Comparison between orthophotomap data and management plan data for a mountainous forest area

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Abstract:
The development in computer technology and graphical data processing, and the increasing availability of high quality digital data have led to new forms and ways of data processing and management in all scientific fields. This caused an increasing need for digital topographical data, which are necessary as 3D background for spatial and non-spatial digital data processing in geographical information system (GIS). The need for up-to-date, accurate, fast acquired, reasonable and blanket coverage 3D data and maps in various scales for environmental planning and monitoring, and for management of natural resources is significantly increasing. Spatial data and high quality maps are required for various applications in forest offices like logging, harvesting operations, etc, in many surveying service companies, departments of governmental offices, in communication, transport and traffic offices, in energy supply companies, and many other fields such as research and tourism. Aim of this paper is the investigation of the reliability and the usefulness of land uses taken from orthophotomap and from a corrected management plan with on the field measurements.

Keywords: data, orthophotomap, management plan, comparison.

1 Introduction

The development in computer technology and graphical data processing, and the increasing availability of high quality digital data have led to new forms and ways of data processing and management in all scientific fields. This caused an increasing need for digital topographical data, which are necessary as 3D background for spatial and non-spatial digital data processing in geographical information system (GIS). The need for up-to-date, accurate, fast acquired, reasonable and blanket coverage 3D data and maps in various scales for environmental planning and monitoring, and for management of natural resources is significantly increasing. Spatial data and high quality maps are required for various applications in planning offices, in many surveying service companies, departments of governmental offices, in communication, transport and traffic offices, in energy supply companies, and many other fields such as research and tourism. Photogrammetry is the technique of measuring objects (2D or 3D) from photographs. Using this technique the co-ordinates of the points in 3D of an object are determined by the measurements made in two photographic images (or more). The georeferencing (dereferencing) of the photographs guarantees later the common use of several different data sets in a GIS. For the following reasons the significance of digital orthophotos is increasing (Gruen et al., 1994):

- Using satellite or aerial images blanket coverage digital data is easily available.
- High quality scanners allow the digitization of analog images and other data.
- Digital terrain models as a basis for digital orthophoto generation is available in different quality levels using various modern data acquisition methods, e.g. digital image correlation, laser-scanning, etc.

- Necessary control point information can be acquired by GPS in an accurate, fast and reasonable way.

- Computers of high performance and increased disk storage capacity are available today at a reasonable cost.

- Commercial software for orthophoto generation is available from a variety of vendors.

- Digital cartography uses increasingly digital orthophotos for map restitution.

- Digital orthophotos are an important and up-to-date information level in GIS.

- With reasonable visualization software on PC, digital orthophotos will gain entry into the public market.

The building of a GIS plays more and more an important role in various applications. Therefore, the individual factors of costs must be correctly estimated in the building phase of a GIS.

As the first operational products of modern techniques in digital photogrammetry, digital orthophotos are generated in a fully automatic process. Digital orthophotos provide the following advantages:

- High accuracy, stability and information density.

- Low production, low cost and high efficiency.

- Flexibility in the production and in derived products.

- Computer supported extraction of information with the capability of a high degree of automation.

- Simple radiometric manipulation (image quality, mosaicing, color editing, dynamic range adjustment, etc.).

- Integration of vector data and additional information (frame, geographical names, numbers, etc.).

Aim of this paper is the investigation of the reliability and usefulness of land uses taken from orthophotomap and a corrected management plan with on the field measurements.

2 Materials and Methods

2.1 Research area

The Taxiarchis – Vrastama University Forest is located in the Chalkidiki prefecture, specifically in the south and southwest slopes of Mountain Holomon in latitude 40° 23΄ to 40° 28΄ and longitude 23° 28΄ to 23° 34΄ and in an altitude of 320-1165 m (Figure 1).

