SOME ASPECTS RELATED TO SPATIAL POSITIONING OF CONTOUR DETAILS FROM “ARBORETUM SYLVA” DENDROLOGIC PARK, ARAD COUNTY

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Abstract

The spatial positioning of the various topographic details can be achieved currently with GNSS satellite technology, the GPS system. Special conditions of satellite positioning of some topographic details involve appropriate working methods, proper logistics and personnel. The determination of the position of the contour points corresponding to the dendrologic collection Arboretum Sylva from Gurahonţ, Arad can be achieved with GPS satellite system using single and double frequency receivers and the GNSS satellite data recorded by Gurahonţ station.

Satellite positioning was achieved in 2014, during the vegetation season; as a result, some of the topographic details that define the contours of the dendrologic park were determined in particular working conditions. Accordingly, where some details have not optimum positioning conditions and it is possible to interrupt the initialization of GPS receivers, the static positioning method is used, with appropriate working sessions.

As a part of the dendrologic collection presents contour topographic details accessible to the satellite positioning, the determination of the spatial position of these details was performed by two different methods in real time - RTK and static, with post-processing of recorded data. Differences between the coordinates determined by the two methods are relatively small.

The results recommend the use of GNSS technology and hence the GPS satellite system to determine the spatial position of the various topographical details in various working conditions.

Key words: GNSS technology, GPS, real-time positioning (RTK), static positioning, post-processing coordinate transformation, reference system.

INTRODUCTION

The usage of modern technologies for spatial positioning of various topographic details is a technical solution possibly adoptable if the logistical base is appropriate. Spatial positioning with GNSS technology, GPS system presupposes the existence of GPS receivers (user segment), (Păunescu et all, 2006) the necessary infrastructure (GPS support network), working methodology and skilled personnel needed to serve the working technology.

The GPS positioning methods can be varied, depending on the proposed technical objectives and available technology. (Sabău, 2010)

