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STUDY ON TOPOGRAPHIC SURVEY OF A FOREST AREA USING COMBINED TECHNOLOGY GPS AND TOTAL STATION

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ABSTRACT

The purpose of this topographic survey study is scientifically show a new methodology for the technical documentation preparation of a forestry properties, based on the combined application of technology, using GPS Topcon GR3 receivers and Topcon total station 3005LN, to obtain its inclusion in the Land Registry, at the request of Forestry Department Dolj. For this purpose was taken into study area from forest planning UP IV Viişoara Forestry Office Amaradia, Dolj County, for which all data were collected on the ground, after which they were processed with specialized software Excel 2003 and TOPOSYS 7, obtaining the coordinates of all contour points in stereo 1970 and finally was drawn location and delimitation plan for the four properties at 1:2000 scale with AutoCAD 2002.

INTRODUCTION

In order to achieve this work were have studied two properties located in UAT Craiova and UAT Gherceşti extravillan, property effectively represents the UP IV Viişoara forest planning - Amaradia Forest owned by the Romanian state being administered the National Forest ROMSILVA Bucharest - Forestry Department Dolj R.A.

These woodlands are situated in the eastern part of Craiova, from the area Hanul Doctorului to County Road Craiova - Gherceşti being thus divided into four bodies:

Location and neighborhoods of first forest sector: SOUTH - Craiova ring road; EAST - Gendarmerie unit, WEST - private owners, NORTH - DJ Craiova - Gherceşti. This forest is located on the UAT Craiova with a total area of 440.153 sqm.

Location and neighborhoods of the second forest sector: SOUTH - Gendarmerie unit, EAST - private owner; WEST - Craiova city boundary NORTH - private owner. This forest is located on the UAT Gherceşti with a total area of 24.925 sqm.

Location and neighborhoods of the third forest sector: SOUTH - Craiova ring road; EAST - Gendarmerie unit, WEST - private owners, NORTH - DJ Craiova - Gherceşti. This forest is located on the UAT Gherceşti village with a total area of 35.503 sqm.

Location and neighborhoods of the fourth forest sector: SOUTH - the Hanul Doctorului; EAST - Metropoly vineyards; WEST - private owners, NORTH - Craiova ring road. This forest is located on the UAT Craiova with a total area of 149.596 sqm. These properties are divided into production units and arrangement units.

PURPOSE AND SURVEYING METHODS

Purpose of this paper is the inclusion in the Land Registry of woodland within the arrangement UP IV VIISOARA FORESTRY OFFICE AMARADIA, Dolj County.

Surveying for setting limits properties subject to the above-mentioned project required the need of a thickening and surveying network using GPS technology, combined with measurements of total stations. In terrestrial measurements, modern technologies by GPS positioning type are used primarily in the global geodetic networks (global and continental) surveying networks for mapping and engineering surveying and also in cadastral works. Networks determined using GPS are not constrained by the need of

visibility between station points as in the case of traverses, triangulation or trilateration, for equivalent or superior accuracy.

Its use has enabled and increased distances between points, above the classical distances used in the measurements. The Global Positioning System technology revolutionizes currently terrestrial measurements succeeding to substantially change measurement theories so far. A major advantage of using GPS technology is that not required angle and distance measurements, thus eliminating many of the disadvantages of using total stations.

In the design work and recognition of land was intended that the points included in the network, to comply a number of favorability criteria for determinations on GPS networks:

- materialization of points to ensure its stability and conservation in time;
- points do not be marked with metal pyramids bridges;
- points must have free horizon and no obstructions around them higher 150 meters;
- access points to be comfortable and possibly by car;
- choosing points position do not raise problems in their use, anytime, by any user, or because the landowner on which they are located.

GPS technology with its only requirement that good visibility into the sky, finally came among the basic equipment used in geodesy. More and more users realize the many opportunities provided by the GPS and use it combined with traditional methods, thus increasing efficiency and productivity. Measurements can be performed both by day and night, in all seasons, in all weather and visibility.

Taking into account the area (land configuration and relief) of UAT Craiova and UAT Ghercești we considered it necessary to plant six new points. New points will be noted with B1, ..., B6, all they respecting the precision conditions required. The method used to determine the new geodesic points was the use of two permanent stations of the ROMPOS national network (CRAIOVA and SLATINA) and using a national network triangulation point, respectively the point of first order Carcea.

