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TOPOGRAPHIC SURVEYS AT THE SDT KM6 FARM, BUASVM TIMISOARA, ROMANIA (TIMISOARA-ARAD NR)

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Abstract: *This paper aims at presenting the topographic surveys on the Didactic Station Farm of Timisoara, Romania, at the km 6, on the Timisoara-Arad NR. The farm belongs to the Commune of Dumbravita; it has the cadastral number CC49 and it consists, according to the Land Cadastre (no. 4631) of agricultural and zootechnic administrative buildings, greenhouses, silos, warehouses, winter stables, fuel storages, pump house, drill, water plant, concrete platforms, access roads, and courtyard. The total area of the farm is 12 ha and 7138 m*^{2}*. In 2005, according to the no. 14597 from April 26, 2005, recorded by the A.N.C.P.I.-O.C.P.I. TIMIŞ, Timişoara Land Cadastre Office, it was recorded in the Land Cadastre of the estate according to the Licence no. 1051/2003 issues by the Mayor of the Commune of Dumbravita as follows: in the 1*st *step, opening a land cadastre with indefinite character for the territory of the Commune of Dumbravita on the grounds of the art. 61 of Law no. 7/1996 where it is recorded in the database as a unitary compulsory system of technical, economic and legal recording system, plot no. CC49, made up of the "****SDT Farm located at the km 6 of the Timisoara-Arad NR****"; in the 2*nd *step, they recorded the ownership right on the estate from the public domain consisting of the buildings and terrain described above in favour of the ROMANIAN STATE in 1/1 quotas as "localisation ownership" as stipulated by the GD no. 123/1993 and GD no. 1225/1996; in the 3*rd *step, they recorded the right "for administration" on the buildings and terrain described above on the grounds of the same legal acts mentioned above in favour of the BANAT'S UNIVERSITY OF AGRICULTURAL SCIENCES AND VETERINARY MEDICINE OF TIMISOARA, for the DIDACTIC EXPERIMENTAL STATION. Topographic survey was carried out with a Leica TC 805 total station and the support points used were GPS-determined with a Leica Geo Office Combined Programme; the resulting files were transformed with DXF Generate, after which the points were reported in AutoCad with a TopoLT Programme. TopoSys is a special geodesic soft that uses modern calculus conception and procedures to solve the geodesic reference of the observations made with total stations or through the GNSS technology. TopoSys encloses all the functions needed to define and use Coordinate Reference Systems according to international Standards with a larger number of Coordinate Systems defined on local or global geodesic data. Inner methods of filtering errors and compensating data through the Smallest Square Method are the result of scientific research in the field, tested on numerous topographic and geodesic measurements on both local geodesic and national GNSS networks. Coordinates were determined in the Stereographic 1970 projection system and point quotas were determined in relation to the Black Sea level. The TopoSys programme system is special software destined for the processing of 1D, 2D, and 3D geodesic networks, to the compensation of observations through statistic methods, to topographic calculus and to coordinate transformation. Reduced observation compensation is done with the Smallest Square Method with correction equations developed through the indirect method. To filer greater errors, we sued the robust (Danish) method and the TAU test to determine the thrust threshold. After downloading, data processing and turning coordinates from ETRS89 into STEREO'70 with the TransDatRO 4.01 application, we calculated the 3D land model with the TopoLT Programme, a programme functioning on the AutoCad platform.*

Key words**:** *Farm, 3DModel, GPS, ETRS89, STEREOGRAFIC 1970, TopoLT, TransDatRO, WGS 1984*

INTRODUCTION

TopoSys is a special geodesic soft that uses modern calculus conception and procedures to solve the geodesic reference of the observations made with total stations or through the GNSS technology.

The TOPOSYS programme system allows the processing and compensation of the observation with total stations or through the satellite positioning technology to develop the geodesic networks 1D, 2D and 3D.

Managing information is done in databases called **Projects** and the calculus proper is done in working units called **Works**. A project can cover several works that have in common reference information such as geodesic points, users, instruments, and reference ellipsoids. Each work contains information such as points, measurements, levelling, transformations, and an operational record.

The graphic window of the programme allows the visualisation of the coordinates and observation in the current work as well as the display of point numbers, their names and error ellipses.

