

## **Soil development in the context of historical land use of northern Jordan**

Bernhard Lucke<sup>1</sup> & Günther Schörner<sup>2</sup>

### **Introduction**

Historic land use in semi-arid regions is widely believed to have caused severe land degradation. However the connection of landscape change or degradation with historic land use is far from certain. Grazing has often been blamed as one of the most detrimental forms of land use (Lowdermilk, 1944), but more recent studies found that periods of predominantly pastoral land use in northern Jordan were connected with natural reforestation (Lucke et al., 2008). A dating of sedimentation alone, even if very precise, proved of little help: local patterns can vary (Bintliff, 1992), and dating does not deliver clues about the reasons of deposition, e.g. whether extension or abandonment of fields was the mobilising agent. In Jordan, a major sedimentation phase in the late 6<sup>th</sup> century AD might have been connected with climate change towards more aridity and clusters of heavy rainfalls (Lucke et al., 2012).

### **How to correlate historic land use and landscape change?**

Attempts to describe causal relations between erosion due to historic land use and sedimentation are usually based on estimates, for example regarding the number of settled sites and supposed resulting pres-

sure on the landscape (Brett Hill, 2004). However, such approaches remain guesswork with high risk of circular arguments as long as it is not known what farmers did on their fields. It is not possible to conclude just from coincidence that periods of high population density are in causal relationship with large-scale soil erosion because large amounts of sediments were deposited during the same period. For example, in some areas no sediment bodies could be correlated with periods of high population density: as long as no unequivocal evidence of soil protection is found, the absence of sediment bodies cannot be interpreted as evidence of sustainable land use practise.

In order to investigate the relation of historic land use and landscape change, it is necessary to study what really happened on agricultural fields. One key mean is intensive archaeological survey for detecting and calculating the material culture outside the sites (so called off-site or non-site scatters). Material culture is mostly sherds of pottery, while fragments of brick and tile – one major finds' category of surveys in other regions – is almost completely lacking in Northern Jordan. Also glass and metal finds could be found only in negligible numbers.

The reason why sherds are to be found on fields in different densities has to be investigated. Several explanations have been proposed (Alcock et al. 1994):

- accidental factors of loss and breakage of vessels on the fields
- remains of less intensively used locations like temporal shelters etc.
- postdepositional disturbances like ploughing causing artefact distribution
- manuring.

It turned out in the last years that manuring is the most reasonable explanation (Bintliff et al. 2007). In the Near East T. Wilkinson (1989) detected material culture scatters around cities during several surveys and made two observations:

- 1) The size of the artefact scatter depends on the size of the site.
- 2) The density of the artefact scatter (how many sherds were found per

<sup>1</sup> bernhard.lucke@fau.de; FAU Erlangen-Nürnberg, Institute of Geography, Wetterkreuz 15, 91058 Erlangen, Germany.

<sup>2</sup> guenther.schoerner@univie.ac.at; University of Vienna, Institute of Classical Archaeology, Franz Klein Gasse 1, 1190 Vienna, Austria.

sqm) decreases with distance from the site.

It is those different densities of artefact cover which are of interest for the reconstruction of agricultural practice because they could be interpreted with regard to land use from high densities in infield zones near the settlement for hand-cultivated field crops like vegetables to the less-intense crowing of cereals on outfield zones.

In this context it is likely that other factors, especially soil properties, affect the distribution pattern. The investigation of agricultural fields and adjacent sediment bodies does not only permit describing soil movement processes and the relative stability of landscape units, but also evaluating soil fertility and the possible contribution of long-term land use to soil development. Specific methods such as biomarkers and phytoliths analysis make it possible to evaluate which animals were kept and which plants were grown. Because it is possible to date the offsite material culture, a historical analysis of changes and developments in the manure and land use regime is feasible. Thus periods of intensive agriculture can be contrasted to periods with lesser agricultural production and/or other forms of land use.

### **First results from the sites of Abila and Umm el-Jimal in northern Jordan**

There are significant differences of material culture on the fields of northern Jordan, both on a regional and local scale. Ancient pottery can be found on most agricultural fields, sometimes in very high densities, and especially the Roman-Byzantine period is strongly represented. The remains of quarrying or other activities releasing calcareous dust seem documented by varying additions of  $\text{CaCO}_3$ , which are reflected by brighter soil colour (Lucke, 2008).

This contribution compares fields surrounding the ancient sites of Abila (today called Queilbeh) and Umm el-Jimal (ancient name unknown). Abila is located in the Csa-BSk climate zone (Steppe – Mediterranean)

according to the Köppen classification, close to the transition to the steppe. While around 400 mm mean annual precipitation allow rain-fed agriculture on fields around the site, annual rainfall drops to less than 200 mm within ~50 km towards the east. There the site of Umm el-Jimal is located in the BSk-BWk climate zone (Steppe – Desert).

At both sites, transect surveys were conducted in the four main directions from the sites. Surface soil samples were collected from each surveyed field, and soil and sediment profiles evaluated in representative catenas of the survey area.

### **Abila**

Soils around Abila consist largely of Red Mediterranean Soils or *Terrae Rossae* developed on a level limestone plateau. Although the rocks are more or less horizontally layered, strong variations of soil properties can be observed on the plateau. These are primarily visible as changes of soil colour and stone content: while colour ranges from bright red to dark reddish brown, stone cover varies from dense coverage with limestone and flint breccia (sometimes including rocks of football-size) to soils free of stones. These variations are not related to soil depth (Lucke, 2008) and seem to partly follow linear structures which might be related to man-made features.