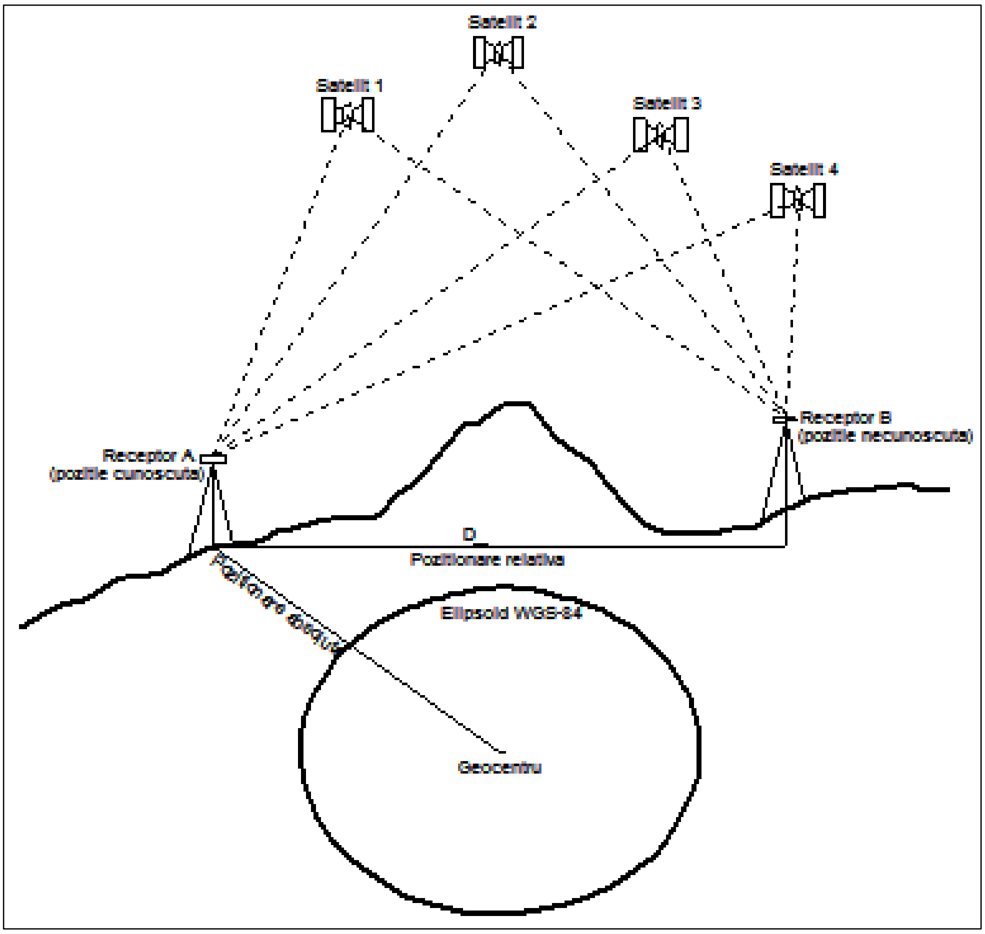

Fig.1-Positioning with GPS system (Novac, 2007, Crainic, 2011)

GPS positioning methods can be classified according to several criteria, the most relevant being the type of solution and respectively the positioning and processing module (Novac, 2007, Crainic, 2011).

Table 1

Characteristics of static measurements (Adam, 2004)

Name of working version	Positioning accuracy (m)	Base length characteristic (km)	Duration of registration
Conventional static	< 0,005	> 10	> one hour
Fast Static	0.010 – 0.020	< 15	10 - 30 minutes
Recovered static	0.010 – 0.020	< 15	2x(5 -10 minutes)

Relative positioning methods provide very accurate results. As a result, satellite positioning using the static method (via dedicated variants) ensures the accuracy required for the introduction and development works of the (infill/thickening) geodetic network. (Adam et all, 2004, Boş, Iacobescu, 2007, 2009) Through the real-time kinematic positioning method, generically called RTK, detailed topographic points (Rus, 2002) can be positioned with high accuracy without the need for a thickening network of the supporting network, a characteristic aspect of the satellite positioning methods (Crainic, 2011).

Table 2

Kinematic characteristics of measurements (Adam, 2004)

Name	Positioning accuracy	Base length feature	Processing
RTK	1-3 cm	< 5-10 km < 40 km	In real time
STOP&GO	1-2 cm	< 15 km	Post-processing
Kinematics real	1-3 cm	< 15 km	In real time

MATERIAL AND METHOD

To achieve the case study, we used as research methods the bibliographic documentation, itinerary observation, site observation, experiment, comparison, simulation.

Photo.1-TRIMBLE R3 receivers used for positioning

Satellite Positioning was done with a GPS receiver of geodetic class, TRIMBLE R4 type with two frequencies (L_1, L_2) with four GPS receivers of topographic class, TRIMBLE R3 type with a single frequency (L_1). (Şipoş, 2014) The records from the permanent GNSS Gurahonț station were also used. Acquisition and processing of data with the geodetic-class receiver was done with Survey Controller application.

Collection of data with the receivers of topographic class was done with the Trimble Digital Field Book software and the primary processing was done with the Trimble Total Control software (TTC). Coordinate transformation in the national reference system (Păunescu et all,2010) was made with TransDatRO.4.01 application, agreed and offered for free by the National Agency for Cadastre and Real-estates Publicity (ANCPI). (Crişan, 2014) Reporting of data was performed with the program MapSys7.0. (Marton, 2007). For guidance in the field and for the design of the positioning works the dendrologic park plan in analogical (Tămâioagă G., Tămâioagă D., 2007) format was used, scale 1: 1000.