These dimensions can be introduced manually, imported from ASCII files or overtaken from the memories of the total stations as different format files. The distances measured can be distanced reduced to the horizon, sloped, or stadimetric.

Original GPS observations should be processed with a specialised software and exported as space vectors (expressed as differences of coordinates DX, DY, and DZ).

The categories of the systems of coordinates that can be selected are: Geocentric - Geographic; Geocentric - Cartesian; Stereographic; Gauss; UTM; Conica Lambert; Topocentric (Local).

Each of these categories contains sub-categories defined both on the ellipsoid WGS84 and on the ellipsoid Krassovsky.

Each system of coordinates can be attributed a datum, a projection, and a geoid model.

Data: WGS84 (ETRS89); Romania - Krassovski (S-42); Datum defined by the user.

Ellipsoids: GRS80 (identical with WGS84, ETRS89); Krassovski; Hayford; Bessel; Ellipsoid defined by the user.

Geoid models: EGM96 - Earth Geopotential Model 1996; EGG97 - European Gravimetric Geoid 1997; EGG97 - Quasi Europeasn Gravimetric Geoid 1997.

Calculus models of approximate coordinates: intersection forwards; intersection backwards; routing / routing networks; radiation as a way of determining approximate coordinates; radiation – calculus of detail points.

Methods of compensating planimetric and levelling networks: constraint network, free network; network with measured coordinates.

Compensating the network 1D, 2D and 3D can be done through the Least square method. The compensation process is an iterative operation and it needs the intervention of the user to establish the following parameters:

- introducing a priori standard deviation of the directions measured;
- introducing a priori standard deviation of the distances measured;
- setting the ponderation method;
- accepting the continuation of the iterations or the termination of the compensation.

Ponderation of the observations: depending on the distance measured; normalised; unity.

Transforming the coordinates can be done in the following ways:

1. By using the options in the menu Transformation: Space transformation; Plane transformation; Datum transformation.

2. By selecting the Coordinate System in the window for the setting of current work, operation through which all the coordinates of the current work are transformed through a single command of the current coordinate system into the desired coordinate system.

MATERIAL AND METHODS

The working methods used to carry out this project were the method of the routing supported at both ends on coordinate points and known orientations and the method of radiation with total station.

The routing is represented in the plan as a broken polygonal line in which the mutual position of the points is determined by measuring the distances between the breaking points and by measuring the angles in the breaking points of the polygonal route.

The routing supposes the increase of the geodesic network to determine the detail point coordinates in the field. The increase of the geodesic network was done by determining the coordinates of some points of the order V that become the main elements of the topographic survey. This is why measuring them supposes a very accurate measurement.

In the design of the routing, we took into account the choice of the routing depending on the alleys available in the area, and the establishment of the routing points so that they allow visibility between them and between them and the radiated points, and in safe areas that allow the apparatus to be mounted without problems.

The characteristic points of planar and level details are done through the radiation method, a method used in any point from which we can peep and measure a distance. The position in the plan of a radiated point (new) is defined depending on the points A and B (old) in the mapping network through the polar angle or orientation θ_{A1} and on the distance reduced to the horizon d_{A1}. In general, the radiated points are located around the station and they are peeped successively by going along the horizon line.

The topographic instruments we use are the Leica TC805 total station and the Leica GeoSystems GPS1200 equipment.

The total station, through its structure and opportunities, has become the representative instrument used nowadays exclusively to measure routing; it is also the only serious competitor of GPS.

Leica total stations are equipped with a software package that allows that most topographic operations are done easily, quickly, and in an elegant way.

The GPS was used to determine the coordinates of the control points (the ends of the routing) of the topographic survey.

Compared to the use of total station, GPS technology offers the advantage that the points that are to be measured should not be visible mutually.

Leica GPS1200 is made up of the colour controller Leica RX1200 and the Leica ATX1250 antenna, with the rover solution “all on the stick”.

Data thus collected by the total station were downloaded with Leica GeoOffice Combined software and compensated through the TopoSys software. TopoSys calculates and compensates any combination of measurements of distances and angles to determine the best correction of the measured point coordinates. The coordinate processing method allows accuracy up to the order of centimetres. With this software, we can create a DXF file that can be later uploaded into the AutoCAD.