The Taxiarchis – Vrastama Forest belongs to the Hellenic Public Lands, while its exploitation was transferred from the Ministry of Agriculture to the Aristotle University of Thessaloniki for educational and research use according to the 15/12/1934 Presidential Decree issued as a reinforcement of Law 6320/1934 "About the transfer of exploitation og public forests to the University of Thessaloniki for reasons of education, research, etc." (Government Gazette 356/17-10-1934). From the geological perspective, the area belongs to the Rodopi zone, in particular to the Melissochorion-Holomon unit. In the northeastern edge of the Forest appears a part of the Serb-Macedonian mass, in particular of the Vertiskos range.

The rock formations that are found include silicate materials and silicate sandstones, marbles, calcarious schists, micaceous gneiss, granites, gneiss and various sedimentary rocks in small areas.

The soils of the area belong to the category of acid forest soils. The climate of the area is considered as Mediterranean with short hot and dry summers and mild winters (method Emberger) (Emberger 1945). The vegetation of the area is dominated by deciduous forests and is comprised of vegetation zones depending on the flora composition, the rock layer and soil conditions, the aspect and slope of the particular area, the ambient temperature and the precipitation. Hence, three zones are distinguished: *Quercetalia ilicis*, *Quercetalia pubescentis* and *Fragertalia*. The greatest portion of the area is covered by the union *Quercetum confertea* (= *frainetto*) at an altitude 400-1000 mm while streams are dominated by the *Orneto-Quercetum ilicis* union. Some species have been established via artificial reforestation, such as *Pinus nigra*, *Pinus sylvestris*, *Pinus brutia*, *Pinus halepensis*, *Abies borisii-regis*, etc., in an area of 1189.67 Ha.

The games which are met in the Taxiarchis – Vrastama University Forest, are wild pigs, hares, partridges, woodcocks, etc. In table 1 is shown the extents from the management plan and from orthophotomap.

