USING THE GIS IN THE FIELD OF ENVIRONMENTAL PROTECTION

Mădălina-Ştefania BUDE[1]

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Abstract

This paper aims to highlight the facilities that Geographical Information Systems make them available to the users in order to determine optimal solutions for the distribution of stands to be exploited. It also highlights opportunities available to control these systems and suggested solutions. For the study area were chosen vectorized cadastral plans and have taken some points and GPS equipment. After this were measured diameters and heights of trees with which the volumes were determined and then the allowable cut

Key words: Geographical Information Systems (GIS), Visual Basic for Applications (VBA), forest.

INTRODUCTION

Using geographical information systems in environmental protection is a key issue, which is seen not only through the advantages of the moment, but also of the future advantages. Forest ecosystem should be managed so that "the future generations should benefit at least as the current generation" (Hartig, 1785, in Leahu, 2001). In order to achieve this challenge a proper scheduling of cuttings is necessary. Until 90s this problem was solved simply in the sense that a calculation of the allowable cut of an entire management unit (which is overlapping, in the hills and mountains zones, over one watershed) was being perform. For the calculation of the allowable cut the growth indicator was used and, for control, the method of age classes was used (Leahu, 2001). After the 90s, with the appearance of property laws, the situation became more complicated due to the fact that there were many owners in the same watershed. Forest management projects that regulated the production forest were replaced by the so-called summary forest management studies which were performed for each owner (Leahu, 2001). These studies have a number of drawbacks among which two are notable:

✓ If in a watershed there is a surplus of exploitable stands (stands with age difference comparing with exploitability age is greater or less than 10 years) and

they belong to different owners, the cutting of a large amount of wood may be legally proposed, a situation that inevitably leads to the manifestation of torrential processes in the area (Tereşneu, 2016).

✓ When clear cutting treatment is proposed to exploit the wood. There is a restriction on such cuts to only 3 hectares. If exploitable stands are large areas within a watershed and belong to different owners, requests may occur (while being still legal) to apply this treatment on adjoining surfaces of more than 3 hectares. In conditions of a high quality forest management for an entire watershed such a situation can be solved by adopting the so-called exploitability sacrifices which means some stands were exempted from cuts even if it had exploitability age (Leahu, 2001, Tereşneu, 2016).

Consequently, we intend to develop a GIS methodology by which the watershed wood cuts may be rigorously verified. This challenge is necessary since the massive deforestation combined with the chaotic manifestations of weather in recent years have led to serious material damages and even losses of human lives (Clinciu et al., 2015).

STUDY AREA

This study has been conducted in Bran (45051'38''N 25036'57''E), Brasov with a total area of 1335 ha.
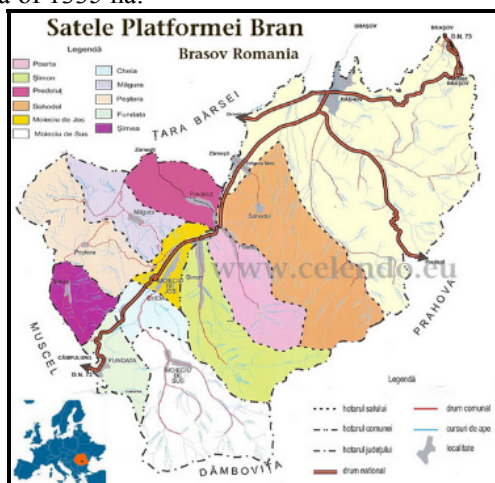

Figure 1. Study area

From the geomorphological point of view the study area includes stands that are placed on sites with slope angle ranging 50 to 400; altitude is between 900 and 1700 m (Tereşneu, 2016).

MATERIALS AND METHODS

28 scanned cadastral base plans, scale 1:5.000 dating from 1970, but updated in terms of forest boundaries, were used from which the interest data was taken through vectorization. For the same purpose, ortophotos, scale 1:5.000 resulting from flights in 2012 have been used. In the Romanian forest practice cadastral plans were and are still used, with the boundaries of compartments and subcompartments overlaid. Other data sources are orthophotos. Using these some boundaries were update and a number of changes that occurred in time were identified, like for example changes in the routes of forest roads. Also, there were used two types of GPS receiver Trimble PROXT and PROXH. GPS equipment was used in numerous situations and two dendrometric devices were used, namely: a precisely caliper for determining the diameters of trees and a hypsometer Vertex type (Vertex III with transponder T3) for measuring the height of the trees (Tereşneu, 2016).

To solve the studied problem direct field measurement method, statistical methods and (mostly) GIS methods: georeference, vectorization and GIS analyzes were used (Tereşneu, 2016).

REALIZATION OF GIS PROJECT

Compartments belonging to UB Bran were identified on plans and maps for the realization of the GIS project. For the correct determination of individual forest area bodies and total area, the position of boundary lines was determined using GPS equipment. The data field, after they have been corrected properly, were stratified by several criteria: general category (forest, forest line, forest road, open wood - forest at the upper limit altitude – alpine zone), stand characteristics (composition, consistency - the closeness of the crowns - age), orographic characteristics (valley, slope, edge, exposition). The overall accuracy of the position points is shown in Figure 2, wherein the 5 categories on the abscissa are intervals of 0.5 m (1 – 0-0.5m, 2 – 0.5-1.0m, 3 – 1.0-1.5m, 4 – 1.5-2.0m, 5 >2.0m).
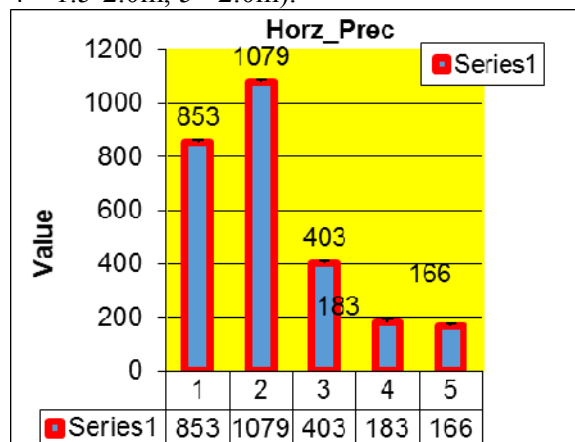

