ISSUES RELATED TO THE USE OF THE POINTS IN GEODETIC TRIANGULATION OF STATE IN POSITIONIG WITH STATIC RELATIVE GNSS METHOD

Crainic Ghiţă Cristian*, Damian Vasilica Laura**

*University of Oradea, Faculty of Environmental Protection, 26 Gen. Magheru St., 410048 Oradea; Romania, e-mail:gccrainic@yahoo.com
**University of Oradea, Faculty of Environmental Protection, 26 Gen. Magheru St., 410048 Oradea; Romania, e-mail:vasilica8630@yahoo.com

Abstract

The use of the state geodesic triangulation points for spatial positioning of the dense points trigonometrical control network of GNSS technology, represents a solution in various areas where the national geodesic network is more modest represented. Working methods of the GNSS technology researches concerning the completion of the trigonometrical control network, I presume the existence of the processing parameters, you can solve the problem through the use of common or direct transformation parameters if they are available.

The common points, you can use the geodetic triangulation points, which has preserved in the appropriate technical conditions and that are relatively affordable. To position these points with GNSS technology using conventional fast static method recommended for implementation trigonometrical control network.

In order to achieve the national datum will use local processing parameters, which ensure an accuracy and a higher accuary for determining coordinates national reference systems.

Key words: geodetic triangulation, spatial positioning, GNSS tehnology, static conventional method, common points, transformation parameters, national reference systems

INTRODUCTION

Geodetic control networks as a sum of points scattered uniform area density required, accurately positioned in a system of reference and durably ground represents all terrestrial infrastructure in raise and/or aerial imagery including georeferenced. Therefore, ensure a sufficient number of points and attention with which the work is being conducted to determine the coordinates of which are basic conditions to be complied with in order to achieve land measurement infrastructure relating to the sector (Neuner et al., 2002).

Effective in our country has caused new National Geodetic Control Network GPS, with the two components of its structure:

-permanent GPS stations, spread throughout the territory;

-ground points delimit classes A, B, C and D, in which you work.

This graticule will soon be supplemented and completed by ensuring a generally solid support for the development of future geo-topographic works (Boş, 2009).

Basically, sometimes with distinction and forestry fund situated in the pitches and rough, hard accessible, they met until now and meet two specific situations related to the existence and the possibilities for realization of geodetic control networks:

-low density in the heap, when existing graticule should be dense with new items;

-the existence in the location of interest, certain points in the old graticule - State geodetic triangulation - which were and still are used.

Regarding the second point out that the old graticule, classic, structured on four orders with technology was ranked second to 50 to 60 of the last century and due attention, having coordinated within the stereograph projection system '70 and '75 heights Marea Neagra. Some of the points there are dimensioned and intact, being considered as such and used and useful work including current transformation of geodetic datum and geo-reference satellite imagery (Neuner, 2000).

MATERIAL AND METHODS

In view of the above, the case study sought to determine whether:

-triangulation, geodetic points of the remaining intact on the ground, can be used with confidence in the work being carried out today with GPS technology;

-what are the working procedures of this technology, including the logistics of hard and soft indicated that the network should be more frequent in modern RNG.

To this end have chosen a number of points in the triangulation height, at haul variables of forestry fund, which have been repositioned in the GPS system in various variants and work on the ground, which were compared with each other by the conclusions reached on the interpretation of results.

Table 1

Geodetic points of the area are known and used (OJCPI Bihor) in STEREO projection system '70 and Marea Neagra 1975 height system

No.	Point			X (m)	Y(m)	Z(m)	Observation
	Indicative	Order	Toponymy				
1	7	IV	Sălard	641143.150	275370.096	109.517	Technical good condition
2	41	IV	Diosig	648959.326	274488.095	111.925	
3	16401	II	Sînicolaul de Munte	648424.902	285780.343	218.360	
4	42401	I	Oşorhei	623315.749	273944.933	294.259	
5	43101	I	Leş	613159.578	258199.448	132.740	
6	52401	IV	Valea lui Mihai	674298.698	284124.563	145.516	
7	11	IV	Sărsig	641359.879	287730.401	138.411	Damaged point 20 %

We note that originally we intended to 16 points in the area in which some have disappeared leaving 7 one of which has damaged the boundary mark (section 11), but it is motionless and with mathematically point intact (fig. 1, tab. 1).

