Mapping of erosion risks in Serra de Grândola (Portugal)

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European Geosciences Union
General Assembly 2012
Vienna | Austria | 22 – 27 April 2012

Introduction

Soil erosion processes can pose environmental risks to people and economical activities (Fig. 1). Information and a better knowledge of the genesis of these processes is important for environmental planning, since it allows to model, quantify and classify risks, what can mitigate the threats. The objective of this research is to assess soil erosion risks in Serra de Grândola (central Portugal).

Figure 1. Effects of erosion processes (Santo André, Santiago do Cacém).

Study area

The study area (675 km²) includes the councils of Grândola, Santiago do Cacém and Sines (southern Portugal; Fig. 2). The principal geomorphological unit is the Serra de Grândola, with an altitude of 383 m, distributed along a N-S axis.

Methodology

The process for mapping erosive status was based on the guidelines for measuring and mapping rainfall induced soil erosion processes in Mediterranean coastal areas, proposed by PAP/RAC (1997), developed and later modified by other authors in different areas (Fig. 3). This method is based on the application of a geographic information system that integrates different types of spatial information such as digital elevation and other derived models. Erosive status are classified using information from soil erodibility, slope, land use and vegetation cover.

Figure 2. Study area.

The rainfall erosivity map was obtained using the modified Fournier index, calculated from the mean monthly rainfall, as recorded in 33 meteorological stations with influence in the study area. Finally, the soil erosion risk map was designed by ovelaying the erosive status map and the rainfall erosivity map

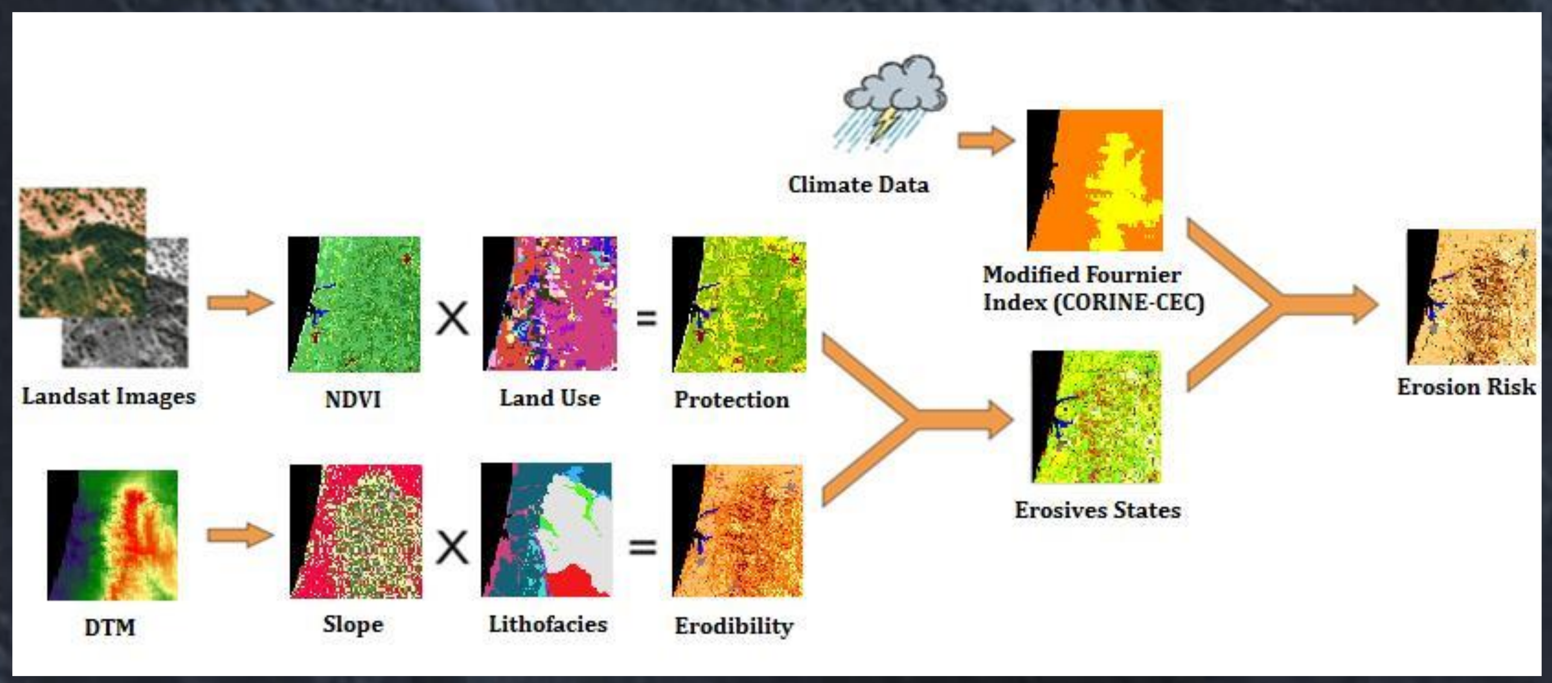

Figure 3. Work methodology.

