DIFFERENTIATED USE OF CARTOGRAPHIC MATERIAL IN THE FORESTRY SECTOR, IN THE PLAIN AREA

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Abstract

The use of cartographic material in the various activities within the forestry sector can currently be done in a different format, depending on the existing logistical base and, respectively, the needs and specifics of the activities.Forest maps in analog format have been used for over six decades, but the working accuracy is relatively low. Currently, forest maps can be used in digital format, after completing some stages specific to digital cartography, and appropriate logistics are also required for the respective activities. The orientation of forest maps in the national reference system can be achieved through special transformations, using known coordinate points in the two coordinate systems for this purpose. The case study was carried out using the common points, with known coordinates in the national reference system STEREO1970, which were identified on the orthophoto plane, in the work area. The precision and respective accuracy with which the forest map was georeferenced is satisfactory for the study carried out, and for the application in other locations, it is necessary to respect the consecrated work stages, to identify precisely the points in the two work systems, as well as to accurately determine of the coordinates of common points, in the national reference system.

Keywords: Forest map, raster, digital map, vector, orthophoto plan, forest sector.

INTRODUCTION

The activities carried out within the forestry sector often require the use of a specific cartographic material, namely forest maps. These have been used over time in analog format, on paper and/or canvas, as the case may be, usually at a scale of 1:20000 (Crainic, 2011).

Currently, forest maps are still sporadically used in analogue format, at a scale of 1: 20000, with the possibility of using them in rasterized - digital format, with the help of specialized geomatics applications (Boş, 2011), on electronic computers, tablets, mobile phones, (on different types of gadgets).

Maps, as conventional graphic representations of the terrain, on a scale, on considerable surfaces, take into account the curvature of the earth and, respectively, the atmospheric refraction. Their content elements depend on their specificity and, respectively, on the activity sector for which they were drawn up.

Forestry maps have a content specific to the activities in the forestry sector, consisting of graphic elements - the contours of plots and subplots, production units, enclaves, etc., and a series of attributes related to the characteristics of stands, to the silvotechnical interventions proposed through forest management in vigor, etc. (Boş, 2011; Crainic, 2011)

The accuracy of exploitation of the cartographic material related to the forestry sector, in analogue format Pg, is directly correlated with the scale at which the forest map was prepared - N, and respectively with the graphic error eg, which depends on the normal acuity of the human eye, which is approximate 0.2 mm (Crainic, 2022).

As a result, the accuracy of working with cartographic material in analog format, related to the forestry sector, presents the following mathematical expression (Crainic, 2022; Sabău, 2010):

Pg = N x eg .

Pg - map precision;

N-the denominator of the analog map scale;

eg - graphical approximation error.

In digital - rasterized format, the cartographic material can be exploited (used) differently (Petrila et al, 2010), depending on the particularities of the scanning process (resolution, colors, etc.) and respectively on the aspects related to georeferencing (scale, coordinate system, common points in the system of reference, transformation parameters, etc.).

In order to use the coordinates of the various characteristic points of detail, which can be found on the forest maps, in the national reference system, it is necessary to georeference them, in the STEREO-1970 system. As a result, through georeferencing, the rasterized forest map is associated with a coordinate system, related to a clearly defined geodetic datum.

The necessary elements for the georeferencing of the raster related to the forest map, in the national reference system, are represented by: the type of ellipsoid, the fundamental point, the type of cartographic projection adopted, the coordinates of the center of the coordinate system, the direction of the coordinate axes, the coordinates of common points in the two systems of coordinates, specialized program (digital cartography) that will be used to create the application, qualified personnel for the respective activity (Bodog&Crainic, 2016; Crainic et al 2021; Crainic, 2011).

MATERIAL AND METHOD

The case study was carried out in the forest fund of Maşloc, Timiş county - photo 1 and figure 1.

To carry out the case study, cartographic materials related to the forestry sector from the location where the research was carried out were used, respectively the forest map, in analogue and digital format - rasterized - figure 1.

Also, the orthophoto plan related to the location of the research was used - photo 1, the forest layout, and the MapSys 10.0 digital cartography program.

The research methods used are represented by: bibliographic documentation, experiment, comparison, simulation (Crainic, 2021).

For the orientation - respectively the georeferencing of the raster related to the forest map used, in the national reference system, the planimetric coordinates (in 2D space) of the characteristic points used, identified on the orthophoto plane, were used.

As a result, four common points were used, representative, respectively easy to identify, in the two working spaces (systems), represented by orthophotoplan and raster - table 1. Because, the parcel related to the forestry unit where the case study was carried out is mostly rectangular, it is relatively easy to identify the corners of the plots and the forest subplots, on the orthophoto plane (Crainic et. al. 2021, Crainic et. al. 2018).

