Geomorphological Investigations of Desert Pavements and Wadi Terraces in the Eastern Desert of Egypt

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Introduction

The mountainous Eastern Desert of Egypt is an extremely eroded environment where the conditions to encounter Pleistocene palaeoenvironmental geoarchives are very rare. Dominated by outcrops of Precambrian basement, the drainage system is characterized by relatively short wadis with small catchment areas (figure 1). The limestone hogback of Djebel Duwi is one of the exceptional regions within the Eastern Desert which provides a significant amount of quaternary deposits, mainly wadi terraces at the eastern and western side of Djebel Duwi, caused by the existing tectonic basin (figure 2). It also serves the location of the archaeological site of Sodmein Cave, where latest dating results of heated chert evidence human presence at the site during MIS 5 (Schmidt et al. 2015). Nowadays, a hyperarid climate is dominant in the area, but the cave deposits have indicate for the Pleistocene regional wetter conditions. In case of a lack of natural sediment sinks beside the cave, no sedimentological investigations are possible to achieve the landscape evolution and therefore, the morphometric analysis of the wadi system is one key feature for the reconstruction of the former terrain and geomorphic processes.

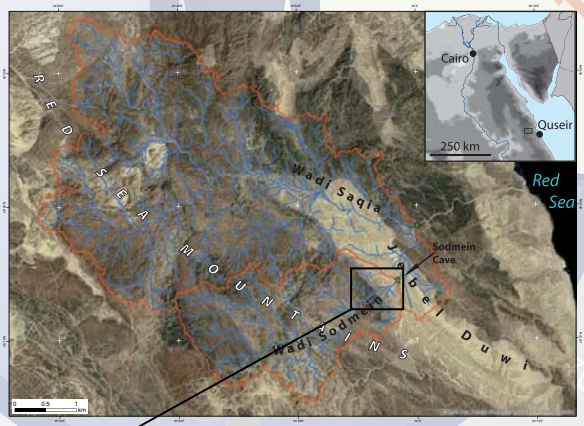


Figure 1: Eastern Desert of Egypt with catchment areas of Wadi Sodmein and Wadi Saquia.

Methods

scale of interest	data sources	item of interest
1: 100 000 1: 50 000 1: 25 000 1: 2 000	SRTM-1 *30m* ASTER *30m* Worldview2, *1m* Quickbird *0.61m* DGPS	- drainage network - catchment area - wadi basin - stream channel - single terrace

Remote sensing and geographical information systems (GIS) as a tool for landscape analysis, especially in desert areas, is very common and the amount of available data sets (free of charge and costly) has grown significantly during the last decades. The new free available SRTM-1arc second DEM and ASTER-DEM characterize the drainage networks in the Eastern Desert. WV2 and QB data were used to identify wadi terraces based on their morphometry and surface colour, because of their dark desert pavement. With this, we gain scale-specific morphometric informations about the different elements of the landscape which helps us to identify the geomorphic processes and different height levels of the terraces.

Desert Pavement

One approach for analysing the terrace surfaces is to describe single squaremeters documented with hyperspectral pictures using a RIKOLA hyperspectral Camera. This characterise the structure and colour of the desert pavement. Furthermore, the detailed recording of the hyperspectral signature serves as a ground check for analysing the satellite images (see figure 2).

