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COMPARATIVE ANALYSIS ON THE PRECISION OF DETERMINATION OF GEODETIC POINTS USING THE STATIC METHOD AND RTK TECHNIQUE

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Abstract

The purpose of this study is to compare the precision of the geodetic points determined with GNSS methods using statistical calculations. Therefore I realized a statistical analysis of the results obtained after processing the data. The analyzed points are localized in the surroundings of Braşov City, Romania, being in number of about 557, of which 541 RTK, and 16 static determined points. Depending on the area, exposure and a number of other factors the precision of the points was different. The stationary time for the RTK determined points varies from minutes to seconds, and for the points determined using the static method the stationary period was much longer, namely around two hours. The stationary period on each point as well as the area in which the points are found directly influences the precision of the geodetic points coordinates.

***Key words**: RTK, GNSS, stationary period, precision, static determined.*

INTRODUCTION

The knowledge and the application of statistical calculations is absolutely necessary, since any study or research must be documented with the statistical analysis of the results (Văleanu, Hîncu, 1990).
Statistics is the science that deals with the description and analysis of numerical mass phenomena. It studies the quantitative side of phenomena, the statistical laws being manifested in the form of trends (Văleanu, Hîncu, 1990).
In this context, the study presents a statistical analysis of the positioning precision both planimetric and altimetric and also planimetric + altimetric, of the points taken with the RTK technique and static method in different areas, different terrain conditions and different time periods, to emphasize the quality of the measurements regarding each method.
The static method requires that, when performing observations, the receivers installed on the reference station and on the new station (or stations), to remain fixed in a session in which they receive signals from at least the same minimum four satellites. The observation time is long, dual frequency receivers are required, which ensure high precision, owned by the higher order networks, with bases greater than 10 km (Bos, Iacobescu, 2009).
The real-time measuring method (RTK) also known as real-time kinematic method eliminates the main drawback of the static method, which involves positioning only through post-processing (Bos, Iacobescu, 2009).

MATERIALS AND METHODS

In order to characterize the quality of each method, for the RTK points as well as for the static determined points, were extracted a number of quality parameters using the Leica Geo Office program version 5.0 (Figure 1). These parameters are: the quality of the position (Posn. Qlty.), the height quality (Hgt. Qlty.) and the position + height quality (Posn. + Hgt. Qlty.).

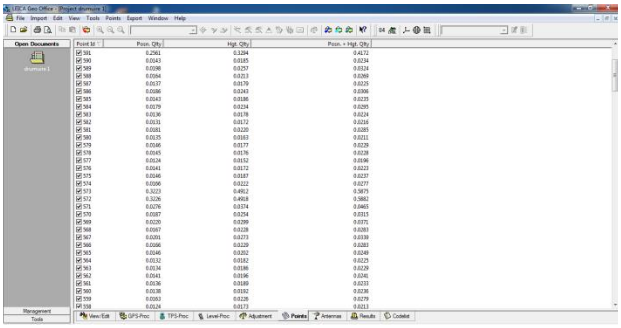

Figure 1. The Leica Geo Office v. 5.0 parameters

The studied area is in Braşov and surroundings. To highlight the points position they were placed on an image extracted from Google Earth, which was then georeferenced using AutoCAD Civil 3D 2014. The points marked with red represent the RTK points and those with cyan represent the static determined points (Figure 2).

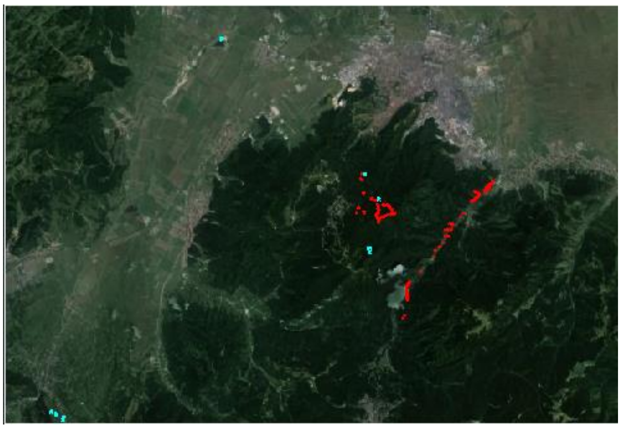

Figure 2. The positioning of the points on the map.

