

Modelling the impact of urbanization over the last half century on the hydrology of a peri-urban catchment

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The impacts of land-use change on catchment water balance may be considerable and are currently widely investigated. In particular the hydrological responses in catchments with complex mosaic landscape patterns are among the least well understood, and particularly so for Mediterranean environments with relatively low availability of long-term time series of relevant historic data. This study uses a spatial distributed modeling approach to investigate hydrological changes driven by increasing urbanization over the last 50 years in a small peri-urban catchment (6.2 km²) in central Portugal. Using the MIKE-SHE model, the study investigates differences in evapotranspiration, as well as storm flow (mainly overland flow) and subsurface flow into and total flow in the stream network of this catchment between three periods: 1) a mainly rural phase (1958 - 1973) with low urban cover (<12%); 2) a discontinuous urbanization phase (1973 - 1995), with urban land-use reaching 27% of the catchment area by 1995; and 3) an urban consolidation phase (1996-2013), which led to a 40% urban land cover by 2013. Model results show good agreement with stream flow measurements during the calibration and validation periods (Nash–Sutcliffe efficiency of 0.68 and 0.60, respectively). Overall the driver of annual precipitation and the resulting annual evapotranspiration were greater during the rural phase (significant change, $p < 0.05$). Changes in total annual runoff between the three periods, however, were small and not statistically significant ($p > 0.05$), but overland flow slightly increased from discontinuous to continuous urbanization periods (despite the decrease in precipitation) as a result of the increasing impervious urban area.