

## TRAVERSE WITH INDEPENDENT STATIONS - A METHOD FOR LIFTING DETAILS ON CONDITIONS OF WORK IN THE FORESTRY SECTOR

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**Abstract:** Determining details of the forestry sector in many cases is a very difficult problem considering the Structural-functional peculiarities of forest stands with direct implications on the technical conditions imposed by modern technology used to determine the spatial coordinates of characteristic points. As a result, mutual visibility is affected consider giving different characteristic points of the structural-functional features of forest stands and obviously of vegetation season. To achieve the various skills involved in forestry projects (design and installation of transport drawing, designing and building hydro drawing, design and drawing compartment line, etc..) Can be successfully applied traverse method with independent stations in order to determine coordinates of points characteristic. This method is based on targeting of points that are visible from the stations between which there is mutual visibility. Of stations considered necessary to be able to cover a sufficient number of points determined in the reference for calculating the official post-processing algorithm based on successive transformations of coordinates corresponding

points in different system of reference, finally obtaining the coordinates in national reference system. The analysis of results for this case study follows a series of features on how the location of control points on the surface of high points which can be used to optimize the working method according to the particular land. Control points used for case study were determined with modern technology that GNSS technology, conventional technology and technology combined, the results obtained are directly conditioned by the precision of determining the control points and that their location within the work area. The calculation algorithm, based on coordinates' translation, does not provide an accurate positioning for the new points. As a consequence the accuracy of transformation parameters will be taken into account in order to assess precision. A series of points, which were previously calculated by the intermediate of modern technologies (GNSS and TS), will be re-calculated. The working method is efficient in the case of relative plane plots of land, a minimum number of four points being required, arranged in the corners of the working surface.

**Key words:** details, traverse with independence stations, conventional technology, coordinate transformations, common points

### INTRODUCTION

To raise various details of the forest fund are not always favorable working conditions for application of different methods of work devoted to terrestrial measurements.

Therefore, with the advantage of modern computing technologies can implement working methods that can solve a series of cases, achieving accurate results.

This situation is presented in figure 1.

In the case presented in Figure 1 it is noted that the work area is known coordinate points 1, 2, 3, etc.. as determined in the national reference.

To raise various details have materialized on the field a number of points that station 10, 20, 30, 40, etc., without vision and that each visibility to the points of known coordinates.

Points station were materialized so there is visibility to points of detail to be high. It also obvious that some of the details to be high to be visible from two or more stations, as

appropriate - that are common points relevant from that. Will collect field data with total station, measuring the directions and distances.

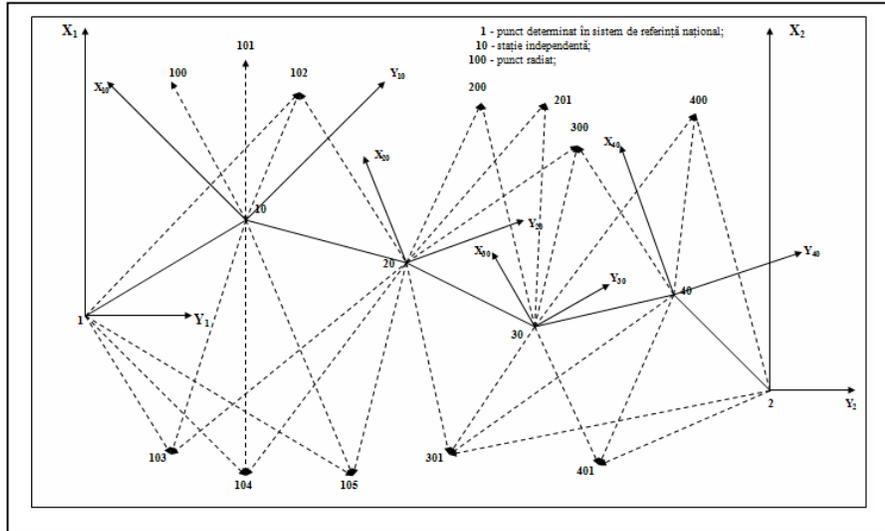


Figure 1: Algorithm for traverse realisation with independent stations (HAZAY I., SZALONTAI L., 1967)

Each station, except on points of known coordinates, will have its own reference system, given the coordinate system of the device. Therefore, the calculation of points of detail for each station will be completed in its reference system (HAZAY I., SZALONTAI L., 1967).

It is noted that a number of points are determined in at least two different reference systems.

To determine the coordinates of the new points it will proceed to carry out successive Transformation of coordinates, the reference systems of points in the national reference station (for points of known coordinates).

The calculation algorithm for coordinate transformation is given below.