New determinated points have been marked by concrete landmarks. They are located in areas easily accessible. New points can be used for guidance either in pairs, a pair of new points that are visible to one another, either individually using one of the new points and a point from the old network.

RESULTS AND DISCUSSIONS

A planimetric network of a locality contains all existing surveying points in a unitary system, determined by triangulation, trilateration, poligonometry, GPS, as detail points determined by any method that ensures the accuracy of determination required (methods of execution of the introduction of real estate cadastre in localities - 1997).

Drawing technical documentation requires making cadastral works in three phases:

1 - operations of documentation and preparation of surveying project;

2 - ground stage;

3 - office stage.

1. Operations of documentation and preparation of surveying project

Through this project was specified area of interest. To delimit the area of interest was taken administrative territorial limit of UAT Gherceşti and Craiova, from OCPI Dolj.

It was necessary to identify and establish territorial-administrative borders of neighboring municipalities. Boundary work was performed in compliance with the technical rules for entering general survey approved by Order no. 534 of 01.10.2001 of the Ministry of Public Administration published in Official Gazette no. 744 of 21.11.2001.

At draws up the draft work, we studied whether there is a plan or an ancient map on which was made recognition of the land, has traced the outline surface, support points and surveying points. Also, the geodesic points were identified in the area.

After studying them, they started to recognize the land, which consisted in identifying support points, the land borders and all the details. Recognition of land is a very important operation, often difficult, conducted over large areas with isolated points, difficult to access.

Objectives pursued at land recognize were:

a) location of the geodetic points

Maps and plans on is made the network design can not provide all the details needed to establish the exact location of triangulation point, so completion will be made at recognition of land.

Upon completion of the field location must be taken into account:

- Points to be located on land with stable soils;
- Points shall be located in close proximity to communication routes, power lines, telephone lines, buildings etc.. Towards these objectives distance should be at least three times the height of the signal and not more than 50 m, and the high-voltage network at least 100 m.

Leveling marks shall be located only in buildings with an proper age and will not be demolished. Access point to be as simple as possible.

b) determining precise height of the geodetic signals

Geodetic signals are built into the dominant points of the field to win in signal height. Final height of the signal depends on the specific features of the landscape and vegetation as well as obstacles. GPS networks in recent years not require signaling points.

c) locating the points of triangulation

Each point of the state geodesic triangulation was located by polar coordinates (azimuth and distance). Azimuthal reference points should be visible from the ground and were chosen existing objects on the field such as churches, lightning rods, water towers, etc..

d) organizational measures

At recognition of land are established measures pertaining to landmark plantation, signals construction and observation such as the establishment of the headquarters of the work, points of work teams accommodation, exploring the possibilities of construction supply materials, employment of workers, access to geodetic points.

At the end of the field recognition was drawn a sketch to scale, with all the features recognized in the field.

On outline of land surveying were established methods of survey, support and detail points. Also, they set out in an annex necessary materials (stakes, landmarks, balises, tools, etc..) as well as technical and auxiliary personnel, which along with outline representing the surveying project.

2. Ground stage

On the ground have determinated a number of new points evidenced by metal bolts and marked with paint. These points have been integrated into the same accuracy class as those evidenced by concrete landmarks, which are used for detail survey in crowded areas, especially in built-up areas.

Surveiyng network consists of at least two points materialized on the ground, which were stationed with GNSS receivers were collected in static / fast-static observations with a duration depends mainly on the distance from the station / stations and / or landmark / reference landmark (having coordinates in SRC ETRS89), by the number of frequencies of the receiver and satellite geometry, the number and the time of observation. Accuracies (internal) of coordinates establishing (3D) can easily reach values below 5 cm for this type of networks.

We believe that as a result of measurements and data processing, resulting network precision joined the existing tolerances. Surveying points network will have a description and a set of coordinates in ETRS89 and national SRC (Stereo70). At OCPI level, the database will be made to include these items. In this way points of surveying networks can be used in the future to works in adjacent areas, to any verifications or expertises, possibly with the classical measurement instruments (optical).

In the GPS network were planted six landmarks with the following coordinates (Table 1.).

