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Vulnerability of Mediterranean ecosystems to Climatic Change, study of soil degradation under different climatological conditions in an altitudinal transect in the south east of Spain

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Abstract

To investigate the potential response of soils to climatic change, measurements of soil physical and chemical properties were carried out during a year in a mountain zone in Alicante (Spain), along an altitudinal and climatological gradient. Hydrological properties (infiltration runoff and sediment concentration) were measured under winter and summer conditions. Chemical and physical soil properties were analyzed for reference soil profiles along the transect. The erosional response of the soils as well as soil properties like organic matter and CEC are found to be under the direct influence of the climate, and as a result they have to be considered as important factors in the desertification processes.

1. INTRODUCTION

To investigate the relationship of climate to the erosion hazard and soil degradation in the Mediterranean area, a climatological and altitudinal gradient in Alicante (Spain) was selected as a study zone. The criteria for the selection of the zone follow the approach used already by some authors [1-3] performing soil studies and experiments along climatological and altitudinal gradients, trying to isolate the impact of the Climatic Change on soil erosion. Two slopes (south and north facing) were selected at three sites situated within a zone of only 30 km and showing a high variation in the range of precipitation (Table 1). The lithology is uniform for the three sites: Upper Cretaceous limestone. The study slopes have had an intensive land use in the past: abandoned agricultural terraces appear in Benidorm (BE) and Callosa (CS) (the lowest and intermediate site, respectively) and signs of grazing and forest fires appear in Cocoll (CC) (the highest site in the gradient).

The objective of this work is to determine the changes in properties and erosional response of the soil caused by climate. The experimental design of the field work, extensively explained in other papers [3,4], was as follows: Rainfall simulation experiments were carried out on the six slopes in winter and in summer using a rainfall simulator producing rain at 55 mmh^{-1} of intensity and during one hour. Several soil profiles were taken along each slope and described in the field. Texture, organic matter, the EC and CEC were sampled and analyzed in the

laboratory. This paper summarizes some of the findings of this research, that will be described in detail elsewhere.

Table 1
Main characteristics of the study zones

Location	Lithology	Vegetation series	Aspect (degrees)	Altitude (meters)	Slope (degrees)	Average precipitation
Benidorm	Upper Cretaceous limestone	*Chamaeropo-Rhamnetum lyciodes*	N 75 S 210	74-90 74-106	15 20	350 mm
Callosa	Upper Cretaceous limestone	*Querco-cocciferae-Pistacietum lentisci*	N 10 S 240	280-360 282-344	25 30	550 mm
Cocoll	Upper Cretaceous limestone	*Rubio-longifoliae quercetum*	N 10 S 120	994-1026 850-910	20 18	850 mm

2. SOIL HYDROLOGICAL PROPERTIES

In general, runoff production in summer shows an inverse trend with increasing altitude, a higher runoff is found at the lowest site and a lower runoff at the highest one (Figure 1).

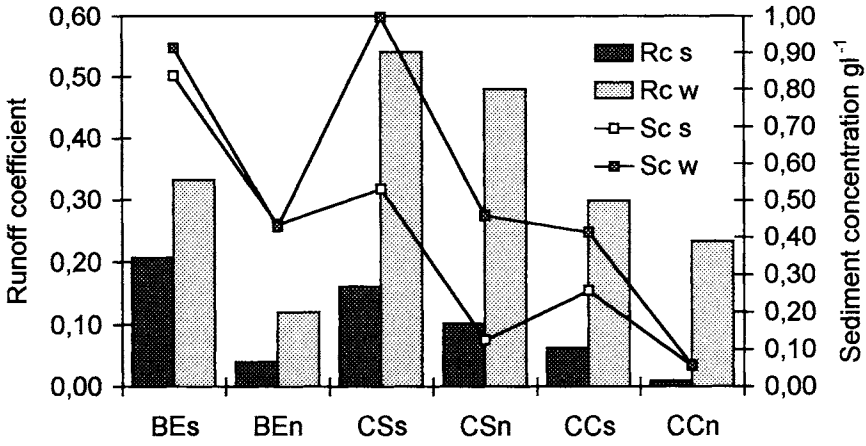

Figure 1: Runoff coefficients and sediment concentration in summer (s) and winter (w) (BE: Benidorm, CS: Callosa, CC: Cocoll, n: north slope, s: south slope)