The equipment used was represented by the R3 model GPS receivers, Pocket Loox N520 Fujitsu Siemens and data collection programmes.

Table 2

Known geodetic points in the geocentric global system (OJCPI Bihor)

No.	Point		X(m)	Y(m)	Z(m)
	Indicative	Toponymy			
1	7	Sălard	4022080.269	1627582.127	4659390.965
2	11	Sărsig	4016997.393	1638839.045	4659866.580
3	41	Diosig	4017227.959	1624350.434	4664669.252
4	16401	Sînicolaul de Munte	4013124.326	1634882.839	4664668.344
5	42401	Oşorhei	4034621.346	1631844.383	4647376.578
6	43101	Leş	4047548.519	1620516.059	4639923.201
7	52401	Valea lui Mihai	3996465.545	1625304.068	4682066.904

Checking existence of geodetic triangulation points 7, pursued by the research of inventory received from OJCPI Oradea, began to identify on the ground and condition control boundary mark. The movements towards point I used a GPS, navigation, model Pocket Loox N520 Fujitsu Siemens fitted with MAPSYS PDA software 2.0 that provides accurate positioning 1,0-1,5 m.

Basically, after placing the starting point coordinates and find the receiver displays on display, in any place on the route, its coordinates, direction of travel, the distance travelled from the point of departure and up to the point of arrival and other elements which facilitates identification of boundary mark. As it has been revealed of the 16 points in the triangulation I retained classically received initially only seven different orders, which were and are frequently used (tab. 1, 2), the rest are either missing or out of place, slow-not trusted.

Please note that in the seven ancient points were redeterminated in GPS system has been checked and meet the minimum requirements of the GNSS positioning, respectively free horizont 15º, the lack of electricity, influences, etc. In all cases these restrictions are met, for the most part, being provided by positioning through intersections assumes the existence of visibility in the lap of horizon and therefore the locations on high places, summits, etc.

Field observations were performed by the static method. In the case of single-frequency receivers L_1 they had a stationary for about five hours, registration periods of 15 seconds, based on the program, Trimble Digital Fieldbook being recorded in the files of type RINEX.