In this context, forest plot 20 was analyzed, with the related forest subplots, respectively u.a. 20A, u.a. 20B, u.a. 20C, u.a. 20D, u.a.20E and u.a. 20F, and forest plot 19, with subplots u.a. 19A, u.a. 19B and u.a. 19C.

The transformation used was carried out in the 2D space - respectively in the plane, on common points, with five parameters, two rotations, two translations and respectively the scale factor (Damian&Crainic 2010, Damian&Crainic 2011; Marton 2007; Tămâioagă& Tămâioagă., 2007).

RESULTS AND DISCUSSIONS

The use of common points for the georeferencing of the raster related to the forest map determined the achievement of some interesting results, which will be analyzed further.

The accuracy and precision of achieving the planar transformation depends directly on the precision with which the characteristic transformation points were materialized on the used orthophotoplane.

The work stages, which were completed for the georeferencing of the raster used, are the following (Crainic, 2011):

-establishing the raster scale;

-raster import;

-choosing the orientation method (georeferencing);

-establishing and materializing transformation points;

-determining the coordinates of the transformation points - tab.1;

-implementation of transformation points;

-the initiation of the transformation process;

-completion of the transformation process;

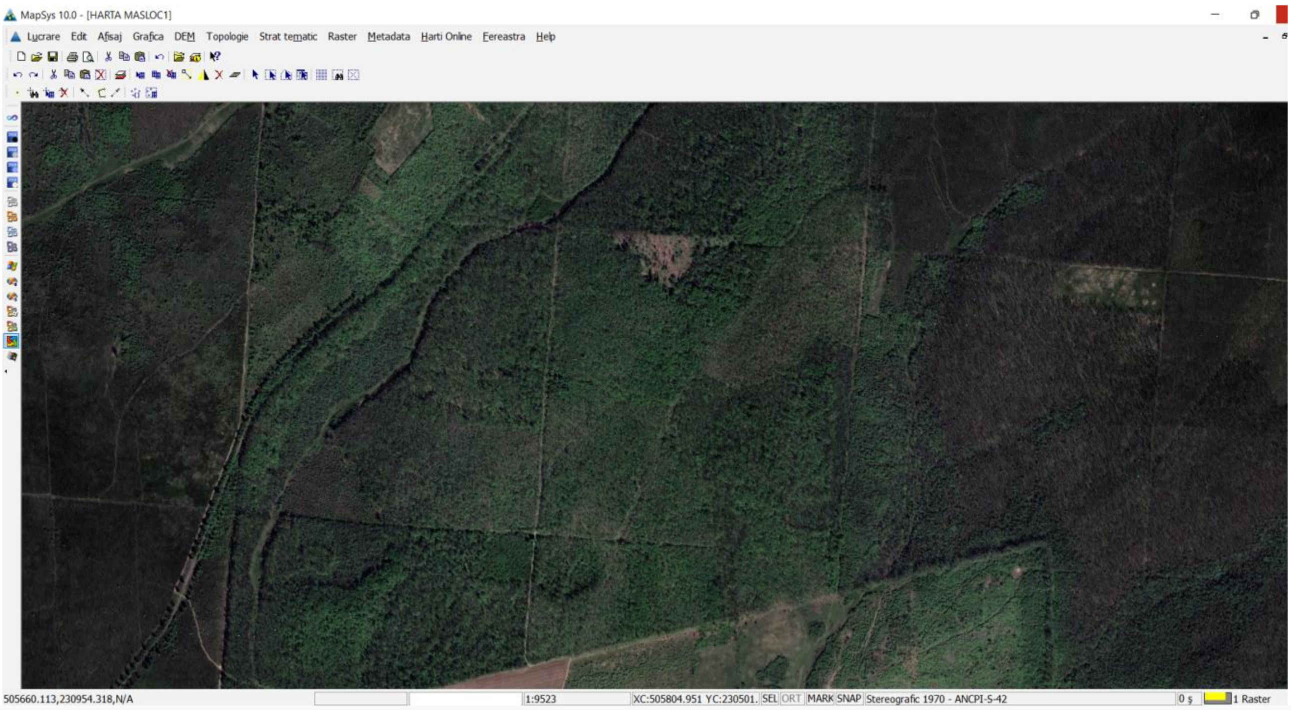

Photo 1 **The orthophotoplan of the working area (obtained with the MapSys 10.0 program)**