Table 1.

Coordinate inventory of determined landmarks

Landmark no.	Coordinates	
	X	Y
1	315883.617	408409.431
2	315927.458	408609.398
3	314324.347	408627.900
4	314335.323	409037.578
5	313450.775	409147.079
6	313465.358	409055.788

Determination of geodetic network - the method used to determine the new points using geodetic method is striking: two permanent stations of the national network (CRAIOVA and SLATINA), and using a single permanent station (CRAIOVA) and an old point fromnational network (PYRAMID CARCEA).

They were planted in six concrete landmarks. New points will be used for guidance in pair, a pair of new points visible to one another, either individually using one of the new points and a point from the old network.

In preparing thickening network was used combined method GPS - total stations. This consisted of thickening main points, evidenced by concrete landmarks. Coordinates X, Y were determined statically in Stereographic 1970 projection system, using GPS receivers.

Were also executed three traverses supported by GPS network points, these points being oriented and verified on points of state triangulation network.

Traverse pd1- supported on landmark 2, oriented on landmark 1, T5, T109, T110, Dealul TeișI pyramid and Teișani Pyramid, closing on landmark 4, with orientation on landmark 3, T33, T114 and T116.

Traverse pd2- supported on landmark 4, oriented on landmark 3, T33, T114, T116, closing on landmark 5, with orientation on landmark 6 and T114.

Traverse pd3- supported on landmark 3, oriented on landmark 4, T33, T109, T110, closing on landmark 6, with orientation on landmark 5.

