:2:4, p. 30 et passim; Palumbo and Cavazza, 13ff.



Conservancy lands in the U.S. Yet international tourism is welcomed in droves into Petra and significant resources are being invested in developing that market further. Intervention in the landscape of the Petra Region is an ongoing, overbearing reality.

It is important to emphasize that non-interventionism is merely ideology: it is not science. The idea that we can simply remove the human hand from the natural landscape, simply not "intervene," is based significantly in Enlightenment conceptions which oppose nature and culture, indeed configure nature as distinct from humanity and do not figure humans into the ecosystem. Protecting the integrity of a landscape by not intervening in it presumes a romantic configuration of Wilderness, in which we can hike, camp and observe nature without intervening in it, as human entities somehow separate from an objectified environment. These activities are in turn culturally constructed as temporary and recreational -- and therefore not interventions, or interventions so light that their traces can be contained or even removed, so optional that they could be simply prohibited. In the context of the Petra Region, however, these constructions cannot be applied successfully: Bedouin life pretty much entirely consists of "hiking" and "camping" -- not temporary, not recreational, not light.

Parsing out what constitutes intervention, or which uses of the landscape are or are not appropriate, also calls into question the notion of integrity when it is applied to landscape. At what point in its history do we designate Petra as a landscape with integrity? on the basis of what criteria? Petra is not a "virgin" landscape or a pristine "wilderness" from which human influence can be isolated. To pretend to be able to remove humans from the ecosystem -- especially in a place as long-inhabited as Petra -- involves ideology based on a preconception of virgin wildlands, in countries with enough resources to imagine sequestering land from human use and economic development. None of this applies to Petra.

The fact that long-term residents were moved out of Petra when the Park was established is perhaps the clearest evidence of this ideology at work. In theory, apparently, we can dislocate the Region's humans and remove them from the "equation," but we are not to intervene with Petra's archaeological remains or the integrity of the landscape. It would be hard to deny that the quality of non-human life in all of southwest Asia would probably benefit if we humans and our accompanying "interventions" all moved out. To exclude human residents and a select range of their activities from a particular, abstractly delineated habitat, however, is itself a transparently *human intervention*. To prohibit a ten-thousand-year tradition of grazing, for example, but allow mass tourism is a curious way to prohibit modification of the landscape.

The goal of this research has been to document what humans have inscribed on the landscape at Sadd al-Ahmar, and to recommend human interventions that might allow all of us to live in an increasingly crowded habitat -- together. Humans in Jordan are reproducing at a fabulous rate, and Jordanian development policy is inviting more and more to visit. The human demand for firewood for cooking, heating, recreation and the tourism business does not promise to abate soon. Humans and the whole range of human activity -- i.e., economic subsistence as well as recreation -- will need to be included in the conception and management of Petra. If they are ignored, they will continue to exist and "participate" in the environment in an *unmanaged* way, because they live there.

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