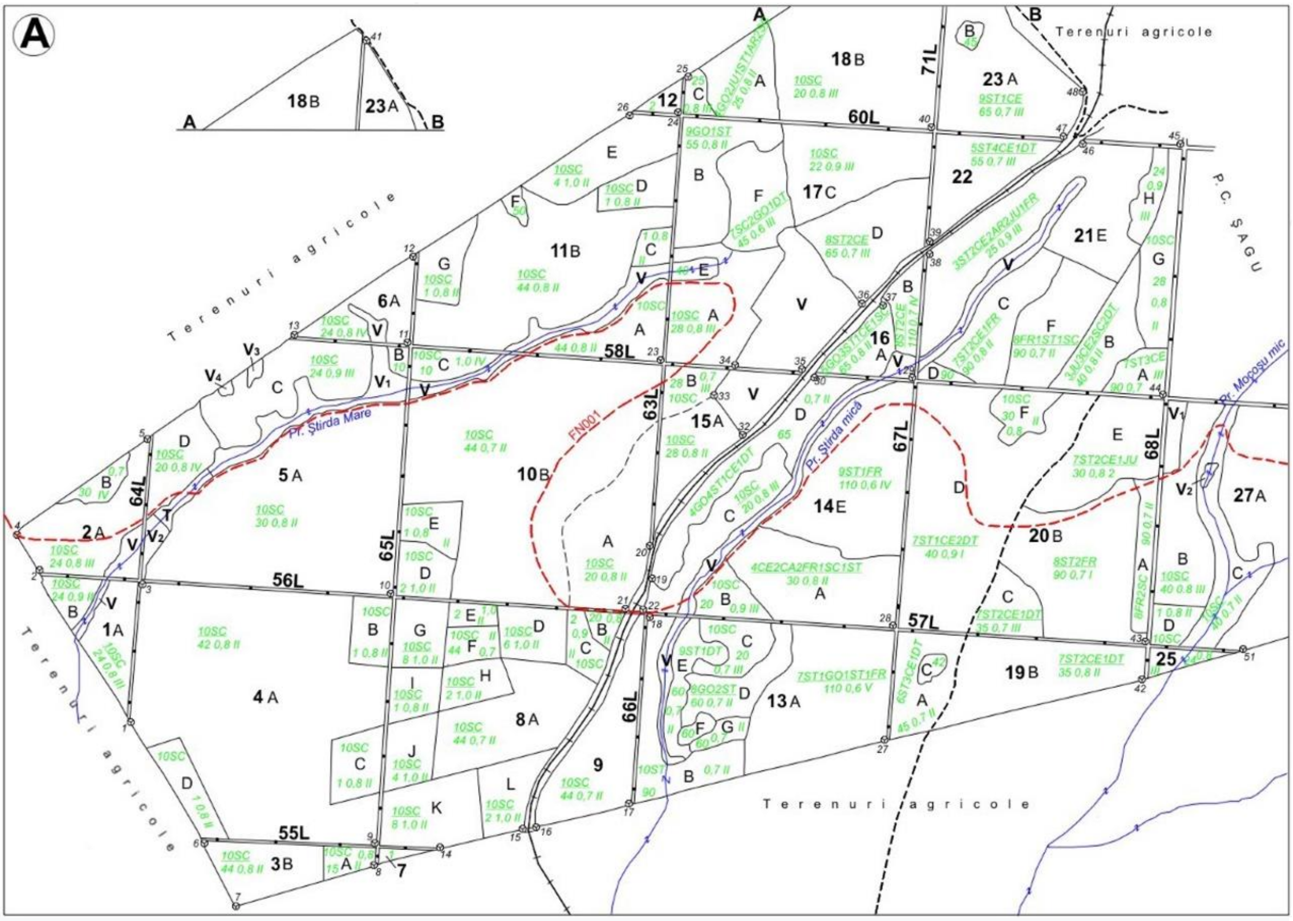

Figure 1 **The forest map used**

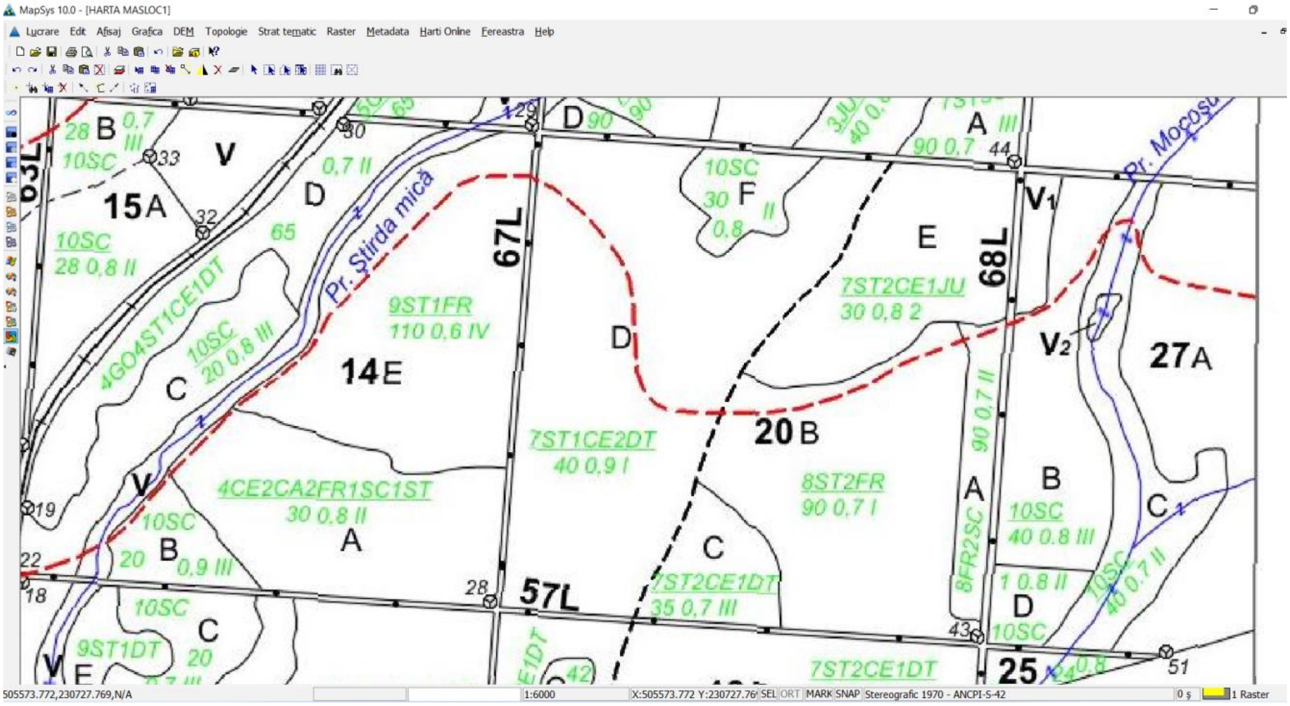

Figure 2 **Location of plot 20 on the forest map**

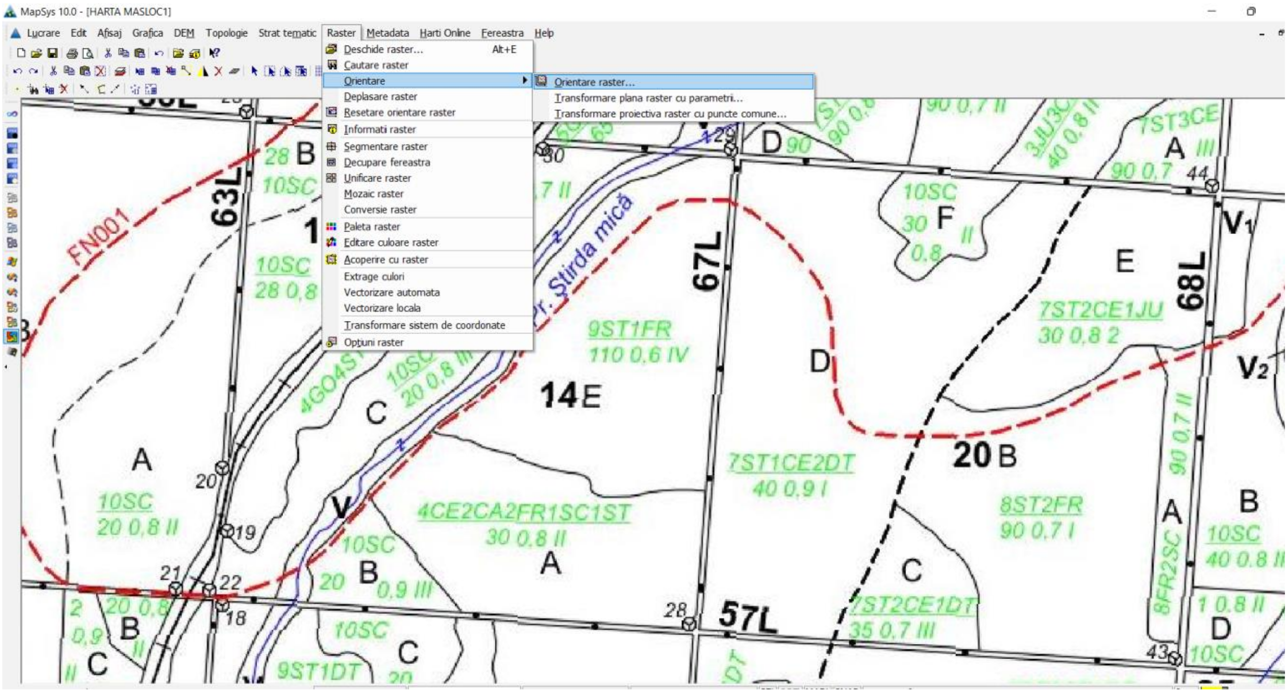

Figure 3 **Initialization of the process of orientation (georeferencing) of the raster related to the forest map**

Table 1

The coordinates of the characteristic transformation points, in the national reference system

