

THE GEODESIC NETWORK THICKENING BY SATELLITE MEASUREMENTS IN BARA COMMUNE, TIMIS COUNTY

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Abstract . The main purpose of this study is the description of the main stages for thickening the geodetic network by satellite measurements in Bara village, Timis County. For geodetic network realization field measurements were taken and then, the gathered data were processed. The measurements were done using the 'static' method with 3 double frequency Leica 1200 series receivers L1/L2, in all the 5 settlements of the county: Bara, Lapusnic, Dobresti, Radmanesti and Spata, having as reference points the GPS national geodetic network: Timisoara, Arad, Faget and Beius. For choosing the points that will thicken the geodetic network several criteria were taken into account. That's why the first stage was to explore the terrain. After this first stage, 20 concrete landmarks were materialized manually after the current rules. This 20 concrete landmarks were equally distributed in the settlements, 4 in each settlement, 2 at the entrance of the intravilan and 2 at the exit of the intravilan. The next stage was thickening of the geodetic network with other 55 field landmarks placed in the intravilan of the settlements, usually at the intersection of the streets, with visibility between them. After materialization of all landmarks, a GPS measurement campaign was made. To this measurements several parameters were taken into account, stationary time at each landmark being the most important. After this static measurements were done, RINNEX data were bought from Cadastral Office and Real Estate Advertising office from Timisoara, Arad, Faget and Beius. This RINNEX data were used for processing the raw data resulted from all the landmarks measurements which were post processed using Leica Geo Office software. After the coordinates for the 20 concrete landmarks were obtained through post processing, the other 55 landmarks were determined through 'radio' method. For verifying the correctness of the measurements, other 3 existing high order geodetic static signals were determined: Bucina signal, Odaia signal and Lapusnic signal.

Key words: geodetic network, satellite measurements, post processing, WGS 1984, Stereografic 1970

INTRODUCTION

In the analysis of the geographical space over recent years, the 'satellite' approach is increasingly being observed, following different aspects, through various techniques and means. Both GIS techniques, used in the previous research [5], and CAD techniques ([6], [2], [1]), provide a complex analysis with significantly better results than the classical methods used in the past.

In order to ensure the support necessary for the subsequent topographical survey works, we will design and determine on the field the thickening points of the support network existing in the area established for the study.

The points designed and determined on the field were materialised through boundary stones and will form a network that will cover the areas included in the study. The number of points included in this network was in line with the land configuration, the type and performance of the devices used for the measurements, the existence of the points belonging to the support network (the national geodesic network), the visibility, the density of the details that need to be represented.

When designing the network, we took into account the existence of the boundary stones in the national geodesic network, which after the recognition process on the field of their existence, proved to be appropriate and consequently usable.

Where, after recognising the land, we have found that the visibility between two successive points of the network is prevented by vegetation (isolated objects), we have materialised and measured pairs of 2 boundary stones. The boundary stones with mutual visibility must be at distances that allow angles and distances to be measured using the total station. Also, the points must be in the open field, away from obstacles, ensuring a minimum free horizon of 15 degrees above the horizon.

When designing the network and planning the GNSS measurements, we took into account both the permanent GNSS stations that are part of the A Class National Geodesic Network, and the boundary stones of the national geodesic network of triangulation (order I - IV), whose existence we have checked in the land recognition phase. All these points were used in the design of the approximate positions of the new boundary stones, and this was the basis on which we determined the material requirements. We also took into account that the lengths of the roads with the total station should not exceed the lengths of 1.5 - 2 km.

For the integration into the national reference systems (planimetric and altimetric), but also into a unitary and homogeneous network, all newly designed boundary stones will be stationed with GNSS technology.

MATERIAL AND METHODS

The research presented in this paper was carried out in the western part of Romania, in the north-east of Timis County, at the base of Lipovei Hills, about 30 km north of Lugoj City, on the administrative territory of Bara Commune, town composed of Bara, Dobresti , Lapusnic, Radmanesti and Spata villages [9] (Figure 1).

