USING THE GNSS TECHNOLOGY TOTHICKEN GEODESIC NETWORK IN SECAŞ, TIMIŞ COUNTY, ROMANIA

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Abstract: *This paper presents the thickening of a geodesic GPS network through the static method in Secaş, Timiş County, Romania. To do so, we marked soil points with concrete landmarks in four localities (Secaş, Crivobara, Vizma and Checheş) and we used 37 Feno landmarks to thicken the network: we set 8 pairs of concrete landmarks, 2 pairs per locality. The concrete landmarks were made manually, observing the current norms. To materialise the works in the field, we prepared a GPS campaign taking into account several parameters. An important parameter was the stationing time for each landmark apart, taking into account the longest base. After measurements in the field, we acquired RINNEX data from the Cadastre and Real Estate Publicity Offices in Timiş, Făget and Arad, to post-process data and acquire WGS 1984 coordinates from post-processing. After the static post-processing, we thickened the network by setting and reading the Feno landmarks. The 37 Feno landmarks were read through radio waves. To check the correctness of measurements, we also read through the static method for other 5 high order geodesic signals (soil pyramids): Signal Dealul Viilor, Signal Dealul Mare, Signal La Matringa, Signal La Prapat and Signal Poiana lui Iancu. Land surveys were done with GPS equipment from Leica series 1200, and the equipment was downloaded with a Leica Geo Office Combined Programme; WGS 1984 coordinates were turned into Stereographic 1970 coordinates with a TransDatRo Programme, and data were processed with TopoLT and AutoCAD 2016 Programmes. Raw data post-processing was done with a Leica Geo Office Combined Programme.*

Key words: *OCPI, GPS, RTK, Feno, TransDatRO, WGS 1984, Stereografic 1970, TopoLT, AutoCad*

INTRODUCTION

In the last years, the Cadastre and Real Estate Publicity Office (CREPO) adopted a vast project meant to modernise the national geodesic network: thus, it managed to install several equipment making up a permanent station geodesic network, called permanent GNSS stations. After setting such permanent stations all over the country, they needed to even the way GNSS measurement cards were made, as well as the documents using such methods. According to Decision no. 1/2009 regarding kinematic GNSS measurements, in September they launched the Romanian Position Determination System (ROMPOS), which includes real time positioning services and that promotes coordinate establishment through real time kinematic GNSS measurements.

The ROMPOS system relies on a National Network of GNSS permanent stations. Permanent reference stations operate 24/7 supplying real time data.

This is meant to even the way cadastral documents are established when measurements are made with GNSS technology – the kinematic method. This takes into account Annexe 15a (for static measurements using GNSS technology) and Annexe 15b (for kinematic measurements using GNSS technology). It is clearly mentioned that “In the case of thickening and surveying geodesic networks using GNSS (GPS) measurements, we need to use the static measurement method.”

Through static measurements, the coordinates of the points of thickening and surveying networks will be obtained through relative measurements in relation to the National Geodesic Network GNSS (NGN GNSS) made up of permanent GNSS stations (Class A) and thickening landmarks (Class B or Class C). Thus, the points of the survey networks (minimum 2 points) will be determined through the static or rapid static method. The geodesic survey network will be introduced into the NGN GNSS through minimum 2 points (2 permanent GNSS stations 2 landmarks Class B or C, 1 landmark and 1 permanent GNSS station). We will take into account the visibility between the points of the survey network.

In the case of kinematic measurements, to determine detail points with GNSS technology, we can use the (rapid) static, kinematic or pseudo-kinematic measuring methods. Any determination of the position of detail points shall be done only after the survey geodesic network is done according to Annexe 15b. The points of the survey network will also be the points from where the (self)checking of kinematic measurements will be done.

For the trans-calculus of the coordinates determined cinematically from the geocentric into the national reference system according to Decision no. 1/2009, we use the TransDat soft supplied free of charge by the CREPO.

MATERIAL AND METHODS

Static and kinematic measurements were done in Secas with GPS equipment from Leica series 1200, an apparatus with multiple applications. It can be used either as reference station, or as rover for both static and kinematic (RTK) measurements.