No. crt.	No. point	X(m)	Y(m)	Code
1	1	505466.785	230174.550	1
2	2	506212.981	230230.481	1
3	3	506166.104	230983.355	1
4	4	505410.869	230915.393	1

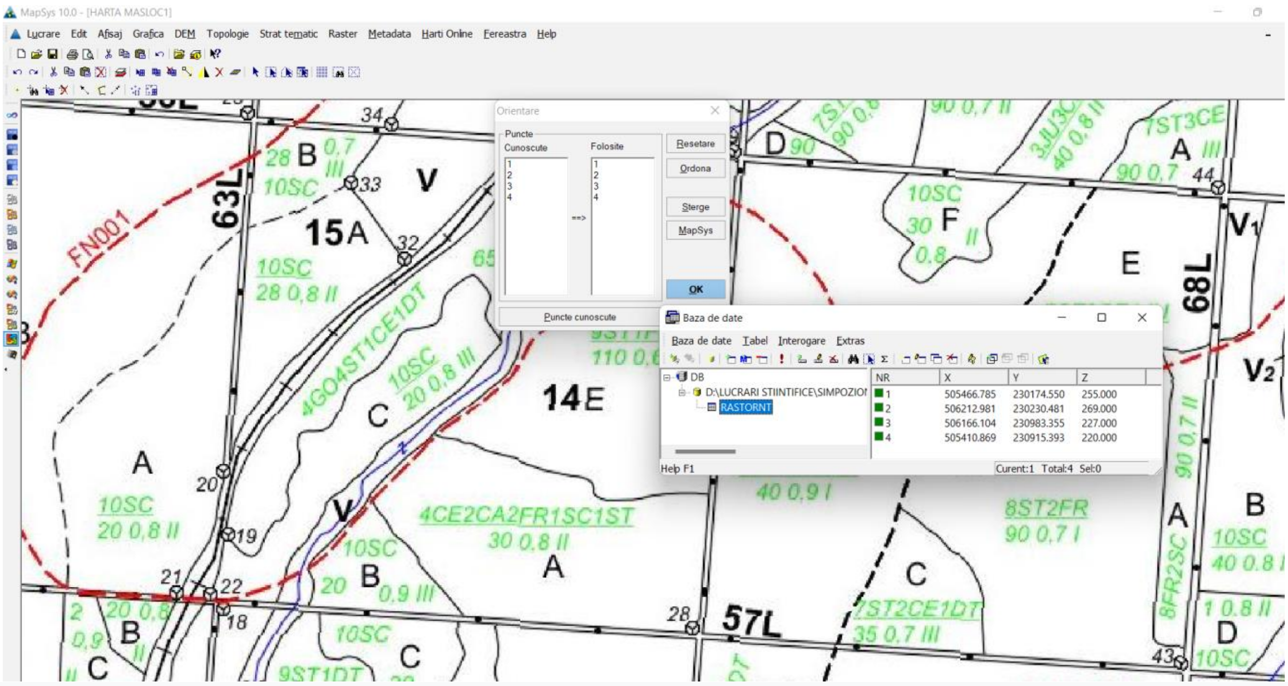

Figure 4 **Realization of the process of georeferencing the raster related to the forest map, using common points 1, 2, 3 and 4**