The ***TransDatRO 4.01*** software application is a transformation procedure similar to other international procedures. It embeds a spatial data distortion model in order to maintain spatial data integrity and topology in each datum. As a result, points with larger distortions are not eliminated. On the contrary, they are tested and included in the transformation, in order to describe as realistically as possible the characteristics of each area containing new points awaiting transformation.

TopoLT is a programme operating under AutoCAD. The ***TopoLT*** programme is of great help for those who develop topographic or cadastral plans in digital format.

In the development of the ***3D*** model, we can apply different colour levels for each facet of the model. Colours are applied from the minimum to the maximum of the point quotas (Z coordinates) through which a ***3D*** model is developed. Colours for level application can be edited. Colour palettes can be saved in files and re-loaded from saved files.

A ***3D*** model of the land can be developed using points whose coordinates are X, Y, Z or spatial lines and poly-lines. Interpolation in this version of the programme is a triangulation method with linear interpolation.

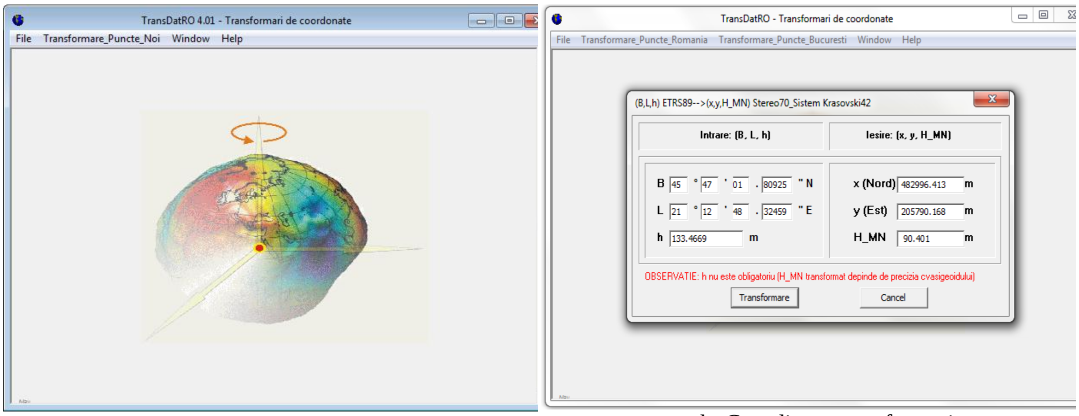
RESULTS AND DISCUSSIONS

Topographic surveys were carried out with a Leica TC 805 total station and support points were GSP determined with Leica GPS 1200 equipment. Downloading and data processing were carried out with a Leica Geo Office Combined Programme; resulting files were transformed with DXF generate after which the points were reported in AutoCad with a TopoLT Programme. The method chosen to determine control points with the Leica 1200 GPS equipment was real-time coordinate determination in the WGS 1984 reference system, i.e. Real Time Kinematic (RTK). Real Time Kinematic (RTK) satellite navigation is a technique used to enhance the precision of position data derived from satellite-based positioning systems, being usable in conjunction with GPS, GLONASS and/or Galileo. It uses measurements of the phase of the signal′s carrier wave, rather than the information content of the signal, and relies on a single reference station to provide real-time corrections, providing up to centimetre-level accuracy. Below is the presentation of the reference station used [3] to determine GPS points in the present paper.

Permanent GNSS station used to carry out topographic surveys

GEOCENTRIC CARTESIAN COORDINATES				
Permanent station	Class	Xc	Yc	Zc
Timişoara (TIM1_2.3)	A	4153556.883	1613641.291	4548330.869
ELLIPSOID COORDINATES				
Permanent station	Class	B[m]	L[m]	He[m]
Timişoara (TIM1_2.3)	A	45°46’47.65271”N	21°13’51.46281”E	154.7278
STEREOGRAPHIC COORDINATES 1970				
Permanent station	Class	X(m)	Y(m)	Z(m)
Timişoara (TIM1_2.3)	A	482495.124	207132.249	111.641

Further on, we transformed GPS coordinates thus obtained with a TrasDatRO 4.01 Programme.



a. Programme interface b. Coordinate transformation

Figure 1 - TransDatRO 4.01 Programme

We chose as point transformation method from ETRS89 into Stereographic 1970 (Figure 1).