*Figure 1: Surveying the fields near Abila.*

Catenas of soil distribution suggest that soils developed on the plateaus are largely stable land surfaces, while slopes of the steeply incised valleys appear much more active. These slopes are probably the main sources of large sediment bodies deposited in the

valleys. Graves on formerly cut-out terraces on the upper slopes were partly buried by *Terrae Rossae*, which sealed off the entrances to the graves but did not penetrate into the voids below. As well, shrink-swell behaviour of the soils might have led to limited upslope movement which is indicated by e.g. buried channels on rocky outcrops channelled for the supply of cisterns. This suggests that erosion-sedimentation patterns on the rims of the plateaus are strongly related to soil creep, which could take place when the very clay-rich soils are saturated with water. Such soil creep could also explain how features of historic land use patterns on the fields could be blurred, although the main elements such as e.g. stones from former field walls are still there. In this context, the strong variation of soil colour speaks against large-scale erosion of the fields, but it seems well possible that land use such as e.g. the release of  $\text{CaCO}_3$  from quarrying and construction activities could impact soil colour (Lucke, 2008).



Figure 2: Grave and former grave terrace buried by soil creep at plateau edge. The grave was sealed, but not filled.



Figure 3: Sediment profile excavated in Wadi Queilbeh close to Abila. It reaches bedrock in 5 m depth.

A first correlation of pottery density and soil properties points to a close connection of levels of plant-available phosphorus and material culture. As well, elevated stone contents seem to be associated with areas of elevated phosphorus and material culture. This suggests human activity, e.g. zones of more intensive farming, are represented by these features. However, in contrast to the findings of Wilkinson (1989) there is no linear spatial relationship with the distribution of former settlements. Other factors than distance could for example be the availability of cisterns, roads, or soil properties – analysis is ongoing.

### Umm el-Jimal

In contrast to Abila, the vicinity of Umm el-Jimal is dominated by basalts sheets connected to the Jebel al-Arab in Syria. Soils in the vicinity are dominated by Yellow Mediterranean Soils (Moormann, 1954) with high share of silts. While Lucke et al. (2014) assumed that aeolian deposits could represent a major part of the parent material of these soils, recent field work confirmed that a 4 m deep loess cover is present throughout the area. Building and looter pits revealed that fluvial incision and re-distribution of this loess cover is limited, but the presence of a dense rock cover on the loess in the eastern part of the area, most likely representing ejecta from craters further east, made this conclusion not straightforward.



Figure 4: Sampling sediments of former agricultural terraces near Umm el-Jimal.

Fields and land use show a pattern completely different from Abila. In contrast to the distribution of archaeological material on the entire surroundings of Abila (because rain-fed agriculture was possible on all

fields) denser scatters at Umm el-Jimal are concentrated on fields within the village and the immediate vicinity of the site. Further ancient fields are associated with remains of terraces along the valleys which were supplied by small channels catching water from dams which slowed down floods in the past. However, sediment bodies behind the remains of the terraces are of limited size, usually not exceeding 30 cm depth. This suggests very different land use practise near Umm el-Jimal than at Abila, which probably was based largely on grazing and limited irrigated cultivation where water was available.

## Conclusions

First results of our survey found very different land use patterns in different climate zones of northern Jordan. Land use in the steppe focused on areas that could be irrigated, but even in these areas only limited amounts of material culture could be found. In contrast, the Mediterranean climate zone is characterized by high amounts of material culture on fields, whose distribution varies and is not directly correlated to distance from settlements.

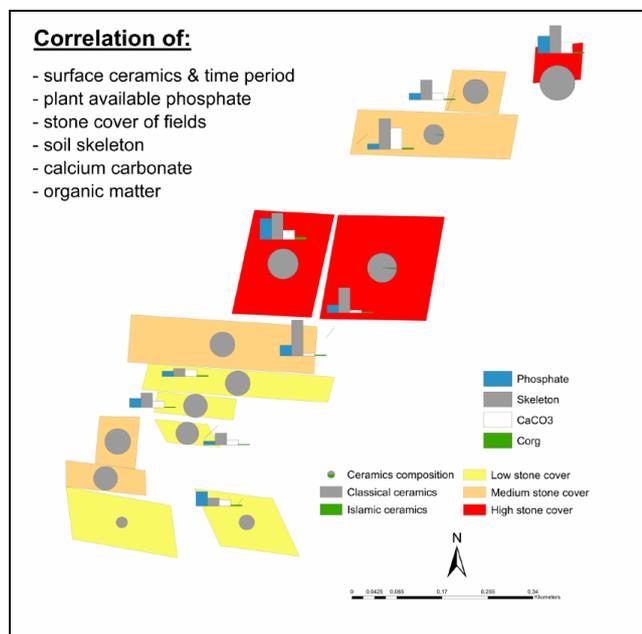


Figure 5: First correlation of amounts of pottery on the fields of the north-east transect at Abila with contents of plant-available phosphate, CaCO<sub>3</sub>, C<sub>org</sub>, skeleton, and stone cover.

It seems likely that the plateau soils represent old land surfaces with limited

erosion, but evidence of soil creep. Therefore it seems well-possible to reconstruct past human activities from the material culture and soil properties. First results suggest that activity zones can be identified and described according to the amounts of material culture, levels of plant-available phosphorus, and stone contents which might be connected with remains of former structures such as field borders, corrals, or roads.

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