ANALYSIS OF SLOPE TO STUDY EROSION

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Abstract
Erosion is a problem that produces an important impact on landscape and especially in agricultural zones. This process is accentuated because of the effects of meteorological factors, agricultural machinery and the slope of the land; it favours the appearance of run-offs that drag vegetal cover being this one necessary to protect the ground from the erosion. Different methods exist to evaluate the losses of ground that causes the erosion. Some of them are qualitative other are quantitative. The topographic properties of the land, like the slope, the type of crop, the agricultural management, as well as the weather in the zone, they all are factors that determine the study and the parameters to be evaluated in order to obtain conclusions about the erosion that is taking place in a property. However, despite the methodology or parameters to use, it is evident that it is needed to work with spatial data to quantify the change that takes place. In this work we analyse the effects of erosion in a property of olive orchards with variable slope. The digital elevations models (DEMs) appear as a fundamental tool for studying erosion. Collected data from the zone of study in different campaigns are used to determine possible variations in the orography of the land. The aim part of this study is to analyze the variation of the slope in each epoch. A work of these characteristics as much requires precision and reliability in the stages of taking data of field as in the phases of treatment and management the information, so such data will be integrated in a GIS so that it allows to interrelate all data, to modelling them, to interpolate and to extrapolate information as well as the possibility of visualising the possible environmental changes that it could take place.

1. – INTRODUCTION

It is well known the great potential of GISs to manage spatial and alphanumerically information. They allow us to interconnect variables of different nature. Nevertheless, the main interest of GIS is not only in the capacity to manage data but in the possibility of updating these data permanently. So, it can make a continuous pursuit of a phenomenon being able to infer behaviour models [Laurini, 1999]. In environmental studies which analyse the spatial variation of landscape, therefore it is needed and special manage and treat of data in order to obtain high quality results to be able to interpolate and extrapolate future performances. A fundamental aspect when it works with spatial variables is the scientific visualisation, that will allow to check the evolution of the phenomenon.

Erosion is a problem that produces more and more impact on landscape and especially in agricultural zones. This process is accentuated by the effects of meteorological factors, agricultural machinery and the slope of the land; it helps the appearance of run-offs that drag vegetal cover being this one necessary to protect the ground from the erosion. Different methods exist to evaluate the losses of ground that causes the erosion. Some of them are qualitative others are quantitative. The use of traditional plough techniques hastens erosion in olive orchards. Nevertheless this is not the only cause. Climatic changes increase this process in sloped zones. Sometimes, according to the rainfall, loss of landcover causes important erosive process because the land becomes waterproof. So, rain water does not leak in terrain causing drought. The main consequence of this situation is the deformation of terrain. It requires an analysis of the variation of the topography of the land studying how the main erosive agents act.

In this work we analyse the effects of erosion in a property of olive orchards placed in a variable sloped land. This property is located in the province of Jaén (Andalusia, Spain), since it is one of the main producers of olive oil of the country and therefore it is the most representative place.

In this zone the erosion phenomenon is accelerated by the use of agricultural machinery, that contributes to the elimination of the vegetal cover, being its main function to protect the ground of the degradation/erosion to that it is put under by the direct hit of the rainwater [Francia, J.R et all, 2000]. However, it is important to add that the loss of this vegetal cover not only takes place by the action of the machinery on the land, the climatic conditions of the region also
are a determining factor. This circumstance requires the analysis of the variation of the topography of the land studying how the main erosive agents act: the slope and the climatology. The used parameters to analyze the effects of the process of erosion are the digital elevation model and the slope. This work studies how erosion process causes important problems of drag materials until it produces a considerable modification of the topography.

Firstly we do not know the magnitude of the variations we talk, despite is anticipated that variations will be of small magnitude in just a short time (4-8) months. For this reason we need to work with a high precision DEM and in addition to small step of grid [Ramos et all, 2004]

2.– DATA AND METHODS

It essential to select suitably the zone of study. This one has to have the characteristics that it was mentioned in the introduction: a zone in olive orchards where agricultural machines are used and that presents an irregular topography with the greater slope as possible to be able to analyse what it happens in extreme conditions. Considering the previous premises it has been chosen a property located in a place called Loma del Madero, province of Jaén, Andalusia (Spain). This one is a property of 1.190 Ha and 120 olive trees (Sig Oleicola Español) of variable slope getting values over 20%.

![Figure 1. - Highest slope in the property.](image1.jpg)  ![Figure 2. - Erosion effects in the property.](image2.jpg)

Another factor that it has been considered on selecting the studying property has been the fact of the existence of a next agroclimatological station, which it is daily provides precipitation data, temperatures, humidity, pressure values, etc. being able to accede to them through the Web of the Consejería de Agricultura y Pesca de la Junta de Andalucía.

The phenomenon of the erosion zones is not only takes place as a result of the working with agricultural machinery but also the incidence of the rainwater of an irregular and discontinuous form causes the acceleration of the erosive process in this terrain.

