Mapping and classification of geoforms in Serra de Grândola (Alentejo, SW Portugal)

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1 Introduction

The study of geomorphic processes is a key point for the development and sustainable land use management. Land use may induce risks that represent threats to environment and human activities. Thus, the study of the geomorphological environment is important to find tools that can mitigate such threats. In the last few decades, geographic information systems (GIS) have become an essential tool for environmental management (Isidoro *et al*, 2012).

The integration of digital terrain models (DTM) in GIS has contributed to improve environmental studies. DTMs are a support for modelling geoforms (terrain units resultant from climate and other natural processes and their interactions with the Earth's surface). The objective of this research is to study the geoforms from the Serra de Grândola area (Alentejo, SouthWest, Portugal), (Fig.1) classified according to their most important physical and structural differences.

Figure 1. Study area.

2 Methods

The methodology is based in hierarchical criteria by Hammond (1964), and in the geographical information related to smooth-slopes, local relief and terrain profiles . The Digital Elevation Model (DEM) has been used as a basic source of information was obtained from a geostatistical study with a resolution of 10×10 m^2, which was based on map information at scale 1:25,000 from the Geographical Institute of the Portuguese Army (Fig.2).

For each pixel from the DEM different terrain variables were determined using the "moving window" technique, with a size of 4900 m^2 (a squared matrix with 7×7 pixels), in particular the slope, the local relief and relative position. Finally, the automatic classification of relief was carried out.

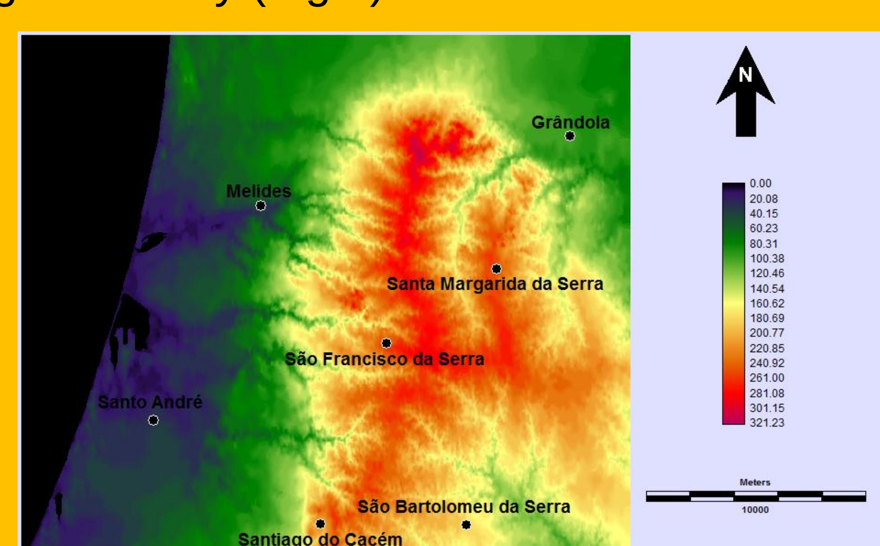

Figure 2. Digital elevation model

Smooth slope map

The slope of the hillside influences directly the velocity of runoff and the resistance of soil to erosion. The calculation of a cell slope (l,k) is based on the cell resolution (E) and the values (H) of the immediate neighbouring cells to the top, bottom, left and right of the cell in question. The slope is calculated as the resultant vector of the slope in X and the slope in Y.

$$\delta_{(l,k)} = \sqrt{\left(\frac{H(l,k+1)-H(l,k-1)}{2E}\right)^2 + \left(\frac{H(l-1,k)-H(l+1,k)}{2E}\right)^2}$$

Based on the slope map, the smooth slope map was created. For each window was determined a percentage of smooth slope (considered below 4%), and that value was assigned to the central pixel of the window. After this process, the map was reclassified in four classes.

Local relief

The local relief can be expressed as the vertical difference between the highest point and the lowest point, of a surface limited by the analysis window.

Relative position

The relative position counts the percentage of gentle slopes in uplands and lowlands. A land is classified as up or low, when presenting an upper or lower elevation, respectively, to mean elevation in a determined area of analysis.