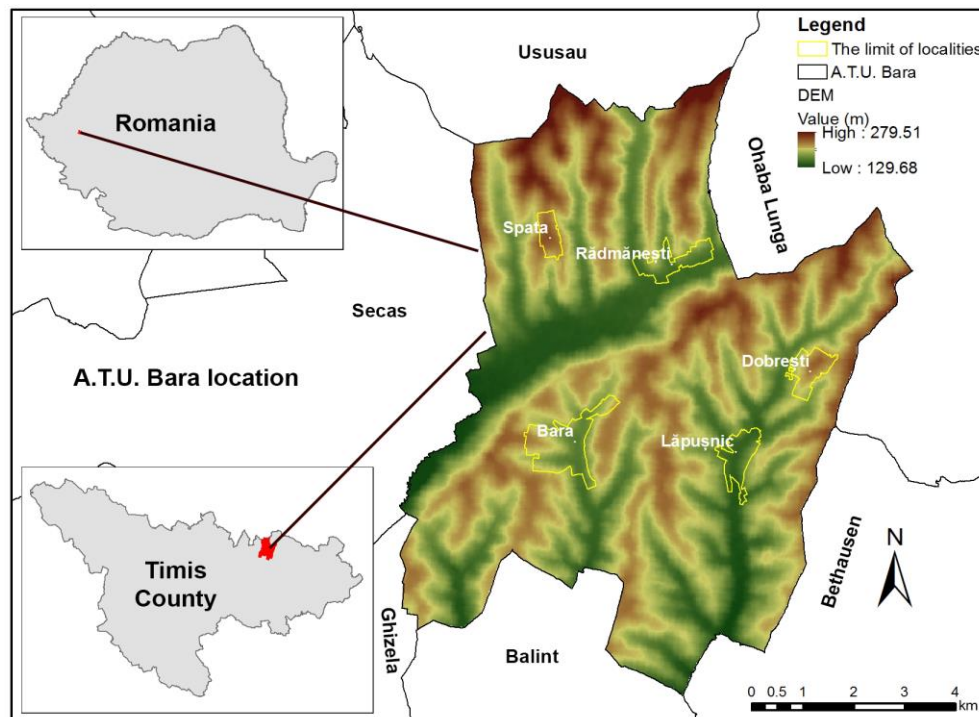


Fig. 1 – Localisation of Bara Commune (adaptation by [11], [14])

In the realisation of the study, in order to achieve the proposed goal, we used:

- analogous, scanned and georeferenced cartographic materials with CAD and GIS software (topographical plans and maps, cadastral maps, orthophotomaps) taken from the specialised institutions [10]
- data in vector format (limits of administrative-territorial units, county limit) [11]
- scientific data and information from the literature, as well as direct observations on the field
- statistical data on the structure of the Agricultural Real Estate [12]
- the Digital Elevation Model, downloaded free of charge from the European Environment Agency website ([13], [14])

The materialisation on the field of the topographical points bear the name of marking. The topographical points were materialised on the field through the boundary stones, which remained on the field even after the measurements were completed. The points of the thickening geodesic network, depending on the conditions offered by the land, materialised in two ways: [3]

- concrete boundary stones, according to the Technical Norms in force (Figure 2A)
- FENO type boundary stones, with the upper part of granite or hard plastic, according to the Technical Norms in force (Figure 2B)

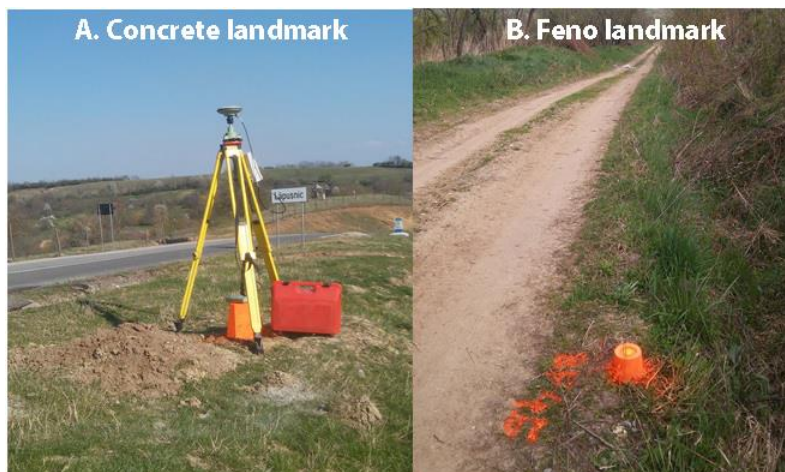


Fig. 2 – Type of boundary landmarks used (original photo)

When designing the GPS observations (GNSS), we also considered elements other than those when designing a classic geodesic network. We have taken into account a number of factors such as: the satellite configuration at the time of the measurements, the number of satellites that can be tracked simultaneously at one point, the length of the base, the number and type of receivers available [7].

An important parameter was the stationary time for each boundary stone, considering the longest base (Figure 3). In our case, the duration of a session to get the correct postprocessing results is 1 min/km + 15 control minutes. In the case of static measurements carried out in the administrative territory of Bara Commune, the stationary time was 1.5

h/measurement session. This means 70 minutes for the longest base of 70 km + 15 control minutes, resulting in 95 minutes of stationary time.

