CREATING A DATABASE FOR THE DENDRARIUM USING REMOTE SENSING AND GIS TECHNOLOGIES – EXAMPLES OF EXPERIMENTAL FOREST DEPARTMENT "PETROHAN", R. BULGARIA

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ABSTRACT: Using Remote Sensing and GIS technologies as an aid for creating database for the dendrarium in the Training and Experimental Forest Range "Petrohan" is the focus of discussion in the paper. The cardinal study goal is illustrating a concrete instance of applying GIS technology in the landscape architecture survey. This paper describs the methodology of vegetation mapping using traditional method combined with remote sensing data. Creating graphical and attribute table databases is also useful in the education of students in the University of Forestry in Sofia. Making semester projects in academic discipline "Dendrology" the students have to learn and analyze the features of trees and shrubs. GIS software provids the capability to analyze large data sets containing features of coniferous and deciduous trees and shrubs in the dendrarium. In the other hand the purpose of the development of the vegetation mapping methodology is to provide an objective and cost-effective survey method utilizing satellite remote sensing for the vegetation mapping. Overall, these results confirm that satellite imagery data coupled with field observations and direct measurements can be used effectively for precise mapping of trees and shrubs.The result of the analysis shows that image objects extracted from satellite data provide a new opportunity to make detailed inventory maps of ornamental vegetation in parks. In such cases, it is imperative that such exploration technologies should be used, which are cost effective and provide greater accuracy. An integrated approach of remote sensing and GIS technologies can just suffice these requirements during exploratory efforts in difficult terrains.
Keywords: satellite image, mapping, vegetation, coniferous, deciduous.

1 Introduction

Detailed mapping of tree and shrub species is often required in various landscape architecture design projects. This paper illustrates a concrete instance of the vegetation mapping using Google Earth Satellite Database, assuming the future use of satellite imagery data for the vegetation inventory information acquisition. A key requirement for the effective inventory of ornamental plants is the accuracy. Hand-mapping in the field is a technique commonly used in practice, but is inaccurate. In addition hand-mapping from field observation requires access to the site from the ground and visibility, a condition that does not exists always, especially on a very steep ground and in the presence of closely planted trees and bushes. Then measurement of distances is extremely time-intensive and often necessitates a large number of linear measurements. Because of these constraints, hand mapping is usually done on an as-needed basis, and comprehensive map that would support data base is done after taking dimensions of the terrain. There is need, therefore, to develop repeatable and reliable techniques for successive field and computer work, which allows mapping the vegetation objects, which can be accomplished using more conventional methods.

This study tested the suitability of the satellite imagery for improved mapping of plants in the parks. This work will be useful in future decisions about methods for detailed mapping of vegetation. (Rangelov 2003).

The objective of the investigation was to make a detailed dendrological inventory. The information it has provided might be useful insofar as directing future surveys or design projects. The graphical output serves as a basic plan to assess future activities in the park. The goals of this project were to map the spatial location of ornamental plants in the study area and to test the efficacy of satellite imagery for plant mapping.

Resolution of Google Earth data is about 1.00 m and provides enough information for distinguishing the majority of the trees. On the other hand, Google Earth imagery provides useful information such as diameters of the crowns. Therefore it is suitable for delineating trees in a quite precise manner. (Asenova 2009).

2 Material and Methods

In this study, a detailed mapping from actual satellite data was conducted for a specific park area. The dendrarium in the Training and Experimental Forest Range "Petrohan" near the village of Barzia was chosen for the study area. According to (Kuneva et al. 2009) this area is characterized by a rich species diversity of trees and shrubs and dense wood massifs. The ground in the area is characterized by displacement and slope configuration by (Destan 2007).

Technical objectives of the research are:

- to conduct the inventory in a way that all trees and shrubs occurring at the park are documented with their location and size in a scientifically credible manner;
- to develop methodology to accurately identify the location of ornamental park vegetation using satellite imagery, image-editing software and graphic software;
- to test methodology in a study area marked by difficult access of terrain and dense vegetation within the AutoCAD environment;
- to assess the accuracy of the mapping.