To make GPS measurements we used, in the **1st stage**, the ***static*** method; data acquisition was done at 5 sec where we activated the Long Raw Observation (5s) function. The measurement engine used is of the ***SmartTrack*** type reaching satellites in a few seconds. The antennae used are of double frequency – ***AX1202GG*** and ***ATX1230 GG*** with SmartTrack; they support ***GLONASS***, ***GPS*** and ***GALILEO*** signals. Raw data can be exported directly by the receiver ***GPS1200***; for the purpose of this study, we downloaded RAW data with a ***Leica Geo Office Combined*** Programme. The reference system of the GPS is ***WGS 84 (World Geodetic System)***.

To post-process data from the field (by stationing with GS equipment on concrete landmarks) we acquired RINNEX data from Permanent Stations at 5 sec; together with data from the field, we post-processed and obtained WGS 1984 coordinates for the stationed landmarks.

To thicken the geodesic network, in **stage 2** we used the radio method by setting a base on a concrete landmark whose coordinates were obtained by post-processing; with 2 rovers, we determined the position of the 37 Feno landmarks.

This GPS 1200 equipment can also be used to trace, monitor and make seismic measurements. GPS receivers are designed to work in the most difficult conditions: they are shock and vibration proof, they can operate while raining or snowing at temperatures between -39^{0}C and +64^{0}C.

Turning raw data from the ETRS89 system into the STEREO’70 system was done with the ***TransDatRO*** Programme; then, we reported points in ***AutoCAD*** with the ***TopoLT*** Programme and we compared them with RTK values after reading. Data comparison was done between GOS RTK values, Static GPS values from post-processing and GPS Radio values from post-processing. The trans-calculus of the coordinates from the reference system ETRS’89 into the system Stereografphic’70 was done with the soft TransDat 4.01 produced by CREPO.

Permanent GNSS stations from which we operated TINNEX data at 5 sec are Timişoara, Făget and Arad.

Table 1

Permanent GNSS stations used in post-processing

COORDONATE ELIPSOIDALE – ETRS89					
Permanent station	**Class**	**B[m]**	**L[m]**	**He[m]**	**Antenna Serial Number/Type**
Arad (ARAD)	A	46° 10' 23.51004" N	21° 20' 40.51052" E	167.6742m	3830135 TPSCR.G3 TPSH
Faget (FAGE)	A	45° 51' 16.42753" N	22° 10' 37.78289" E	216.4898m	LEIAR25.R22 LEIT
Timisoara 1 (TIM1)	A	45° 46' 47.65271" N	21° 13' 51.46281" E	154.7278m	200496 LEIAT504GG_LEIS TIM1

RESULTS AND DISCUSSIONS

To make kinematic measurements, we followed the steps below:

1. Planning GPS measurements. In this stage, we tried to use time intervals in which the value of Geometric Dilution of Precision (GDOP) is low. This GDOP value helps analyse the influence of available satellite geometry on the working area. It is recommended that we choose sessions below the value 6. It is ideal to choose working sessions during periods when at least 5 satellites with elevation above 15 degrees are visible and the value of GDOP is below 4 for both reference station and mobile station. Figure 1 shows the GDOP values for UAT SECAS on May 10, 2017, and Figure 2 shows the constellation and trajectory of the satellites for UAT Secaş.

Another important element to be taken into account during measurements is **satellite elevation**. Though for measurements we can programme the receiver to records data from satellites below 15 degrees, we need to eliminate error-inducing satellites upon introduction of data into the **Leica Geo Office Combined**. Here we can also study the **Almanach**, where we can see if the GDOP values meet the conditions. Figure 3 presents satellite elevation above the concrete landmark point Secaş 3.