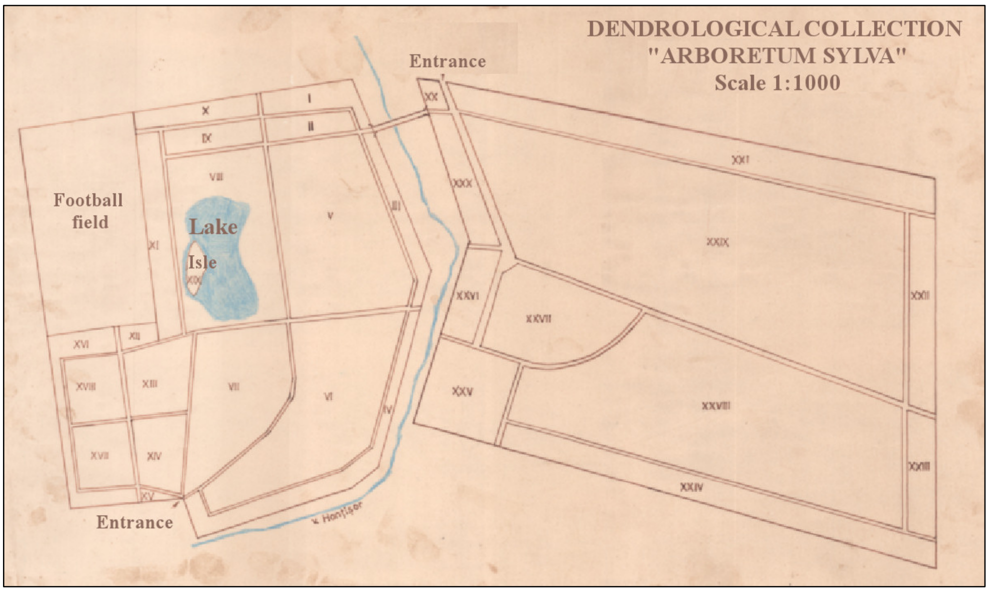

Photo.2- Plan of *Arboretul Sylva* dendrologic park

RESULTS AND DISSCUSIONS

Spatial positioning of contour details related to the dendrologic collection was conducted in two working variants. Contour points for the stand part consisting in plots I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII, XIII, XIV, XV, XVI, XVII, XVIII and XIX were positioned by rapid static method with post-processing, given the particular working conditions, determined by the presence of forest vegetation of considerable size in some plots, leading in some cases to the loss initialization for the kinematic positioning methods (RTK and PPK).

For the right side of the river within the dendrologic park consisting in plots XX, XXI, XXII, XXIII, XXIV, XXV, XXVI, XXVII, XXVIII, XXIX and XXX the positioning of the contour points was achieved in two ways, namely by means of real-time kinematic method (RTK) and fast static method with post-processing.

The accomplishment of the two variants requires the thickening of the support network in the working area. As a result, four points were positioned by traditional static method, a method that is proven and recommended by the technical standards for such applications. For a comprehensive analysis of the effective thickening possibilities of the support network, four points were positioned experimentally and by the real-time kinematic method (RTK).

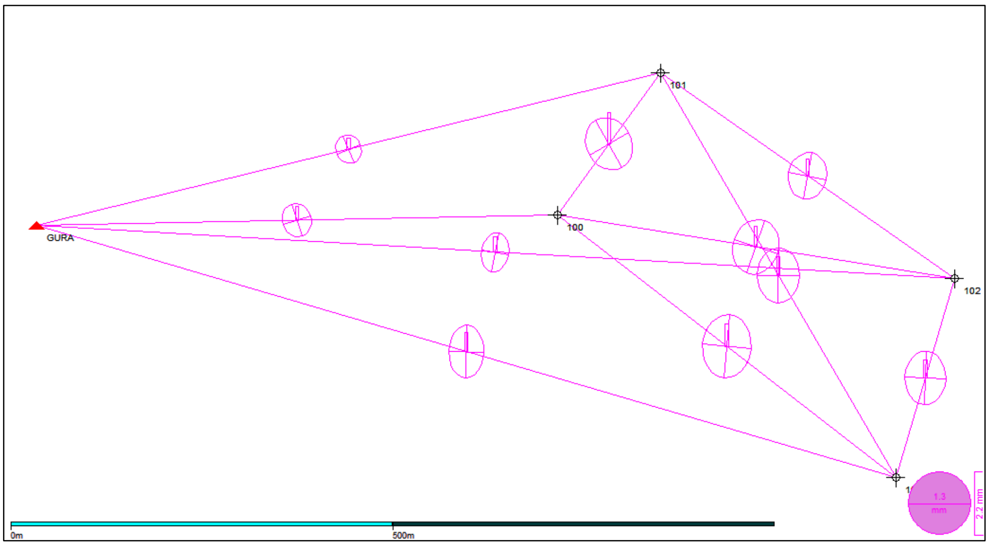

Fig.2-Primary processing in geocentric system of the thickening points of support network

Analysis of the data in the figure above show that the error ellipse in the plan is 1.3 mm and the ellipse error rate value is 2.2 mm.