3 Results

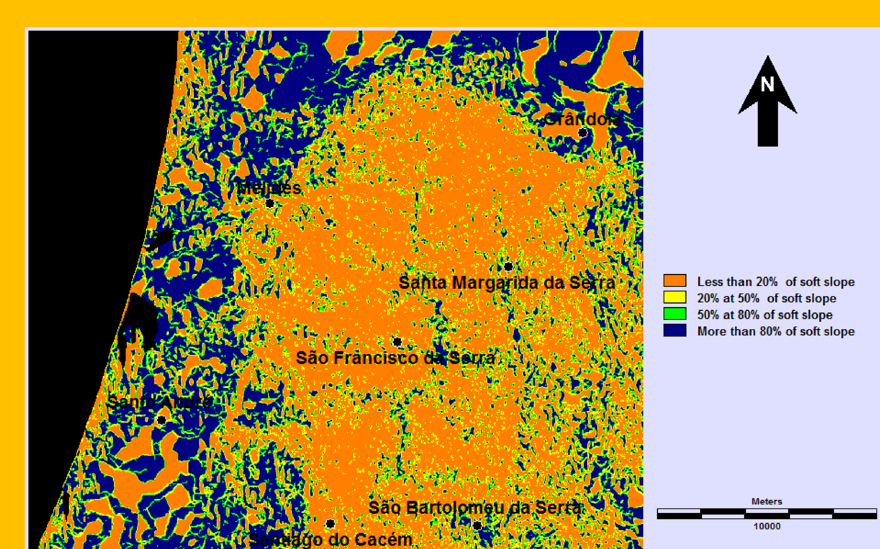

Figure 3. Map of smooth slopes.

Table 1. Smooth slopes occupation

Percentage of smooth slope	Area (%)
More than 80%	32.6
50% at 80%	14.1
20% at 50%	11.4
Less than 20%	41.9

Table 2. Local relief occupation

Class (m)	Relief classification	Area (%)
0-15	Very smooth	25.6
15-30	Smooth	26.3
30-60	Localized	35.2
60-90	Moderate	11.5
90-150	Rough	1.3

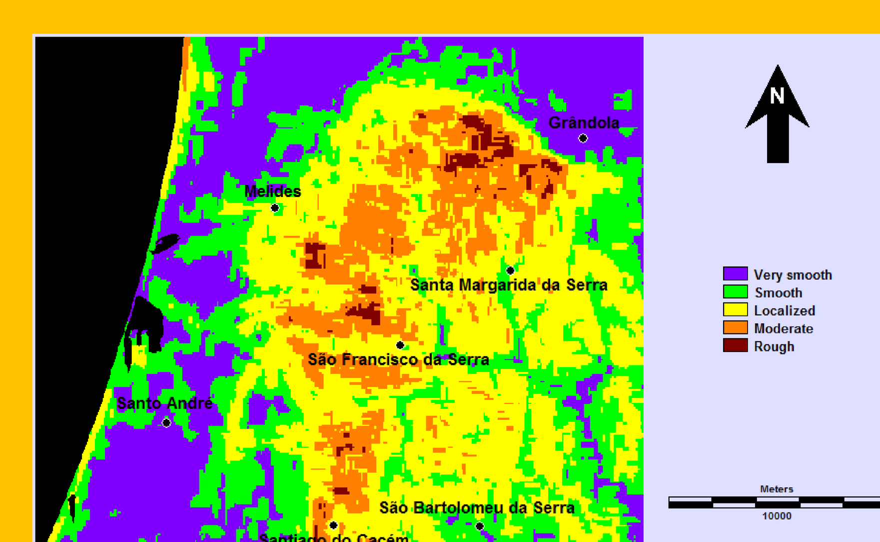

Figure 4. Map of local relief.