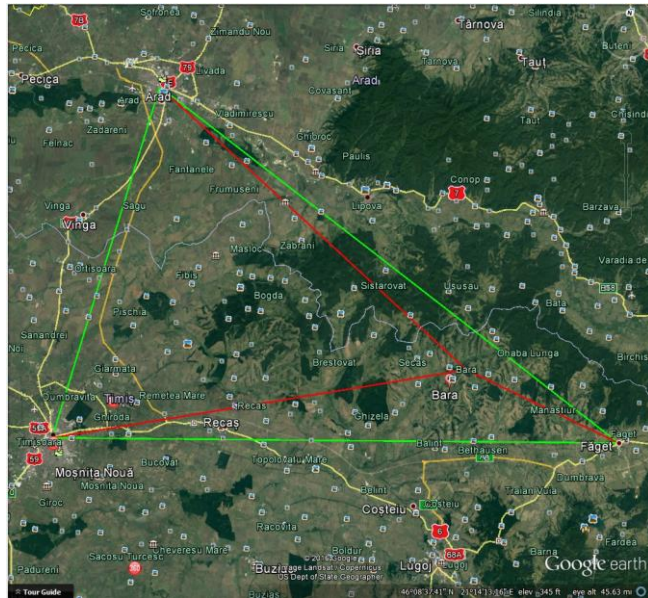


Fig. 3 – Lengths of bases
(adaptation by [16])

The GNSS measurements were performed with 3 Leica 1200 series L1/L2 double-sided receivers (Figure 4). The processing of the measurements made using GNSS technology was performed with specialised software, aiming in particular at obtaining ‘fixed’ solutions for each vector and their compensation as a constrained network using measurements and coordinates of the A Class National Space Geodesic Network through the Romanian service of determining the position of ROMPOS.



Fig. 4 – Leica GPS 1200 (original photo)

RESULTS AND DISCUSSIONS

This paper aims at thickening the geodesic network in Bara Commune by measurements using GNSS technology. For the realisation of this geodesic network, the following topo-geodesic works were executed:

- The GNSS measurements using the STATICA method for thickening the support network
- The GNSS measurements using the RADIO method for thickening the support network

The network has been thickened from the following geodesic points in the A Class GPS national network (Table 1).

Table 1

Used stations in the national network

NR. CRT.	DENUMIRE	CLASA	B[m]	L[m]	He[m]
1	STATIA PERM. TIMISOARA	A	45°46'47.65271"N	21°13'51.46281"E	154,7278
2	STATIA PERM. ARAD	A	46°10'23.51004"N	21°20'40.51052"E	167,6742
3	STATIA PERM. FAGET	A	45°51'16.42753"N	22°10' 37.78289"E	216,4898

The signals selected as known points within the project were Odaia Signal, Bucina Signal and Lapusnic Signal (Figure 5).



Fig. 5 – Existing signals (original photo)

When choosing the points that will thicken the national network and which are to be determined by GPS measurements, we have considered the following criteria: [4]

- keeping the point secure for a long time
- visibility from 15g above the horizon
- the GPS receivers have been set to collect data every 5 seconds

- the base points that are determined should be used in subsequent works
- there shall not be large power installations near stations or transmitting relays

The measurements were made using the 'static' method with the following equipment: 3 Leica 1200 series L1/L2 double-sided receivers, having as reference the points in the GPS national geodesic network of Timisoara, Arad, Faget (Table 1).

As a result of the measurements, 75 new points were determined, of which 20 are concrete boundary stones and 55 are feno-type boundary stones.

Data processing was executed with the Leica Geo Office Combined software, version 8.3.0.0 produced by Leica Geosystem in Switzerland [15]. The accuracy required for processing this data is 5cm+/-2ppm. The points in the thickening geodesic network were determined from 3 vectors.

Based on the results obtained in the processing of the thickening and elevating network determined by GNSS technology, namely the ellipsoidal coordinates in the ETRS89 reference system, their transformation will be carried out into the national reference systems (planimetric and altimetric).

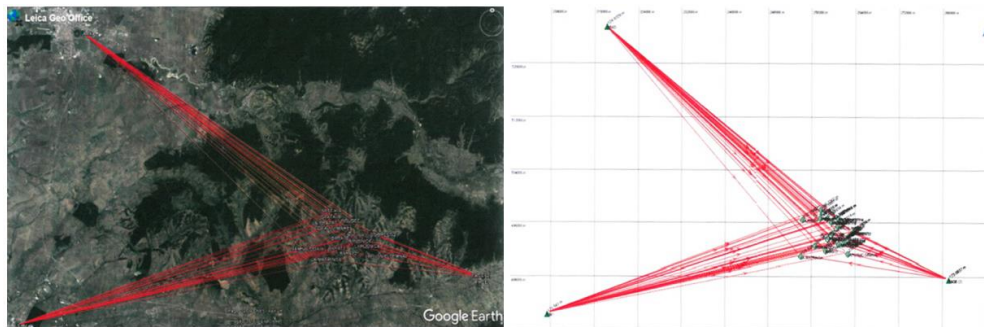


Fig. 6 – Static measurements
(generated from Leica Geo Office Combined)

After the static determination of the 20 concrete boundary stones, we started the measurements through the RADIO process of the other 55 feno boundary stones with the following equipment: 3 Leica L1+L2 double-sided GSP receivers. Of which, we used 1 reference station and 2 mobile rovers.

