Geophysical Research Abstracts
Vol. 16, EGU2014-15555, 2014
EGU General Assembly 2014

The Nahal Oz Reservoir dam-break flood: Geomorphic impact on a small ephemeral loess-channel in the semi-arid Negev Desert, Israel

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The Nahal Oz Reservoir - in the coastal, semi-arid southwestern Israel was designed to enhance local irrigation of crops using reclaimed sewage water during the dry summer months. On March 2001, part of the western dike of the reservoir was breached and generated a flow release of 3.5*106 m3 of secondary irrigation water that was channeled down the 1st order ephemeral loess stream (Nahal Yare'akh). The consequent 12-hour flood surge, with an estimated peak discharge of 1000 m3s-1, inflicted severe loess erosion, agricultural, property and infrastructural damage downstream.

Post-flood mapping documented the geomorphic response to the flood which included channel scour and widening along the initial 2 km downstream of the reservoir where a spillway channel was formed. The increase in the cross-sectional area was about 60% and had an estimated 170,000 m3 of sediment bed, bank and floodplain erosion. Calculated maximum shear stress and stream power along this section are estimated at 300 Nm-2 and 900 wm-2, respectively. The peak discharge at the end of this segment was estimated at 800 m3s-1 indicating only minor attenuation along this segment. Two km downstream of the breach, a wide braided fan indicated deposition of the eroded sediments. At the end of this segment the floodwater diverged into several watercourses and inundated tilled agricultural fields and neighborhoods. Downstream, 9 km from the reservoir, the discharge attenuated to 100 m3s-1, slightly above bankfull. Further downstream and upon reaching the large Shikma stream the flow was already very low. This reduction in discharge is attributed to the anthropogenic infrastructure - roads, neighborhoods and agricultural fields and the large transmission losses typical of sandy ephemeral streams.

The study shows that channels within erodible materials respond to high peak discharges very locally. Erosional thresholds that severely incised the channel are only maintained for 2 km below the breached reservoir and as distance from the source area increases, available energy is substantially reduced due to high transmission losses, gentler valley gradients, very wide shallow flow and the ability of the drainage network to accommodate large discharges. Consequently, the geomorphic impact was limited to the first 2.6 km with only minor erosional or depositional evidence downstream. The current natural flow regime has only minor impact on the newly formed channel geometry below the breached dam. Accordingly, the channel geometry may be preserved for a relatively long time. However, channel recovery in this segment was rapid and within a few years all bare loess surfaces exposed during the flood have been covered by dense vegetation. The analysis also shows that Nahal Oz Reservoir's dam-break flood transmission losses and flood attenuation rates were extreme in comparison to other case studies. This artificial flood event in a desert environment offers a rare opportunity to quantify channel and bank erosion evolution processes during an extremely high magnitude flood within highly erodible fine sediment as well as to detect the recovery processes a few years later.