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Hydrological effects of climate and land use changes in regulated vs. unregulated headwaters of Southern Calabria

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Surface runoff rates in torrents are driven by land use and climate changes. Moreover, the effects of control works, such as the check dams, can modify these rates. In the Mediterranean semi-arid watersheds (e.g., in Southern Italy and Spain), this forcing may sum to local factors, such as steep slopes, small drainage areas and heavy and short-duration rainstorms. Therefore, it is important to evaluate the hydrological effects of each action (presence of check dam, land use changes and future climate forcing), in order to control flash floods, soil erosion and landslides at the watershed scale. To this aim, this study evaluates the annual runoff rates in two headwaters of Southern Italy, mainly forested and agricultural, using a modeling approach. More specifically, the well-known Soil and Water Assessment Tool (SWAT) model is applied to Vacale (12.5 sq. km) torrent, regulated by check dams built in '1950-1960, and Serra torrent (13.7 sq. km), not regulated. Both sub-watersheds experienced an increase in forest cover up to 70%, while the agricultural land decreased by about 30% of the total area in the period after the construction of the control works until now. Previously, the model was calibrated in a third torrent (Duverso, 12.5 sq. km, gauged for runoff measurements), with the same climatic and geomorphological characteristics, using the automatic calibration by the SWATCUP program. After calibration, SWAT simulated the hydrological response under different land uses (forest, pasture and bare soil, the latter simulating total deforestation) and climate change scenarios (applying a Global Circulation Model, under 2.6 and 8.5 Representative Concentration Pathways) throughout the next 80 years. The results of this modeling experience showed that: (i) the presence of check dams noticeably reduced the hydrological response of the regulated headwater compared to the torrent without check dams; (ii) the vegetal cover of the forestland has been the most important factor in mitigating the surface runoff rate in comparison to the other land uses; (iii) under the future climate change scenarios, the surface runoff will increase with increasing mean temperatures and precipitation intensity. The model outputs help supporting a better understanding on the impacts of control works as well as land use and climate changes on the runoff generation capacity in Mediterranean torrents. These indications are useful to watershed managers in the adoption of the most effective strategy to mitigate flash flood hazards and heavy erosion risks in similar environmental contexts.

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