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THE DIGITIZED DATA MANAGEMENT SUPPORTED BY MODERN TECHNOLOGY ON THE GREEK FOREST CONDITIONS

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Abstract: *The digitized data management supported also by modern technology, like the digital terrain model (DTM), in collaboration with the geographical information system and the positioning system, can contribute to the better ecological management and protection of the forests. The target of the present paper is the connection of two different scientific fields, the Global Positioning System (GPS) with the Geographical Information Systems (GIS), and its implementation on forests. The measurements have been performed in 2007, at the Taxiarchis-Vrastama University forest, in the forest area "Solinaria". The digital photogrammetric plotting of the research area will be used as the base for the database development in GIS environment. Some probable eventualities of the implementation of the present operation on forests are indicatively reported, like the piloting of firefighting vehicles, or wood transportation machinery, on the digital map and in contact to the base, and also harvest and forest road network planning and mapping in mountainous terrain, the control of forest cadastral diagrams and thematic maps, and the development of geoinformatics models for the forecasting of fires and optimization of the land uses.*

1. Introduction

The contemporary technology of computer science provides a tool for structure and management of the graphic and descriptive information in a holistic environment. This tool is the G.I.S. The G.I.S. as a depiction tool is used to demonstrate the spatial data of an image. The continued progress of computer technology provides new potentialities for the traditional practical work of Forestry, because it combines the office where they process the data with the field works, using also digital maps and interactive bidirectional communication via palmtops and G.P.S. (G.P.S. GmbH, 2003, Heiderbauer, 2003, AGIS GmbH 2003).

The use of satellites compared with the traditional terrestrial methods on geodetic works is superior in that the designation of the position is genuinely three-dimensional and that does not require intervisibility among the points of measurement.

These two dynamics of innovative technologies, G.I.S. and G.P.S., have began to develop almost in parallel since the mid ‘80s, with full assistance and support of the continuous developing and evolving technology of the computers.

From the outset it was understood that the combination of these two technologies would produce reliable and interesting results. The initial effort of combining G.I.S. and G.P.S. was made in 1987 with the development of a G.P.S capable enough to collect, as a field digitizer, spatial data which could be used exclusively on G.I.S. applications. Its use by the Environmental Systems Research Institute (ESRI) allowed for the first time the creation of a common database, which resulted to the spatial reference when using coordinates of the G.P.S for the first time in a G.I.S. package.

Every G.I.S. has a digital topographical map as a database. This digital model recreates accurate and detailed characteristics of each research area. It enables us to add points of interest making detailed reference to them and highlighting their special characteristics. Afterwards we can easily start the research of these and navigate from point to point.

There are many companies around Europe who develop G.I.S. programmes for the purpose of updating forest maps, cadastral tables and borderlines of forest cadastre with the assistance of digital maps, which are downloaded from the Internet and coordinated with G.P.S. in the field (Sprenger, 2003a). Sprenger (2003b) reports that user friendly G.I.S. programmes with the appropriate database have helped the modern management of forest in north Austria while conducting a pilot programme.

The wide use of G.P.S for civilian applications is controlled using a technique which is widely known as Selective Availability, which modifies on purpose the satellite emitters of the G.P.S. system. Its abolition – even when using simple receivers – leads to accuracies up to 5 meters to the planimetrical and hypsometric position, which means that this can be done without the use of the specific designation with two receivers.

The accuracy of the G.P.S on a forest environment is a disadvantage for many applications that require accuracy, especially when it needs to be done under crown-closed. After the completion of the selective availability the accuracy of low cost G.P.S. was improved (Gianniou, 2000, Doukas et al., 2002, Resnik, 2002). The small devices are more ergonomic when using them in forests, they are combined also with a compass and altimeter and so they have a reliable basic accuracy, when the measurements are made with clear sky, and from there the directions can be determined using the compass at particular points under the foliage (Gzaja and Heurich, 2003, NWF, 2002).

It is of high interest the evolving technology of the combination of mobile phones and G.P.S, which can also function even in enclosed environments, i.e. buildings and beneath dense foliages. But of course their accuracy is 15-20 meters is limiting at the time being for all forest applications (Groten et. al., 2002).

The use of the combination of two G.P.S. receivers improves the obscurity in reception of the satellite signals and gives high accuracy, but still it is an application useful for forests only on basic trigonometric (control) points in open sky positions (Wanninger, 2002).