In order to achieve the survey, we used 7 old known coordinate points that we determined with a Leica 1200 GPS equipment; transforming WGS 1984 coordinates was done with a TransDat Programme into Stereographic 1970 coordinates.

Table 1

Points determined with GPS (Leica 1200) equipment

GPS - Station point	Field mark	X(m)	Y(m)	Z(m)
(GPS) 1	Metal bolt	485396.025	204973.415	**94.350**
(GPS) 2	Metal bolt	485399.628	204892.911	**94.010**
(GPS) 3	Metal bolt	485452.281	205142.101	**93.730**
(GPS) 4	Metal bolt	485303.600	205004.108	**94.430**
(GPS) 30	Metal bolt	485321.434	204950.748	**93.744**
(GPS) 42	Metal bolt	485199.850	205091.110	**93.560**
(GPS) 43	Metal bolt	485220.623	205139.622	**93.370**

After GPS measurements, we could notice upon downloading that there were 11 files and that the LGO Programme could see all 12 files as a single file through raw data import.

Raw file: **FERMA6 ST GPS_9734_1014_110620.i00**
FERMA6 ST GPS_9734_1014_110620.m00
FERMA6 ST GPS_9734_1014_110620.X01
FERMA6 ST GPS_9734_1014_110620.X02
FERMA6 ST GPS_9734_1014_110620.X06
FERMA6 ST GPS_9734_1014_110620.X08
FERMA6 ST GPS_9734_1014_110620.X12
FERMA6 ST GPS_9734_1014_110620.X14
FERMA6 ST GPS_9734_1014_110620.X18
FERMA6 ST GPS_9734_1014_110620.X22
FERMA6 ST GPS_9734_1014_110620.X23

FERMA6 ST GPS_9734_1014_110620.XCF

Below is the processing and compensation of the points surveyed (field book) in the work with the TopoSys programme.

We imported determined points (Figure 2) GPS transformed, the ASCII File with old points (GPS determined points).

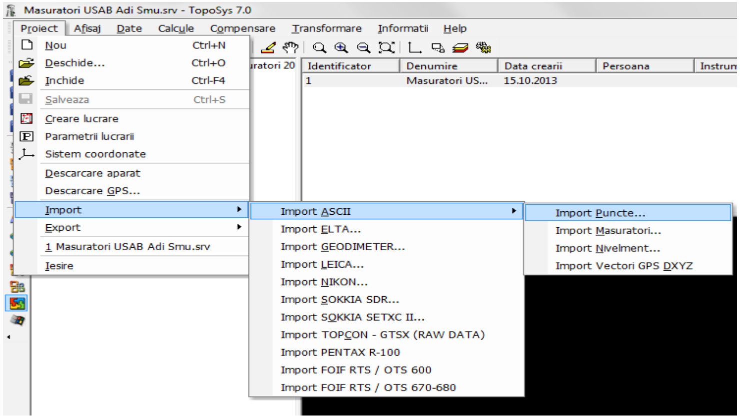


Figure 2 – Import of ASCII File with old points

Old points (GPS determined points) introduced, i.e. 1, 11, 16, 17, 19, 20, 4, and 5 were reported into the TopoSys Programme (Figure 3).

