TOWARDS HIGH PRECISION DIGITAL ELEVATION MODEL

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ABSTRACT

In this work, in experimental phase, the digital elevations models (DEMs) appear as a fundamental tool for studying erosion of the land in a concrete zone of agricultural production, olives production. Collected data from the zone of study in different campaigns are used to determine possible variations in the orography of the land. GPS is the used tool to measuring coordinates of points in the land due to the special characteristics of the zone of work. This study is complemented with the analysis of those parameters that influence in the erosion of the olives land: slopes and climatology. A work of these characteristics as much requires of precision and reliability in the stages of taking of data of field like in the phases of treatment and management of the information, so such data will be integrated in a GIS so that it allows to interrelate all data, to modellling them, to interpolate and to extrapolate information as well as the possibility of visualising the possible environmental changes that they take place.

Keywords

GIS, scientific visualisation , modelling data, DEM, slopes.

1. INTRODUCTION

The great potential is known for GIS to manage spatial and alphanumerically information allowing to interrelate variables of different nature. Nevertheless, the true interest of the GIS is not only in the capacity to manage data but in the possibility of updating these data permanently with which it could make a continuous pursuit of a phenomenon being able to infer behaviour models [Laurini, 1999]. In environmental studies that modify the aspect of the landscape, they need an adapted treatment and management of data to be able to obtain the sufficiently coherent results of quality and trustworthy thing like interpolating and extrapolating future situations from certain premises. The experimental device consists, in addition to an equipment and methodologies of very concrete work of field, a suitable treatment of the data, revision of variables and parameters provided by external organisms, etc. A fundamental aspect when it works with spatial variables is the scientific visualisation, that will allow to check how the studied phenomenon evolves and the results that are obtained from different modelling phenomena. The phenomenon to analyse in this work is the wearing down of the land in olives production zones. The erosion of the ground by rain is the most important problem of the olives Mediterranean production since annually million tons of ground are dragged by run-off waters, which gradually has a negative effect on the production from the olive grove when being reduced the fertility of the ground. This effect is accentuated in zones with great slopes. In those zones where working techniques are used the erosion phenomenon is accelerated because the use of agricultural machinery contributes to the elimination of the vegetal cover also 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 is a determining factor.

This situation requires the analysis of the variation of topography of the land studying how they act the main erosive agents: the slope and the climatology. It precise safe results of variations of the topography given by a high precision DEM and in addition to small step of grid

2. OBTAINING AND TREATMENT OF DATA

In an initial phase of the study it is precise to select the zone of work suitably. This one has to reunite the characteristics that score in the introduction: a zone in olive production where the earth working practices and that presents an irregular topography with the greater slope as possible to be able to analyse what it happens in extreme situations.

Considering the previous premises has chosen a property located in a place known like Loma del Madero, pertaining to the province of Jaén, Andalusia (Spain). This one is a property of 1.190 Ha and 120 olive trees (Sig Oleícola Español) of variable slope getting to reach values over 20% (Fig. 1). The phenomenon of the erosion involves 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 these earth.

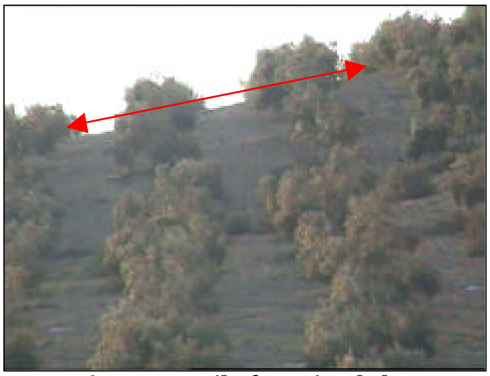

Fig. 1.- Detail of maximal slope.

Thus another factor that it has been considered on selecting the studying property has been the fact of the existence of a next agroclimatologycal 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. In principle is tried to analyse the influence of precipitation on the vegetal cover, despite does not discard to include in the analysis the rest of climatologycal data: maximum and minimum temperatures, wind speed, humidity, etc,

Once chosen the zone of work 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 0.75-1m, so it conditions the process of taking data having to adopt special measures, as much instrumental as methodological to obtain the required results. From the point of view of the instrumentation it was considered more opportune to use GPS system, since the fact to work between olive trees causes that the visibility conditions are limited discarding for that reason the classic topographic instrumentation; adding the versatility that offers this system allowing to work in a faster way and providing precision that is below the centimetre. In which it concerns to 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 (see Fig. 2):

Fig. 2.- Measuring data

We use a metacrylate plates with a small orifice in the center where the tug leans. The plate is dropped in the ground so that it breaks those sand stones and it leans on the surface then the tug is fitted in the orifice to make the measurement.

