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Long-term variability and extreme rainfall response of runoff and baseflow processes in Cyprus

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Accurate streamflow predictions are a crucial aspect of sustainable water management planning. This is particularly important for areas that are highly dependent on water resources stored in dams, and even more so when these areas are water stressed. Thus, a proper understanding of the physical processes determining the behavior of a watershed will lead to a more realistic description of these processes in hydrological models for predicting river discharge into dams in the future. Runoff and baseflow processes in five watersheds located in the Troodos mountain range in Cyprus for a 30-year period are investigated in this study. The watersheds' areas range from 14.9 to 76.5 km^2 while mean watershed slopes vary between 31% and 48%. The 30-year average annual rainfall over the five watersheds ranges between 518 and 617 mm. Daily precipitation and streamflow records were analyzed and runoff coefficients (RC) were computed for annual duration and for extreme events. Baseflow indices (BFI) were calculated with the computer program PART. The long-term average RC ranged between 15% and 23% for four out of the five watersheds and reached 4% during the driest and 41% during the wettest year. The fifth watershed seemed to systematically exhibit a lower RC, equal to 6% on average, and equal to zero during eight out of 30 years. This could be attributed to the fractured nature of the geologic formations of the watershed. The average annual contribution of the groundwater to the streamflow ranged between 50% and 83% for the five watersheds. The interannual variation was more than double (standard deviation 0.19) for the watershed with the lowest RC, compared to the mean standard deviation of 0.09 of the other four watersheds The overall event RC varied between 16% and 68% for January 1989, when 189 mm of rain were received during a three-day period and in the most extreme case 108 mm of rain and 66 mm of streamflow were recorded in one day. For the November 1994 event, 291 mm of rain were received during a five-day period, with 96 mm of rain and 40 mm of streamflow as single day extremes. For that event, RC ranged from 10% up to 41%. These results suggest, firstly, that both RC and BFI, due to their significant spatial variability, cannot always be transferred to neighboring basins, even when similar land use, geologic and climatologic conditions prevail. Secondly, hydrological models, such as these that are employed to predict future streamflows, need to adequately describe the watershed surface and subsurface processes in order to capture the temporal variability of the RC.