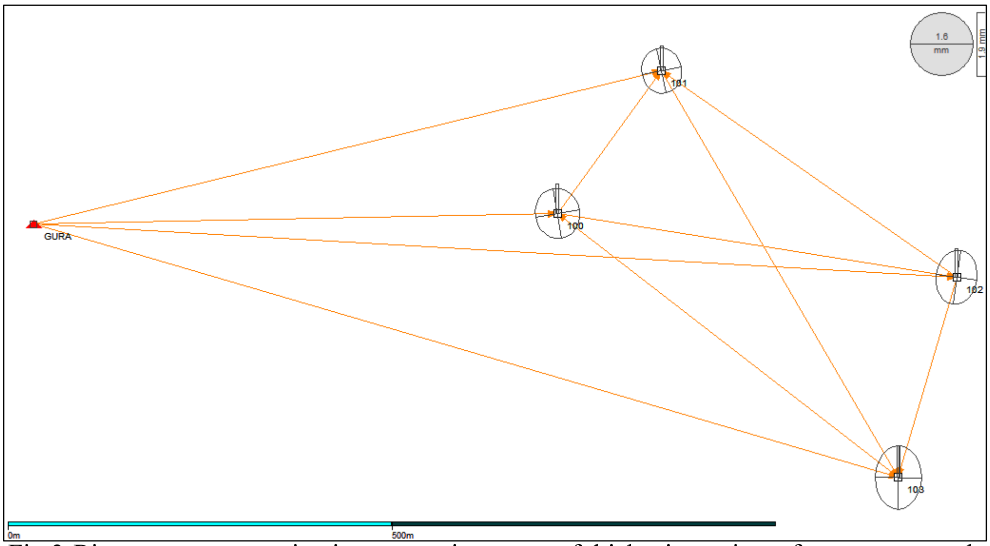

Fig.3-Rigorous compensation in geocentric system of thickening points of support network

After rigorous compensation of thickening points in geocentric system (fig.3), we find that the error ellipse in plan is 1.6 mm and the error ellipse rate is 1.9 mm. The coordinates obtained by the transformation with the application TransDatRO4.01 are shown in the table below.

Table 3

Inventory of thickening points coordinates in the national reference

No. pct.	X(cm)	Y(cm)	Z(cm)	Observations
100	533094.979	295643.284	167.791	Points positioned with TRIMBLE R3 GPS receivers by static method with post-processing
101	533280.566	295778.893	166.599	
102	533011.888	296162.651	167.896	
103	532751.616	296087.167	193.593	

The coordinates obtained by real-time kinematic positioning are shown in table 4.

Table 4

Inventory of thickening points coordinates in the national reference

No. pct.	X(cm)	Y(cm)	Z(cm)	Observations
100	533094.970	295643.295	167.814	Points positioned with R4 TRIMBLE GPS receivers by means of real-time kinematic method (RTK)
101	533280.552	295778.906	166.628	
102	533011.877	296162.660	167.921	
103	532751.604	296087.189	193.626	

The analysis of the two sets of coordinates corresponding to thickening points calculated by the two methods of positioning it is noticed relatively small differences between these tables and the results are presented in table 5. The OX axis of the coordinate difference in the absolute value will vary between 0.009 and 0.012m, OY axis difference values between 0.009 and 0.022 m and the OZ axis coordinate differences vary between 0.023 and 0.033 m.