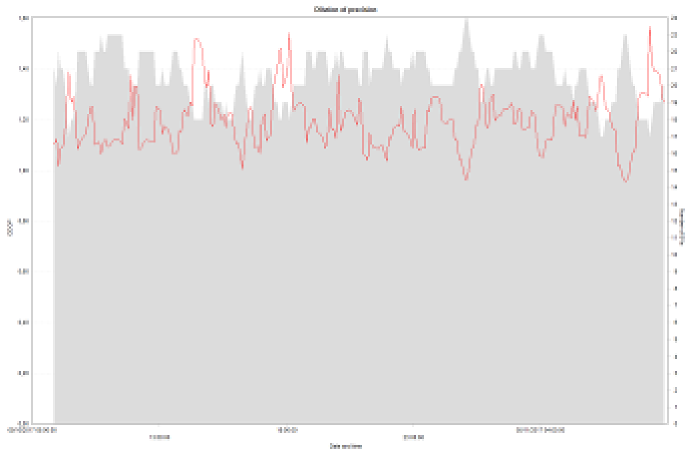
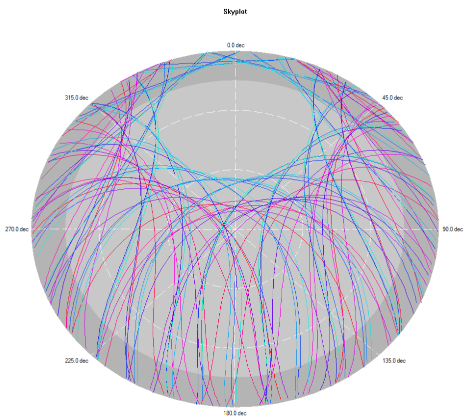


Fig. 1 - GDOP values at UAT SECAŞ

Fig. 2. Constellation and trajectory of the satellites for UAT Secaş



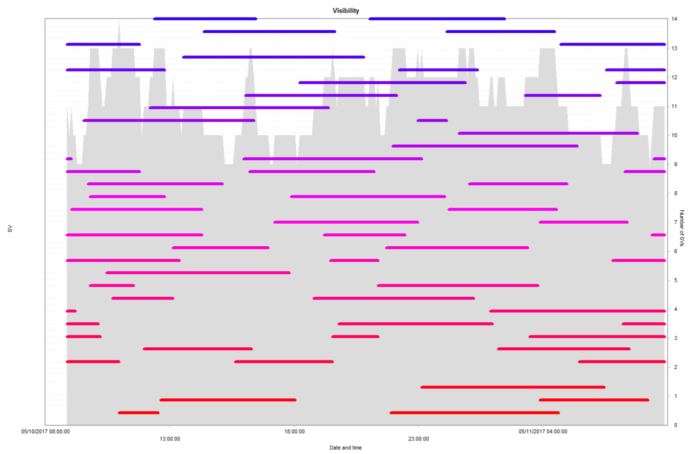


Fig. 3. Satellite elevation above the point Secaş 3 UAT SECAS

Stationing time on each concrete landmark. The duration of a session to obtain correct results upon post-processing depends on factors such as base length, number of satellites observed, and value of GDOP. For double frequency receivers, stationing time (the duration of a measurement session) is 1 min/km + 15 control min: **T = 1 min/km + 15 min** or **T = 1 min*Lbase + 5 min**, where T – stationing time, and Lbase – the longest base.

In the case of the static measurements made in the Administrative Territory Secaș, stationing time was 1.5 h/measurement session.

This means **T = 70 min + 15 min = 95 min** stationing time.

2. <u>Preparing stage.</u> In this stage, we need to get as many data as possible and to compared them before starting the field stage. It consists in **data collecting** and **establishing the working method and the necessary equipment**.

As for the **working method**, after analysing all data and information regarding this project, as well as the task book, we made a survey network to thicken the state geodesic network. The signals chosen as known points within the project were Signal Dealul Viilor, Signal Dealul Mare, Signal La Matringa, Signal La Prapat and Signal Poiana lui Iancu (Figure 4 and Table 1).

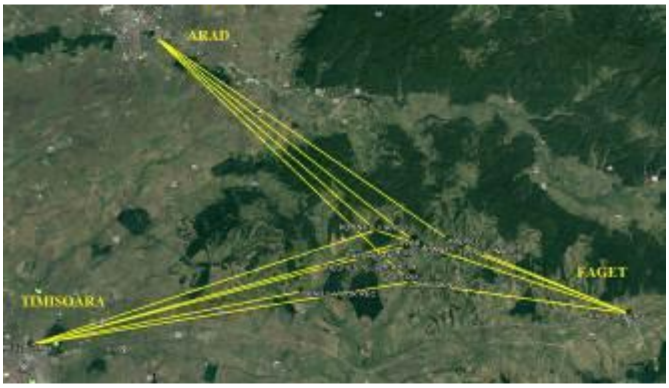


Fig. 4. Higher order signals and reference stations TM, AR and FG

3. <u>Field stage</u>

<u>The first step</u> was to identify the field according to the following: letting the authorities know, identifying access routes to old points in the state geodesic network, identifying areas for the setting of the new points and the access routes to these points, and checking the GSM signal coverage of the area.