For this study, traditional methods by (Rangelov 2003) were used in the beginning of the field work for initially mapping of the terrain data, which was recorded in a sketch and then transferred to the digital format. According to (Asenova 2009) the multispectral satellite data with a spatial resolution of 1.00 m allows identification of quite a number of vegetation objects and amend their location and size at a drawing.

The sketch-map was created for use as a tentative set. Using a combination of field photos and field notes hand-mapped trees, shrubs and massifs were adjusted on the display of the image data. Using distinguished and adjusted trees as pickets were conducted direct measurements in the field and small trees and shrubs were fixed in the drawing.

The final product was derived from the Google Earth data after conducting the field work and after some amendments in the drawing. This product will allow the resource manager of the park to make up to date, well informed management decisions with a detailed vegetation map in a relevant and efficient timeframe.

A detailed drawing for the plants is created in three stages. The investigation started with drawing up a field sketching map produced for the park including areas managed as a dendrarium. The investigation used standard floristic inventory procedures to identify and document all 116 plant species observed. Location of the existing plants was judged by sight at first and was recorded as coniferous and deciduous trees or shrubs. The locations were marked in the geodetic survey as points (for the ornamental trees) or as polygons (for woodlands and shrubs). The geodetic survey was updated and made more precise prior to conducting the first stage of field work at the park. The primary purpose of the conducted field inventory is to create a field sketching map, and also verify the current presence of already-documented species, provide information on relative abundance, provide distribution information on endangered or threatened species or species of concern. Positions of the plants on the sketching map were fixed by traditional methods, i.e. approximately. The vegetation of the sketch-map has been scanned and processed in a digitized form. The trees were delineated over the drawing like points and the shrubs – like polygons.

The study starts with the image conversion in derivative formats for CAD software, which allow to insert it into AutoCAD where is possible to delineate image objects. The conversion was done using image processing software. The satellite photo was not put under geometrical rectification. This was equilibrated with just a little deformation of the image in order to coinciding with the geodetic cadastre. The satellite photo was used for this study as a technical aid. Its purpose is to provide pickets for the following stage of work – detailed field observations. At this stage, using an electronic ranger had been fixed positions of small trees and shrubs toward amended by satellite photo trees. Image insertion implemented in the AutoCAD was used to improve and to specify the field sketching map.

The image was converted to a derivative format for AutoCAD and used to rectification of the location and size of the distinguished tree crowns. Thus the draft of vegetation map was obtained and was finalized and supplemented by subsequent field surveys (field observations and direct measurements). The map compilation took into account massifs and single trees conducted in the area. The method permitted to delineate areas of conifers and deciduous woodlands on an extremely steep and difficult of access terrain, and to identify precise location and size of many individual tree crowns.

3. Results and Discussion

Many image objects at this zoom level correspond to individual tree crowns, as well as other spatial objects including roofs of buildings, walks, retaining walls, etc. Some of the shrubs are smaller than the individual pixels. A research question is how to determine an optimal zoom level for identification of individual plants.

The purpose of the work was to obtain sound information on the locations and real sizes of the trees and shrubs in a digitized form. The initial objective was to travel all over the entire territory

of the dendrarium, and to draw up a sketch of the existing vegetation over the geodetic survey.

