Satellite-based remote sensing and multitemporal modeling approach for mapping soil erosion hotspots in global mountain grasslands under climate change

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Mountain grasslands play a pivotal role in delivering both economic and cultural ecosystem services, including food production, carbon sequestration, the provision of clean water, and preserving local traditions. However, these ecosystems are facing increasing threats from climate change around the world. Among the main challenges is the intensification of extreme precipitation events. They can aggravate the process of soil erosion and trigger landslides in mountain grasslands, with possible negative consequences on both ecosystems and human activities. However, the high variability of these ecosystems, as well as their wide distribution, makes it complex to adequately map their locations and investigate possible soil erosion hotspots, especially under future scenarios with varied rainfall regimes. In this context, the use of remote sensing technologies and modeling approach could open new frontiers to investigate critical areas and therefore guide mitigation solutions. The satellite Earth Observation (EO) through international space missions, coupled with cloud-based data analysis platforms like Google Earth Engine (GGE), facilitates ecosystem mapping at a resolution and frequency previously inaccessible. Furthermore, the utilization of multi-temporal models for potential soil erosion analysis in present and future scenarios can enhance our understanding of erosion dynamics attributed to climate change. In this research, we first map at high resolution the global mountain grasslands distribution taking advantage of Sentinel-based EO’s products. In such locations, we evaluate the multi-temporal soil erosion dynamics caused by water employing diverse climate scenarios (RUSLE model; 2015 vs. 2070-RCP8.5). Our findings indicate a potential global escalation in soil erosion within mountain grasslands, notably in South America and Africa, alongside identifiable localized hotspots. Remote sensing-based research paired with a modeling approach aimed at mapping critical areas and analyzing environmental challenges in ecosystems is therefore imperative. Such investigations not only delineate vulnerable regions but also guide targeted solutions crucial for safeguarding these ecosystems and their ecosystem services in the face of climate change.