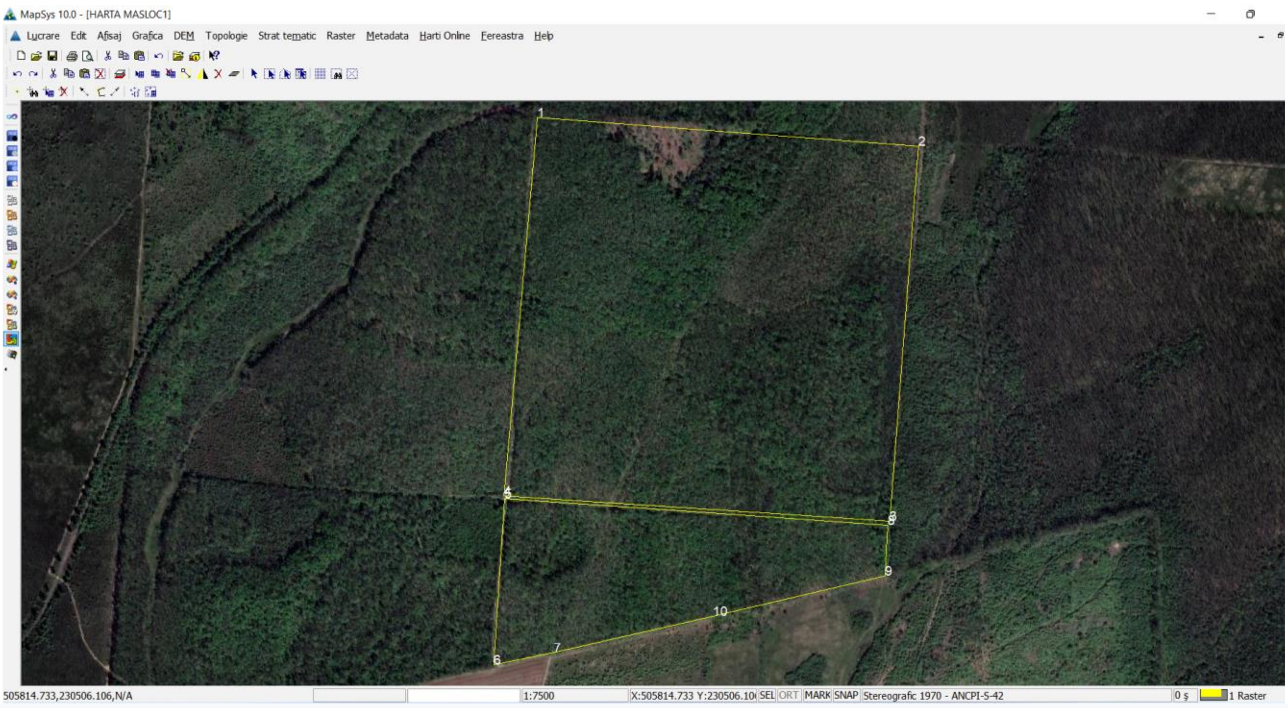

Photo 2 **Obtaining the related vector**

Table 2

Comparative presentation of the values of the areas of the subplots according to the data from the forestry management and the respective ones obtained on the vector related to the forest map

No. crt.	Subplot (u.a.)				
	No.	Surface (ha)		The surface difference	
		from forest management	from the vector	(ha)	(%)
1	19A	5,00	4,74	0,26	5,2
2	19B	10,80	10,89	-0,09	-0,8
3	19C	0,50	0,56	-0,06	-12,0
4	**Total plot 19**	**16,3**	**16,19**	**0,11**	**0,7**

Table 3

Comparative presentation of the values of the areas of the subplots according to the data from the forestry management and the respective ones obtained on the vector related to the forest map

No. crt.	Subplot (u.a.)				
	No.	Surface (ha)		The surface difference	
		from forest management	from the vector	(ha)	(%)
1	20A	2,30	2,65	-0,35	-15,2
2	20B	14,20	14,37	-0,17	-1,2
3	20C	3,30	3,26	0,04	1,2
4	20D	25,60	24,75	0,85	3,3
5	20E	8,50	8,65	-0,15	-1,8
6	20F	2,30	2,26	0,04	1,7
7	**Total plot 20**	**56,2**	**55,94**	**0,26**	**0,5**