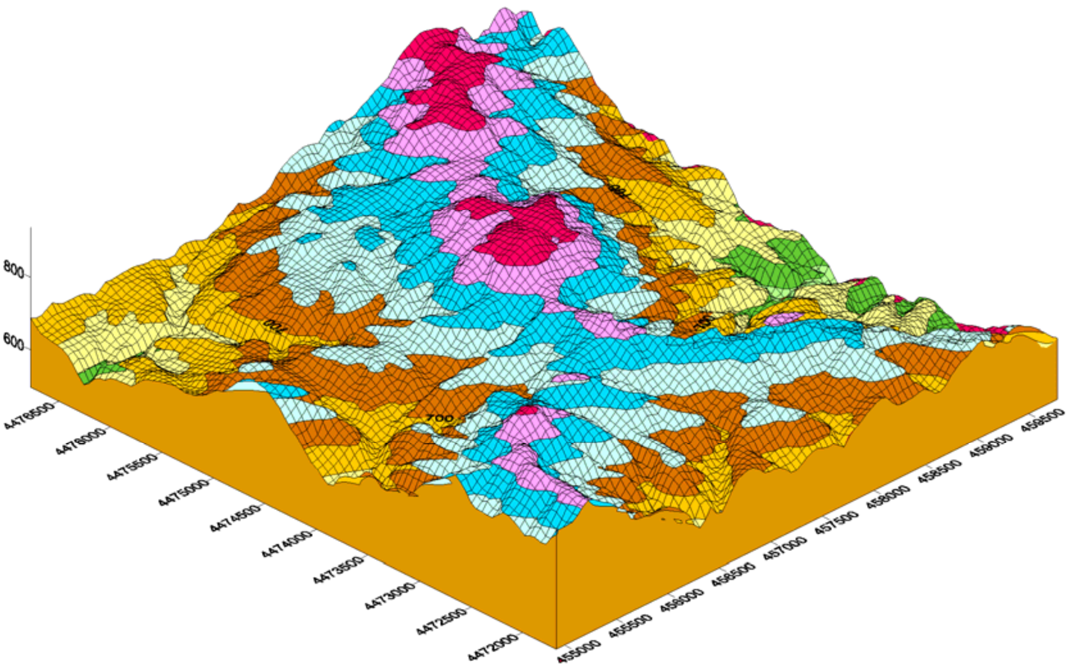

Figure 1: Research area of Taxiarchis – Vrastama University Forest

Table 1: Extents from management plan and orthophotomap for the study area

Land Uses	**Extent from management plan (m^2)**	**Extent from orthophotomap (m^2)**
Oak	22470331.56	26863662.47
Beech	2307629.092	3351111.588
Pine	11297594.33	7228021.789
Scrubs	7036839.878	6788110.917
Agricultural crops	8579231.223	6596345.5442
Arid	238265.3059	147310.97
Beech - Oak	605964.6778	2024148.517
Pine - Oak	1232139.693	481085.85
Scrubs - Pine	296061.952	468143.64
Oak – Beech – Pine – Evergreen broadleaves	872442.2883	988558.7148

2.2 Methodology

Data from the management plan is the true value of the measurements for every land use because with the field measurements we can check the reliability of the observations.

Descriptive statistics methodology was used in order to describe the main features of the collected data. Specifically, in order to allow us to represent graphically the distribution of measurement scores collected for the various categories of land use, for the data of management plan, orthophotomap and associated measurement errors, boxplots were utilized (Boxplots were created with the use of SPSS 15.0). The boxplot, also known as box-and-whisker diagram, (McGill et al., 1978) is a graphical display of data that shows: the median, which is the middle black line, middle 50% of scores, which is the shaded region, top and bottom 25% of scores, which are the lines extending out of the shaded region, the smallest and largest (non-outlier) scores, which are the horizontal lines at the top/bottom of the boxplot, and finally outliers. In order to check for correlations between the measurements of management plan and orthophotomap data one can use the graphical method of scatterplot (Utts, 2005).

A bar chart is a chart with rectangular bars with lengths proportional to the values that they represent. The bars can be plotted vertically or horizontally For a visual representation of the two measurements of both the management plan and orthophotomap data, with respect to the subcategories of the various land uses, as well as the representation of their differences (measurement error), we have chosen to utilize barcharts, where y-axis depict the continuous variable of measurements and the x-axis the various categories of land use. Barcharts were constructed using statistical package SPSS 15.0 (Norusis, 2006).

3 Results

In figures 2, 3, 4 and 5 are represented in bar chart form all the data and the comparison between management plan data and orthophotomap ones.

In figures 6 and 7 are shown boxplots for the data and the differences between them. In figure 8 is shown scatter plot between data for management plan and orthophotomap included fitted line from simple linear regression