Figure 2. The horizontal precision of points taken with GPS equipment

Data were processed using Statistica software and some conclusions could be drawn on the accuracy of determining the points coordinates in areas with forest vegetation: the lack of vegetation on the one side is not necessarily an advantage, highest precision is obtained in high landforms (edge) regardless of the stand characteristics, the orientation of the exposition positively influences accuracy so far as it is close to the satellites route (Tereşneu et al., 2014, 2016).

Forwards the hybrid method AutoCAD-ArcGIS was used for the project GIS of study area (Tereşneu, 2007).

Below, were made in the database GIS specific calculations of forest planning (Tereşneu, 2016).

In order to have accurate data regarding the amount of wood that can be extracted from a forest in a year is need that the volumes of trees to be correctly determined. Volumes computation was achieved using the method of relative heights series (Giurgiu et al., 2004).

With the purpose of determining a mathematical model that should allow the automation of the determinations specific to the method of indicating growth, there an adapted variant of the SIMBIOF was used (Tereşneu, 2007, 2008). The adaptation of this software Referred to the conditions imposed to every stand with the purpose of its being fit within one of the 6 groups presented above.

Determining the measure of the allowable cut of main products through the intermediary of this model implies compulsorily going through two stages:

a) Repartition of the stands included within the production fund, through the intermediary of a condition of separation in six groups (C1…C6). In the framework of every group, for every stand there the growth of the principal production in different moments specified in the relations described within the algorithm will be calculated. There the condition for every stand to be placed in a single group imposes itself (Tereşneu, 2006, Tereşneu and Vasilescu, 2006);

b) Calculation of the indicators XV1…XV6 and application of the procedure for determining the allowable cut.

The obtained result for the allowable cut indicator through the method of the indicating growth is 2802 m^3. In order to verify, this indicator was determined with the help of two other types of software: the software AS which is still being used on the national level in view of determining the allowable cut and the software Microsoft Excel. The obtained results were identical (Tereşneu, 2007, 2008, 2016).

The indicator calculated above is not the only element necessary to establish the cutting wood. Also, it is necessary a spacing of these cuts in time and space. For this a review of the distribution of the forest stands by age class is performed, by achieving a proper thematic map (Tereşneu, 2006) (Figure 3).
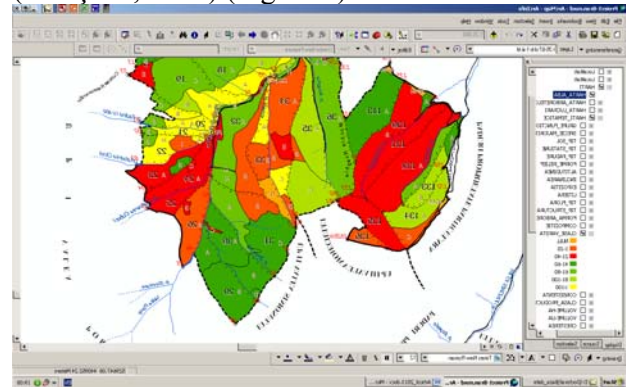

Figure 3. GIS project

In order to realize a control of how the stands are proposed for exploitation, the following way of thinking way was followed:

• storing all data on a central server, which is organized by localities and watersheds;

• obligation to surrender the forest management control projects in a common format – ArcGis (this measure is already beginning to be implemented);

• importing the data from the new project in the properly project of the locality and watershed and linking the new database via functions *Relate* and *Join* ;

• verifying the accuracy of calculated data. For this purpose a series of tests are made, such as: correctness of the calculated volumes (it is create a new field that is completed by a VBA sequence which is recall from the old project memory; this sequence was created in the manner described above); correctness of calculations relating to allowable cut (VBA sequences are used to calculate the indicators presented in pct. 4.2 and, finally, the allowable cut can be determined). If these calculations are correct the following steps are done;

• realization of a thematic age classes map with common data across watershed and following the possible critical situations (which will be indicated automatically, by creating a distinct color in thematic map) (Figure 4) (Welch et al., 2002; Butler and Schlaepfer, 2004);

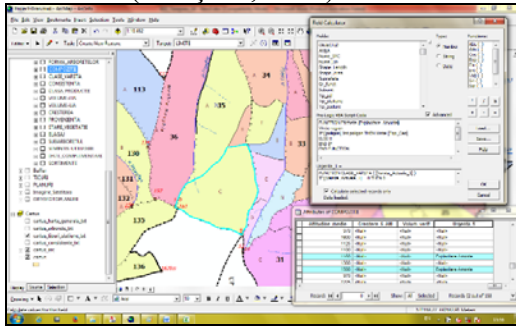- rescheduling the cuts after new observed situation (Tereşneu, 2016).

Figure 4. Reporting the problematic situations in GIS

The method is easy to implement and facile to control (Tereşneu, 2016).

CONCLUSIONS

Using Geographic Information Systems proves to be not only desirable but also highly effective in solving these environmental problems. As shown in this paper is not enough just to calculate the correct amount of wood that can be exploited in a forest, but a similar importance is the way in which the areas that follow to be exploited are distributed in space. On this line, this paper has demonstrated that it can use this modern tool for an optimal solution for this situation.

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