In the case of Benidorm, the infiltration capacity is limited by the presence of a crust which generates more runoff and. However, the runoff production in winter does not follow clearly the altitudinal and climatological gradient, as shown also in Figure 1. Callosa, the intermediate site, shows the most runoff in winter due probably to the combined effect of a high soil moisture content at the time of the experiments and a high percentage of stones at soil surface. Looking at the slope aspect, the runoff coefficients and the sediment concentration (understood as an indicators of the soil erosion), were found always to be higher at the south facing slopes, in summer and in winter (Figure 1). South slopes present, in general, more degraded soil conditions and lower values of soil moisture content.

3. CHEMICAL AND PHYSICAL SOIL PROPERTIES

The results obtained demonstrate that there are several soil parameters which show a trend following the climatological gradient. At the most arid site (Benidorm) the soils are shallow and poorly developed (lithic Leptosol) while in the more humid areas (Callosa and Cocoll, respectively) better developed soils can be found (lithic Leptosol, haplic Calcisol and chromic Luvisol). The maximum contents in organic matter, clay percentage and CEC values occur at the highest site: upwards along the transect. Considering aspect, the maximum values are always found on the north facing slopes.

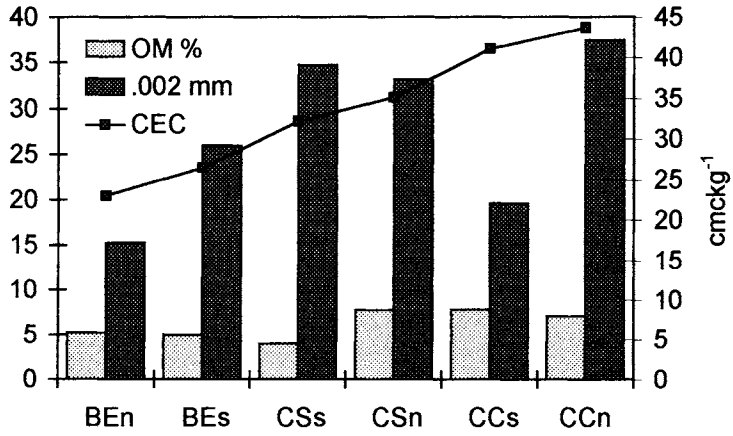

Figure 2. Organic matter, clay content and CEC (BE: Benidorm, CS: Callosa, CC: Cocoll, n: north slope, s: south slope)

4. DISCUSSION AND CONCLUSIONS

The runoff and the sediment concentration values obtained from the rainfall simulation experiments are, in general, very low. But, paying attention to the differences between the three zones, the hazard of erosion of the soils is found to be higher when the climatological conditions become more arid and under dry soil conditions (summer). Under wet soil

conditions (winter) the runoff coefficients and the sediment concentration are higher in the intermediate site (Callosa), but this result coincides with the high soil moisture conditions in the soil at the moment of the winter experiments. For the south facing slopes the sediment concentrations and the runoff coefficients decrease upwards along the transect.

Among the studied soil properties only the organic matter content, the clay content, and as a consequence of that the CEC, increases upwards along the transect while the electrical conductivity decreases .

When the climatological conditions are less favourable (more dry) and the soils less well developed, the rate and the spatial variability, of parameters such as the runoff coefficient, sediment concentration and erosion rate, increases. With more favourable climatological conditions (in the case of Cocoll) the soils show better physical and chemical characteristics, with very low runoff coefficients and sediment concentrations. In the case of Callosa (an intermediate situation), the soils can have high runoff coefficients and sediment concentrations when they are very wet, but lower values when they are dry.

In general the soils are more fertile and less erodible when the climatological conditions become more humid. Even on the smaller scale of the difference in micro climate between south and north slope there is found in general a better developed vegetation cover and soil properties as well as less erodible soils on the north slopes.

4. ACKNOWLEDGMENT

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