Results

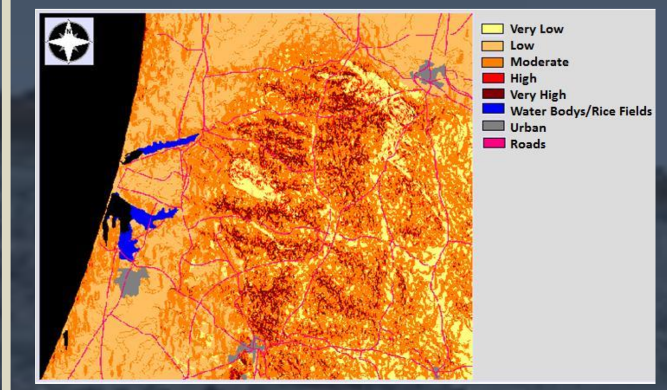

Figure 4. Soil erodibility map (litofacies × slope).

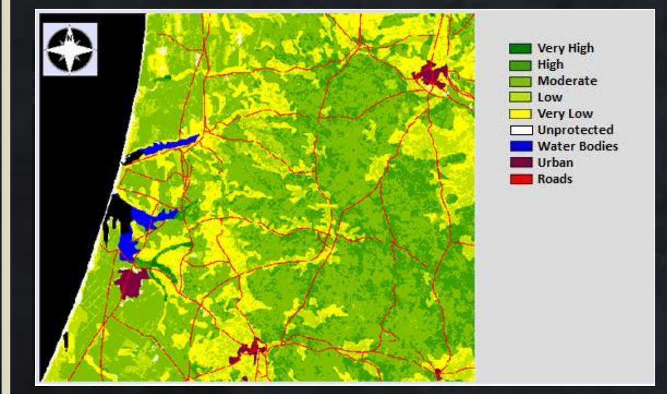

Figure 5. Soil protection map obtained by overlapping data from land use (CORINE Land Cover) and vegetation cover (calculated from Landsat NDVI data).

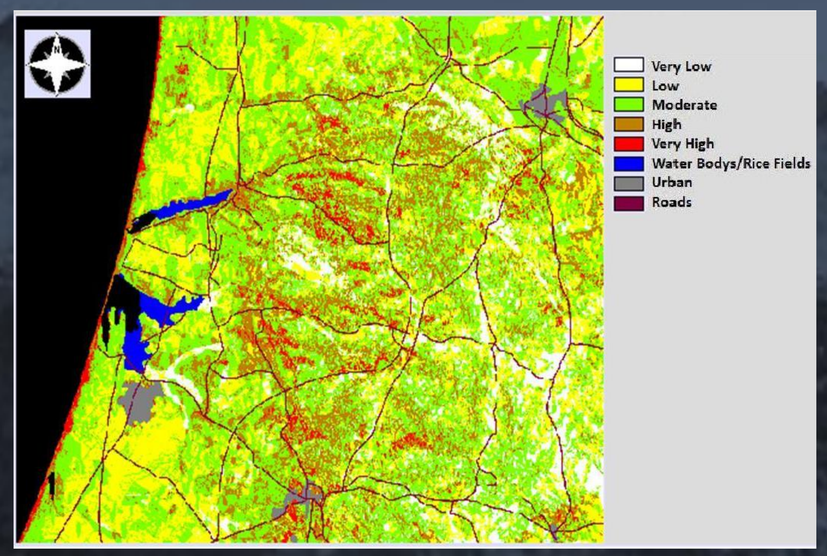

Figure 6. Erosive status.

Table 1. Description of erosive status.