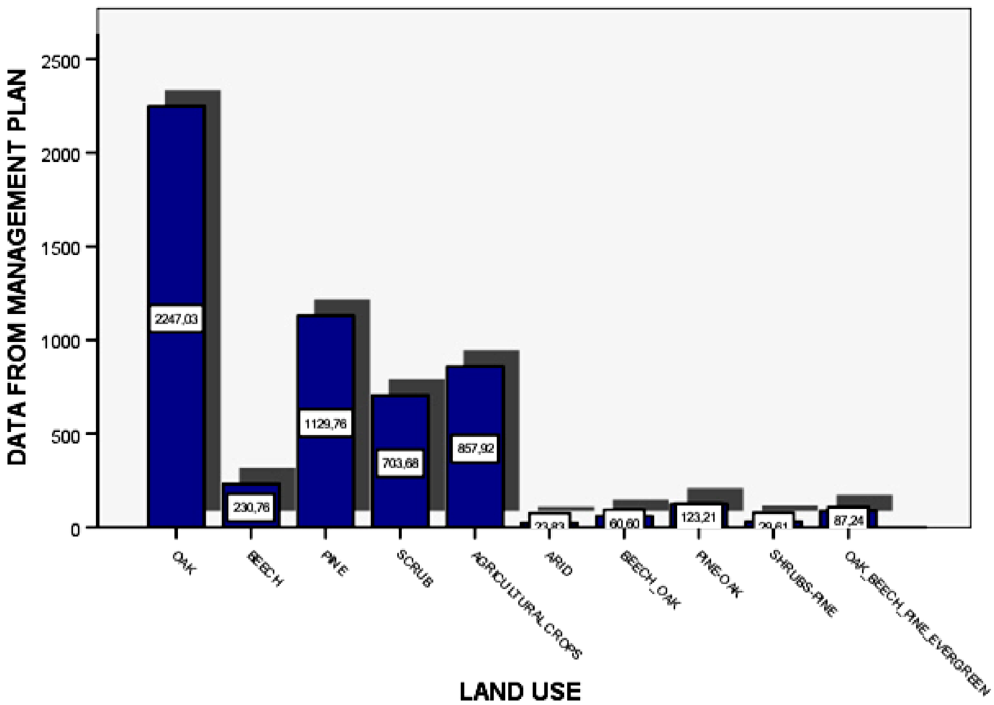

Figure 2: Bar chart with management plan data

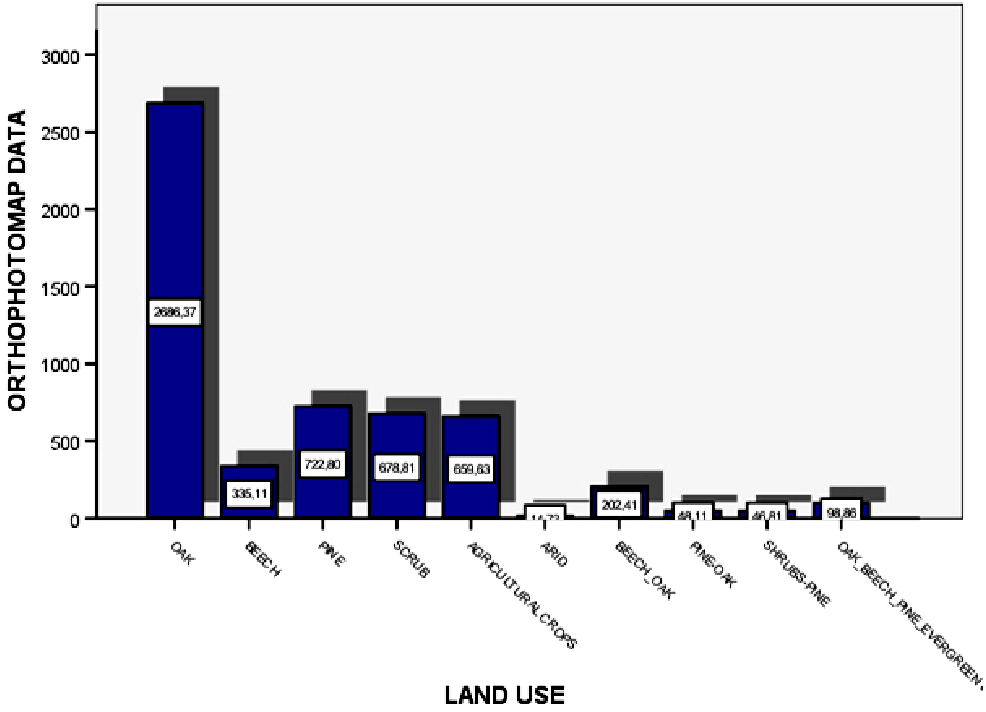