Once the zone of study is chosen it comes the planning from the methodology and instrumentation to use for taking data of field to obtain the high precision DEM. At a first moment, for being in experimental phase, we are going away to take points approximately each 0.5m -1m, so it must be taken into consideration to adopt special methodology of measuring data. From the point of view of the instrumentation it was considered more opportune to use GPS system. Taking measures in olive orchard between is limited because of the lack of visibility, so it forced us to discard the classic topographic instrumentation; adding to it the versatility that offers this system allowing us to work in a faster way and providing precision that is below the centimetre. The way to operate in field is important to indicate that it was analysed with extreme well-taken care, studying the best way to give coordinates to the land with the greater precision as possible, considering that the surface is have sand stones which they are just by broken to touch them which makes difficult any attempt to measure topography of the zone accurately. Considering all this the following system was adopted:
We use metacrylate plates with a small orifice in the centre where the bar is putted on. The antenna GPS is hitched on this bar (figure 3). The way to operate is described by followed: it is dropped the plate in the ground so that it breaks those sand stones and it leans on the surface then the bar is fitted in the orifice to make the measurement. This way of measuring data will be repeated in successive campaigns. Each campaign is next to heavy showers or bad meteorology or next to a period of farm work with hard agricultural machinery. In short, after erosion agents had been acted and they could have any repercussion on the topography of the plot of land. It is obvious that as much campaigns we will have better knowledge about when erosion takes place.

The first campaign has been made during the last weeks of June of 2004 This was an especially dry time. This campaign will be used to compare with later campaigns that will be measured by the month of November. November is the previous month at the beginning of the harvest. The distribution of measured points for the accomplishment of DEM is showed in figure 5. The pattern followed is a whole of alignments that cover the zone without taking points very closed to the olive trees. These zones mentioned are the white holes that are shown in the figure. In order not to disturb the high precision of DEM, these holes will not be taken into account; it means that they will be considered like edges.

There are many interpolation methods to generate grid. We used the software of treatment (interpolation, analysis and management) of grids Vertical Mapper v. 3.0, application that works under MapInfo Professional. to obtain the DEM. The two algorithms commonly used to represent terrain models are based one on triangulation and the other on inverse distance weighting. We have not found quite significant differences so we chose the triangulation method. The parameters checked was 2 m. of maximum triangle side length and 0.5 m of cell size. As it is mention we manage a
high precision digital elevation model to study small changes, so we need to work with a grid of very high resolution. The result is showed in figure 6.

The main advantage of GIS to study spatial phenomenon is that they have lots of tools that provide many possibilities of representing data. Therefore, in this case is possible to tackle the topographical consequences of erosion numerical or using spatial visualization. These maps of contour have been generated from the same software of treatment (figure 6). They have been used to integrate planimetical data with them. For example, other study we are doing paralleled to this is the displacements of olive trees between campings, so the displacements vector can be added to the map contour (figure 7) to analyze how it goes towards down maximum slope or how much does the drop terrain influence.

3.– DEVELOPED WORK

The analysis of erosion implies to manage information that is needed to be visualized. Several times the consequences of erosion are expressed by numerical parameters. They are far from be useful for making decisions. Here we suggest a methodology to integrate vectorial and raster data in order to approach a visualization problem. Therefore, data must be properly integrated in GIS in order to make good decisions about erosion in agriculture [Neményi, 2003].
GPS allows to georeference spatial elements of our system. In this case spatial elements are the points to generate DEM and also olives trees. They are all codified by their coordinates in the reference system adopted. Also, other important entities stored are slopes, date of each campaigns, harvest data, rain fallen, etc. Some of these parameters are constant but other changes continuously, so the design of data base must be cared to improve the quality of the system [Stafford, 2000]. In an initial phase of the work we manage the parameters mentioned above and we have related each other like is shown in figure 8.

![Conceptual model of data base](image)

Figure 8– Conceptual model of data base.

Nowadays there are GIS to improve precision agriculture but all of them are too expensive or inappropriate to process data at small scales [Runquist et al, 2001]. Because of this reason we are designed this data base model to be integrated in the software GIS.

In this work we are considered slope as the main erosion agent. Vertical Mapper v.3.0 (User Guide) calculates slopes values from each node of a grid. The slope of terrain is given in percentage values or grades from 0 to 90 as regards an horizontal plane. It is considered the 8 points around the central one to calculate slope. We have checked different algorithms to calculate slope: ArcInfo v. 8.0 [Burrough, P.A, 1986 ], and the algorithm used by Javier G. Corripio [Corripio, J.G, 2003]. Vertical Mapper v.2.6 (User Guide) calculates the value of slope of each node of a given Grid. The slope of the land is expressed in degrees: from “0” (horizontal) until “90” (vertical) or in % values respect to a horizontal plane. For each point of the surface there is not significant differences. The slope model resulted of the first campaign of observation has been the following one:
4. – CONCLUSIONS

We find significant variations on slopes values from one campaign to the second one. It is caused by variation of altimetric values. Also we have found planimetric displacement but they are smaller than in altimetry. Here we can
confirm that movement are not always causes by slope and climatic agent. The agricultural machinery causes great deformation of the terrain making slopes to variate. Also, the machinery used in the olives recolection campaigns moves the trunk to make falling down the olives, so this could be the reason why zone very closed to the tree have important deformations. From now this investigation is being improve by the integration of climatologicaly parameters, haverts parameters, erosion parameters come from soils studies, etc... Working in this way we will be able to make good decision about precision agriculture. The results obtain in this investigation work will be able to be applied to other environmental phenomenon.

5.– REFERENCES