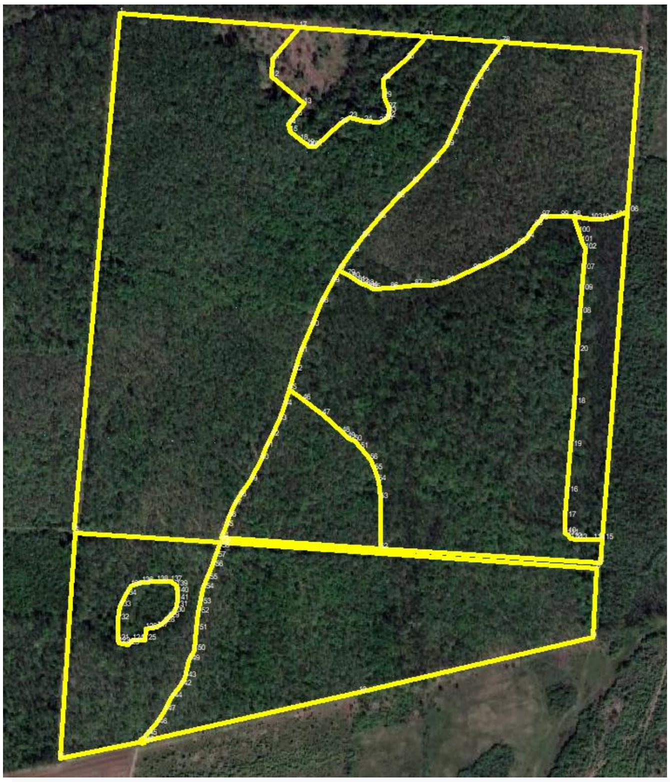

Photo 3 **The vector of subplots on the orthophotoplane**

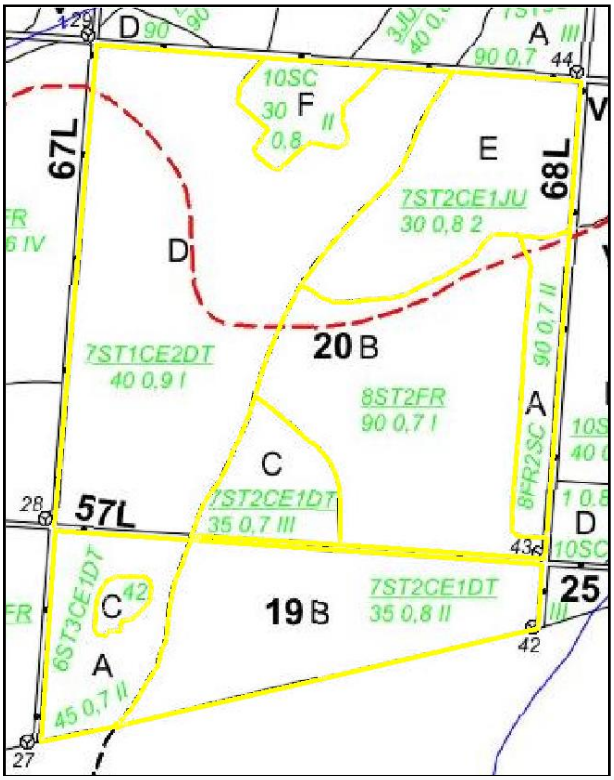

Figure 5 **Vector of subplots on the raster**

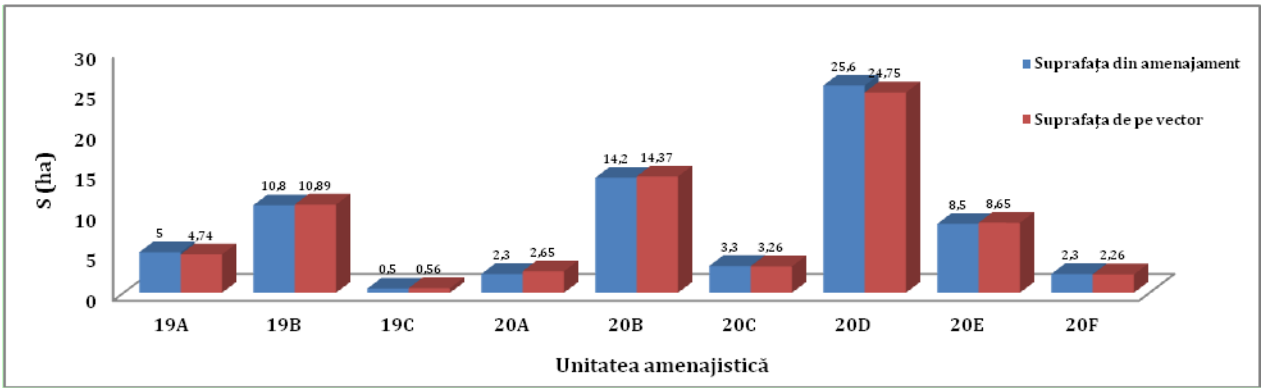

Figure 6 **Comparative presentation of the sub-plots' surfaces according to the values from the forestry management and those obtained on the vector related to the forest map**

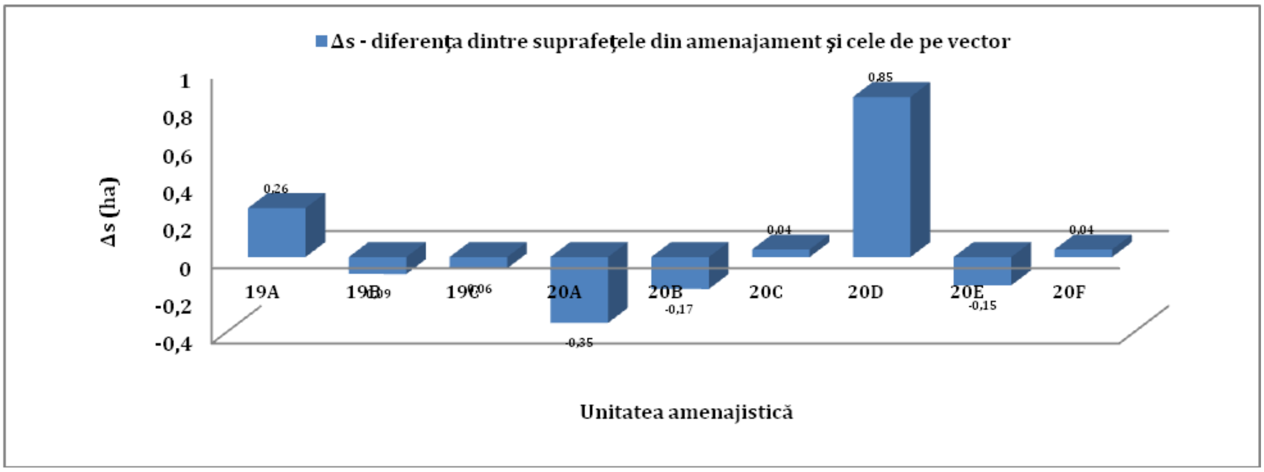

Figure 7 **The difference between the area in the forest management and the one on the vector, expressed in hectares**

