Comprehensive Hydrological Modeling Tool for Flood Discharge Estimation in Sicilian Watersheds

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Designing hydraulic infrastructures and/or carry out a flood risk assessment analysis, as mandated by Directive 2007/60/EC of the European Parliament regarding the assessment and management of flood risk, needs estimating flood discharges for different return periods. In the current era, Geographic Information Systems (GIS) make more efficient the integration of spatially distributed data and advanced analytical tools for hydrological applications.

This work introduces a Python-based tool that merges GIS functionalities (i.e., open-source geospatial libraries, such as native QGIS plugins, GDAL, SAGA) with hydrological modeling techniques, providing a comprehensive framework for watershed analysis aimed to derive synthetic flood hydrographs for specified return periods. The tool is composed of different modules, performing different operations: following the delineation of the watershed based on a user-specified outlet, the tool uses a regionalized approach to establish Depth-Duration-Frequency (DDF) curves and derives the synthetic Chicago hyetographs for specified return periods. The tool comprises a module for calculating runoff depths using the Curve Number method and another module where flow hydrographs are derived by using distributed unit hydrograph (D-UH) through a spatial representation of times of concentration, accounting for varying flow velocities within the watershed. Additionally, the tool allows for the simulation of the basin response to historical precipitation. In the present study, the tool underwent testing on catchments of Sicily (Italy) even if it is worth noting that the tool can be customized for application in various regions worldwide.