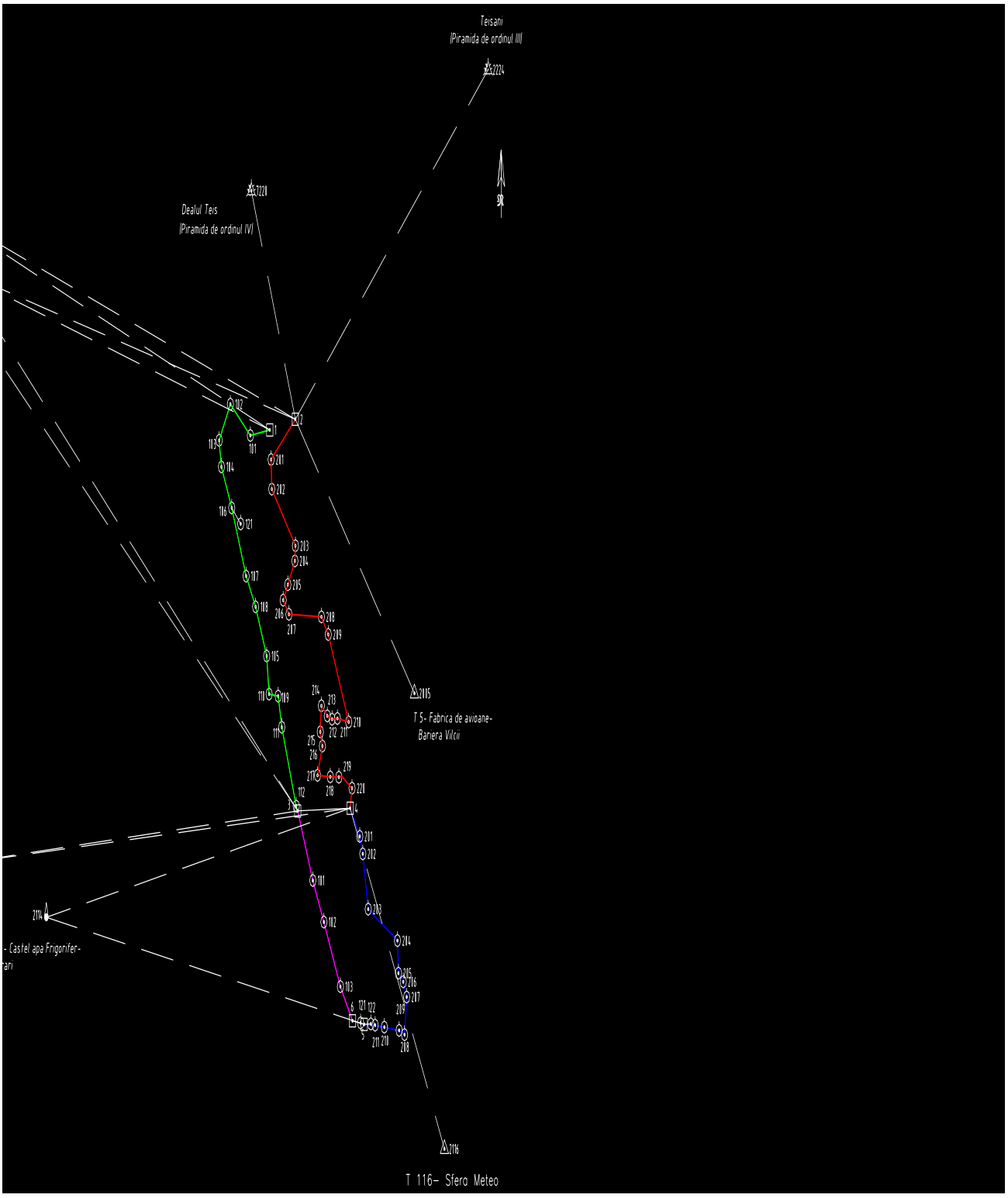

Fig. 1. Network support points and contour of the forest property

3. Office stage, which consisted of calculating absolute coordinates of all characteristic points of the surface covered with woody vegetation, inventory and reporting them on location and delineation plan at scale and accurately. Data processing was carried out in programs TopoSys 7.0, Autocad LT 2002 Microsoft Office 2003, after which he wrote technical documentation (written part and the location and boundary plan).

Table 2

Calculation of supported traverse

Station point	Target point	Orientation	Reduced distance	ΔX	ΔY	X	Y
2	1	286.260				**315927.458**	**408609.398**
2	201	254.478	251.377	-164.813	-189.808	**315762.632**	**408419.572**
		0.002		-0.013	-0.018		
		254.480		-164.826	-189.826		
201	202	197.091	121.009	-120.883	5.520	**315641.743**	**408425.083**
		0.004		-0.006	-0.009		
		197.095		-120.889	5.511		
202	203	157.171	296.793	-232.140	184.924	**315409.588**	**408609.986**
		0.006		-0.015	-0.021		
		157.177		-232.155	184.903		
203	204	204.443	61.935	-61.784	-4.327	**315347.800**	**408605.655**
		0.008		-0.003	-0.004		
		204.451		-61.787	-4.331		
204	205	232.773	111.650	-97.171	-54.987	**315250.624**	**408550.660**
		0.010		-0.006	-0.008		
		232.783		-97.177	-54.995		
205	206	233.356	73.354	-63.506	-36.712	**315187.114**	**408513.942**
		0.012		-0.004	-0.005		
		233.368		-63.510	-36.717		
206	207	157.989	73.522	-58.097	45.059	**315129.013**	**408558.996**
		0.015		-0.004	-0.005		
		158.004		-58.101	45.054		
207	208	102.532	254.124	-10.169	253.920	**315118.831**	**408812.898**
		0.017		-0.013	-0.018		
		102.548		-10.182	253.902		
208	209	159.283	89.836	-72.095	53.598	**315046.731**	**408866.489**
		0.019		-0.005	-0.006		
		159.302		-72.100	53.592		
209	210	173.298	392.399	-358.437	159.686	**314688.274**	**409026.147**
		0.021		-0.020	-0.028		
		173.319		-358.457	159.658		
210	211	310.446	89.288	14.617	-88.083	**314702.887**	**408938.058**
		0.023		-0.005	-0.006		
		310.469		14.612	-88.089		
211	212	295.304	42.083	-3.085	-41.970	**314699.799**	**408896.085**
		0.025		-0.002	-0.003		
		295.328		-3.087	-41.973		
212	213	322.290	39.463	13.552	-37.063	**314713.349**	**408859.019**
		0.027		-0.002	-0.003		
		322.317		13.550	-37.066		
213	214	346.419	62.108	41.400	-46.298	**314754.746**	**408812.717**
		0.029		-0.003	-0.004		
		346.448		41.397	-46.302		
214	215	205.023	107.029	-106.692	-8.487	**314648.049**	**408804.222**
		0.031		-0.006	-0.008		