Table 5

Differences between the coordinates of thickening network points calculated by the two methods

No. crt.	$DX = X_{STATIC} - X_{RTK}$ (m)	$DY = Y_{STATIC} - Y_{RTK}$ (m)	$DZ = Z_{STATIC} - Z_{RTK}$ (m)
100	0.009	-0.011	-0.023
101	0.014	-0.013	-0.029
102	0.011	-0.009	-0.025
103	0.012	-0.022	-0.033

Positioning of the contour points in the first variant was performed by rapid static method. In order to use the application TransDatRO4.01 in the transformation and achievement of the coordinates in the national reference system, the records of permanent GNSS station from Gurahonț were used.

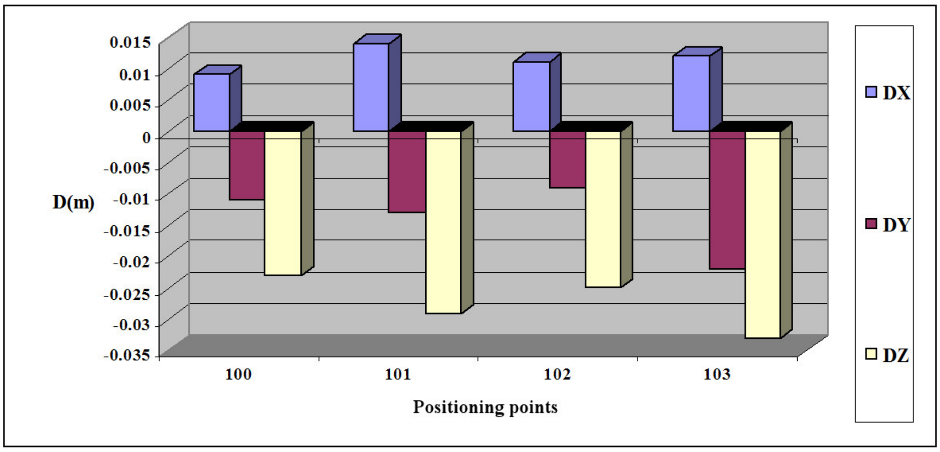

Fig. 4-Histograms of the differences between the coordinates of the thickening points network calculated by the two methods

Table 6

Inventory coordinates contour points for the first variant positioning

No. crt.	X(m)	Y(m)	Z(m)	Observations
1	533275.426	295784.661	166.590	Points positioned with GPS receivers by rapid static method with post-processing. To convert the national reference system to use the TransDatRO4.01
2	533232.586	295864.492	166.893	
3	533214.113	295871.777	165.940	
4	533118.015	295873.930	165.616	
5	533098.257	295862.376	164.359	
6	533078.898	295849.208	165.840	
7	533025.039	295804.866	166.445	
8	533021.069	295733.827	167.121	
9	533018.010	295679.568	166.947	
10	533012.401	295618.743	168.546	
11	533025.667	295625.219	167.652	
12	533027.252	295617.621	168.869	
13	533056.011	295672.816	167.975	
14	533067.512	295635.537	167.704	
15	533082.026	295604.316	167.173	
16	533169.211	295644.440	167.738	
17	533164.512	295653.027	167.605	
18	533158.425	295650.350	167.516	
19	533129.913	295700.835	167.257	
20	533145.615	295707.476	167.150	
21	533139.143	295723.551	167.460	
22	533315.465	295716.983	166.279	

It is noted that, the outline of the dendrologic collection for the first positioning variant consists in 22 topographic characteristic and it is presented in table 6.