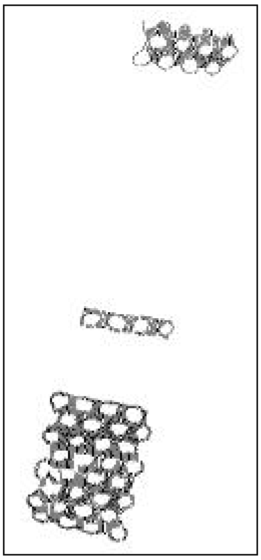

Fig. 3.- Measured points

This way of measuring data will be repeated in successive campaigns after bad meteorology or working the land with hard agricultural machinery.

The first campaign has been made during the last weeks of June of 2003, being this specially dry time it will be used to compare with later campaigns that will be measured by the month of November, previous month in the beginning of the harvesting of the olive.

The distribution of measured points for the accomplishment of DEM is in figure 3. In this figure appears three zones, this is because it is the beginning of the initial phase of the investigation so we have chosen the more particular areas of the property: the extreme zones present greater differences than the central zone being this one practically level, despite has been considered interesting its study to confront these data with those of greatest slope.

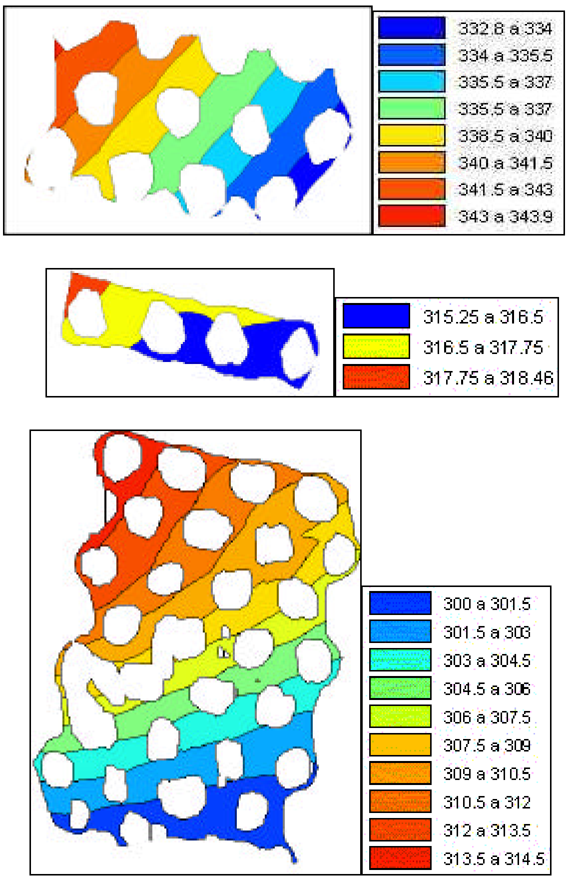

Fig. 4.- Resulting DEM's for each zone (A, B, C)

These maps of contour (Fig. 4) have been generated from the software of treatment (interpolation, analysis and management) of grids Vertical Mapper v. 2.6, application that works under MapInfo Professional. From such it is possible to be appreciated the differences between the three zones: the zone A is the one that displays the greatest declivity followed by zone C, whereas zone B is the smoothest zone, so we have had to reduce the interval of representation of heights to 1,25 m in order the resulting map was representative. These have been the criteria followed at the time of discriminating zones of the property on others, we look for variability in levelling to analyse different slope maps and to contrast how and how much they will be able to vary in a future as a result of the agricultural working. At the present time it is counted on an observation campaign, when more measuring (campaigns) will be made we will make similar maps to check possible changes, later from an analytical point of view we will study the files of coordinates X, and, H with geostatistical techniques.

3. DEVELOPED WORK

Finalised the first campaign of observation it begins the process of analysis of data and the more advisable models of interpolation in order to obtain the best results to solved the problem investigated. In the first place it is important to choose the most suitable interpolator to generate the DEM of better precision for our zone of work. Different interpolating algorithms will be applied and these results will be compare with the GPS measured values obtained directly on the land.

