



Geographical Information Technology to support research on forest fires and soil erosion

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Introduction

The RECOVER (Immediate Soil Management Strategy for Recovery after Forest Fires) project aims to develop mitigation techniques and strategies to reduce soil and water degradation immediately after forest fires. Forest fires are becoming increasingly frequent as a result of climate variability, socio-economic change, and unsuitable forest planning, with adverse impacts on soil fertility and structure. One of the most important is the erosion of the top soil layers, where the 'nutrient pool' of the majority of Portuguese soils is located (Bento Gonçalves *et al.*, 2008). This nutrient mobilization happens during the first autumn rainfall events, and therefore sediment and nutrient exportation typically occurs in the first 4/6 months after a fire. The speed at which nutrient loss occurs and the extension of forest fires, tend to limit, in terms of costs and logistics, the solutions that can be taken to reduce soil and water degradation.

RECOVER presents an innovative approach based on field surveys of soil and vegetation properties following forest fires, which will be used to create a GIS database from which the critical spots will be identified.

The implementation of an integrated information system (integrating a spatial database, a map server and GIS software) will allow us to store the data collected in the field as well as the information produced through the spatial analysis. This information will be available in a web-GIS portal, accompanied by information for producers and all other agents involved in forest management.

Objectives

The aim of this work is to present the methodology applied in the implementation of an integrated information system (a Spatial Data Infrastructure) with GIS technology which can support the research on soil erosion mitigation techniques after forest fires.

The main objective is to produce a tool, based on Geographical Information Technology that is able to store all the data gathered throughout the project which is necessary to develop and implement spatial analysis processes that allow us to identify the critical spots where erosion mitigation techniques should be applied. The ultimate goal is to allow those with responsibilities in managing scorched areas to identify the critical areas where

interventions must be made to obtain the best conservation results at the lowest price. This will have a significant impact on soil conservation, vegetation recover, and, therefore, on the functioning of the ecosystem.

Methodology

Since the start of the project (2007) and during the years of 2007 and 2008, there were no large or high intensity forest fires in central Portugal. These were a necessary condition for the normal development of this project. To overcome this problem, the solution was to choose an area monitored for a long time: Vale Torto catchment (Penedos de Góis) in Açor Mountain. It's a small (8,9 ha) schist and quartzite catchment, covered by shrubs and located in the municipality of Góis, Coimbra.

The project includes an initial phase of collecting and processing information related to the variables identified for the study and defining the data model to implement and organize the spatial database.

The survey of the study area (Fig. 1) allowed for the three-dimensional modeling of the area and the establishment of a surface runoff/flow modeling.

Also the characterization of land use and soil components (structure, texture, moisture, porosity, etc.), at the slope scale, as well as the analysis of the forest fires factors (intensity, recurrence...), will be used and integrated in the geographic database, allowing for the definition of the variables required in an erosion risk model.

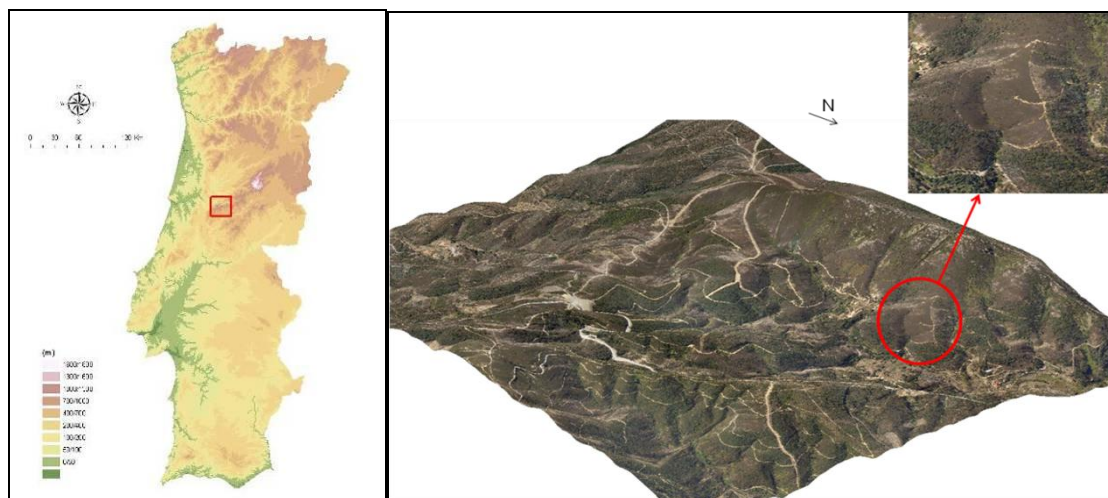


Figure 1. Study area – Vale Torto (Penedos de Góis) in Açor Mountain

Results

The modeling process of the environmental variables has been developed following the need to make explicit its spatial component. Thus, the integration of GIS technology was preferred due to its ability to integrate such models, as well as its efficiency in managing and analyzing large amounts of information and, above all, for its capacity to relate the information based on their spatial expression.