For each RADIO session, after mounting the base on a concrete boundary stone with known coordinates, another boundary stone was occupied with the Rover to compare the newly obtained RADIO coordinates of the boundary stone with the previous coordinates obtained by postprocessing. The coordinate differences were maximum 1-3 cm on X, Y and Z after 10 seconds of occupation. The data recordings were made by the observation record setting at 3 seconds.

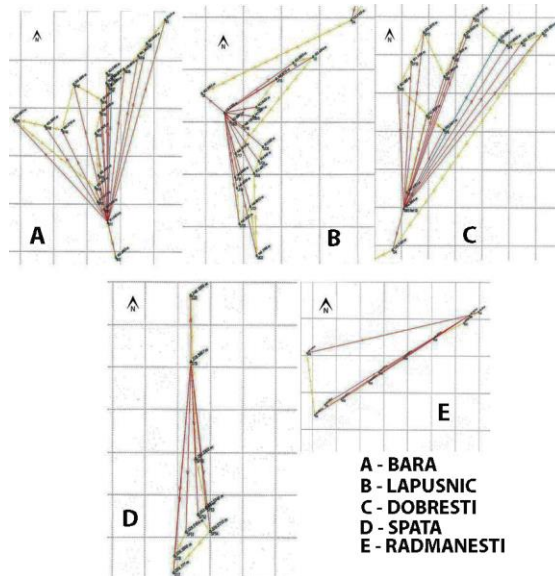


Fig. 7 – Radio measurements
 (generated from Leica Geo Office Combined)

The realisation of the Thickening and Elevating Geodesic Network is a compulsory stage in order to ensure the technical conditions for carrying out all the measurements and technical operations subsequently necessary to achieve the final purpose of the work [8].

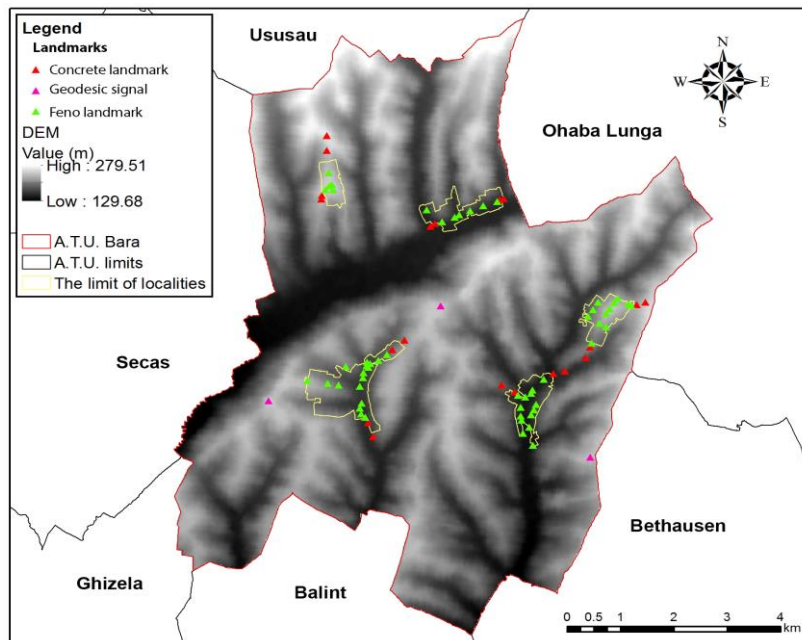


Fig. 8 – Location of the boundary landmarks
 (adaptation by [11], [14])

CONCLUSIONS

The static method provides the highest precision for coordinate determination, this method is very practical, but it has to comply with the conditions for the correct planning of a GPS campaign.

The realization of geodetic mesh networks aims to satisfy administrative, economic and legal requirements and is the basis of topographic measurements performed for various purposes:

- aerofotogrammetric flying, resulting in orthophotoplan;
- realization of the photogrammetric survey for the production of orthophotoplan;
- performing the measurements resulting in the Digital Elevation Model (DEM) and its derivatives;
- mobile laser scanning;
- surface surveys (topographical surveys) for the drawing of vector plans;

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