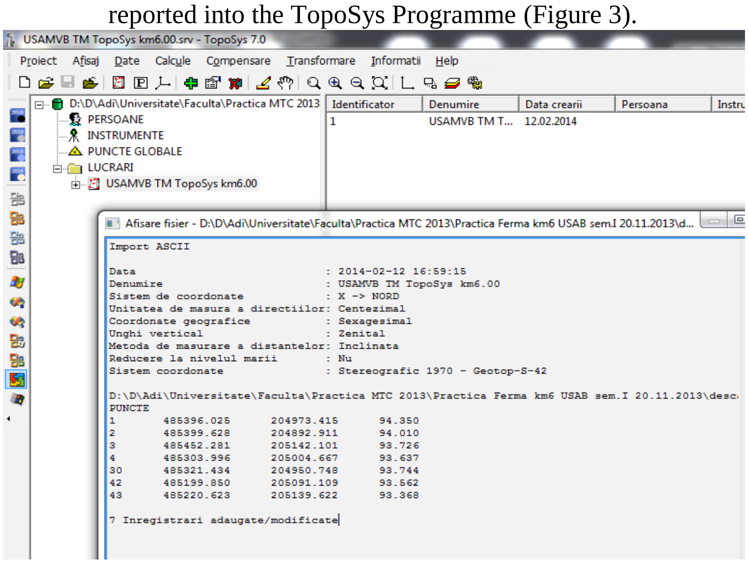


Figure 3 – Presentation of old points introduced into the TopoSys Programme

After topographic measurements, we processed the data and we made the plans. Figure 4 shows the shape of the route and the network calculus in TopoSys.

To carry out the work, we first deleted the points manually, and then we deleted the measured points automatically. Since manual deletion is done for each station point apart and the information is very numerous, we insist only on the presentation of the manual deletion in Station 1 (Figure 5).

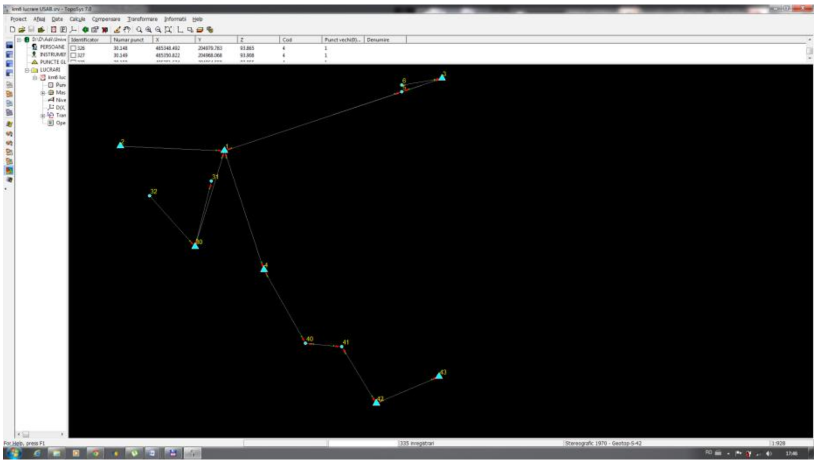


Figure 4 – Presentation of the route

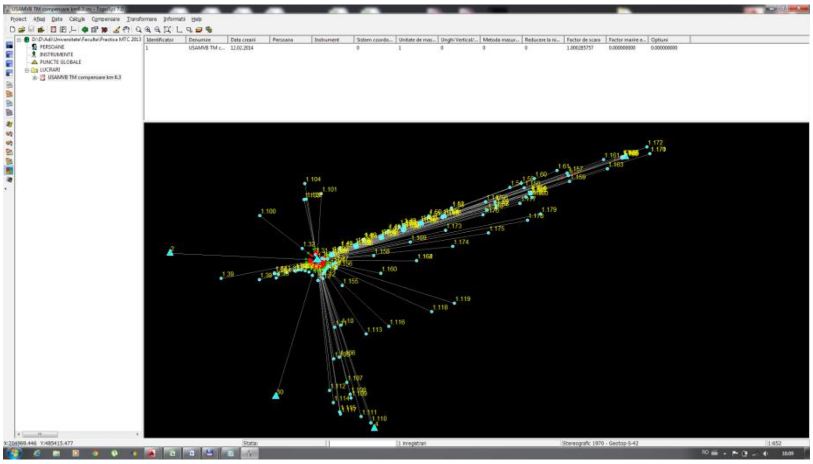


Figure 5 – Presentation of the manual deletion in the station point 1

MANUAL DELETION with the TopoSys Programme - STATION 1

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STATION 1
Orientation
Mean Orientation angle 400.0002

  Npv Direction U. Zenithal Distance Orientation Orient. angle Difference[gr]
    2  302.8495  100.1933    80.590  302.8473  399.9978   -0.0024
    3   79.5140  100.2097   177.830   79.5074  399.9934   -0.0068
    4  179.1506  100.4407    97.209  179.1590  400.0084    0.0082
    5   79.5229  100.1800   145.005   79.5242  400.0013    0.0011
   30  218.7811  100.4716    77.981  218.7813  400.0002   -0.0000