We work with a vectorial GIS where the element of spatial analysis is a grid (Fig. 5) that uses identical resolution as the interpolating algorithms to generate DEM. Given the three zones of study a grid by each one is created.

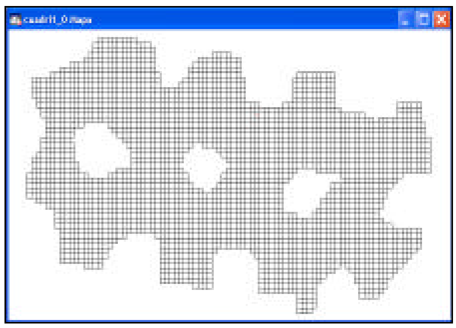

Fig. 5.- Zone A. Grid

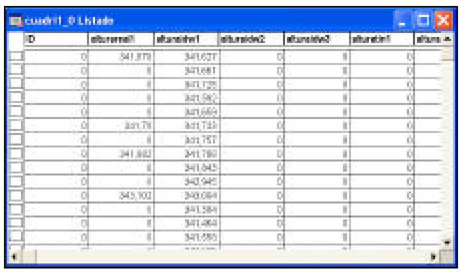

Fig. 6.- Zone A. Table of data information.

Each cell will have associated all the information that is arranged (Fig. 6): coordinates X, Y of the centroide and heights values (H) resulting of applying the interpolator. Measured values of H, evidently, there will be cells with data and others with no data since the taking of data in land was not rigorously regular.

To carry out the analysis of the most appropriate interpolator, on each cell of the grid, is compared each value of H interpolated with the real value measured verifying which comes near more to the reality. Once made this comparison the most suitable algorithm is TIN (Triangular Irregular Network) that produces a DEM which H values are very similar to real topography.

Determining the most appropriate interpolator we have a high precision DEM of each zone of work, in which one more data can be added, slope. As it was mention in the introduction, slope is other important element responsible for the deformation of the land, this phenomenon favours terrain sliding. From DEM the values of slope is calculated for each cell of the grid.

The calculation of slope is made applying different algorithms, the obtained ones from software Vertical Mapper v. 2.6, ArcInfo v. 8.0 [Burrough, P.A, 1986], and the algorithm used by Javier G. Corripio [Corripio, J.G, 2003].

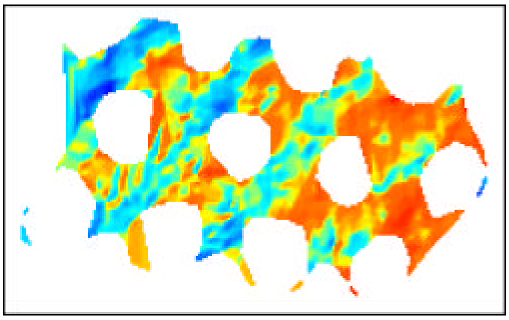

Fig. 7.- Slopes model (%) of Zone A.

When we fix the step of the grid the result given by Vertical Mapper v. 2,6 is an image (Fig. 7) with resolution of according to the grid used for the DEM where each cell has its coordinate X, Y and their coordinates Z will be the value of the slope interpolated in that zone that occupies that cell.

We work in the same way to calculate slopes with ArcInfo software or according to the algorithm of Corripio [Corripio, J.G, 2003]. Then differences obtained from each method are compared and analised to look for the most suitable algorithm for the studied zone.

The same developed methodology will be used for the following campaigns of observation. Once we have selected the best algorithms to calculate DEM and slopes the differences between data of each campaign will be obtain to detect values of possible changes of the terrain studied [Caspary, W.F, 1988].

4. CONCLUSIONS

This work is in experimental phase so we do not have already numerical conclusions, but the study we are making shows how important is to evaluate the quality of data before integrate them into a GIS. Collected data from the zone of study in different campaigns are used to determine possible variations in the topography of the land, so a work of these characteristics as much requires of precision and reliability in the stages of taking data from field like in the phases of treatment and management of the information. Also if the entry data are very precise, methods and algorithms to calculate parameters must be efficient enough to obtain quality conclusions. GIS generated must be configured to be able to update data at any moment in order to provided a real model of changes in studied zone. The results obtain in this investigation work will be able to be applied to other environmental phenomenon.

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