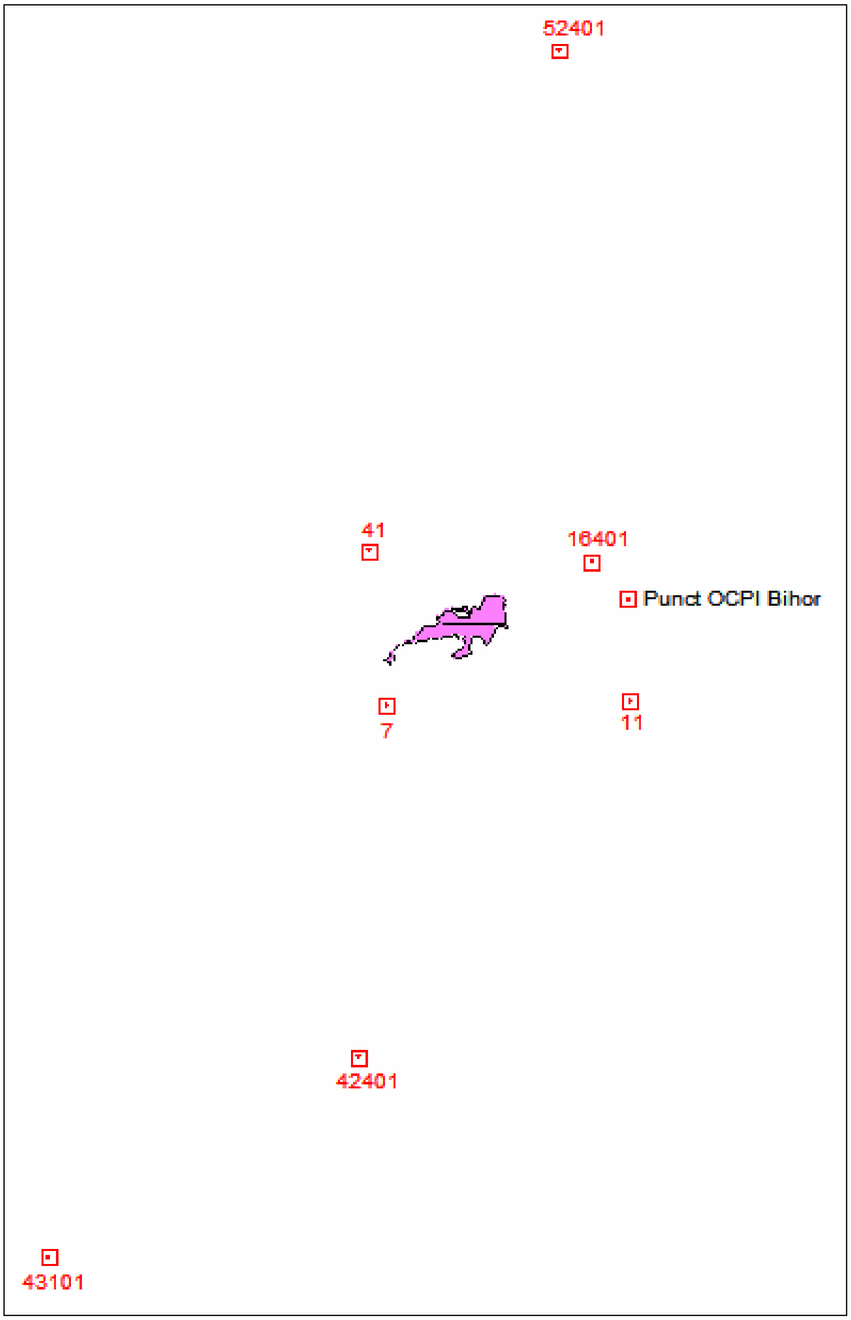


Fig.1 Sketch of case study

RESULTS AND DISCUSSION

In the preliminary operations on the data processing shall ensure the possibility of checking data recorded including the removal of some inappropriate, disruptive factors affected by disabling certain portions or even the moon. Thus, for registration of the points to be repositioned after processing has been inadequate solutions, FLOAT.

