Submitted Abstract

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Abstract

Understanding erosion, transport and sediment dynamics in high mountain catchments is essential to ensure effective conservation strategies. In Mediterranean high-mountain environments, the diversity of hydro-meteorological drivers, the torrential nature, the high topographic gradients, and the quick response of snow dynamics condition significant sediment transport rates. However, the relationship of erosion and transport processes between hillslopes and the fluvial network is poorly understood. The emerging topic of sediment connectivity offers the opportunity to study erosion and sedimentation processes holistically, with the potential to increase system understanding and improving catchment management. This work analyzes the processes that control sediment connectivity, and its associated transport processes, in several high-mountain watersheds of Sierra Nevada (southern Spain). For this purpose, 18 years of monitoring works of hydro-meteorological drivers, hillslope erosion processes, and bedload and suspended loads sediment transport along the fluvial network have been used to assess sediment connectivity. Besides, long-term assessment and spatial approaches were used by physical-based and distributed hydrological modeling, with a model designed, calibrated, and validated in the study area, specially configured to evaluate snow dynamics and erosive processes in Mediterranean mountainous environments. In addition, the current situation was contrasted with different future climate scenarios, which were adapted and implemented from European reference databases. The simulation results show how changes in the frequency and amount of snowfall affect hillslope erosion processes associated with raindrop impact and rill erosion. These changes alter downstream sediment connectivity patterns and their relationship between hillslope and fluvial systems, where downstream sediment connectivity increases along the rivers due to an increase of torrential events. These results also highlight the large variability between regional climate models used in this study and their relatively low spatial resolution with respect to the complex topographies of the study areas. The proposed methods and results of this research highlight the great sensitivity of both hydrological and erosive responses of high mountain environments to climate change and provide clues as to where and how best to plan adaptation and mitigation strategies. This work is part of Smart EcoMountains, the Thematic Center on Mountain Ecosystems of LifeWatch-ERIC.