Figure 3: Bar chart with orthophotomap data

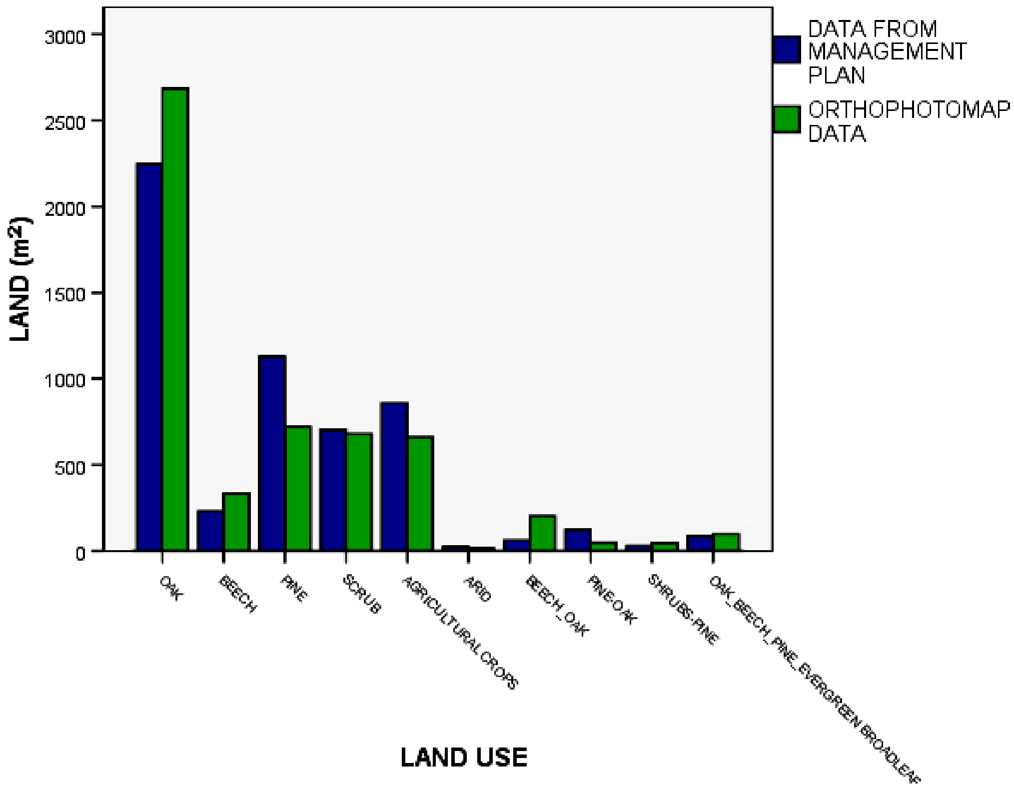

Figure 4: Comparative chart between data from management plan and orthophotomap