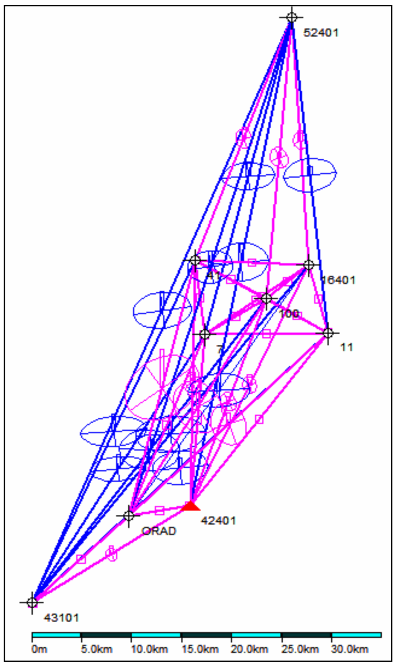


Fig. 2 The vectors before solve the triangle misclosure

	Enable	Adjust	Reference	Rover	Solution
1	✓	ADJ	42401	SATU	Double Diff. / Float / L1
2	✓	ADJ	SATU	43101	Double Diff. / Float / L1
3	✓	ADJ	42401	ZALU	Double Diff. / Float / L1
4	✓	ADJ	ORAD	41	Double Diff. / Fixed / L1
5	✓	ADJ	SATU	100	Double Diff. / Float / L1
6	✓	ADJ	ZALU	43101	Double Diff. / Float / L1
7	✓	ADJ	SATU	11	Double Diff. / Float / L1
8	✓	ADJ	SATU	7	Double Diff. / Float / L1
9	✓	ADJ	16401	ZALU	Double Diff. / Float / L1
10	✓	ADJ	ZALU	52401	Double Diff. / Float / L1
11	✓	ADJ	ZALU	7	Double Diff. / Float / L1
12	✓	ADJ	ZALU	41	Double Diff. / Float / L1
13	✓	ADJ	SATU	41	Double Diff. / Float / L1
14	✓	ADJ	ZALU	11	Double Diff. / Float / L1
15	✓	ADJ	ZALU	100	Double Diff. / Float / L1
16	✓	ADJ	SATU	52401	Double Diff. / Float / L1
17	✓	ADJ	16401	SATU	Double Diff. / Float / L1
18	✓	ADJ	43101	16401	Double Diff. / Float / L1
19	✓	ADJ	41	43101	Double Diff. / Float / L1
20	✓	ADJ	16401	ORAD	Double Diff. / Float / L1
21	✓	ADJ	43101	100	Double Diff. / Float / L1
22	✓	ADJ	ORAD	100	Double Diff. / Fixed / L1
23	✓	ADJ	43101	52401	Double Diff. / Float / L1
24	✓	ADJ	42401	52401	Double Diff. / Float / L1
25	✓	ADJ	43101	11	Double Diff. / Float / L1
26	✓	ADJ	43101	7	Double Diff. / Float / L1
27	✓	ADJ	52401	7	Double Diff. / Float / L1
28	✓	ADJ	52401	11	Double Diff. / Float / L1
29	✓	ADJ	ORAD	52401	Double Diff. / Float / L1
30	✓	ADJ	ORAD	11	Double Diff. / Fixed / L1
31	✓	ADJ	41	52401	Double Diff. / Fixed / L1
32	✓	ADJ	52401	16401	Double Diff. / Fixed / L1
33	✓	ADJ	42401	16401	Double Diff. / Fixed / L1
34	✓	ADJ	42401	41	Double Diff. / Fixed / L1
35	✓	ADJ	52401	100	Double Diff. / Fixed / L1
36	✓	ADJ	42401	100	Double Diff. / Fixed / L1

Fig. 3 Extract from the report data processing with the solutions adopted to used vectors

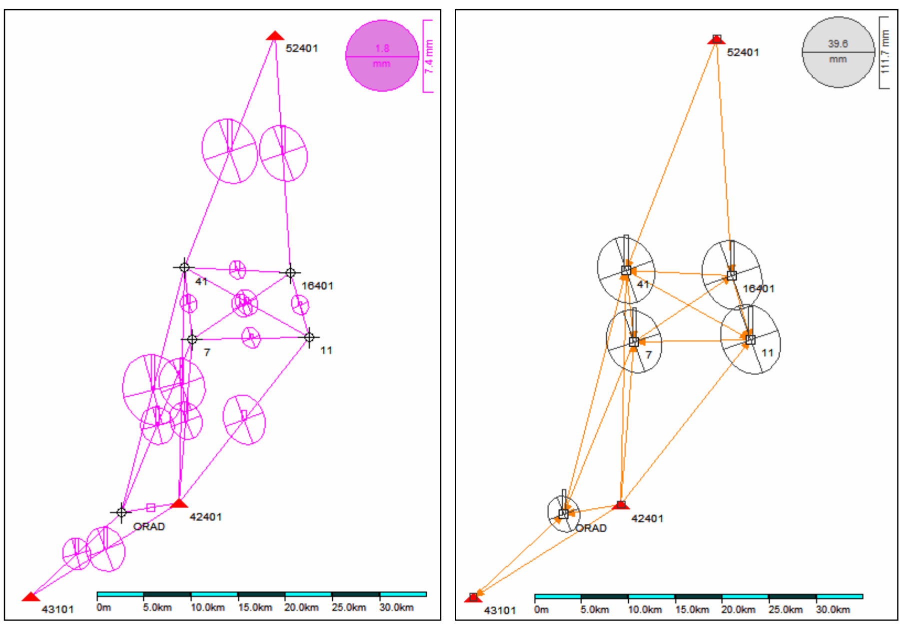
Contributed to this situation and distances between points pursued in research, leading to over 30 miles of vectors (fig. 2).

As a result, after analyzing the situation, they disabled the vectors which led to solutions processing FLOAT and remained only 16 vectors which have provided solutions for FIXED, and type the new every point can be redetermined from at least three vectors (fig. 4).

For redetermination points from the geodetic triangulation by static method using regional transformation parameters, I proposed two variants of calculate, using three and four points respectively of the common transformation. After closing of triangles and adoption solution FIXED, resulting in the error ellipse processing primary does not exceed 1.8 mm in plan and elevation, 7.4 mm and for rigurous adjustement 39,6 mm in plan and the heights 111.7 mm (fig. 5, 6).

