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Impacts of long-term erosion rates on Portuguese wheat croplands under future climate scenarios

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The Mediterranean drylands of southern Portugal have experienced centuries of agricultural exploitation and associated erosion processes, leading in many cases to degraded soils with low agricultural productivity. These conditions have been associated with ongoing desertification processes. Future climate conditions could accelerate these processes, due to increased winter rainfall intensity associated with less favorable conditions for vegetation development. This work explored scenarios of long-term erosion rates, and associated consequences for soil fertility, for winter wheat croplands in southern Portugal in the Loures mountain range (sub-humid climate, with relatively deep Cambisols) and the southwestern Guadiana basin (semi-arid climate, with relatively shallow Leptosols).
The impacts of climate change on hydrological processes, conditions for vegetation growth, and soil erosion rates were explored using the SWAT ecohydrological model. Eight synthetic climate change scenarios were created using a stochastic weather generator, creating an envelope which includes a large number of the climate change scenarios predicted for these regions for 2071-2100. The scenarios comprised temperature increases between 1.6 and 6.4 ºC and rainfall decreases between -2.5% and -40%. The impacts of predicted erosion rates for soil fertility in wheat croplands was then estimated using an empirical approach based on wheat rooting depth and present-day soil depth.
The results indicate that:
1) Wheat growth is expected to decrease by as much as 40% in the most extreme scenarios due solely to climate change.
2) Soil erosion in wheat croplands is expected to decrease in climate change scenarios with the lowest rainfall (-60%), increasing by as much as 150% in scenarios with the highest rainfall, although they are expected to remain relatively low (between 2 and 12 ton/ha.yr).
3) In the Loures study area, lower wheat productivity is expected to be caused mostly by climate change, with relatively few changes associated with erosion.
4) In the Guadiana study area, lower wheat productivity is expected to result from both climate change and soil erosion; soil erosion would dominate the impacts on productivity for low-magnitude climate changes, with the impact of climate becoming higher with the severity of the climate change scenario.