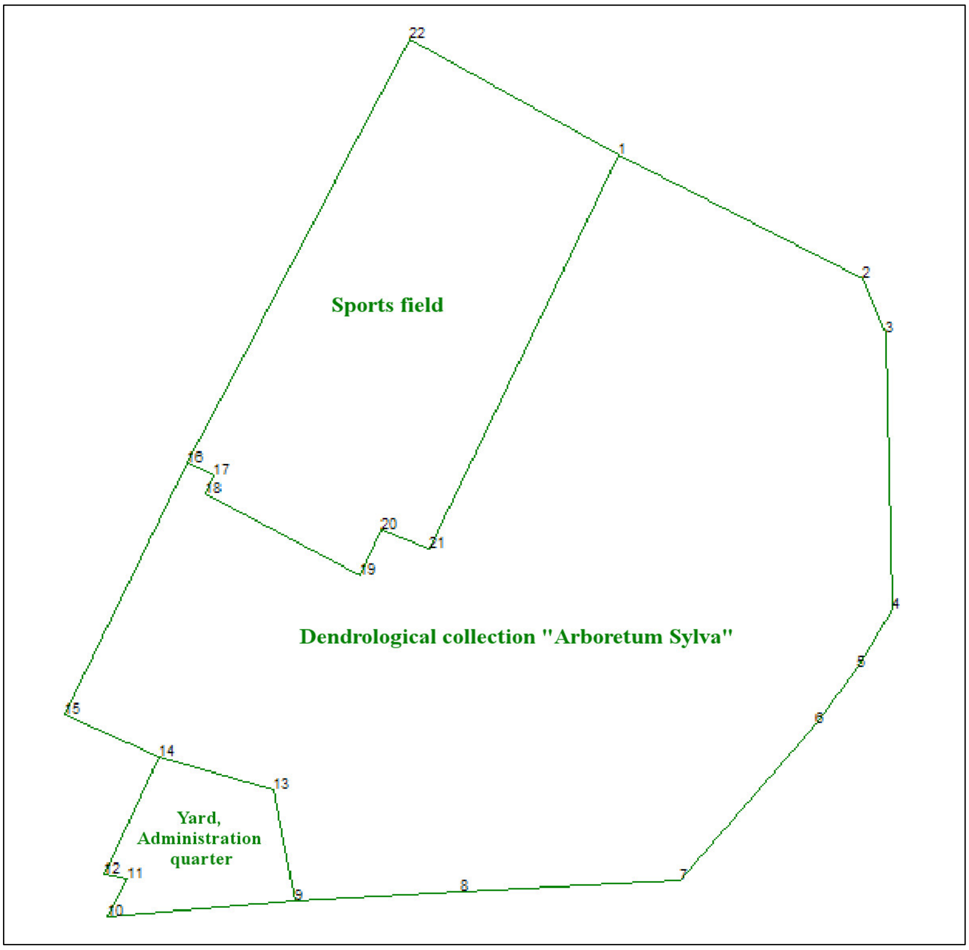

Fig.5-Layout of the dendrologic collection for the first positioning variant

The analysis of the layout (fig.5) shows that the dendrologic park located in the first working variant contains the park courtyard and headquarters and is bordered by the sports field, issues that have been defined with the project of locating the dendrologic collection.

In this latter position, the contour points were positioned by fundamentally different methods and the results obtained are tabulated below.

Table 7

The coordinates of contour points determined by the static method

No. crt.	X(m)	Y(m)	Z(m)	Observations
200	533000.642	296154.378	168.080	Points were positioned with receivers TRIMBLE R3 through fast static method with post-processing
201	532759.557	296094.255	190.789	
202	532995.944	295816.075	170.530	
203	533085.988	295899.941	165.401	
204	533199.232	295913.582	164.969	
205	533202.740	295915.969	164.964	

