Plinius Conference Abstracts
Vol. 16, Plinius16-28, 2018
16th Plinius Conference on Mediterranean Risks

Synoptic-scale control over heavy rainfall and flash floods in the drylands of the Eastern Mediterranean

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Rainfall in the drylands of the Eastern Mediterranean is scarce, but can potentially generate high-magnitude flash floods. Rainstorms are usually caused by distinct synoptic-scale circulation patterns: Mediterranean cyclone (MC), active Red Sea trough (ARST) and subtropical jet stream (STJ) disturbances, also termed tropical plumes (TPs). Here we identified the unique spatiotemporal characteristics of rainstorms and floods for each circulation pattern. To characterize the chain of hydrometeorological processes leading to distinct flood patterns in the drylands of the Eastern Mediterranean we used meteorological reanalyses, quantitative precipitation estimates from weather radars, hydrological data, and indicators of geomorphic changes from remote-sensing imagery.

We identified significant differences in the hydrometeorology of the three flood-producing synoptic systems. MC storms draw moisture from the Mediterranean and generate moderate rainfall in the northern part of the Levant drylands. ARST and TP storms transfer large amounts of moisture from the south, which is converted to rainfall in the hyperarid southernmost parts of the Levant. ARST rainfall is local and intense, whereas TP rainfall is widespread and prolonged due to high precipitation efficiency and large-scale forcing. Thus, TP rainfall is accompanied by high-magnitude floods in the largest catchments; this activation and integration of numerous basins leads to the feeding of sediment from the south into the Dead Sea lake, exhibited in large sediment plumes. Anecdotal observations indicate that these TP floods account for noticeable geomorphic changes in the channel. The distinct rainstorm patterns associated with synoptic-scale circulation and the changes in their future occurrence frequency should be considered in evaluating regional flood hydrology under proposed climate-change scenarios.

In addition to the above, we identified Heavy Precipitation Events (HPE) in a very long ($\sim$24 years) radar dataset record, characterized their patterns and compared them with a high-resolution output from numerical weather model (WRF), and the main factors controlling the heavy rainfall were examined.