Each graphical object in the hand made sketch needs to be amended, in accordance with the image (Figure 1). Some image objects in this study were relatively easy to be identified based on the spectral properties, and others are difficult to be determined only by the contextual information such as relative sizes, spatial relationships, texture, and so on. The Google Earth data used in this study was taken in spring, and vegetation–covered and non-vegetation areas were spectrally distinctive on the imagery. Among the conifer and deciduous trees, and grass areas showed relatively distinctive spectral properties on the photo so that their identification were easier after an arbitrarily variation of their color adjustment. On the contrary, instances of some vegetation classes were difficult to distinguish from other vegetation classes. For instance, some trees (both coniferous and deciduous) with loose crowns are very difficult to identify, but they cast clearly visible shadows on the ground so that property must be used for the determination rule. For distinguishing deciduous from coniferous trees, texture information of image objects appears to be useful. Sizes and shapes of image objects were also useful properties for distinguishing some trees such as high specimens with large crowns from others. Figure 2 shows a precise drawing illustrating conifer and deciduous trees as well as decorative shrubs within the dendrarium. Figure 3 shows developed GIS database concerning detailed graphical and attribute information for the dendrarium territory.

Fig. 1. Amendment of the drawing.

In comparison with traditional inventory methods the remote sensing data tend to produce better results representing vegetation cover. In the case of vegetation mapping using very high resolution satellite data, the results are useful in combination with traditional methods results, because the image provides additional information about the location and size of trees in the image objects delineated by the sketch. Anyhow some gaps in the drawing come into sight during the drawing amendment. To rectify these gaps, additional field work is needed, with an electronic telemeter.

Fig. 2. Dendrological drawing of the object.

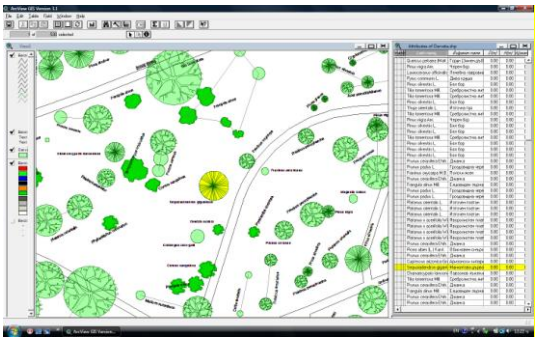

Fig. 3. GIS database for the dendrarium.

4. Conclusions

Traditional methods for large scale vegetation mapping require expensive time intensive field surveys. The use of remotely sensed, high resolution, multispectral data for mapping vegetation provides a detailed, accurate product in a time and cost effective manner. For this project, applying a hybrid approach was developed a plant inventory map using imagery data.

The result of the hybrid approach and using Google Earth data in this study suggests that Google Earth data would be a useful additional information source for the vegetation mapping for the landscape architecture design projects.

Very high-resolution satellite images are a useful information source for vegetation mapping, which is part of the design project data set.

Through this project, the spatial distribution of ornamental plants was mapped at a famous Bulgarian park in digital format.

The information collected through this effort will:

- increase the ability of landscape architects to analyze and map plants and non vegetative elements of the parks;

- serve as a baseline for long-term monitoring, assist with the characteristics of changes in parks over time and detect new elements there.

In addition, the data collected through this study will provide the basis for a plant inventory plan for the dendrarium in the Training and Experimental Forest Range "Petrohan" near the village of Barzia. This study shows that ornamental plants in the parks can successfully be mapped using satellite data and conventional methods. These techniques show promise as useful tools for vegetation inventory. This is especially applicable in the landscape architecture design projects because spatial extents and distribution of existing vegetation is very important and define the future plant composition of the parks.

5 REFERENCES

Asenova M. 2009. GIS as an effective tool for forest management. Management & sustainable development, University of Forestry, Sofia, Vol. 22 (1): 94–101. (in Bulgarian).

Destan S. 2007. Importance of Maturity Concept in Determination of Functional Rotation in Forestry. Review of the Faculty of Forestry, University of Istanbul. Series B, Vol. 1, № 1: 52–53.

Kuneva Ts., Kabatliyska Z., Petrova R., Yancheva D. 2009. One year flowering meadows. "Avangard Prima", Sofia, 108 p. ISBN 978-954-323-326-7.

Rangelov V. 2003. Spatial characteristics significantly affect the appearance of park areas. Proceedings of the "Jubilee Scientific Conference 50 Years University of Forestry – Sofia", April 2003, Sofia, Bulgaria: 272–276.