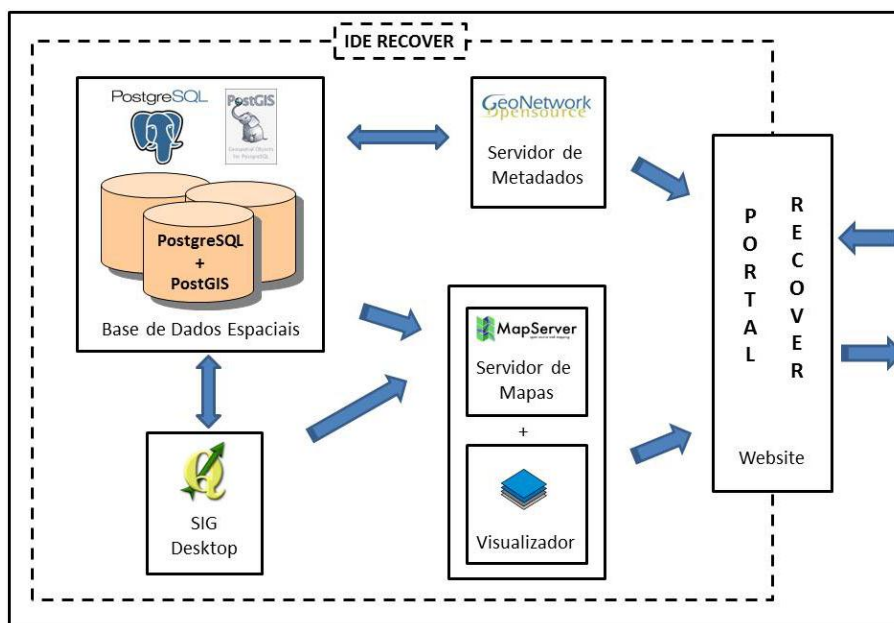
Given the intimate relationship between geomorphological processes and the area in which they are triggered, we consider it appropriate to apply the methodologies of modeling provided by GIS spatial analysis of erosion processes operated in the aftermath of forest fires.

Thus, following the installation and monitoring of erosion plots in various sectors of the slope in the mountain areas occupied with production forest in central Portugal, a wide

range of information concerning several parameters which combine to the genesis of the erosive geomorphological dynamic was produced.

The organization and analysis of the collected data was made based on the implementation of an SDI.

The implementation of an SDI (fig. 2) on such a subject implies the involvement of several components of GIT (Geographic Information Technologies). First of all, it is fundamental to integrate a Spatial Database that allows the storage of a large volume of the spatial data and the alphanumeric data gathered in the field or information acquired from official institutions. This spatial database allows us to implement spatial analysis tools (within the GIS) and integrate and disseminate the outputs through Web GIS solutions. This SDI makes the delivery of project results and its dissemination to the general public easy.



Source: Vieira *et al.*, 2009
Figure 2. Structure of the SDI-RECOVER

Although complex, the structuring of the specific data collected in the spatial database (fig. 3) was essential for the adequate functioning and access by the GIS software. The need for correct integration of the several GIS technologies forced us to establish some SDI principles and components, based on international and national regulations and patterns, namely institutional and normative structure, technology, data policy, data and metadata structure, and web-services.

To implement these web-services the integration of a map server, that will make available the outputs produced through the project, was fundamental.

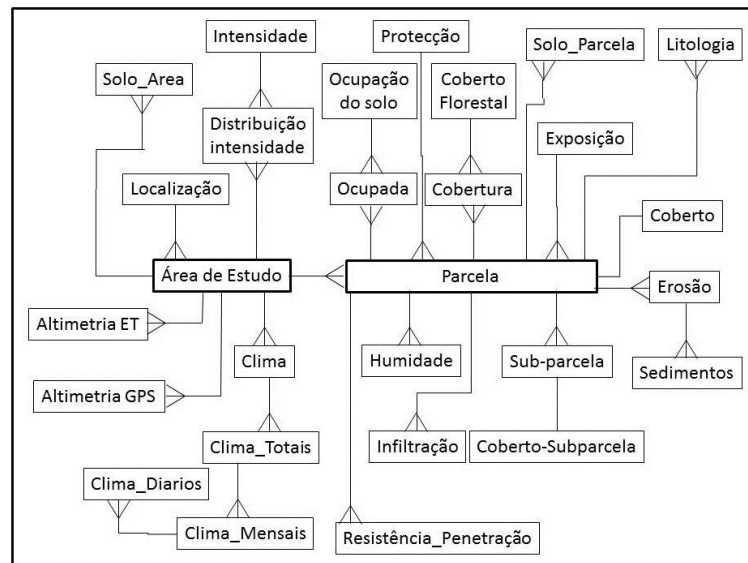


Figure 3. Database model (EAR)

But the key-feature of this SDI and the fundamental tool for the project success is the GIS software, in which we will integrate the modeling process to identify the critical areas for intervention.

In this sense, the development process of modeling the variables will allow for the measurement of possible interrelationships between them and the definition of behavior standards that can lead us to predict those processes in order to determine the validity and effectiveness of the mitigating techniques implemented during the project.

The implementation of the modeling process, conducted with the use of geographic information systems (GIS) technology, will be based on the information gathered, its validity, and reliability, which is stored and structured in a database integrated in the GIS. The results will be available through a web-GIS portal with available web-services (WMS, WFS, WCS, 'Gazetteer Service', CSW).

Conclusions

The information included in the geographic database will develop a variety of modeling operations, initially directed at the study plots, leading afterwards to the development of predictive scenarios. The modeling results will then be generalized to the shed in order to ascertain the validity of extrapolating data and the ability to produce useful indicators of general trends for the decisions on the proper techniques to mitigate erosion of scorched areas.

This spatial database will be a key component of the Integrated Information System, which, at a later stage, will be complemented with a component of spatial analysis (GIS desktop, to develop the processes of data modeling) and a spatial data server, allowing for the implementation of a Web-GIS that will provide the results obtained on the Internet.

Thus, one can draw a reliable structure to store, analyze, and disseminate spatial and alphanumeric data, which is available project RECOVER the web portal, and which integrates GIS technologies for the effective presentation of the spatial information produced.

IDE are valuable tools to numerous public and private institutions worldwide, allowing access to various and valuable information, and providing assistance in the decision-making process.



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