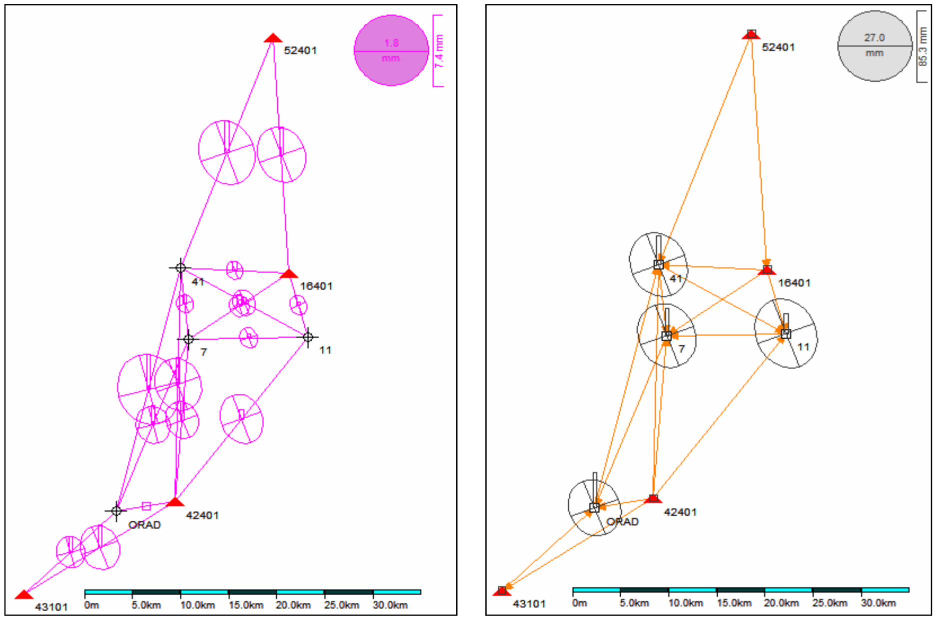
	Enable	Adjust	Reference	Rover	Solution
1	☑	ADJ	7	16401	Double Diff. / Fixed / L1
2	☑	ADJ	16401	11	Double Diff. / Fixed / L1
3	☑	ADJ	11	7	Double Diff. / Fixed / L1
4	☑	ADJ	52401	16401	Double Diff. / Fixed / L1
5	☑	ADJ	42401	7	Double Diff. / Fixed / L1
6	☑	ADJ	42401	11	Double Diff. / Fixed / L1
7	☑	ADJ	42401	43101	Double Diff. / Fixed / L1
8	☑	ADJ	16401	41	Double Diff. / Fixed / L1
9	☑	ADJ	41	7	Double Diff. / Fixed / L1
10	☑	ADJ	41	11	Double Diff. / Fixed / L1
11	☑	ADJ	52401	41	Double Diff. / Fixed / L1
12	☑	ADJ	42401	41	Double Diff. / Fixed / L1
13	☑	ADJ	7	ORAD	Double Diff. / Fixed / L1
14	☑	ADJ	43101	ORAD	Double Diff. / Fixed / L1
15	☑	ADJ	42401	ORAD	Double Diff. / Fixed / L1
16	☑	ADJ	ORAD	41	Double Diff. / Fixed / L1

Fig. 4 Solutions FIXED after solving the closing of triangles



a) primary processing b) rigurous adjustement

Fig. 5 Sketch of vectors processed for adjustment (variant with three common points)



a) primary processing b) rigurous adjustement

Fig. 6 Sketch of vectors processed for adjustment (variant with four common points)

Table 3

The inventory coordinates of points redeterminated in the variant 1
(with three common points)

Point	X (m)	s_X (mm)	Y (m)	s_Y (mm)	s_{XY} (mm)	He (m)	Z (m)	s_Z (m)	N (m)
7	641143.105	47	275370.168	41	62	122.491	109.594	116	12.897
11	641359.884	51	287730.383	44	68	152.249	138.606	113	13.644
41	648959.255	49	274488.131	42	65	124.718	111.959	120	12.759
16401	648424.768	51	285780.323	44	68	232.240	218.873	121	13.368
42401	623315.749	0	273944.933	0	0	307.298	294.259	0	13.039
43101	613159.578	0	258199.448	0	0	144.799	132.740	0	12.059
52401	674298.698	0	284124.563	0	0	158.435	145.516	0	12.919
RTC	622249.978	27	267841.577	24	36	168.643	155.999	78	12.644

The analysis of data presented in table 3 shows that standard planimetric deviation ranges between 36-68 mm, and the heights for the standard deviation is worked between 78-121 mm.