The data that we collect constitute a database useful also in other future applications of cadastral surveys. This happens at Hessisch in Germany where they use them within the scope of a pilot programme of exploitation of the National Cadastre's data in other applications (Hartmann et. al., 2002).

The digital information consists of two categories: the geometrical and the descriptive or thematic. Progress of image resolution allows the export of the geometrical and thematic information for a variety of objects. Improvements on data presentation and modelisation that accord with the development of three-dimensional GIS, where representation, methods and data are all dependent on objects.

The digital photogrammetry (orthophotography) is used and will be widely used in the near future. The continuous growth on the software and equipment make the photogrammetric production of orthophoto more simple, faster and cheaper. Hence, the automatic production of D.T.M. and the use of G.P.S., has made the time-consuming aerial triangulation, easier or even useless, improving the attractiveness of orthophotos. The orthophotos are produced in all scales, and gradually on a large scale, not only because of the necessity of the important G.I.S.-users such as municipal authorities, public offices etc, but also because the data update is more important on that scale.
The aim of the paper is, after proving the combination between the two technologies to utilize this know how via one PDA GPS, on tough circumstances that can be found in a forest or a forest areas in general. We know that the application of this technology at the forest and at forest areas is peculiar, while at the same time the necessity for applying it in such lengthy lands is very high.

2. Materials and Methods

2.1. Research area and materials

The forest area named "Solinaria" locates southwest of the Forest Office, on the borderline between the Public Forests of Polygyros – Palaiohora and the University Forest of Taxiarhis – Vrastama of Halkidiki.

96% of the region is covered by Broadleaved Oak (*Quercus Conferta*) and isolated trees of Fluffy Oak (*Quercus Pubescens*), Beech (*Fagus Moesiaca*), coppice of Trachea Pine (*Pinus Brutia*) and Black Pine (*Pinus Nigra*). The region is ranges 700 – 890 meters above the sea level and has an exposition SW and NW. The relief is mountainous and the slopes are not more than 45 %. The trees' height varies between 15-25 m. The basic rock is the Marmarygiakos Shistolithos (CAMUF, 2002).

The points that were used as control points were surveyed planimetrically and hypsometrically, with the total station TC 805 (Figure 1).

The accuracy of the total station according to the technical specifications is 2-5 mm + 2 ppm according to the time of measurement and the distance. The hand G.P.S. that was used was GPSmap 60CSx of Garmin (Figure 2).

It concerns a receiver of low weight that receives signals from 12 satellites, according to which we can succeed the definition of our position, the speed and the direction of movement, as well as the time and the distance until the final destination.

It is a tool of survey that combines the creation and information of GIS geodata with the manageability of a hand GPS. It's very easy to use. It collects easily points, polylines, polygons, as well as points of grid for DTM creation with attributes and features. When combined with the appropriate software it can easily process and export the data that have been received at the field, informing the GIS basis. This way, the map can be scanned on the GPS and exist as background at the field, as well as to export all the measured data in IMG format.

The instrument that was used for specifying the variety of characteristic points of the ground that were used as control points was the total station LEICA TPS 300.

The Hellenic Military Geographical Service (HMGS) delivers using cash on delivery the aerial photos and the diapositives and the Calibration report.

2.2. Methodology

For this specific paper we will try to combine two scientific fields, the G.P.S with the G.I.S, on the Greek forest reality.

The digital image that we are going to use as a background is the digital orthophotography that covers the research area and will be produced photogrammetrically to achieve the better plotting of the area, compared with the existing digital maps that are widely available.

The technique that we are going to apply is a combination of a digital map, a relational database and a G.P.S, which allows to a user to depict and analyze the relation between spatial and descriptive information that have common reference to a specific geographic position. All the information that are connected with the geographic position of the details of a map, are available via the map itself.

A couple of aerial photos were used, which were taken in 1994, and after they were scanned on a special photogrammetric scanner, it was processed using the Leica Photogrammetry Suite (LPS 9) software of the Leica Geosystems of the Leica Geosystems company.

Figure 1: TC 805 total station.

Figure 2: G.P.S.

The relative orientation as well as the automated production of Digital Terrain Model (D.T.M.), were realized with the application of the automatic correlation of homological digital pictures using as a pattern windows of the radiometrical rates of the digital pictures (area based matching). This method is used more often than the rest for digital photogrammetry (Wolf and Dewitt 2000). Also the LPS 9 software provides the potentiality of producing and use pyramids of the digital images that improve the final results since they consist of an auxiliary means for the finding of suitable initial values that are used for the determination of the optimum solution in the problem of digital correlation (Kraus 1996). On figure 3 the automated production of Digital Terrain Model using pyramids are picturized.