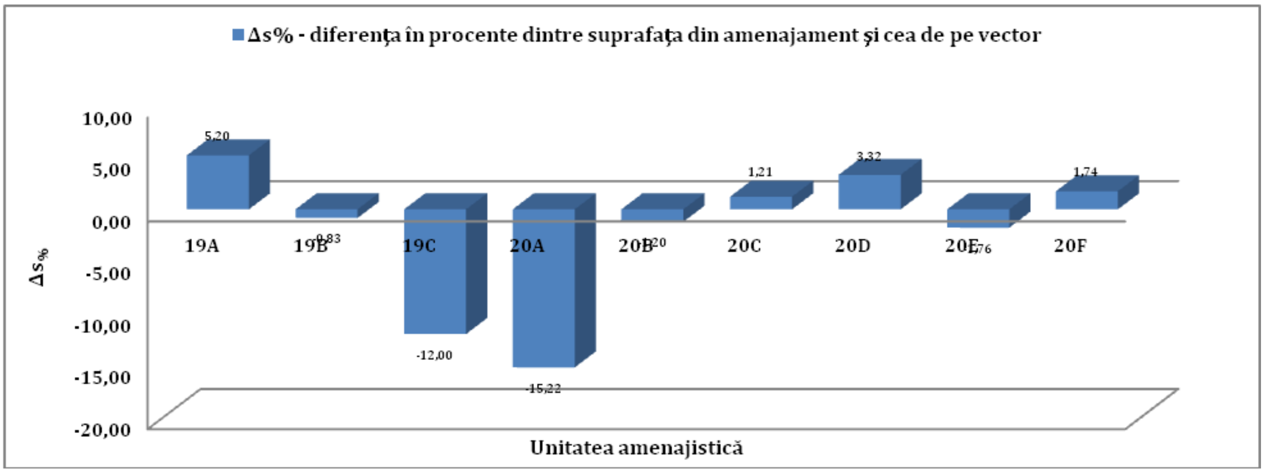

Figure 8**T he difference in percentages between the area in the forest management and the one on the vector**

-checking the oriented raster.

These work steps that have been listed are presented synthetically in the related images, taken from the MapSys 10.0 program – fig.3, fig. 4 and photo. 2.

Through the vectorization process of the georeferenced raster, related to the forest map used, a vector (a digital copy of the raster) will be obtained that will overlap relatively faithfully over the orthophoto plane of the analyzed and studied location (in this case study, parcels 19 and 20 are analyzed in detail).

As a result, a series of aspects related to the delimitation of the stands can be analyzed under optimal conditions on the orthophotoplane, being materialized on the related raster vector (which overlaps the orthophotoplane) - photo. 3 and fig. 5.

In order to be able to analyze the accuracy and precision with which the process of orientation (georeferencing) of the raster related to the forest map was carried out, the values of the areas of the subplots in the forest management were compared with those obtained from the vector related to the oriented raster.

Thus, the differences obtained vary between 0.11 ha for plot 19 - table 2 and respectively 0.26 ha for plot 20 - table 3, fig.6, fig. 7 and fig. 8.

If the differences obtained are related to the surfaces of the sub-plots (presented in the forest management), the percentage difference of these analyzed surfaces results, respectively 0.7% for plot 19 and 0.5% plot 20.

From the analysis of the values related to the surface differences, for the plots studied and analyzed, it is found that these differences are very small, consequently the georeferencing process was carried out with high precision and accuracy.

It can also be noted that the surface differences at the sub-plot level (u.a.) show significantly different values compared to those at the plot level, an aspect that is due to the particularities of identifying and delimiting the stands (corresponding to the sub-plots) on the orthophoto plane (Curilă et al 2014).

CONCLUSIONS

The use of forest maps in analog and/or digital format, depending on the working conditions, offers the possibility to forest sector specialists to adopt effective technical solutions, for perspective strategies and respectively for various current activities in the forest sector.

Considering the facilities offered by modern technologies for the differentiated use of cartographic material, in the activities of the forestry sector, it is necessary to implement of specialized geomatics applications, regardless of the owner and administrator.

For the realization of some complex geomatic applications, related to forest management and management activities, the existence of an appropriate logistic base, namely the Hard base, the Soft base, and last but not least the existence of a specialized staff to serve them, is required.

The use of the orthophoto plan and forest maps in digital format facilitates the adoption of optimal solutions regarding the spatial location of various details in the forestry sector, related to the activities of culture, guarding and exploitation of the forest.

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