Before planting the landmarks in the field, we paid attention to the absence of magnetic fields or reflective surfaces, to the absence of obstacles that could prevent point observations, to the setting of obstacles at the limit of the cadastral plots to avoid their destruction by agricultural implements, the accessibility of the landmarks, and the setting of the landmarks as far as possible from high-voltage lines.

<u>The second step</u> contains measurements proper. This is the proper time to fill in field charts properly and in detail. Another important aspect is to synchronise all operators for the starting and stopping of measurements, which is easy due to the GSM technology.

Table 2

Coordinates of the static Higher Order signals

UAT	Point name	Landmark	Trapeze	X	Y	Z	QUOTA	UAT
1	BARA	MATRINGA	3	L-34-80-B-c	490467,9	254802,2	221,24	221,607
2	BRESTOVAT	POIANA LUI IANCU	4	L-34-80-B-a	497805,7	249392,5	276,589	276,956
3	SECAS	LA PRAPAT	4	L-34-80-B-a	496609	254140,6	232,44	232,807
4	BARA	DEALUL MARE	4	L-34-80-B-b	495661,1	260577	250,29	250,58
5	BRESTOVĂȚ	DEALUL VIILOR	4	L-34-80-A-d	489692,9	240105,9	195,3	195,656

4. <u>Office stage</u>

Processing field data is the last and maybe the most important stage of the study: it needs lots of attention particularly during the introduction of the raw data from different working sessions and during their proper correlation. Though current softs process data automatically, special care should be given to post-processing: the post-processing result is good when point determination accuracy is minute.

<u>Data post-processing</u>:

In this stage, all data files downloaded from receivers are loaded and field charts are examined. In our case, we monitored the filling in of the data regarding the height of the instrument. Upon data processing, we used the soft Leica Geo Office Combined, a programme allowing data processing and network compensation. Data files were imported in RINEX, a universally known format. Figures 5 and 6 represent both networks, STATIC and RADIO.

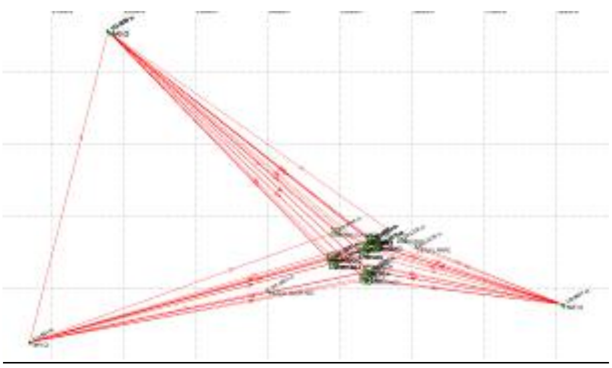


Fig. 5 – Static measurements at UAT Secaș

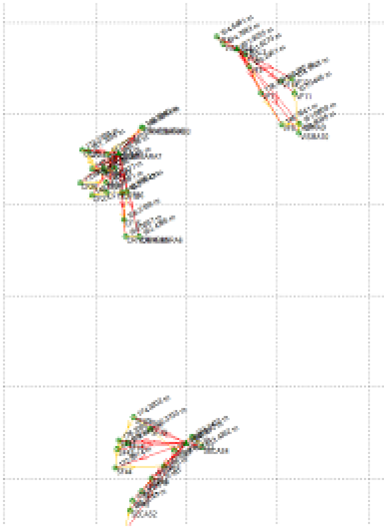


Fig. 6 – Radio measurements at UAT Secaș

Below, we present data introduced in the processing soft (Table 2 and 3).