The analysis of data presented in table 4 shows that standard planimetric deviation ranges from 44 to 53 mm, and the heights for the standard deviation is worked between 68-95 mm.

Table 4

The inventory coordinates of points redeterminated in the variant 1 (with four common points)

Point	X (m)	s_X (mm)	Y (m)	s_Y (mm)	s_{XY} (mm)	He (m)	Z (m)	s_Z (mm)	N (m)
7	641143.200	37	275370.173	33	50	121.901	109.202	86	12.699
11	641359.990	40	287730.395	35	53	151.103	138.188	68	12.916
41	648959.360	37	274488.137	32	49	124.257	111.554	90	12.703
16401	648424.902	0	285780.343	0	0	231.178	218.360	0	12.818
42401	623315.749	0	273944.933	0	0	306.923	294.259	0	12.664
43101	613159.578	0	258199.448	0	0	144.968	132.740	0	12.228
52401	674298.698	0	284124.563	0	0	158.301	145.516	0	12.785

In order to properly analyze the results we calculated the difference between the coordinates from redetermination points in the network of triangulation, in different variants of processing and the coordinates of the same points in the inventory OJCPI Bihor.

Table 5

The differences of the coordinates associated with variant A1 and geodetic triangulation

No. point	Diferențe de coordonate					
	Geodetic triangulation - Variant 4 points			Geodetic triangulation - Variant 3 points		
	DX(cm)	DY(cm)	DZ(cm)	DX(cm)	DY(cm)	DZ(cm)
7	-4.5	7.2	7.7	5	7.7	-31.5
11	0.5	-1.8	19.5	11.1	-0.6	-22.3
41	-7.1	3.6	3.4	3.4	4.2	-37.1
16401	-13.4	-2	51.3	-	-	-

The analysis of data from table 5 is found that the differences of the coordinates in absolute value on the x-axis are between 0 and 13,4 cm on the y-axis between 1,2 and 7,8 cm, and the Z axis between 3.4 and 51,3 cm.

CONCLUSIONS

Positioning dense points technology in GNSS can be achieved by applying methods of optimal conditions established for this type of work, methods that are featured and technical rules in use. As a result, the relative static method with the two variants, respectively static conventional and fast static represents the main possibilities for positioning of dense points.

The use of computer programs, specialized professional, which is characterised by a high degree of customization (TTC, TGO, TopoSys, etc.), offers the possibility of checking and analyzing data recorded with the different types of receptor in the postprocessing stage, making it possible to remove from the calculation of the data affected by errors.

The points from the geodetic triangulation of state can be used with confidence in view of the fact that they have been determined with an accuracy and a high accuracy, resulting in the appearance and the results of the process of repositioning.

The study of various variants of GNSS positioning technology within traditional static method has led to the outcomes resulting, respectively achieve precise coordinates, which are indicators of accuracy in plane and in space are within tolerances, test results confirmed and used for statistical analysis of the differences of the coordinates.

Determination and use the local transformation of coordinates, in order to obtain the final results in the national system of reference represents an important stage in the processing of data, the aspect that must had in mind to achieve precise results. Transformation parameters recommended by ANCPI does not offer the possibility of obtaining precise coordinates because as is well known the number of common points which have been determined is extremely low, following the configuration of the land has not been lodged properly.

It is found that the minimum number of control points used in the positioning of the GNSS technology through relative static method, as the common points for determining the parameters of the transformation in optimum conditions is four.

If you know the parameters of the transformation for a given area, for processing the data recorded with GNSS technology in various working sessions for that area, just one point of control (by known coordinates) to obtain the coordinates in the national system is completely cleared. If the location is having by several control points, they can be used to provide a control in the process rigorous or compensation may be recalculated in order to analyze the accuracy of precision also in the process of spatial positioning.

Analysis of variations of positioning within the rapid static method, working sessions with relatively short (about 10-15 minutes) to vectors (s) having a length of less than about 5 miles offers the possibility to optimise the process of data collection with GNSS receivers with one frequency type Trimble R3.

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