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Impacts of climate change on water balance, vegetation productivity and soil erosion in southern Portugal

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The impacts of a warmer and drier climate on water balance, vegetation productivity and soil erosion in southern Portugal, caused by global climate change, were evaluated using the SWAT ecohydrological model and the MEFIDIS event-based erosion model. The study focused on a humid region, occupied by vineyards, croplands and commercial pine/eucalyptus forests; and a semi-arid region, occupied by croplands and cork oak stands. SWAT was applied at the regional scale for several meso-scale watersheds, and MEFIDIS was applied to one catchment in each region. The scenario (PROMES regional climate model using the A2 CO_2 emissions scenario) points to higher temperature, lower rainfall (esp. in the dry season) and higher rainfall intensity during rain days; the scenario was used to create synthetic storms based on present-day measured rainfall events.

The results indicate that a decrease in rainfall would result mostly in a decrease in water yield (surface and subsurface runoff) and groundwater recharge, leaving effective evapotranspiration and wet season soil moisture close to present-day levels. The negative impacts of climate change (especially the increased length and severity of the summer dry season) could be counteracted by a shift in vegetation growth towards the wet season (thanks to less cold-season temperature stress days), combined with the positive impact of higher CO_2 concentrations; this would result in modest productivity increases for most vegetation types.

As for soil erosion, the simulation results indicate that the increase in vegetation cover is sufficient, in many cases, to decrease or counterbalance the impacts of increased storm intensity on soil erosion at all spatial scales, leading to lower erosion in the dry catchment and a modest increase in the humid catchment. Catchment sediment yield is noticeably more sensitive to the climate change scenarios than within-watershed soil erosion, mostly due to the impacts of changes to connectivity; and, within the watershed, impacts on soil erosion vary with landcover type, with croplands suffering the most negative impacts.