Table 3

Raw data introduced into LGO, SECAS with corrected stations

Point ID	Point Class	Duration	GNSS Type	Type	Height Reading
FAGE	Control	6h 59’ 55’’	GPS/GLONASS	Static	0.0000
TIM1	Control	6h 59’ 55’’	GPS/GLONASS	Static	0.0000
ARAD	Control	6h 59’ 55’’	GPS	Static	0.0000
SECAS1	Navigated	1h 30’ 30’’	GPS/GLONASS	Static	0.8900
CRIVO6	Navigated	1h 29’ 55’’	GPS/GLONASS	Static	0.7400
CRIVO7	Navigated	1h 56’ 30’’	GPS/GLONASS	Static	0.9100
CRIVO8	Navigated	1h 40’ 45’’	GPS/GLONASS	Static	0.8750
VISMA10	Averaged	1h 20’ 30’’	GPS/GLONASS	Static	0.7500
VISMA9	Navigated	1h 32’ 10’’	GPS/GLONASS	Static	0.9500
CHECHES 13	Navigated	1h 31’ 45’’	GPS/GLONASS	Static	10.900
CHECHE14	Navigated	1h 36’ 50’’	GPS/GLONASS	Static	11.100
CHECHES15	Navigated	1h 34’ 19’’	GPS/GLONASS	Static	10.640
CHECHES16	Navigated	1h 32’ 48’’	GPS/GLONASS	Static	0.9170
VIZMAL3	Navigated	1h 32’ 22’’	GPS/GLONASS	Static	0.9950
VIZMAL1	Navigated	1h 43’ 52’’	GPS/GLONASS	Static	0.8330
SECAS 3	Navigated	1h 40’ 01’’	GPS/GLONASS	Static	0.8790
SECAS 4	Navigated	1h 41’ 18’’	GPS/GLONASS	Static	10.280
SECAS 2	Navigated	2h 21’ 40’’	GPS/GLONASS	Static	13.850
CRIVO5	Navigated	1h 36’ 04’’	GPS/GLONASS	Static	11.290
LA-PRPAT	Navigated	1h 54’ 19’’	GPS/GLONASS	Static	11.260
LA-MATRINGA	Navigated	1h 46’ 40’’	GPS/GLONASS	Static	0.7510
INSUSEC	Navigated	1h 50’ 00’’	GPS/GLONASS	Static	0.9780
DEALUL.MARE	Navigated	1h 34’ 34’’	GPS/GLONASS	Static	10.910
POIANA LUI IANCU	Navigated	1h 30’ 02’’	GPS/GLONASS	Static	11.590
DEALUL VILOR REC	Navigated	2h 04’ 26’’	GPS/GLONASS	Static	0.9950

Table 4

Post-processing of static thickening network through satellite measurements at Secas, WGS 1984 coordinates with corrected stations

Point ID	Posn. Qlty	Hgt. Qlty	Posn.+Hgt. Qlty
ARAD	0.0005	0.0005	0.0008
LA-PRPAT	0.0037	0.0028	0.0047
INSUSEC	0.0019	0.0011	0.0022
DEALUL.MARE	0.0025	0.0009	0.0027
DEALUL VILOR REC	0.0030	0.0022	0.0037
CRIVO7	0.0004	0.0006	0.0007
CRIVO8	0.0005	0.0007	0.0009
VIZMAL1	0.0005	0.0008	0.0009
CHECHES15	0.0002	0.0004	0.0004
CHECHE14	0.0003	0.0004	0.0005
CRIVO6	0.0003	0.0005	0.0006
CHECHES 13	0.0002	0.0003	0.0004
VISMA10	0.0007	0.0011	0.0013
VIZMAL3	0.0003	0.0005	0.0006
CHECHES16	0.0002	0.0003	0.0004
SECAS1	0.0004	0.0006	0.0007
ARAD	0.0002	0.0003	0.0004

VISMA9	0.0006	0.0009	0.0010
SECAS 3	0.0003	0.0005	0.0006
SECAS 4	0.0005	0.0008	0.0010
CRIVO5	0.0005	0.0009	0.0011
LA-PRPAT	0.0010	0.0017	0.0020
LA-MATRINGA	0.0004	0.0005	0.0006
INSUSEC	0.0004	0.0006	0.0007
DEALUL.MARE	0.0004	0.0006	0.0007
POIANA LUI IANCU	0.0014	0.0027	0.0031
DEALUL VILOR REC	0.0010	0.0016	0.0019