Erosive status	Area	Slope	Soil/lithofacies	Land Cover
Very Low	10%	0-3%	Schists, phyllites, silltites, quartzites and formation of Mira	Hardwood forest
			Dunes	Permanently irrigated land
Low	28%	0-3%	Sand, sandstone and gravel	Coniferous forest
		3-16%	Formation of Mira and Mértola	Hardwood forest
Moderate	44 %	3-16%	Sand, sandstone , gravel and dunes	Coniferous forest
			Formation of Mira and Mértola	Hardwood forest
High	16%	3-16%	Limestone, dolomite, sand, sandstone gravel and dunes	Cultures /systems parcelares complex / non-irrigated arable land
		16-31%	Formation of Mira and Mértola	Hardwood forest/agro forestry
Very High	3%	21-31%	Limestone, dolomite, sand, sandstone gravel and dunes	Non-irrigated arable land/ forest or shrub vegetation transition/beaches
			Formation of Mira and Mértola	Agroforestry

Rainfall distribution, which is highly variable in space and time, is sometimes difficult to study due to the lack of good quality data (e.g., insufficient or poorly-distributed weather stations; non-homogeneous rainfall data series; dubious readings from non-automated gauges; lack of radar coverage, etc.). This lack of data (Fig. 7) may be partially addressed by climate data which are directly related to the rainfall (e.g., solar radiation) and other parameters, such as curvature, slope and aspect, which influence local climate, obtainable from DTM.

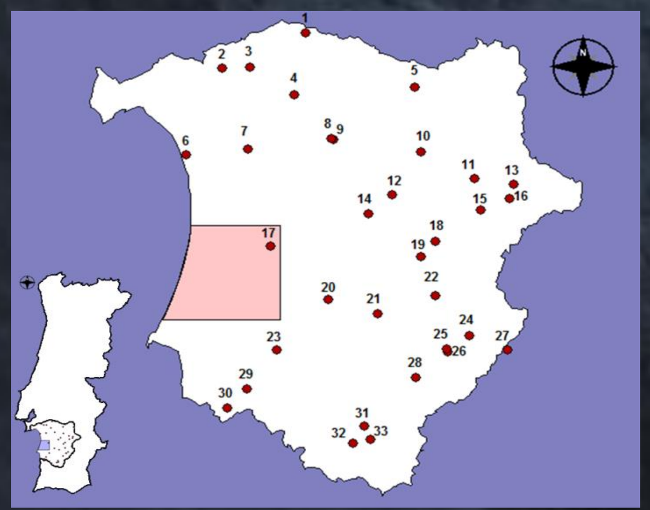

Figure 7. Spatial distribution of the 33 meteorological stations

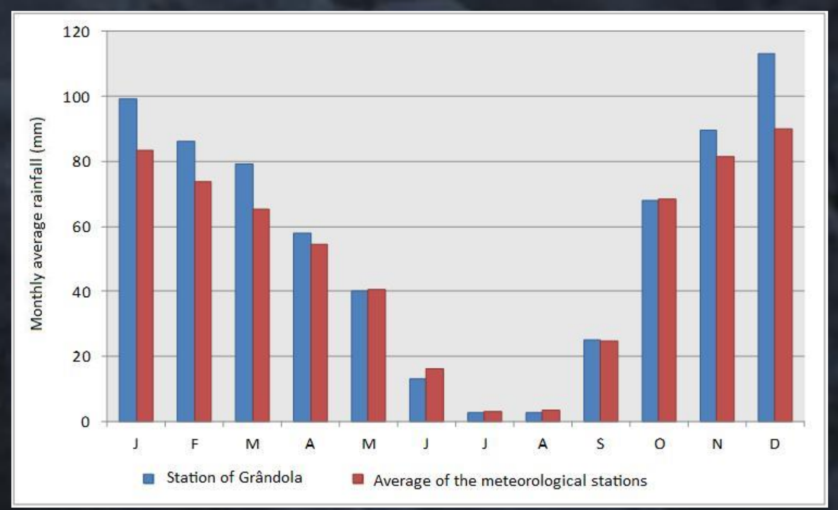

Figure 8. Average monthly rainfall of the meteorological station Grândola Vs monthly average of 33 meteorological stations..