Calculated points
```

Nrp	X	Y	Z	dX	dY	dZ
2	485399.631	204892.906	94.031	0.003	-0.005	0.021
3	485452.266	205142.117	93.692	-0.015	0.016	-0.034
4	485303.982	205004.685	93.649	-0.014	0.018	0.012
1.10	485360.363	204986.424	93.755			
1.11	485359.119	204983.053	93.770			
1.12	485385.797	204976.618	94.224			
1.13	485384.710	204973.895	94.258			
.....	.....	.....	.....			
1.60	485440.356	205092.344	94.101			
1.61	485444.714	205104.657	93.154			
5	485441.866	205110.983	93.913	0.007	0.013	0.000
30	485321.413	204950.742	93.744	-0.021	-0.006	-0.000
1.100	485420.092	204942.181	94.445			
1.101	485432.060	204975.590	94.474			
.....	.....	.....	.....			
1.177	485426.712	205084.403	93.915			
1.178	485417.431	205088.457	93.835			
1.179	485420.886	205095.621	93.870			
1.180	485429.932	205091.122	93.867			

Total Calculated points : 133

Above is the presentation of the calculus of the manual deletion with the TopoSys system from the station point 1. From this station point, we deleted with the Leica TC805 total station 133 points that are only partially presented for reasons of space. Below is a presentation of the automatic deletion method with the TopoSys Programme (Figure 6).

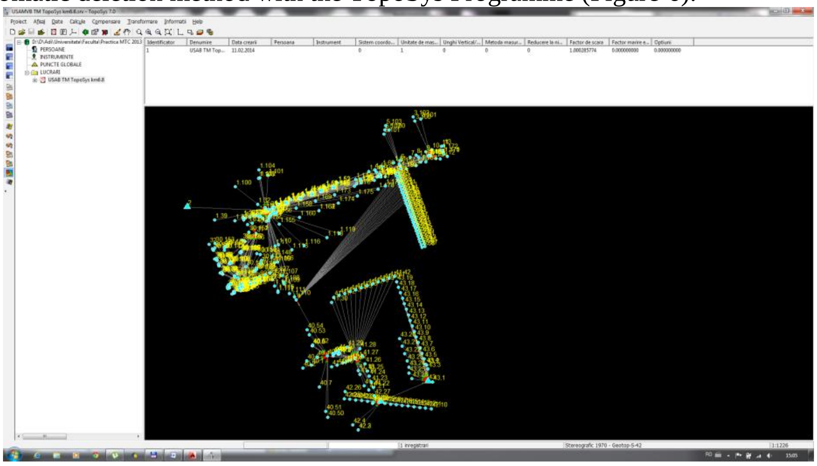

Figura 6 - Prezentarea radierii automate cu programul TopoSys

AUTOMATIC DELETION with TopoSys System - STATION 1

STATION 1
Orientation
Mean Orientation angle 400.0034

Npv	Direction U.	Zenithal Distance	Orientation	Orient. angle	Difference[gr]
* 2	302.8495	100.1933	80.590 302.8473	399.9978	-0.0056
* 4	179.1506	100.4407	97.209 179.1596	400.0090	0.0056

Calculated points

Nrp	X	Y	Z	dX	dY	dZ
2	485399.635	204892.906	94.031	0.007	-0.005	0.021
3	485452.258	205142.120	93.692			
4	485303.981	205004.680	93.649	0.006	0.007	0.000
1.10	485360.363	204986.422	93.755			
1.11	485359.119	204983.051	93.770			
1.12	485385.797	204976.618	94.224			
1.13	485384.710	204973.894	94.258			
....	....	....	....			
1.60	485440.350	205092.346	94.101			
1.61	485444.707	205104.659	93.154			

....

STATION 43
Orientation
Mean Orientation angle 0.0002