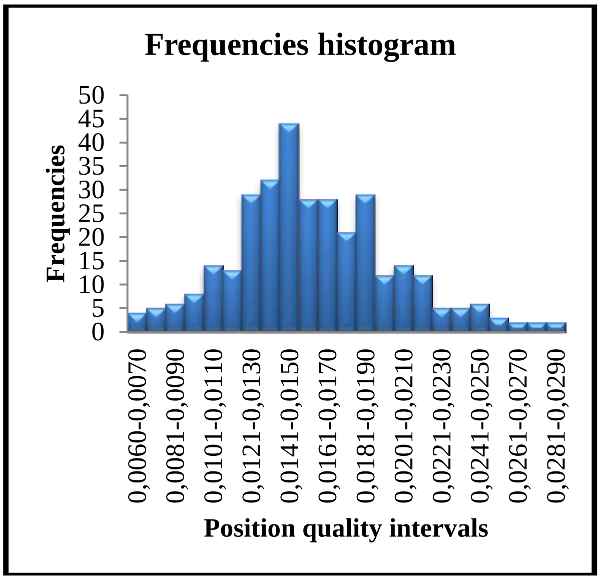

Figure 3. The Frequencies histogram

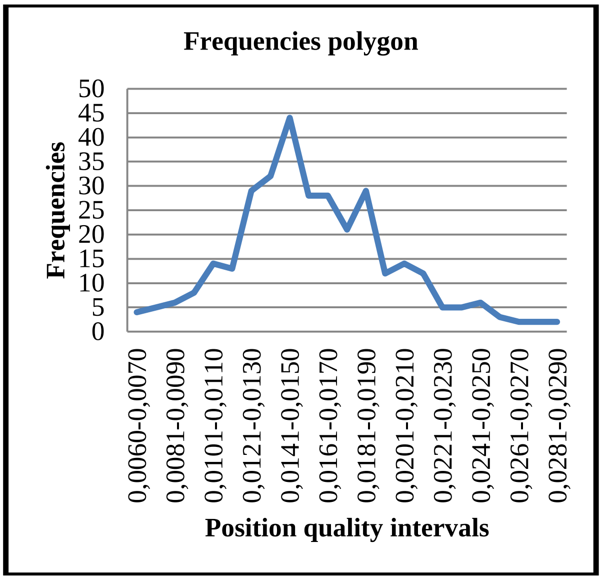

Figure 4. The Frequencies polygon

Based on the parameters extracted from Leica Geo Office v. 5.0, using Microsoft Excel the frequencies of the values in certain class intervals were determined, and also a series of indicators: central tendency indicators (the arithmetic mean and the median), variability indicators (variance and standard deviation), the quartiles (Q1, Q2, Q3), the minimum and the maximum. Also, using the same program, I realized a series of charts such as the frequencies histogram (Figure 3), the frequencies polygon (Figure 4), the cumulate frequencies polygon (Figure 5), the standard normal distribution chart (Figure 6) and the boxplot chart (Figure 7).

