Geophysical Research Abstracts
Vol. 19, EGU2017-15597, 2017
EGU General Assembly 2017

Two millennia of soil dynamics derived from ancient desert terraces using high resolution 3-D data

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Large areas in the arid southern Levant are dotted with ancient terrace-based agriculture systems which were irrigated by runoff harvesting techniques. They were constructed and maintained between the 3rd – 9th centuries AD and abandoned in the 10th century AD. During their 600 years of cultivation, these terraces documented the gradual aggradation of alluvial soils, erosion processes within the drainage basins, as well as flashflood damage. From their abandonment and onwards, they documented 1000 years and more of land degradation and soil erosion processes. Examination of these installations presents an opportunity to study natural and anthropogenic induced changes over almost two millennia. On a global scale, such an analysis is unique as it is rare to find intact manifestations of anthropogenic influences over such time-scales because of landscape dynamics. It is also rare to find a near millennia documentation of soil erosion processes.

We study in this paper the aggradation processes within intact agriculture plots in the region surrounding the world heritage Roman-Byzantine ancient city of Avdat, Negev Highlands. We follow the complete cycle of the historical desert agriculture, from the configuration pre-dating the first anthropogenic intervention, through the centuries of cultivation, and up to the present erosion phase, which spans over more than a millennium. We use high resolution 3-D laser scans to document the erosion and the environmental dynamics during these two millennia. The high-resolution data is then utilized to compute siltation rates as well as erosion rates.

The long-term measures of soil erosion and land degradation we present here significantly improve our understanding of the mechanism of long-term environmental change acting in arid environments. For sustainable desert inhabitation, the study offers insights into better planning of modern agriculture in similar zones as well as insights on strategies needed to protect such historical installations.