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Comparing the hydrological response of regulated vs. not regulated mountain torrents in the Mediterranean semi-arid environment: a case study in Southern Italy

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In the Mediterranean semi-arid environment (e.g., in Southern Italy and Spain), headwaters are characterized by local factors, such as steep slopes, low drainage areas and heavy and short-duration rainstorms, which make the torrents prone to flash floods, soil erosion and landslides. The construction of check dams has contributed to mitigate the runoff and erosion rates, but the effectiveness of these structures has been rarely assessed. In these contexts, the availability of studies monitoring the mitigation effect of check dams on the hydrological response of torrents at the watershed scale over a long time could help developing new management strategies. To this aim, this study proposes an assessment of the multi-decadal runoff and erosion rates in two headwaters of torrents in Southern Italy, using a modeling approach. The first torrent (Vacale, 12.5 sq. km) is regulated by check dams built in '1950-1960, while the second torrent (Serra, 13.7 sq. km) is not regulated. Both catchments experienced an increase in forest cover up to the 70%, while the agricultural land decreased by about 30% of the total area after the construction of the control works until now. The hydrological response of the two headwaters has been simulated using the widely applied Hydrologic Modeling System (HEC-HMS) model for runoff and peak flow, coupled with the Modified Universal Soil Loss Equation (MUSLE) to model sediment yield. To this purpose, 10 heavy rainfall-runoff events occurred between 1956 and 1971 were modeled. The peak flows and sediment yields of the regulated watershed were compared with the corresponding simulations at the undisturbed torrent. To summarize the results of this modeling experience, the changes in land cover resulted in a noticeable decrease in flood peak discharge (on average -53%) in both torrents, while the torrent with check dams showed a significant reduction of eroded sediment for each event (on average -9%) compared to the unregulated headwater. These findings help supporting a better understanding on the impact of control works and land use changes on the hydrological responses of Mediterranean torrents, indicating the most effective strategy to mitigate flash flood hazards and heavy erosion risks in similar environmental contexts.

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