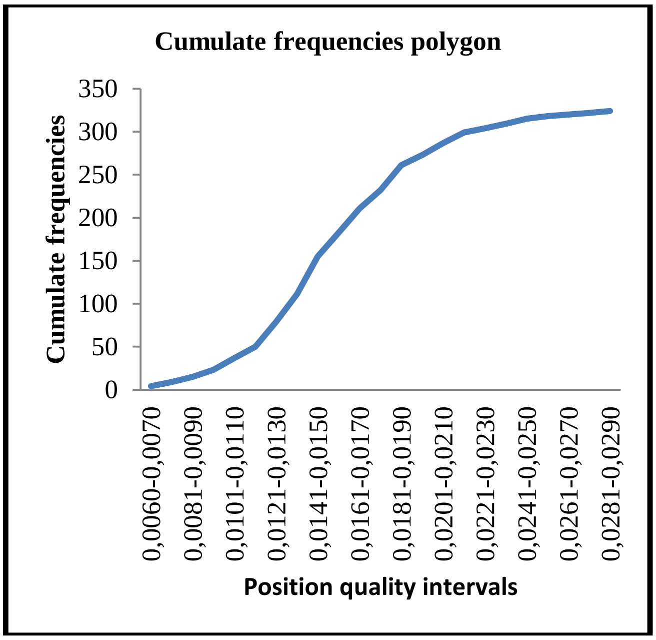

Figure 5. The cumulate frequencies polygon

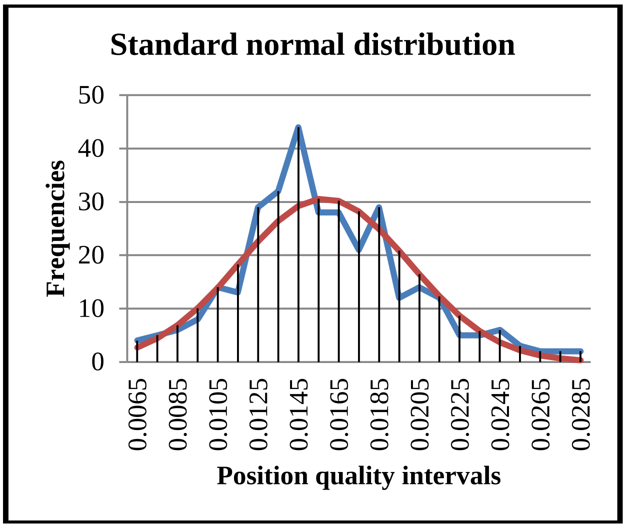

Figure 6. The standard normal distribution

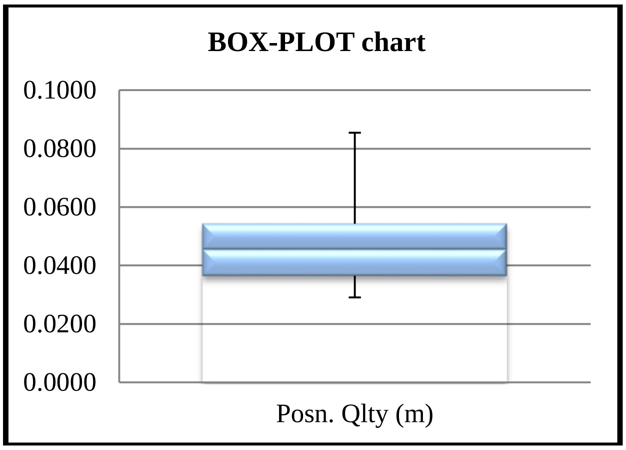

Figure 7. The boxplot chart

RESULTS AND DISCUSSIONS

In order to examine in detail the precision of the analyzed methods, each set of parameters was statistically interpreted separately (Table 1).

Because of the fact that the RTK points were measured in different areas and different conditions, the precision values are distant. Therefore, it is necessary to use a differentiated analysis of this data. For this, the parameter set regarding each case (planimetric, altimetric, planimetric+altimetric) was sectioned in several value groups depending on the precision.

In this way the determination of the class intervals was much easier.

In order to determine the distribution type of the data, the frequency of the values in a certain class interval was calculated (Figure 3).

For the data groups that had a normal distribution (Gaussian bell) the experimental curve was determined (Figure 7).