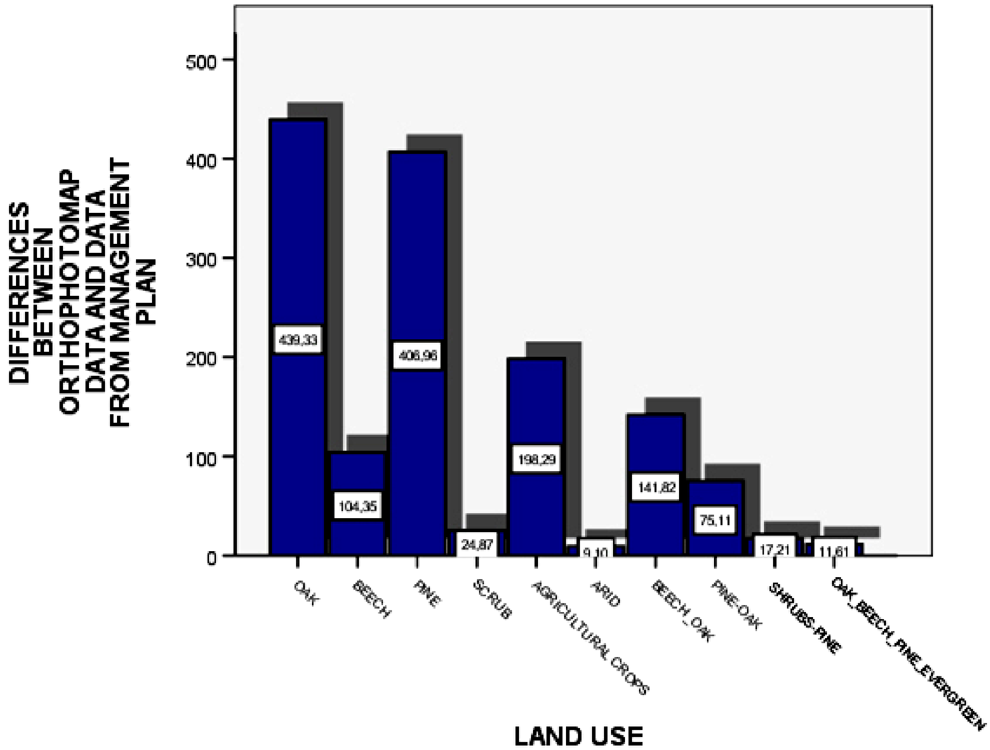

Figure 5: Differences between management plan data and orthophotomap data in bars

