Geophysical Research Abstracts
Vol. 18, EGU2016-7338-2, 2016
EGU General Assembly 2016

Calibration of commercial microwave link derived- rainfall and its relevance to flash flood occurrence in the Dead Sea area

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Flash floods are a common phenomenon in arid and semi-arid areas such as the Dead Sea. These floods are generated due to a combination of short lasting, yet intense rainfall and typical low infiltration rates. The rare flow events in ephemeral rivers have significant importance in the replenishment of groundwater via transmission losses and in sustaining the vivid ecology of drylands. In some cases, flash floods cause severe damage to infrastructure as well as to private property, constituting a threat to human life. The temporal variation of rainfall intensity is the main driver generating the majority of flash floods in the Judean Desert, hence its monitoring is crucial in this area as in other remote arid areas worldwide.

Cellular communication towers are profusely located. Commercial Microwave Links (CML) attenuation data obtained by cellular companies can be used for environmental monitoring. Rain is one of the most effective meteorological phenomena to attenuate a CML signal which, unlike radar backscatter, relates to near-surface conditions and is, therefore, suitable for surface hydrology.

A 16 km CML crosses the Wadi Ze'elim drainage basin (∼250 square kilometers), at the outlet of which the discharge is calculated using the Manning formula. The hydrometric data include accurate longitudinal and cross sectional measurements, water level and importantly mean water surface velocity when present during a flash flood. The latter is first-ever obtained in desert flash floods by portable, radar-based surface velocimetry. Acquisition of water velocity data is essential to avoid assuming a constant roughness coefficient, thereby more accurately calculating water discharge.

Calibrating the CML-rain intensity, derived from the International Telecommunication Union (ITU)'s power law, is necessary to correlate the surface hydrologic response to the link. Our calibration approach is as follows: all the Israel Meteorological Service C-band radar cells over the CML's path were extracted and rain intensities were derived and averaged to simulate the dependence of the CML rain intensity on path's length. The CML-derived rain intensity is then multiplied by a correlation factor, found by fitting the CML intensity to that of the radar's rain (instantaneous rather than cumulative values) using least squares. Relative humidity is taken into account from the beginning of storms because its low values can lead to the Virga phenomenon - rain drops evaporate before reaching the ground, particularly in arid regions. This is a significant disadvantage of using radar data in dry regions. Therefore, the CML contribution may be significant in this environment.

Spatial assumptions including uniformity are used to allow the computed specific discharge to be compared to the corrected and the uncorrected rain intensity. The time difference between the runoff generating attenuation pattern and the arrival of the wave at the outlet is examined and can constitute the base of a future short term flood warning system.