After data processing, we adjusted the network with the Leica Geo Office Combined Programme with the option **ADJUSTMENT:**

Clasical 3D

Project name:	Posprocesare SECAS
Date created:	01/17/2017 18:15:41
Time zone:	2h 00'
Coordinate system name:	E-TransDatRO
Application software:	LEICA Geo Office 8.3
Processing kernel:	MOVE3 4.1

General Information

Adjustment

Type:	Constrained		
Dimension:	3D		
Coordinate system:	WGS 1984		
Height mode:	Ellipsoidal		
Number of iterations:	1		
Maximum coord correction in last iteration:	0.0000 m	✔	(tolerance is met)

Stations

Number of (partly) known stations:	5
Number of unknown stations:	21
Total:	26

Observations

GPS coordinate differences:	171 (57 baselines) (including 2 baselines as free observations)
Known coordinates:	15
Total:	186 (including 6 free observations)

Unknowns

Coordinates:	78
Total:	78
Degrees of freedom:	108

Testing

Alfa (multi dimensional):	0.6330
Alfa 0 (one dimensional):	5.0 %
Beta:	80.0 %

Sigma a-priori (GPS):	10.0		
Critical value W-test:	1.96		
Critical value T-test (2-dimensional):	2.42		
Critical value T-test (3-dimensional):	1.89		
Critical value F-test:	0.95		
F-test:	20513.17	⚠	(rejected)

Results based on a-posteriori variance factor

Input data

Approximate Coordinates

Station	Latitude	Longitude	Height [m]	
ARAD	46° 10' 23.51010" N	21° 20' 40.51054" E	165.6742	Known in Position and Height
CHECHE14	45° 53' 36.66050" N	21° 46' 00.42858" E	262.3138	
CHECHES 13	45° 53' 34.84568" N	21° 45' 59.19429" E	269.7873	
CHECHES15	45° 54' 10.43481" N	21° 45' 49.36682" E	265.9795	
CHECHES16	45° 54' 02.07144" N	21° 45' 38.69765" E	265.1694	
CRIVO5	45° 54' 26.25384" N	21° 49' 05.31431" E	194.4995	
CRIVO6	45° 54' 26.46730" N	21° 49' 12.34966" E	207.2442	
CRIVO7	45° 54' 55.83456" N	21° 49' 00.41527" E	191.3937	
CRIVO8	45° 55' 05.21485" N	21° 49' 11.45658" E	193.9901	
DEALUL VILOR REC	45° 51' 28.12682" N	21° 39' 02.14982" E	238.7883	
DEALUL.MARE	45° 55' 08.00689" N	21° 54' 39.54588" E	294.0488	
FAGE	45° 51' 16.42753" N	22° 10' 37.78288" E	216.4898	Known in Position and Height
FAGE (2)	45° 51' 16.42753" N	22° 10' 37.78288" E	216.4898	Known in Position and Height
INSUSEC	45° 55' 43.30560" N	21° 53' 07.90529" E	266.9788	
LA-MATRINGA	45° 52' 33.75653" N	21° 49' 33.67933" E	172.7265	
LA-PRPAT	45° 55' 30.49554" N	21° 49' 39.36826" E	276.2867	
POIANA LUI IANCU	45° 56' 03.03768" N	21° 45' 56.96063" E	320.4215	
SECAS 3	45° 53' 13.76388" N	21° 49' 40.59250" E	176.9547	
SECAS 4	45° 53' 12.44651" N	21° 49' 48.41920" E	176.3739	
SECAS1	45° 52' 40.55383" N	21° 49' 10.35339" E	177.6961	
TIM1	45° 46' 47.65273" N	21° 13' 51.46271" E	154.7278	Known in Position and Height
TIM1 (2)	45° 46' 47.65273" N	21° 13' 51.46271" E	154.7278	Known in Position and Height
VISMA10	45° 55' 05.38828" N	21° 50' 31.57532" E	204.1450	
VISMA9	45° 55' 08.66265" N	21° 50' 31.59124" E	206.9969	
VIZMAL1	45° 55' 35.83349" N	21° 49' 51.24547" E	237.8075	
VIZMAL3	45° 55' 34.39834" N	21° 49' 58.35599" E	240.9782	