Npv	Direction U.	Zenithal	Distance	Orientation	Orient. angle	Difference[gr]
42	274.2439	99.7506	52.747	274.2441	0.0002	-0.0000

Calculated points

Nrp	X	Y	Z	dX	dY	dZ
42	485199.861	205091.134	93.556	0.011	0.025	-0.006
43.1	485219.499	205144.263	93.307			
43.2	485236.961	205138.323	93.103			
....	....	....	....			
43.25	485228.587	205120.214	93.253			
43.26	485223.028	205122.947	93.333			

Total Calculated points: 430

We have used, in the present work, THE METHOD OF 2D COMPENSATION CONSTRAINT IN FIXED POINTS, presented in Figure 7 below.

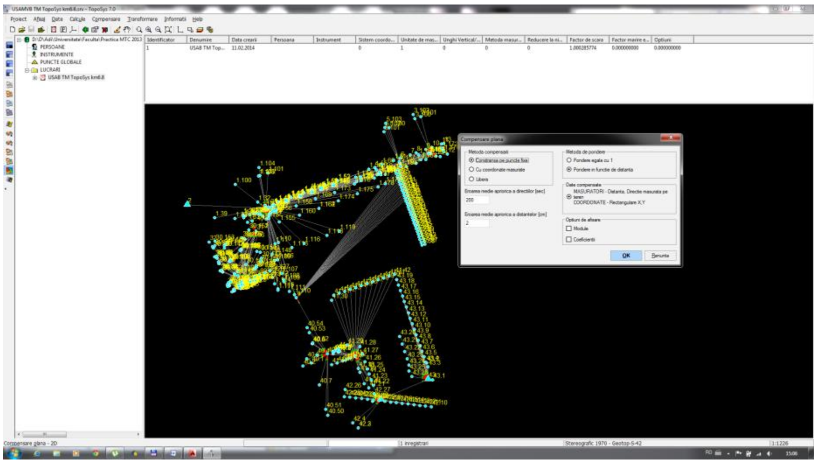

Figure 7 - 2D Compensation with the TopoSys Programme

After the calculus of the compensation, we exported the measured points; the points exported were compensated in the Stereograpgic System 1970. Then, we achieved the 3D plan based on the topographic survey, and the situation plan based on the representation of the level curves of the 3D model, of the quotas, of the station points, of the routing, etc. (Figure 8).

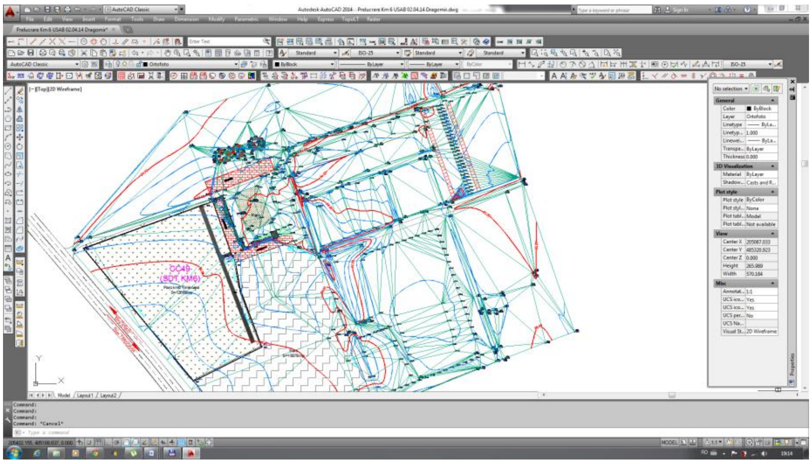

Figure 8 – Presentation of the situation plan for the km 6 of the Timisoara-Arad NR

CONCLUSIONS

Topographic surveys were made for the situation plan with a Leica TC805 total station; to do so, we developed a routing supported at both ends by known coordinate points and orientations: in the field, we determined the seven support points with a GPS Leica 1200 equipment, points that we RTK (Real Time Kinematic) determined. These points were transformed from the WGS 1984 system into the Stereographic 1970 System with a TransDat Programme. From the total station, the GSI measurements file was transformed with a DXF Generate Programme into a DXF file and then into a DWG file. After the compensation with the TopoSys programme, the points were exported as a TXT file and then reported into AutoCad with a TopoLT Programme; then we united the measured points and we achieved the 3D model of the terrain, of the quoted plan, of the plan, and of the situation plan with the representation of the level curves.

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