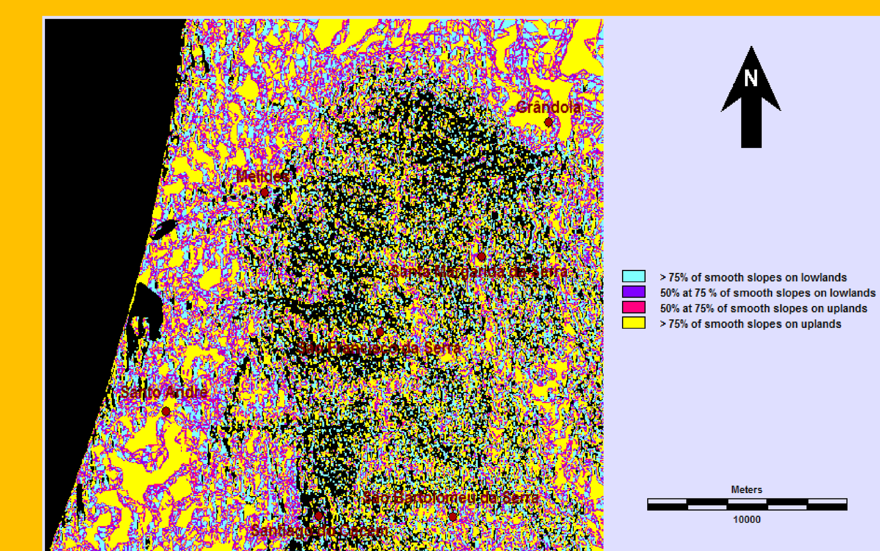

Figure 5. Map of relative position.

Table 3 Relative position.

Relative position	Area (%)
> 75% of smooth slopes on lowlands	26.6
50% at 75 % of smooth slopes on lowlands	15.2
50% at 75 % of smooth slopes on uplands	15.6
> 75% of smooth slopes on uplands	42.7

4 Conclusions

The map of landforms was constructed by crossing three levels of information: smooth slope areas (areas with slope < 4%), local relief and relative position. The five main forms considered were: plains, plateaus, plains with hills, and open hills. In turn, these classes were divided into twenty sub-classes. As can be seen, the plains cover most the study area (46.7%), mainly on areas near the coast and around Serra de Grândola. In the hills are also seen flat areas due of the existence of eroded surfaces. The hills are the second class of the highest representation (41.9%), distributed on littoral and highlands (Fig. 6).

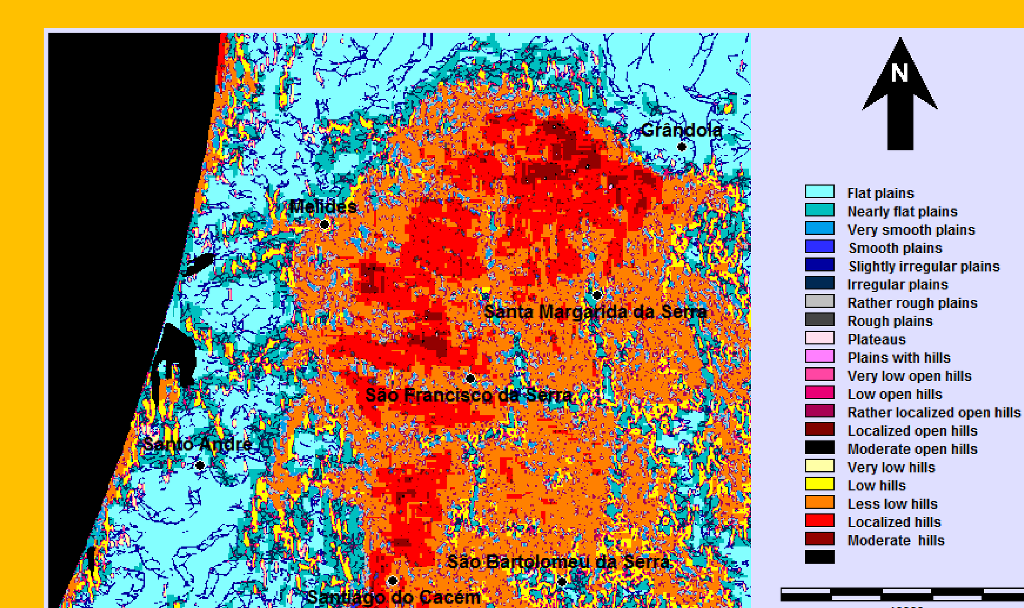

Figure 6. Map of geoforms.

5 References

Hammond, E.H. 1964. Classes of landsurface form in the forty-eight states, USA. Annals of the Association of American Geographers, Map Supplement 54.

Isidoro, J.M., Fernandez, H.M., Martins, F.M., de Lima, J.L. 2012. GIS-Based Models as Tools for Environmental Issues: Applications in the South of Portugal. In: Bateira, C. (Ed.), Cartography - A Tool for Spatial Analysis. InTech, Porto. Pp. 252-276.