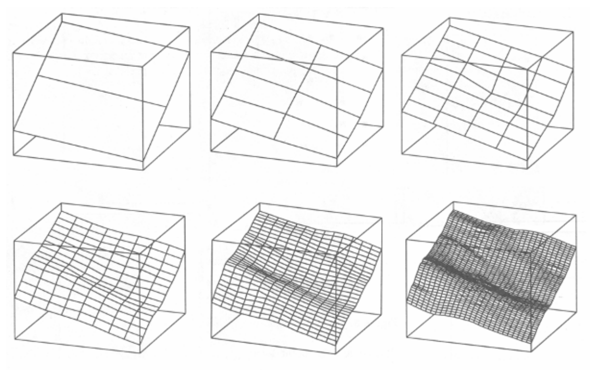

Figure 3: Automated production D.T.M. with the use of pyramids (Ackermann and Hahn 1991).

Final product of the photogrammetric process of the aerial photos of the research area is the digital orthophotography, which result from the differential rectification, of the aerial photos with the abolition of the position errors which they include because of the ground relief. The production of digital orthophotography is the first full automated procedure of the digital photogrammetry (Baltsavias 1996).

After the completion of that, the introduction of the orthophotography on G.I.S. started, which was based on the ArcGIS 9 software of the ESRI Company. Geographical vector data were created (polygons and lines), based on the photo-understanding of the research area, which were connected with descriptive data on the geographic database of the ArcGIS. After the definition of the topology, the recording of the road network of the area was carried out. The next step was the cartographic plotting and the production of the final digital orthophotomap.

This was followed by the introduction and on line communication of the raster archive of orthophotography with the localization of the position using the G.P.S. receiver. Finally, after the elaboration of data at the office, the improvement of the database on a G.I.S environment began which will be followed by tests on a forest environment. The palmtop will be connected with the hand GPS and the tests on a forest environment will begin. There will be an effort for data transfer with the assistance of a mobile phone from the database, using the Internet on the palmtop.

3. Results

The processing of primary aerial photos gave the orthophotomap of our research area. In figure 4 we have a perspective depiction of the research area Solinaria as it comes out from the GIS.

4. Conclusions - Suggestions

At this paper an initial effort is done for developing and materialization of a combination of GIS with G.P.S., which aims to utilize the geographical position on a palmtop, which will be connected to a hand G.P.S.

The application of this connection at the field enables to the user to know each every moment where he is. Hence, he can direct the device to on direction or specific point, finding the shortest route. It is widely known that the application of this combined technology on the forest and the forest areas is particular, while at the same time the necessity of the application on such wide areas is extremely big.

The GPS can combine with the Geographical Information Systems (GIS). This combination re-defines the way that we locate, organize, analyze and mapping the data.

The laborious part of the photogrammetric procedure is the plotting of the relief. Palmtop software is required, so as to organize and expand the applications of utilization services of the geographical position. The flexibility of moving, the friendly for the user function, the potentiality to use a huge mass of data and the potentiality of reviewing and updating the results anywhere and wherever, is necessary.

It is considered necessary to report the results on coordinates of a report system widely known and used such as the report system EGSA ’87 that records all the control points that are going to be used during the photogrammetric procedure, will be calculated on that system and, if needed, they will be transformed on WGS ’84.

