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Spatially Smooth Residual Hydropower Potential Assessment and Management in North-Western Italy

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In the perspective of the further development of renewable energy production, residual hydropower still holds considerable importance even in developed economies. In this framework it is essential to analyze performances and impacts of existing plants, to determine feasibility and optimal location of new plants, to consider mutual interferences between water withdrawals and operational rules, and to verify the compliance with environmental requirements. To achieve this goal a robust, open and shared system of tools is needed to support both investors in the hydroelectric sector and policy maker administrations.

A preliminary implementation of a web-based infrastructure is presented, with the aim of providing a Free&OpenSource tool to support hydropower potential assessment and mapping at the regional scale. The system exploits a statistical hydrological model to evaluate the annual flow duration curve (FDC, i.e. the probability distribution of daily runoff) also in ungauged basins. The model is based on a regional spatially-smooth procedure which allows the predicted FDC to vary smoothly along the river network, thus allowing the mapping of water availability along any river reach on the basis of topographic, climatic, land use and vegetation characteristics of the basin. The hydrologic model directly reconstructs a “naturalized” FDC; the presence of existing reservoirs and hydropower plants is accounted for by properly correcting the L-moments of the FDC.

A set of spatial algorithms and data management techniques (mainly implemented in GRASS GIS and PostgreSQL/PostGIS) have been developed to couple the hydrological analysis with the morphologic landscape characteristics, returning different possible scenarios of exploitation. An example of output, including a flow-altitude relation for each pixel along a drainage path assuming different possible headrace length (1, 2.5 and 5 km) is reported for the considerable areas in the Piemonte region (Italy), while the framework of models is customizable for other areas.

To make the procedure largely usable, a Web Processing Service (WPS) is also available to perform the hydrological analysis of any river section of the case study; the procedure is accessible from web browsers or through the use of desktop GIS software such as QGIS.