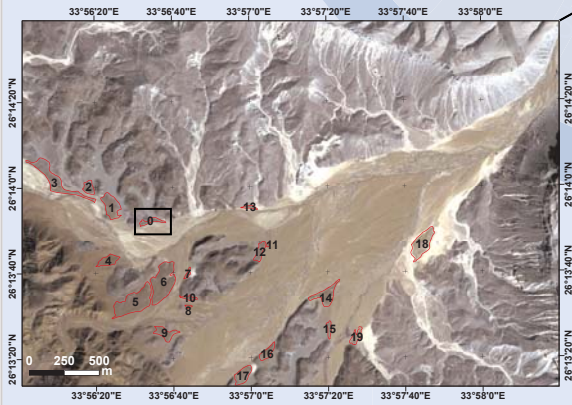
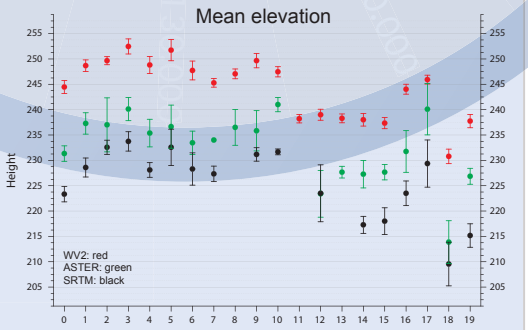
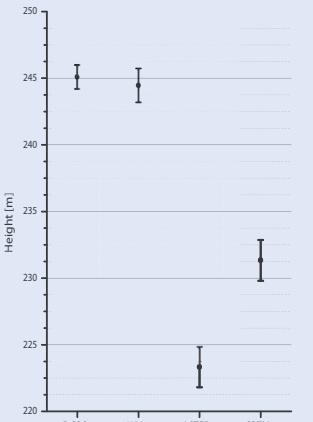


Figure 2: Based on field observations, location in the wadi and surface colour, 20 different terraces can be mapped in the western basin in the area of Sodmein Cave. Satellite image QuickBird.

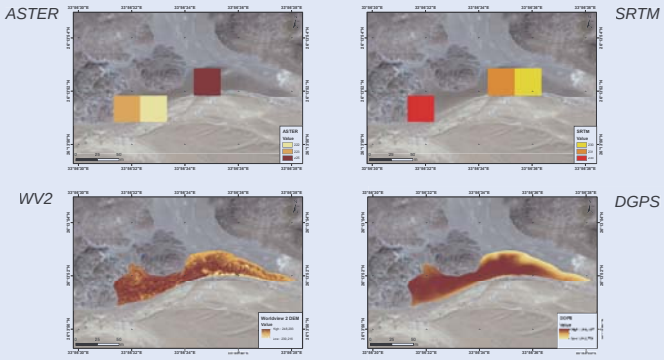
Wadi Terraces



The mean elevation of the terraces, based on the high-resolution WV2-data set, clearly identifys and seperate the terraces into different cluster. SRTM and ASTER also show some of the main relationships between the single terraces (relatively - not absolut), but the clear identification of cluster is possible with the low resolution of this data set in comparison of the scale of othe specifiv investigated object.



ID	Maximum	Minimum	Mean	STD
DGPS	246,19	242,77	245,09	0,89
WV2	248,29	239,21	244,46	1,27
ASTER	225	222	223,33	1,52
SRTM	233	230	231,33	1,52



The recently new discovered MSA site “Sodmein Playa” is situated at the edge of one terrace (van Peer et al. 2015 subm) and was studied in detail with a high resolution DEM based on DGPS measurements. This provides an excellent groundcheck for the DEM validation of the different methods.The results of the mean height show that the WV2-model is comparable with the DGPS data and that the use of this DEM can be applied in broader areas to analyze the morphometry of the different terraces.
SRTM-1 and ASTER have also relatively small error bars, but the total amount of data points (n=3) used for this calculation are to small.

Conclusion

Our multi-scale approach using various data sources with different spatial resolution shows the high potential for mapping and analyzing the wadi terraces as archives for the landscape evolution in the area of Sodmein Cave. Further investigations of morphometric parameters including the total drainage network and single terraces will provide (1) a comparison for the application of different (free) data sources (e.g. advantages and disadvantages of the new SRTM-1 in comparison to ASTER; mapping small features with WV2 data) and (2) a strong geomorphological framework for the landscape evolution as the background for palaeoenvironmental changes in the Eastern Desert of Egypt.

References

Schmidt, C., Kindermann, K., van Peer, P. Bubenzer, O., 2015. Multi-emission luminescence dating of heated chert from the Middle Stone Age sequence at Sodmein Cave (Red Sea Mountains, Egypt). Journal of Archaeological Science, 63, 94-103.

van Peer, P., Kindermann, K., Henselowsky, F. 2015. Sodmein Playa, a new Early Nubian Complex site associated with lacustrine sediments from the Eastern Desert, Egypt. Journal of Human Evolution, submitted.

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