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Comparing the impacts of land-use management and climate change on soil erosion: a modeling exercise for humid and dry Mediterranean regions in Portugal

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Climate change could impact soil erosion rates in the Mediterranean, either directly via the concentration of rainfall in a smaller number of winter events, or indirectly through changes in vegetation cover. In particular, climate-induced changes in land-use management and associated agro-forestry practices could lead to much greater impacts than the ones expected from climate change alone.
This work compares how future climate and land-use changes could impact soil erosion. The Soil and Water Assessment Tool (SWAT) model was applied to two contrasting watersheds in Portugal. The Vez has a humid Mediterranean climate (1500 mm/yr average rainfall) and is presently covered by plantation forests and shrublands. The Xarrama has a dry Mediterranean climate (600 mm/yr annual rainfall) and is presently occupied mostly by an agroforestry system consisting of pasture and evergreen oaks. Both watersheds currently experience very low erosion rates due to the landcover type.
In both cases, climate scenarios presuppose a small decrease in rainfall (-4% in the Vez, -9% in the Xarrama) but more concentrated in winter, where an increase is expected. Possible future land-use scenarios could lead to an intensification of agriculture, due to the expansion of vineyard areas in the humid region and the plantation of sunflowers for biofuel production in the dry region (up to c. 45% of the watershed in both cases).
The results for both study sites were similar. The impacts of climate change itself were an increase in erosion, of 28% in the Vez and 18% in the Xarrama, which still resulted in low erosion rates. However, the impacts of land-use change were much higher: an erosion increase of 529% in the Vez and 120% in the Xarrama, leading to important erosion rates in the new agricultural areas. Despite the different changes, which could be to a large degree attributed to the higher erosion rates usually found in vineyards, the conclusions in both sites point to the much higher impact of land-use management on soil erosion when compared with climate change.
These results highlight the fact that land-use management has a large potential to offset the impacts of climate change on erosion. On the other hand, the indirect impacts of climate change – potentially leading to changes in landcover and land management – could have much more important impacts on erosion than changes in climate itself. Therefore, future impact assessment studies should invest in creating realistic land-use scenarios with a similar attention to the one currently devoted to creating climate scenarios.