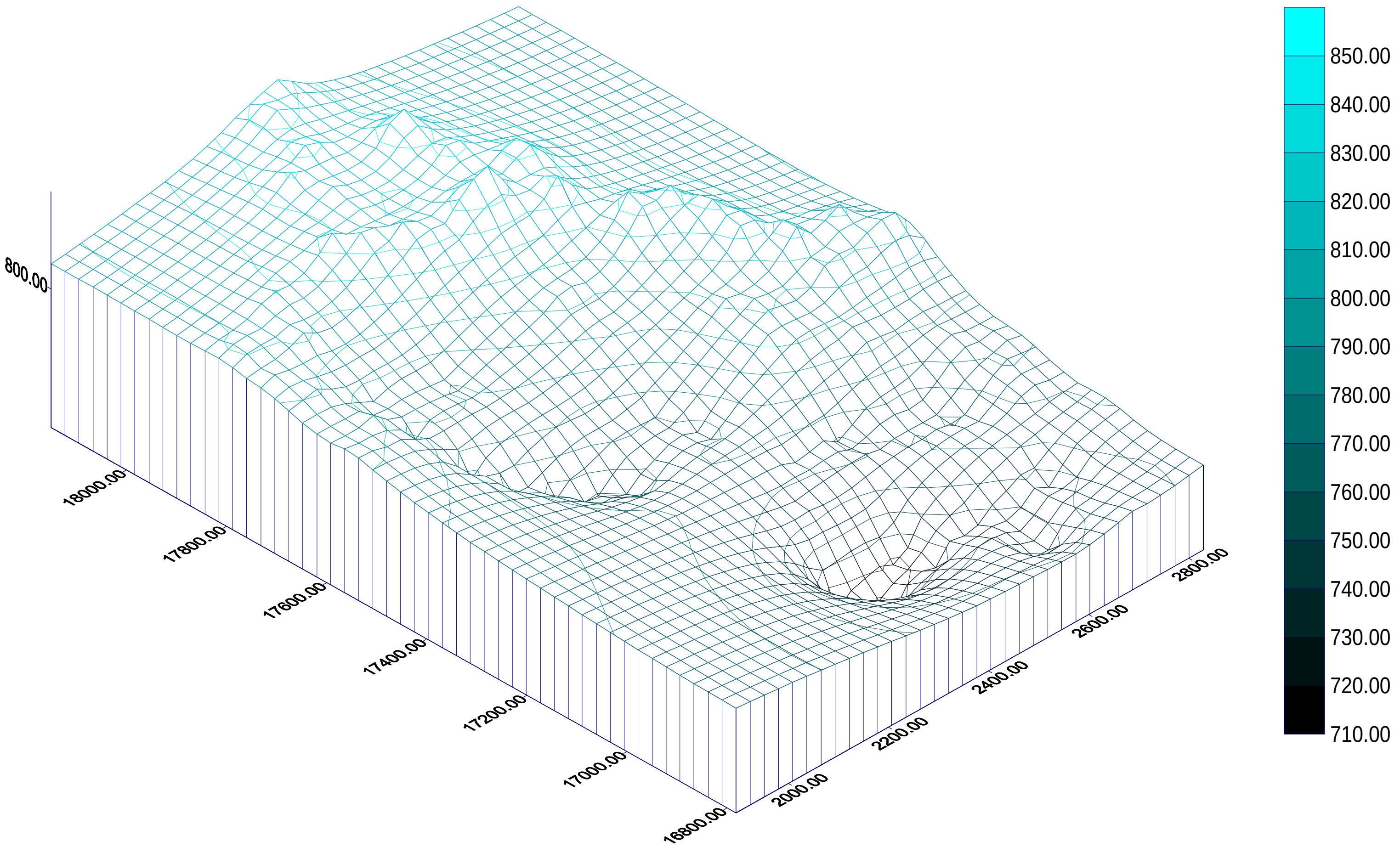

Figure 4: Perspective depiction of research area Solinaria.

As an example it is mentioned that certain likely scripts of implementation of this specific application in forest practice, as the navigation e.g. its use of a nature friend, who makes gladly walks in the forest, until the control of fire-fighting vehicles, or vehicles of shift and transport timber, from earthwork and forest management work, still the mapping of forest roads in a map on a small scale, like also the control of the forest cadastral maps and thematic maps, the update of the database. Therefore geoinformation models can be created, which will act as plans for prediction of natural disasters and the optimization of the land uses. These applications by the forest services concern a field of as much as 60% of the entire country.

Digital orthophotography has been used as a background because it possesses a huge number of advantages, the most important of which are: high accuracy and stability, their production is considered more economical and efficient compared with the production of analog orthophotographies, there is high flexibility on the way it is produced ad well as on the resulted products, high level of cybernation, simple radiometric process of the image (picture quality, creation of photomosaics, color elaboration etc) and supply of a huge number of digital information (frames, toponimies, numbers etc), as other researchers report (Kersten and O' Sullivan 1996 et al.).

The management of the digital information with the help of the modern technology, as is the Digital Terrain Model (D.T.M.), in collaboration with the Geographic Information System (G.I.S.) and the Global Positioning System (G.P.S.), can contribute in the better ecological management and protection of forests. The digital information can be useful in other applications such as:
- Photogrammetrical backgrounds of forest maps' drawing up.
- Environmental Impact Assessments (E.I.A.)
- Fires.
- Land planning (Uses of land).
- Vinicultural - Olive-growing cadastre.

With the application which is going to be used and after is considered a success and with the relevant experience, we hope that it is going to be expanded to other forest areas as well.

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