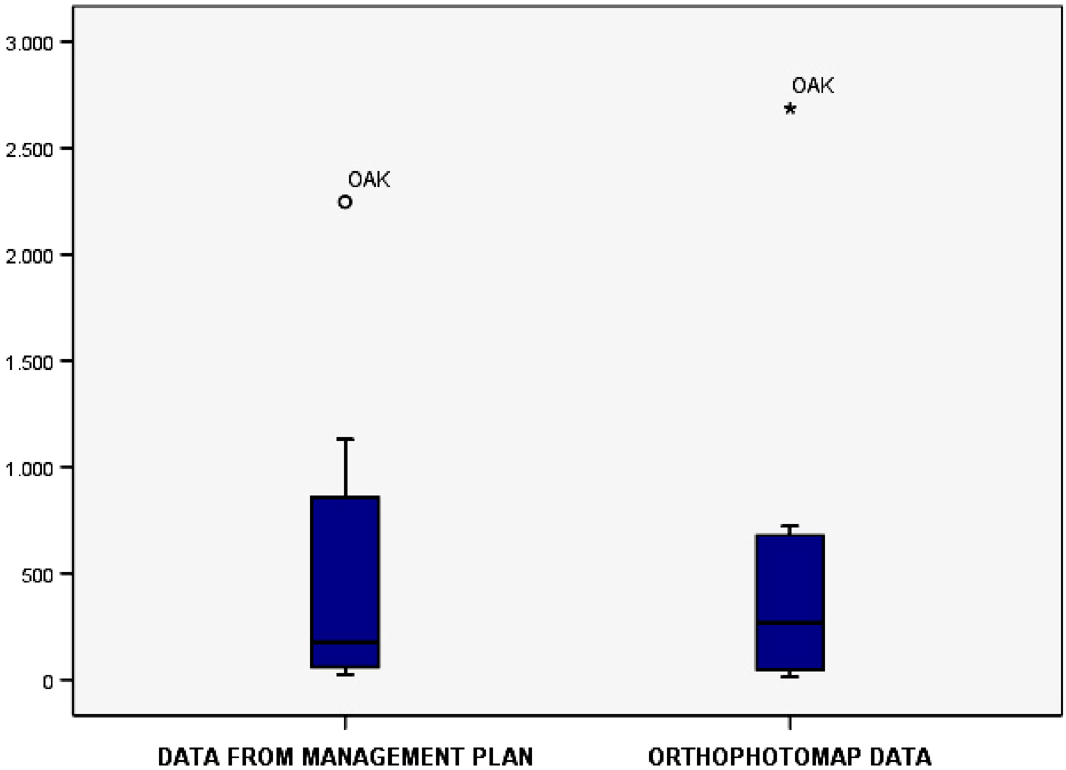

Figure 6: Boxplots for data from management plan and orthophotomap

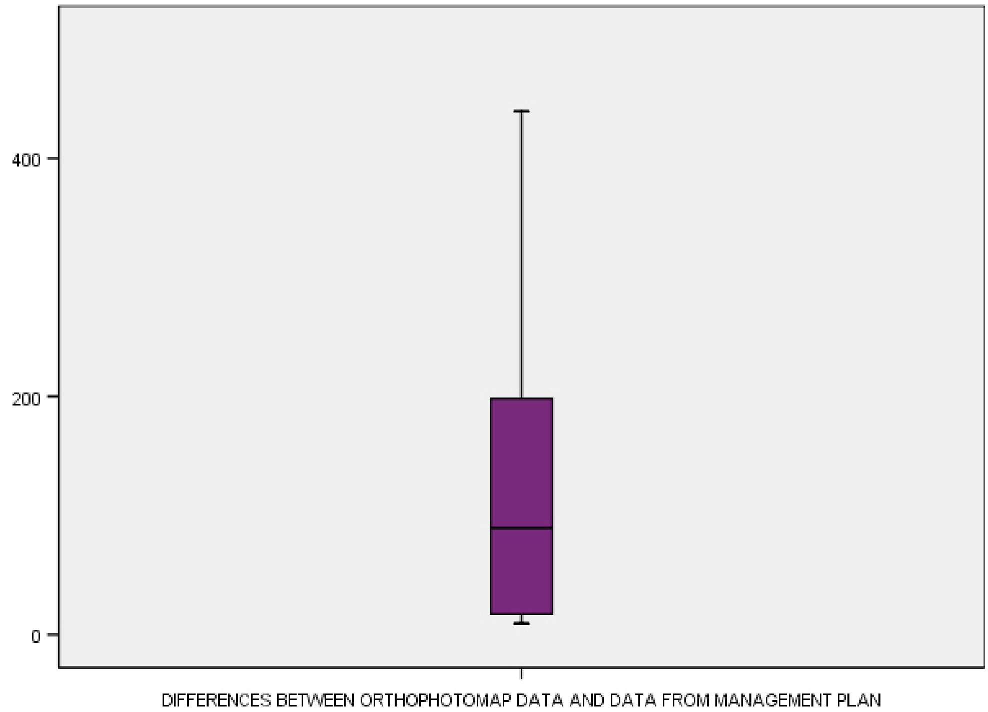

Figure 7: Boxplots for the differences between orthophotomap data and management plan data