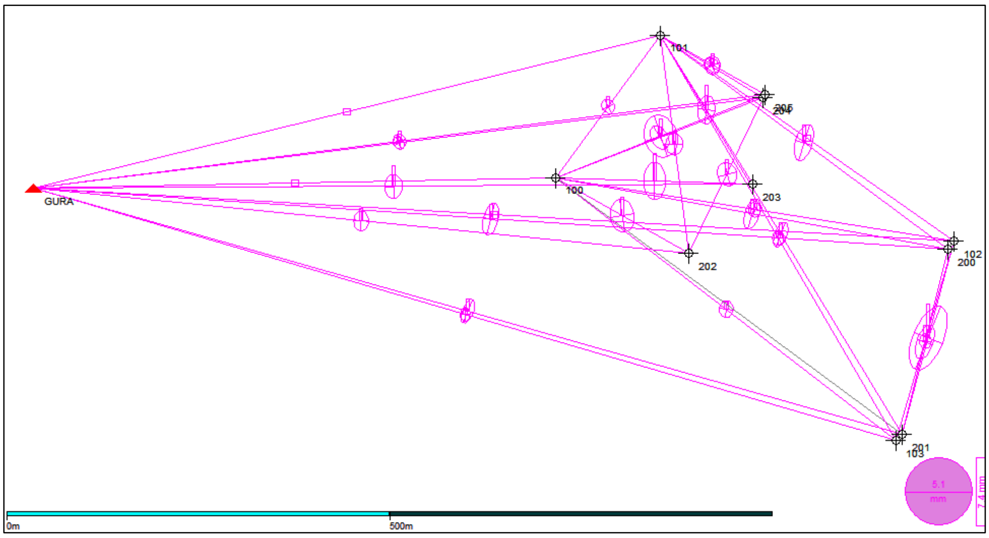

Fig.6-Network of vectors primarily processed in geocentric reference system

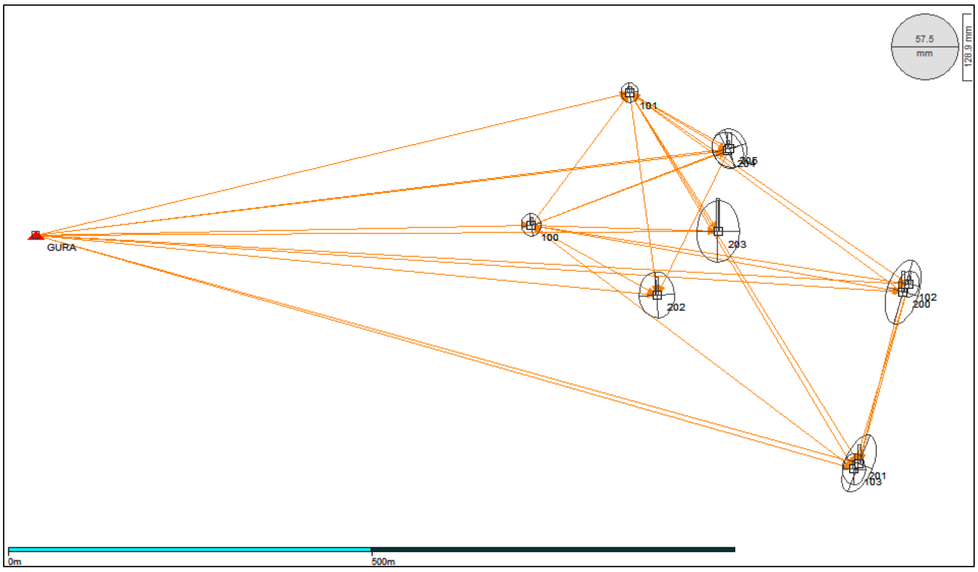

Fig.7-Network of vectors rigorously compensated in geocentric reference system

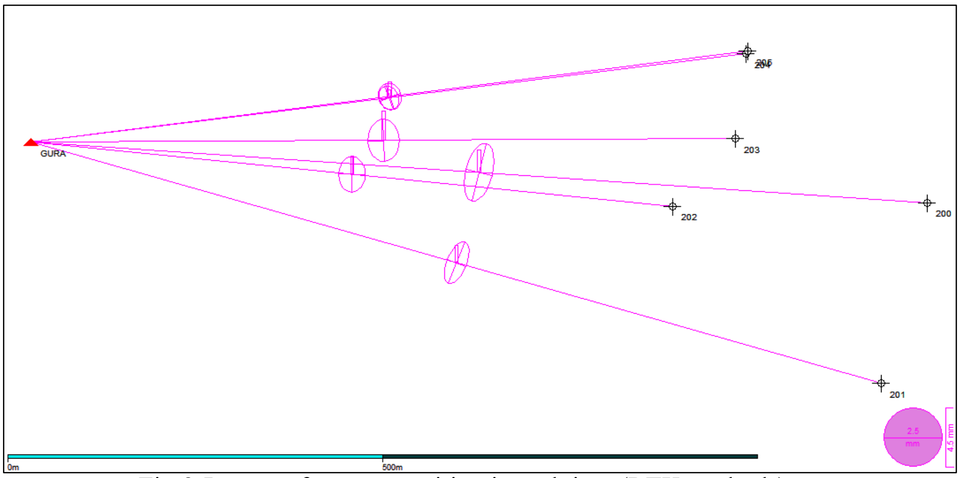

Fig.8-Layout of vectors position in real time (RTK methods)