Adjustment Results

Coordinates

Station		Coordinate	Corr	Sd	
ARAD	Latitude	46° 10' 23.51010" N	0.0000 m	-	fixed
	Longitude	21° 20' 40.51054" E	0.0000 m	-	fixed
	Height	165.6742 m	0.0000 m	-	fixed
CHECHE14	Latitude	45° 53' 36.62855" N	-0.9865 m	0.2691 m	
	Longitude	21° 46' 00.38455" E	-0.9494 m	0.2065 m	

	Height	262.5163 m	0.2025 m	0.5017 m	
CHECHES 13	Latitude	45° 53' 34.81362" N	-0.9900 m	0.2442 m	
	Longitude	21° 45' 59.15003" E	-0.9544 m	0.1738 m	
	Height	269.9422 m	0.1548 m	0.4634 m	
CHECHES15	Latitude	45° 54' 10.40165" N	-1.0239 m	0.2227 m	
	Longitude	21° 45' 49.32149" E	-0.9770 m	0.2054 m	
	Height	266.4157 m	0.4363 m	0.4364 m	
CHECHES16	Latitude	45° 54' 02.03850" N	-1.0171 m	0.2093 m	
	Longitude	21° 45' 38.65322" E	-0.9577 m	0.1984 m	
	Height	265.5614 m	0.3920 m	0.4159 m	
CRIVO5	Latitude	45° 54' 26.25287" N	-0.0301 m	0.5230 m	
	Longitude	21° 49' 05.31391" E	-0.0086 m	0.3345 m	
	Height	193.7399 m	-0.7596 m	1.0709 m	
CRIVO6	Latitude	45° 54' 26.47099" N	0.1137 m	0.2117 m	
	Longitude	21° 49' 12.35280" E	0.0676 m	0.1749 m	
	Height	206.0208 m	-1.2234 m	0.3212 m	
CRIVO7	Latitude	45° 54' 55.83481" N	0.0077 m	0.2201 m	
	Longitude	21° 49' 00.41563" E	0.0078 m	0.1665 m	
	Height	190.4956 m	-0.8981 m	0.4035 m	
CRIVO8	Latitude	45° 55' 05.21521" N	0.0114 m	0.2924 m	
	Longitude	21° 49' 11.45700" E	0.0090 m	0.1995 m	
	Height	193.1349 m	-0.8552 m	0.5070 m	
DEALUL VILOR REC	Latitude	45° 51' 28.12683" N	0.0002 m	1.1682 m	
	Longitude	21° 39' 02.14977" E	-0.0012 m	0.7921 m	
	Height	238.7883 m	0.0000 m	2.3183 m	
DEALUL.MARE	Latitude	45° 55' 08.00688" N	-0.0003 m	0.4591 m	
	Longitude	21° 54' 39.54589" E	0.0001 m	0.2958 m	
	Height	294.0488 m	0.0000 m	0.9112 m	
FAGE	Latitude	45° 51' 16.42753" N	0.0000 m	-	fixed
	Longitude	22° 10' 37.78288" E	0.0000 m	-	fixed
	Height	216.4898 m	0.0000 m	-	fixed
FAGE (2)	Latitude	45° 51' 16.42753" N	0.0000 m	-	fixed
	Longitude	22° 10' 37.78288" E	0.0000 m	-	fixed
	Height	216.4898 m	0.0000 m	-	fixed
INSUSEC	Latitude	45° 55' 43.27389" N	-0.9789 m	0.2964 m	
	Longitude	21° 53' 07.86020" E	-0.9714 m	0.1697 m	
	Height	267.6163 m	0.6375 m	0.4902 m	
LA-MATRINGA	Latitude	45° 52' 33.75708" N	0.0169 m	0.2567 m	
	Longitude	21° 49' 33.67883" E	-0.0108 m	0.1504 m	
	Height	172.1807 m	-0.5458 m	0.4321 m	
LA-PRPAT	Latitude	45° 55' 30.49436" N	-0.0362 m	1.1230 m	
	Longitude	21° 49' 39.36950" E	0.0265 m	0.7816 m	
	Height	276.0139 m	-0.2728 m	2.2141 m	
POIANA LUI IANCU	Latitude	45° 56' 03.03796" N	0.0086 m	1.0992 m	
	Longitude	21° 45' 56.96142" E	0.0170 m	0.7465 m	
	Height	319.5171 m	-0.9045 m	2.6659 m	
SECAS 3	Latitude	45° 53' 13.73244" N	-0.9708 m	0.3342 m	
	Longitude	21° 49' 40.54790" E	-0.9617 m	0.2064 m	
	Height	177.4679 m	0.5133 m	0.6053 m	
SECAS 4	Latitude	45° 53' 12.41517" N	-0.9678 m	0.3512 m	
	Longitude	21° 49' 48.37458" E	-0.9623 m	0.2281 m	

