A regional GIS-based model for reconstructing natural monthly streamflow series at ungauged sites

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Several hydrologic applications require reliable estimates of monthly runoff in river basins to face the widespread lack of data, both in time and in space. The main aim of this work is to propose a regional model for the estimation of monthly natural runoff series at ungauged sites, analyzing its applicability, reliability and limitations.

A GIS (Geographic Information System) based model is here developed and applied to the entire region of Sicily (Italy). The core of this tool is a regional model for the estimation of monthly natural runoff series, based on a simple modelling structure, consisting of a regression based rainfall-runoff model with only four parameters. The monthly runoff is obtained as a function of precipitation and mean temperature at the same month and runoff at the previous month. For a given basin, the four model parameters are assessed by specific regional equations as a function of some easily measurable geomorphic and climate basins' descriptors.

The model is calibrated by a "two-step" procedure applied to a number of gauged basins over the region. The first step is aimed at the identification of a set of parameters optimizing model performances at the level of single basin. Such "optimal" parameters sets, derived for each calibration basin, are successively used inside a regional regression analysis, performed at the second step, by which the regional equations for model parameters assessment are defined and calibrated. All the gauged watersheds across the Sicily have been analyzed, selecting 53 basins for model calibration and using other 6 basins exclusively for validation purposes. Model performances, quantitatively evaluated considering different statistical indexes, demonstrate a relevant model ability in capturing the observed hydrological response at both the monthly level and higher time scales (seasonal and annual).

One of the key features related to the proposed methodology is its easy transferability to other arid and semiarid Mediterranean areas; thus, the application here shown may be considered as a benchmark for similar studies. The calibrated model is implemented by a GIS software (i.e. Quantum GIS 2.10), automatizing data retrieving and processing procedures and creating a prompt and reliable tool for filling/reconstructing precipitation, temperature or streamflow time series at any gauged or ungauged Sicilian basin. The proposed GIS plug-in can, in fact, be applied at any point of the hydrographical network of the region, assessing the precipitation, temperature and natural streamflow series (at the monthly or higher time scales) for a desired time-window.