

### Hydrology of Mediterranean catchments

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Regional analysis is an essential step to improve water management plans and transpose flow characteristics on ungauged catchments. The Mediterranean region is a highly fragmented area with 1270 catchments ranging between 100 and 3000 km<sup>2</sup>, and is qualified as one of the most sensitive and challenging regions to climatic and anthropogenic variations and lacking flow measurements, mostly in its southern side (North Africa). Despite all the research at the regional scale, a specific Mediterranean hydrology is long to be defined yet and require additional research related to the relation between hydrological processes and their climate and physiographic descriptors. This work seeks to define these relations relying on multivariate analysis approach following three steps: i) What can we learn from the state of the art? ii) Establishing a specific climate classification for Mediterranean hydrology and future evolution under regional climate model scenarios; iii) Hydrological characteristics of Mediterranean catchments.

First, we analysed 140 hydrological studies conducted in the Mediterranean region. The results enable to identify key characteristics of the hydrological responses catchments at various time and space scales, and compares different methods and modelling approaches used for individual-catchment studies. The study area is divided into the north-western, eastern and southern Mediterranean. The analysis indicates regional discrepancies in which the north-western parts shows the most extreme rainfall regime. A tendency for reduced water resources driven by both anthropogenic and climatic pressures and a more extreme rainfall regime are also noticeable.

Second, se developed a new high-resolution climate classification for hydrology purposes based on Mediterranean-specific climate indices taking into account inter-annual variability,

seasonality, flood and drought periods. The proposed approach includes the use of Principal Component Analysis to reduce the number of indices to the most contributing and K-means classification to distribute them into classes. The classification was set and validated by WorldClim-2 at 1 km high-resolution gridded data for the 1970–2000 baseline period and 144 stations' data over 30 to 120 years, both at monthly time steps. Climatic classes coincided with a geographical distribution in the Mediterranean ranging from the most seasonal and driest class 1 in the south to the least seasonal and most humid class 5 in the north, showing the climatic continuity from one place to another and enhancing the visibility of change trends. The MED-CORDEX ALADIN and CCLM historical and projected data at 12 and 50 km resolution simulated under the RCP4.5 and 8.5 scenarios for the 2070–2100 period served to assess the climate change impact on this classification.

Third, we established a hydrological characterization of Mediterranean catchments. To that end, we collected a physioclimatic database covering all the Mediterranean and a hydrometric dataset of 55 catchments from 15 Mediterranean-rim countries. We studied the flow regimes of these catchments according to Haines (1988) to verify if Mediterranean rivers fall into same regime class. Second, we characterised the Mediterranean hydrological response through different water balance functional models as advanced by Budyko (1974), L'vovich (1979) and elaborated by Ponce & Shetty (1995a, 1995b), Sivapalan et al. (2011) and Moussa and Lhomme (2016). The water balance analysis highlighted the Mediterranean trend following the general climatic setting from the wet Northern region to the arid Southern region; it also showed hydrological homogeneity for mountainous karstic and snow influenced catchments which yield the highest baseflows and runoff coefficients. Finally, we applied the functional water balance models developed to study the impact on water balance under climate change scenarios.

The regional analysis highlighted “homogeneous sub-regions”, similar “climatic”, “physiographic” and “hydrologic” catchments, and resulted with a new cartography for Mediterranean catchments hydrological characteristics.