Table 1. Initial data (raw data)

Raport RTK					Raport Static			
Punct	Qlty.				Punct	Qlty.		
	Posn. Qlty (m)	Hgt. Qlty (m)	Posn.+Hgt. Qlty (m)			Posn. Qlty (m)	Hgt. Qlty (m)	Posn.+Hgt. Qlty (m)
1	0,0169	0,0239	0,0293		1	0,0313	0,0963	0,1013
2	0,0133	0,0245	0,0279		2	0,0913	0,1456	0,1719
3	0,0115	0,0234	0,0261		3	0,0125	0,0299	0,0324
4	0,0135	0,0267	0,0299		4	0,0708	0,1550	0,1704
5	0,0105	0,0154	0,0187		5	0,0104	0,0155	0,0187
6	0,0136	0,0229	0,0267		6	0,0092	0,0139	0,0167
7	0,0079	0,0171	0,0188		7	0,0137	0,0261	0,0295
8	0,0069	0,0166	0,0180		8	0,0150	0,0290	0,0327
9	0,0146	0,0274	0,0310		9	0,0251	0,0349	0,0430
10	0,0133	0,0237	0,0272		10	0,0325	0,0465	0,0567
11	90,9323	7,3916	91,2322		11	0,0154	0,0224	0,0272
12	9,2711	7,2062	11,7424		12	0,0138	0,0204	0,0246
13	22,3812	32,5088	39,4682		13	0,0198	0,0346	0,0398
14	2,7033	2,7781	3,8763		14	0,0164	0,0384	0,0418
15	1,3730	1,5023	2,0352		15	0,0145	0,0236	0,0277
16	0,7786	1,1111	1,3567		16	0,0135	0,0174	0,022

For the data with irregular distribution (Figure 8) the median, the quartiles, the minimum and the maximum were calculated and the boxplot chart was realized (Figure 7), which offers information on the amplitude of data over extreme values, on central tendency (using the median) and on the way the values were grouped (using the quartiles) (Chitea, Petritan, Chitea, 2010).

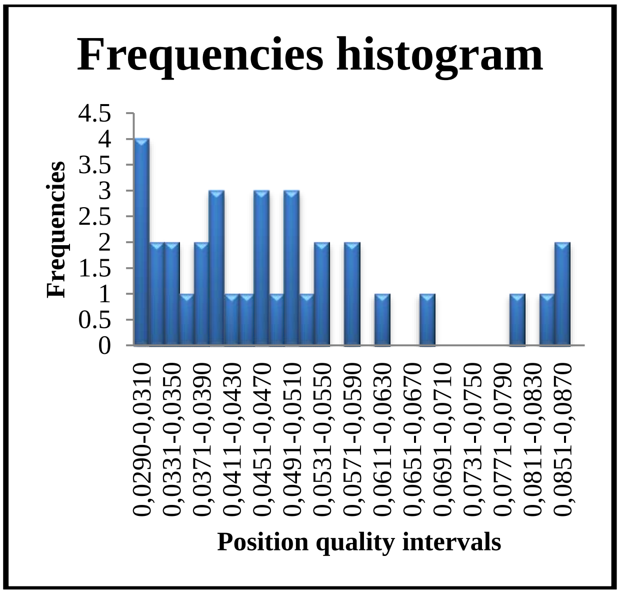

Figure 8: Irregular distribution

After these calculations were noted:

- the points located in open horizon areas and favorable terrain conditions showed good precision; in terms of planimetry most points were in the range of 0.014-0.015 m, in terms of altimetry the precision decreases and most of the points is in the range of 0.221-0.230 m, and in terms of planimetry + altimetry most points were in the range of 0.026-0.028 m;

- the points in the hill areas, with relative closed horizon, showed poor precision; in the case of planimetry most points were in the range of 0.150-0.350 m, in the altimetry case most points had a higher frequency in the range of 1.100-2.100 m, and in terms of planimetry + altimetry most points were found in the range of 1.000-1.200 m.

Regarding the static determined points, these points showed a very good precision in all cases (planimetric, altimetric, planimetric + altimetric) regardless the exposition.

- planimetricaly, the points with higher frequencies were found in the range of 0.009 – 0.014 m;
- altimetricaly, most points were found in the range of 0.020 – 0.027 m;
- planimetricaly+altimetricaly, most points were found in the range of 0.024 – 0.032 m.

CONCLUSIONS

Between the two methods used for the determination of geodetic points the most accurate proved to be the static method, providing better results than the RTK method. The only drawback of this method is the long stationary time that is required for the points to be determined.

ACKNOWLEDGEMENTS

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