Table 8

The coordinates of contour points determined by real-time kinematic method

No. crt.	X(m)	Y(m)	Z(m)	Observations
200	533000.660	296154.387	168.102	Points were positioned with TRIMBLE R4 receivers by using the kinematic method in real time (RTK)
201	532759.565	296094.267	190.791	
202	532995.896	295816.092	170.711	
203	533085.991	295899.985	165.410	
204	533199.201	295913.625	164.981	
205	533202.726	295915.980	165.038	

Table 9

Differences between the coordinates of the thickening points calculated by the two methods

No. crt.	$DX = X_{STATIC} - X_{RTK}$ (m)	$DY = Y_{STATIC} - Y_{RTK}$ (m)	$DZ = Z_{STATIC} - Z_{RTK}$ (m)
200	-0.018	-0.009	-0.022
201	-0.008	-0.012	-0.002
202	0.048	-0.017	-0.181
203	-0.003	-0.044	-0.009
204	0.031	-0.043	-0.012
205	0.014	-0.011	-0.074

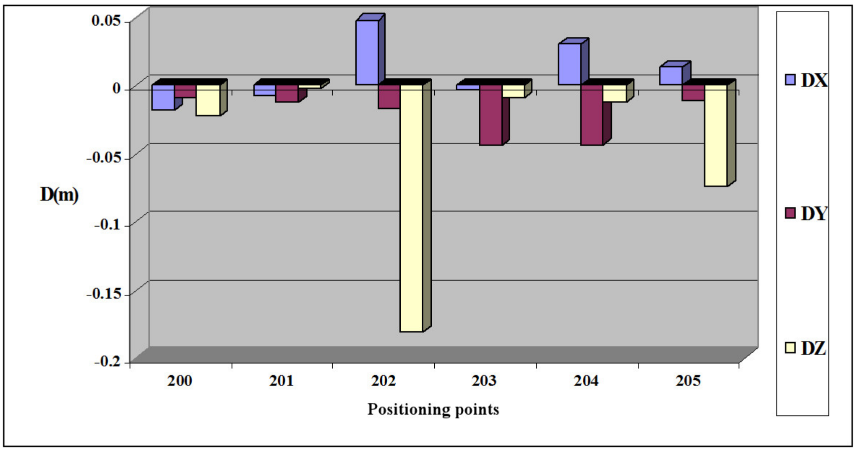

Fig.9-Histograms of the differences between the coordinates of the points belonging to the thickening network calculated by the two methods

CONCLUSIONS

Positioning with GPS details involves a series of technical conditions necessary for data collection. Using in real-time kinematic (RTK) positioning of detail ensures high productivity but requires the use of two-frequency receivers and ensuring appropriate conditions for maintaining initialization throughout the data collection.

The presence of large forest vegetation, with a canopy well defined and developed method, limits the use of real-time kinematic (RTK), because it can easily lose repeated initialization. The static method allows positioning and details for particular working conditions, since the residence time can be determined according to the situation on the ground, and end results (final coordinates) are obtained by post-processing with specialized computer programs that allow removing the processing the observations affected by a number of errors. The difference between the coordinates obtained by the two methods is relatively low position in the centimetre range for the 2d space (OX axis and the OY) and in the decimetre to planes (OZ axis).

Although the method of real-time kinematic positioning (RTK) is more productive, it appears that it is limited by the particular working conditions, but under appropriate conditions of land use without restraint. Post-processing positioning methods provide higher accuracy for the final coordinates of points positioned even in private, but requires more time for data collection and processing them respectively.

The two positioning methods can be used in tandem, in order to carry out a check of the coordinates obtained by the GPS satellite positioning system.

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