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Using a dynamic model to assess trends in land degradation by water erosion in Spanish Rangelands

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This work presents a model aimed at evaluating land degradation by water erosion in dehesas and montados of the Iberian Peninsula, that constitute valuable rangelands in the area. A multidisciplinary dynamic model was built including weather, biophysical and economic variables that reflect the main causes and processes affecting sheet erosion on hillsides of the study areas.

The model has two main and two derived purposes:
Purpose 1: Assessing the risk of degradation that a land-use system is running. Derived purpose 1: Early warning about land-use systems that are particularly threatened by degradation.
Purpose 2: Assessing the degree to which different factors would hasten degradation if they changed from the typical values they show at present. Derived purpose 2: Evaluating the role of human activities on degradation.

Model variables and parameters have been calibrated for a typical open woodland rangeland (dehesa or montado) defined along 22 working units selected from 10 representative farms and distributed throughout the Spanish region of Extremadura.

The model is the basis for a straightforward assessment methodology which is summarized by the three following points: i) The risk of losing a given amount of soil before a given number of years was specifically estimated as the percentage of 1000 simulations where such a loss occurs, being the simulations run under randomly-generated scenarios of rainfall amount and intensity and meat and supplemental feed market prices; ii) Statistics about the length of time that a given amount of soil takes to be lost were calculated over 1000 stochastic simulations run until year 1000, thereby ensuring that such amount of soil has been lost in all of the simulations, i.e. the total risk is 100%; iii) Exogenous factors potentially affecting degradation, mainly climatic and economic, were ranked in order of importance by means of a sensitivity analysis.

Particularly remarkable in terms of model performance is the major role played in our case study by two positive feedback loops in which the erosion rate is involved. Those loops are responsible for erosion to accelerate over time, thereby outweighing the effect of negative feedbacks also involved in the erosion rate.

The estimated lengths of time to loss the upper 5, 10, 15 and 20 cm of the soil (with and initial depth of 23.4 cm) corresponds to 138, 245, 317 and 360 years, respectively. The importance of climatic factors on soil removal considerably exceeds that of the economic ones, which showed low impacts on the final model results.