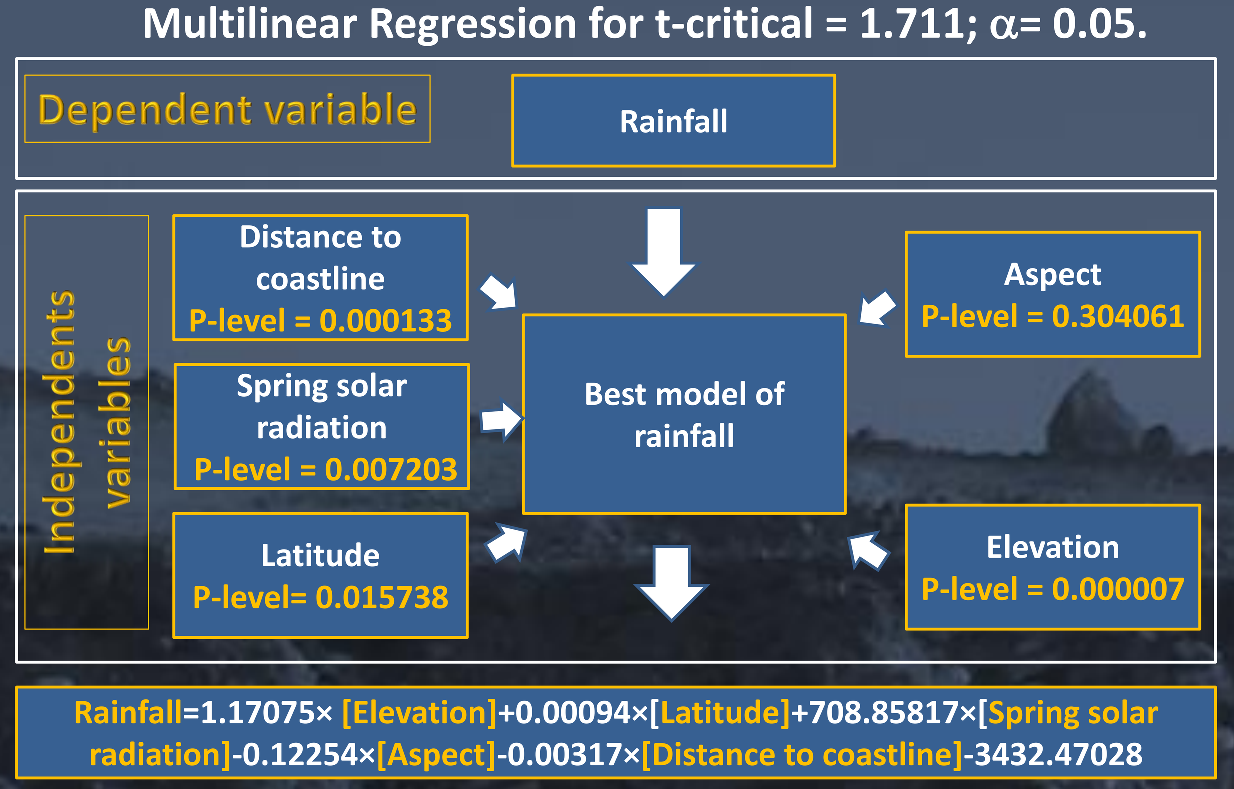

Figure 9. Model of multilinear regression for rainfall.

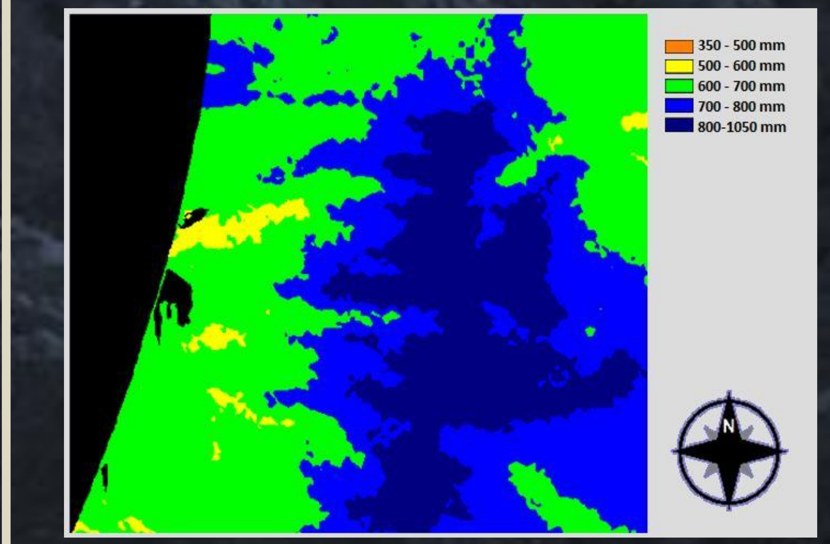

Figure 10. Digital rainfall model.

