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Man as a hydro-geomorphological agent: modelling pathways and shifts in evolving catchment response.

Increasingly, man plays an active role in the hydrological cycle thus modifying the storage and transport of water near the topographic surface and the resulting geomorphic work. This influence cannot be simply neglected when looking at the internal organization of catchments or at long-term changes in their response. It can be postulated that in medium-sized catchments (1-1000 km^2) prolonged human activity, such as agriculture, will have a profound impact as it emphasizes contrasts in hydrological functioning. This would imply that under exceptional (stationary) conditions, landscape and human activities will co-evolve towards stable new patterns and process intensities. However, such stable conditions may never be reached as a result of the short- and long-term changes in driving factors such as climate, population pressure and technology. To what degree human impact leads to differences in hydrological functioning can therefore only be induced through comparison of the transient response with a natural control experiment. Comparative modelling overcomes some of the issues that are associated with the study of actual catchments; it allows for full control of initial conditions, imposed forcing and number of replicates and reveal the patterns and processes that underlie catchment response. Such an experiment is performed here using the meso-scale landscape dynamics model, CALEROS, that accounts for the interactions between climate, soil production and erosion, vegetation, population and land use on geomorphological to human time scales. This model was applied to a medium-sized Mediterranean catchment for a 6000-year period to i) establish patterns of co-evolution in soil properties and land cover under pristine and human-impacted conditions on a millennium-scale, ii) investigate resilience in post-disturbance response under varying levels of human impact, and iii) establish the depth of the human imprint following simulated abandonment.

Although the results of this study are evidently conditioned by the physiographic setting of the study area and by the interactions simulated by the model, they can help us to understand the organization of medium-sized catchments and their resilience in light of ongoing changes. As such, it can be seen as a first step to give man a place within the theoretical framework of co-evolution and to consider not only present but also past human impacts in hydrological analysis. Still, several major challenges confront us, one being the integration of human actions in hydrological modelling and the other the validation of the findings with observations. To overcome these, we may have to turn to other disciplines in the next decade and define new theories and techniques to underpin this field of hydrological science.