		205.054		-106.698	-8.495		
215	216	182.471	60.380	-58.114	16.386	**314589.932**	**408820.604**
		0.033		-0.003	-0.004		
		182.504		-58.117	16.382		
216	217	219.599	125.666	-119.737	-38.146	**314470.188**	**408782.449**
		0.035		-0.006	-0.009		
		219.634		-119.743	-38.155		
217	218	104.023	100.207	-6.386	100.003	**314463.797**	**408882.444**
		0.037		-0.005	-0.007		
		104.060		-6.391	99.996		
218	219	101.357	66.886	-1.467	66.870	**314462.327**	**408949.310**
		0.039		-0.003	-0.005		
		101.397		-1.470	66.865		
219	220	126.088	112.189	-44.765	102.871	**314417.556**	**409052.172**
		0.041		-0.006	-0.008		
		126.129		-44.771	102.863		
220	4	211.136	83.512	-82.228	-14.590	**314335.323**	**409037.576**
		0.044		-0.004	-0.006		
		211.179		-82.232	-14.596		
4	3	298.249					
		0.046					
		298.295					
	No. of stations		22.000		Diff. x:	-0.135	
	Azimutal error:		0.0456		Diff. y:	-0.188	
	Orientation tolerance:		0.0469		Coord. er.:	0.231	
	kx:		-0.0000510		Coord tol.:	0.676	
	ky:		-0.0000720				

Another very important operation of the technical documentation is the Calculation of Surface - total area consists of four corpses was calculated by the analytical method using Excel programme.

Table 3

Calculation of body surface two

SURFACE 2PD			
Point no.	X	Y	Distance (m)
1121	314911.260	408848.394	
1123	314903.181	408852.717	9.16
1124	314881.215	408870.431	28.22
1126	314854.565	408894.006	35.58
1128	314828.186	408917.813	35.53
1131	314789.426	408951.748	51.52
1133	314760.771	408977.957	38.83
1141	314741.738	408997.980	27.63
1142	314739.058	408998.361	2.71
1143	314704.650	409013.626	37.64
1145	314699.386	409014.297	5.31
1223	314684.367	409007.119	16.65
95	314678.679	409004.974	6.08
1172	314674.203	409002.150	5.29

1178	314678.147	408931.981	70.28
1190	314682.152	408888.311	43.85
1222	314688.451	408840.848	47.88
1221	314670.871	408839.595	17.62
1220	314670.716	408824.161	15.43
127	314710.639	408826.726	40.01
1199	314740.992	408830.675	30.61
99	314766.083	408834.185	25.34
98	314799.595	408836.905	33.62
97	314824.685	408839.362	25.21
96	314892.761	408844.100	68.24
1121	314911.260	408848.394	18.99
	S =24925 sq.m.		

CONCLUSIONS

1. Methods for measuring topographic elements on land provided necessary precision aim, and the equipment used was checked beforehand ensuring accuracy imposed, fact confirmed also by recorded unclosures.
2. Because surveying was performed by the combined method (3005LN Topcon Total Station and Topcon GR3 GPS receivers) for drawing support network by GPS methods, was not necessary to measure distances and angles classical topographic elements, which led to obtain a high yield measurements and maximum efficiency.
3. Network of support surveying points were taken from topographic maps and plans, coordinate inventories of support points provided by ANCPI / OCPI, and the thickening and surveying network was done so that to ensure the number of points needed for detail topographic-cadastral measurements.
4. All performed topographic measurements were checked both in the field and in the office, observing that they fall within the tolerances allowed, and because from some of the traverse stations were targeted points from state geodetic network, their compensation was made by the method of least squares.
5. Data processing was done with specialized programs (Excel 2003 and TOPOSYS 7), achieving high precision and efficiency and correlated perfectly with the required precision, and finally was drawn boundary plan for the four property bodies at 1:2000 scale, using AutoCAD 2002.
6. The documentation has been prepared in both analog as well as digital, with respect all regulations regarding cadastral works, being submitted to OCPI Dolj, for the entry in the land register of land arrangement UP IV VIISOARA - AMARADIA FOREST DISTRICT.

Fig. 2. Surveyed forest surface superimposed on orthophotomap

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