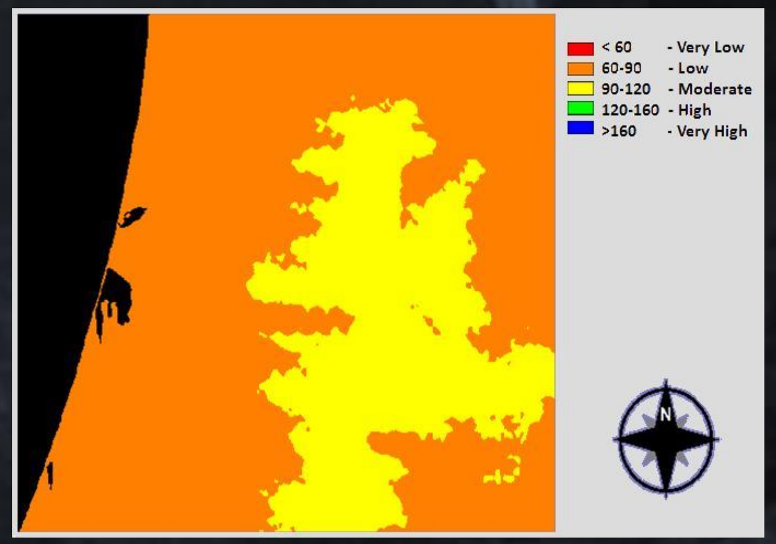

Figure 11. Digital model for the modified Fournier index.

The model for the modified Fournier index (MFI) in the study area was obtained by linear regression, with rainfall as the independent variable (for t-critical = 1701, α= 0.05): MFI= 0.11939 × Rainfall - 2.51558

The model obtained was reclassified in accordance with Corine CEC (1992).

The zone more favorable to erosion is along the coast and highlands. The coastline consists mainly of cliffs with material no-cohesive (sand gravel). In the mountains the material is more resistant (Flysh formations) but the amount of rainfall is greater and the steep slopes favor soil erosion processes.

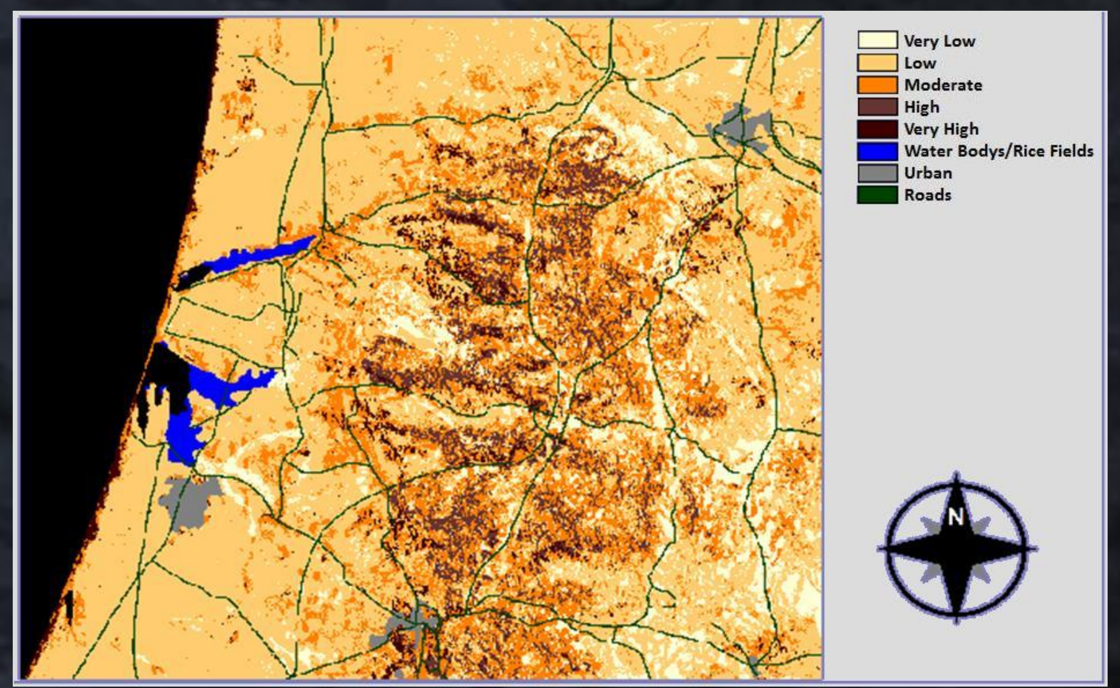

Figure 12. Model of erosion risk.