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Evaluating the hydrological functioning and the supply of water provisioning services to support the ecosystem–water–food–energy nexus in the Arno river basin

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Water, flowing in a basin, underpins key provisioning ecosystem services like freshwater supply, food and energy production. River basin management largely determines the type of water-related ecosystem services (WES) that are provided and the extent to which trade-offs and synergies might arise. Gaining insights on the ecohydrological behavior of a basin and on the conflicting anthropic pressures on the available water resources allows to identify the most important WES, as well as the existence of WES supply and demand hotspots. This information is crucial for water resources management and, in the context of the European Union, also required to comply with the requirements of the Water Framework Directive (WFD).
The purpose of this research is to quantify the provisioning WES in the upstream part of the Arno river basin (Central Italy) and identify WES hotspots and fluxes. Current information on how water is allocated in the Arno basin remains scarce, despite the increasing water demand by some sectors, particularly irrigation, and a number of emerging conflicts among users. It is expected that research outputs can support the improvement of the existing management framework, moving from the classical DPSIR (Driving forces, Pressure, State, Impact e Response) approach, where impacts must be reduced or mitigated, to a more proactive framework to support the sustainability of the Arno basin and meet the different policy goals.
The eco-hydrological model SWAT (Soil Water Assessment Tool) is applied to spatially quantify the provision of WES. The preliminary results of this research indicate that the highest amount of water yield, i.e. net amount of water that contributes to streamflow and represents the main blue water fund, originates in the northern part of the basin, characterized by forest areas. In contrast, the southern part of the basin, which is mainly agriculturally used, gives a minor contribution to the overall water yield, in direct proportion to the precipitation. In order to highlight the role of green water in irrigated land, potential green water funds are also estimated on the basis of the available soil water content simulated by SWAT.
The water provisioning for the different sectorial uses, which represent the actual flow of the ecosystem services, have been estimated for every sector at the subbasin or municipality scale: agriculture is the most water intensive sector followed by industrial, domestic and hydropower water use.
Comparing the water withdrawals and the water yield, WES supply (mainly located in the northern part of the basin) and demand hotspots (mainly in the central and southern part of the basin) are identified. This analysis framework highlights WES fluxes that connect supply and demand areas and supports the understanding of the tradeoffs between different water users, aiming at the improvement of the WES provision within the water resources system.