	Height	177.0133 m	0.6394 m	0.6760 m	
SECAS1	Latitude	45° 52' 40.55689" N	0.0945 m	0.2071 m	
	Longitude	21° 49' 10.35252" E	-0.0187 m	0.1868 m	
	Height	176.5454 m	-1.1507 m	0.3274 m	
TIM1	Latitude	45° 46' 47.65273" N	0.0000 m	-	fixed
	Longitude	21° 13' 51.46271" E	0.0000 m	-	fixed
	Height	154.7278 m	0.0000 m	-	fixed
TIM1 (2)	Latitude	45° 46' 47.65273" N	0.0000 m	-	fixed
	Longitude	21° 13' 51.46271" E	0.0000 m	-	fixed
	Height	154.7278 m	0.0000 m	-	fixed
VISMA10	Latitude	45° 55' 05.38771" N	-0.0177 m	0.3885 m	
	Longitude	21° 50' 31.57904" E	0.0802 m	0.2512 m	
	Height	203.2144 m	-0.9307 m	0.6410 m	
VISMA9	Latitude	45° 55' 08.66996" N	0.2256 m	0.3322 m	
	Longitude	21° 50' 31.59494" E	0.0796 m	0.2077 m	
	Height	205.7974 m	-1.1995 m	0.4338 m	
VIZMAL1	Latitude	45° 55' 35.80060" N	-1.0157 m	0.4539 m	
	Longitude	21° 49' 51.20074" E	-0.9639 m	0.3195 m	
	Height	238.5206 m	0.7131 m	0.8848 m	
VIZMAL3	Latitude	45° 55' 34.36554" N	-1.0129 m	0.3460 m	
	Longitude	21° 49' 58.31142" E	-0.9603 m	0.2219 m	
	Height	241.4707 m	0.4925 m	0.6235 m	

CONCLUSIONS

Taking into account the accuracy of the measurements for each point after network compensation and after comparing the data, we can say that:

❖ To thicken the geodesic network we made the following field measurements (figure 7):

a. GPS measurements through RTK (Real Time Kinematic) method;
b. GPS measurements through STATIC method;
c. GPS measurements through RADIO method;

❖ The static method provides the highest precision on coordinates X and Y.

❖ The method is practical, but it needs observing the conditions for the correct and effective planning of a GPS campaign.

❖ The GPS determined support points can be sued in land survey no matter the method used (RTK or total station) at Secaș, Timiș County, Romania.

❖ Technically, it ensures the accuracy required by the task book and by current technical norms.

❖ Checking results emphasise the god quality of GPS measurements and particularly of static ones.

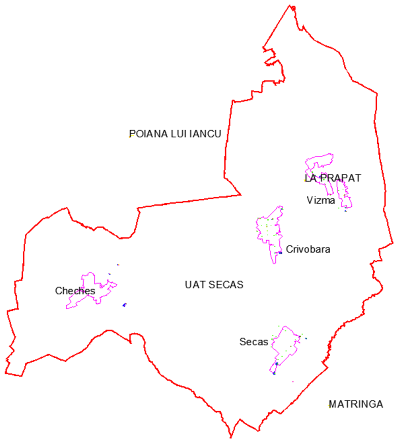


Fig. 10
Măsurători GPS, UAT Secaș

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