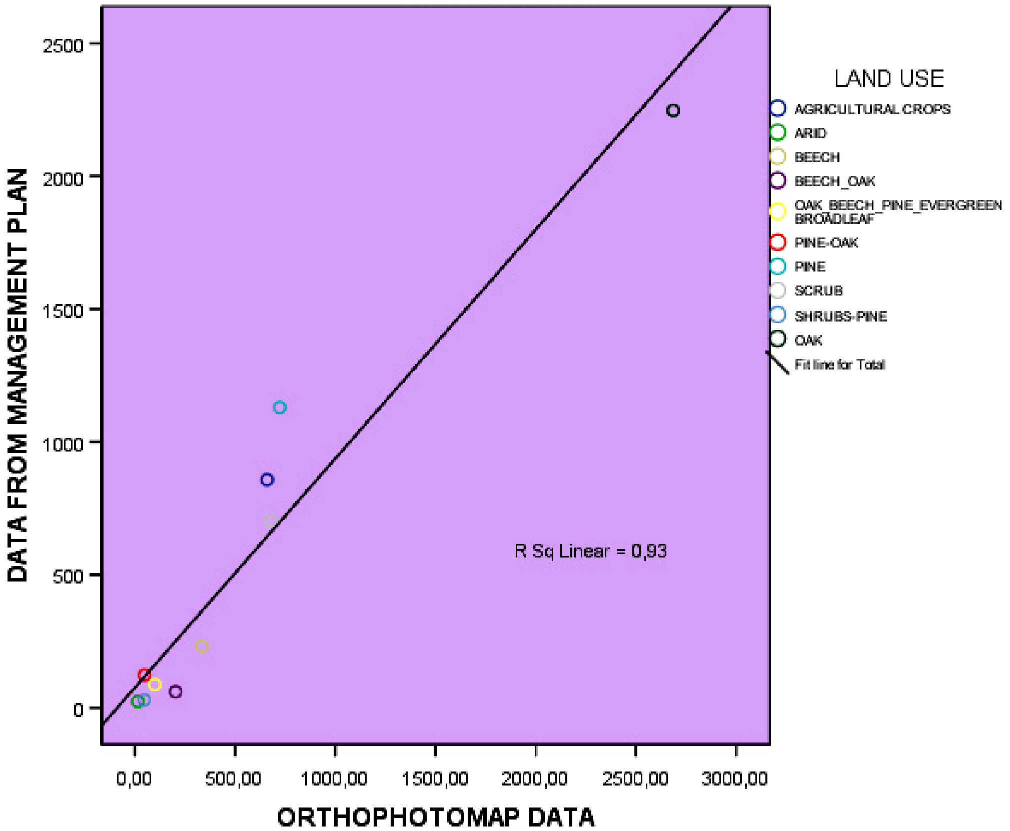

Figure 8: Scatter plot between data for management plan and orthophotomap included fitted line from simple linear regression

The average difference in hectares is 142.86; the standard deviation of differences in hectares is 160.42; the minimum difference in hectares is 9.10 and finally the maximum difference in hectares is 439.33.

4 Discussion

As one observes from the above boxplot, measurements for the land use on oak are extreme outliers (indicated by stars), when compared with the measurements of the rest of the land uses.

Figure 8 presents in a more quantitative manner the associations between the data obtained from management plan and those obtained from orthophotomap. Along the scatterplot, a line representing the fit of a simple linear regression model has been added to test for the association between the two measurements (Draper and Smith, 1998). As can be observed from the scatterplot and the line from the fit of a simple regression model between the two variables, there is a strong linear association between the two measurements (R^2 value = 0.93).

Natural ecosystems are a natural renewable resource with enormous environmental, social and economic value. The growing human needs for products, coupled with sensitivity for the environment, making it ever more necessary to adopt a more integrated science policy for the protection, preservation and development of these ecosystems.

To achieve this there must be a rational design and develop management strategies which take into account the political, economic, social, biotic, abiotic and environmental influences and constraints. These factors create a dynamic system over time, requiring a comprehensive understanding and knowledge of the distribution (identification, classification and mapping) of the characteristics and properties of natural ecosystems.

While it is necessary to examine all phases of collection, analysis and comparison of longitudinal data and information. In this way will allow the study of environmental changes and trends of anthropogenic pressures, etc. Given the size, distribution and diversity of natural ecosystems, the complex ecological, forestry and environmental consequences of human intervention, the huge volume of data and information, etc., developing integrated monitoring and management of natural ecosystems can provide a mechanism for solving problems through the management of complexity by using precision components due to a reliable map.

In this paper has been an attempt for recording and represented land uses. Within the scope of Geoinformatics, we can combine spatial and non spatial information with Digital Terrain Model (DTM) and Geographical Information Systems (GIS). The hybrid out of these technologies is a digital map created by specialists.

Consequently is very important the role of land use’s maps. Four forms of land uses are mainly exist and respectively four teams of scientists that oversee the Greek countryside: the cultivated areas, the wooded areas and the pasture lands, the settlements or regions of illegal building under the supervision or management of respectively Agronomists, Foresters, Veterinarians and Engineers.

Greek forests are an invaluable source of products and services. However, due to severe exploitation and fires they have been degradated seriously. To improve their condition, sound management procedures should be applied by forest managers. To do so, accurate and up to date inventory data are required and their representation on a digital or analogue map.

The digital maps of land uses can help to the more direct and more effective fighting of fires in mountainous regions with the information that they provide, as well as in the assessment of size of destruction that they caused and in the drawing of precious conclusions on the species that they harmed. The potential of social and ecological factors ought to be examined as it concerns the promotion of the protected area within sustainable rural development. Advantages of registration in the form of a spatial tool, especially when many types of information participate, are presented and give us a visual potential of how can forest operation can be planned in order to have a sustainable development considering low prices for harvesting and the best outcomes from the timber that will get.

5 References

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