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MAPPING SENSITIVITY TO LAND DEGRADATION IN EXTREMADURA. SW SPAIN

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INTRODUCTION

Land degradation represent a remarkable phenomenon which is widespread over large areas of the world where soils has suffered from a loss of biological production and resilience caused by both, natural and anthropogenic factors. The need to assess sustainable use of the lands requires the degradation issue and risks associated to be addressed by proper methods according to the locally dominant degradation-related processes. It is important to identify and describe the driving forces leading to land degradation in order to properly understand the phenomenon at a local scale.

An environmental sensitive area to degradation (ESA) could be considered as a spatially delimited area in which some key aspects related to its sustainability are unbalanced and not sustainable for a particular environment.

The main goal of this work is to identify places with different environmental sensitivity to land degradation in Extremadura (SW Spain) by means of a modelling approach developed in the European Commission funded MEDALUS project (Mediterranean Desertification and Land Use) which identifies such areas on the basis of an index (Environmental Sensitive Area index, ESA index) in which environmental quality (climate, vegetation, soil) as well as anthropogenic factors (management) are incorporated and mapped.

STUDY AREA:

The study area correspond to the region of Extremadura, SW Spain. Most of the region (350 m of average high) is made up of vast stretches of undulating to flat peneplains and river depressions made on old schist and graywaques as well as geologically more recent alluvial deposits. Reliefs of quartzite and granite dominate the three main mountain ranges that intersect over the undulating plains. Climate is Mediterranean semiarid to dry subhumid with some oceanic influence.

METHODS:

A geographical information system methodological approach has been taken in the study. A set of key elements related with land degradation assessed by means of several associated parameters were considered when selecting the GIS layers for the investigation of environmental sensitivity. Most of the parameters can be easily obtained from databases and thematic cartography at different scales, and others produced *ex nova* to the study. Each of those elements was assessed by computing a quality index resulting from averaging several variable parameters for soil, climate, vegetation and management respectively (Table I).

Computation of the four abovementioned quality index and the final ESA index was made as described below:

SQI (Soil Quality Index) = (Parent material * Texture * Soil depth * Slope * Drainage capacity) $^{1/4}$

CQI (Climate Quality Index) = (Total annual precipitation * aridity * aspect) $^{1/3}$

VQI (Vegetation Quality Index) = (Fire risk * Erosion protection * Draught resistance * Soil cover) $^{1/4}$

MQI (Management Quality Index) = (Land use intensity * Management policy) $^{1/2}$

ESA index = (SQI * CQI * VQI * MQI) $^{1/4}$

The final map of sensitivity was obtained partitioning the ESA index into four classes of sensitivity values, ordered attending to their degree of sensitivity as: non affected, N; potentially affected, P; fragile, F; and critical, C. Critical and fragile areas were further subdivided again in three classes ranging from 3 (high) to 2 (medium) and 1 (low sensitivity), i.e. C3, C2, C1 and F3, F2, F1.

In order to test de reliability of the map of sensitivity obtained, an analysis was carried out by which the class of sensitivity obtained was related with data gathered from an independent data base. The data consisted on filed data about six variables of taklen fron the Spanish National Inventory of Soil Erosion: Soil covered by woody vegetation, sheet erosion, bulk density, and total organic matter. Spearman R correlations were calculated between the independent variables and the classes of sensitivity.

RESULTS:

Most of the region (67%) belongs to any of the highest classes of sensitivity, i.e. the critical classes (C1, C2 and C3); 29% to any of the fragile areas (F1, F2 and F3) and 3% to potential areas. Only 1% of the study area was considered not sensible. C2 class dominates 43% of the total surface of the study area, while C1 and C3 accounted for 15% and 13.2% respectively. Among the fragile areas, 14% belongs to F3 class, 10% to F2 and 3% to F1.

Distributions of the values of sensitivity over the study region are clearly related with its general physiographic characteristics, which plays a strong determining role on the configuration of many of the elements and parameters used to build the model. Critical and fragile areas show the lower qualities for the different index, while potential and non affected areas are higher, observing a clear decreasing trend between the critical and non affected areas for each index, except for climate, where quality decreased from the potential to the non affected areas.

Based on the data obtained by the Spearman Correlations as described in methods, a good coherence was found between the observed and expected correlations for the different variables. Correlation was statistically significant ($p<0.01$) to all four variables. In addition, the sign (positive or negative) of the correlations were coherent with the sign expected, which implies, at least at the stage of the work, that the classes of ESA performed and mapped correctly respond to the field data, that is, the observed soil degradation.

Some work still remains to be carried out to asses the reliability of the map of eight classes of sensitivity and to refine the values of ESA assigned to the different classes of sensitivity, as well as test the performance of the maps with other filed data related with soil degradation processes.

Table I
TYPE, SCALE AND SOURCE OF THE PARAMETERS USED AS THEMATIC LAYERS FOR THE CALCULATION OF SOIL (SQI), CLIMATE (CQI), VEGETATION (VQI) AND MANAGEMENT (MQI) QUALITY INDEX.

	Parameter type	Scale	Source
SQI	Soil Texture	1:250,000	Soil Maps. Departamento de Agrobiología y Edafología. CSIC. Spain
	Soil depth	1:250,000	Soil Maps. Departamento de Agrobiología y Edafología. CSIC. Spain
	Parent materiall	1:250,000	Soil Maps. Departamento de Agrobiología y Edafología. CSIC. Geological maps (MAGNA). Instituto Geológico y Minero. Spain.
	Drainage capacity	1:250,000	Soil Maps. Departamento de Agrobiología y Edafología. CSIC. Spain
	Slope	Raster 25x25 m pixel size	Classification from MDT of 25 m hypsometric equidistance)
CQI	Bagnouls Gaussen Aridity Index	Raster 25x25 m pixel size	Digital Climatic Atlas of the Iberian Peninsula (Ninyerola et al, 2005)
	Total anual precipitation	Raster 25x25 m pixel size	Digital Climatic Atlas of the Iberian Peninsula (Ninyerola et al, 2005)
	Aspect	Raster 25x25 m pixel size	Digital Climatic Atlas of the Iberian Peninsula (Ninyerola et al, 2005)
VQI	Fire risk	1:100,000	CORINE Land Cover 2000 revised with the National Forest Inventory of Spain
	Erosion protection	1:100,000	CORINE Land Cover 2000 revised with the National Forest Inventory of Spain
	Drought resistance	1:100,000	CORINE Land Cover 2000 revised with the National Forest Inventory of Spain
	Plant cover	1:100,000	CORINE Land Cover 2000 revised with the National Forest Inventory of Spain
MQI	Main land use intensity	1:100,000	Reclassification of croplands, pastures, natural areas, mining areas and recreation areas from the CORINE Land Cover 2000.
	Management policies (protected areas)	1:100,000	Thematic maps and information from the regional administration