The general formula of achieving transformation of reference system  $i+1$  and the system  $i$  is as follows (HAZAY I., SZALONTAI L., 1967):

$$S_i = \begin{pmatrix} X_o \\ Y_o \end{pmatrix}_{i+1} + T_{i+1,i} \cdot \begin{pmatrix} X \\ Y \end{pmatrix}_{i+1} \quad (1)$$

To meet the case study, the transformation relations are presented below.

$$S_1 = \begin{pmatrix} X_o \\ Y_o \end{pmatrix}_{S_{10}} + T_{10,1} \cdot \begin{pmatrix} X \\ Y \end{pmatrix}_{S_{10}} \quad (2)$$

Elements of transformation matrix  $T$ , is determined on the basis of common, the form:

$$T_{10,1} = \begin{pmatrix} a & -b \\ b & a \end{pmatrix}_{10,1} \quad (3)$$

As a result, the transformation relations have the following form:

$$S_1 = \begin{pmatrix} X_o \\ Y_o \end{pmatrix}_{S_{10}} + \begin{pmatrix} a & -b \\ b & a \end{pmatrix}_{10,1} \cdot \begin{pmatrix} X \\ Y \end{pmatrix}_{S_{10}} \quad (4)$$

$$S_{10} = \begin{pmatrix} X_o \\ Y_o \end{pmatrix}_{S_{20}} + \begin{pmatrix} a & -b \\ b & a \end{pmatrix}_{20,10} \cdot \begin{pmatrix} X \\ Y \end{pmatrix}_{S_{20}} \quad (5)$$

$$S_{20} = \begin{pmatrix} X_o \\ Y_o \end{pmatrix}_{S_{30}} + \begin{pmatrix} a & -b \\ b & a \end{pmatrix}_{30,20} \cdot \begin{pmatrix} X \\ Y \end{pmatrix}_{S_{30}} \quad (6)$$

$$S_{30} = \begin{pmatrix} X_o \\ Y_o \end{pmatrix}_{S_{40}} + \begin{pmatrix} a & -b \\ b & a \end{pmatrix}_{40,30} \cdot \begin{pmatrix} X \\ Y \end{pmatrix}_{S_{40}} \quad (7)$$

Steps for the systematic calculation we proposed a model tabulated below.

Table 1

The calculation of points determined by the method traverse with independent stations

Points inregistered	Nearby stations own independent coordinate systems					
	1	10	20	30	40	2
0	1	2	3	4	5	6
1	x	x	-	-	-	-
2	-	-	-	-	-	-
10	x	x	-	-	-	-
20	-	-	-	-	-	-
30	-	-	-	-	-	-
40	-	-	-	-	-	-
100	-	x	-	-	-	-
101	-	x	-	-	-	-
102	x	x	x	-	-	-
103	x	x	x	-	-	-
104	x	x	x	-	-	-
105	x	x	x	-	-	-
200	-	-	x	x	-	-
201	-	-	x	x	-	-
300	-	-	x	x	x	-
301	-	-	x	x	x	x
400	-	-	-	x	x	x
401	-	-	-	x	x	x

**MATERIAL AND METHODS**

The case study was performed in the management unit (UP) I Siniob, Sacuieni District Forest, County Forest Administration Bihor in forest area Cabana - figure 2.

For project realisation the operations of lifting details through traverse method with independent stations was analysed orthophotomap, topographic map scale 1:25 000 and respectively management map 1:25 000 scale.

Four points determined with combined technology (GNSS and total station) were employed (table 2) and they were used for coordinate transformation.

Field data collection was carried out with total station Trimble 3605 using a single prism. Data were transferred with Datatransfer program 147 and processing was performed with the program Terramodel 10.43.

Coordinate transformations were done with the program TopoSys 5.0. For reporting specific points were being used Mapsys 8.0.

Algorithm to achieve traverse with independent stations is presented schematically in the table 3.



Figure 2: Location of the case study

Table 2

Inventory of common points coordinates used for the transformation

No. point	Destination system (STEREO 70)			Source system (Sistem local)		
	X(m)	Y(m)	Z(m)	X(m)	Y(m)	Z(m)
<i>0</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>
125	645281.183	279475.741	207.877	5105.701	4942.651	150.000
314	645399.931	279494.697	210.507	5050.299	4949.940	149.679
800	645205.755	279561.732	210.700	5127.573	4816.489	150.000
803	645014.353	279631.246	206.830	5202.320	4683.195	145.969

### RESULTS AND DISCUSSIONS

After processing the data recorded with conventional technology were obtained coordinates for the points measured in the apparatus coordinate system respectively a local system of coordinates.

Basic feature of traverse with successive processing stations is independent of the coordinates of local systems of coordinates in the national reference - Stereo 70 respectively, for 2D space.

Detailed point coordinates determined by traverse with independent station and transformed in local reference system on presented in table 4.

Coordinate values for were points in national reference system were obtained by transformation of detailed coordinate points of the local reference system using four common points according to Helmert algorithym specialised calcules programs that were employed for data procesing coresponding to terestrial measurements develop this calcules algorithym succesfully.

Table 3

The calculation of points determined by the method traverses with independent stations

Inregistration points	Own stations independent coordinate systems with independent points station					
	125	128	314	800	803	8031
1	-	-	X	-	-	-
2	-	-	X	-	-	-
3	-	-	X	-	-	-
4	-	-	X	-	-	-
5	-	-	X	-	-	-
6	-	-	X	-	-	-
7	-	-	X	-	-	-
8	-	-	X	-	-	-
20	X	-	-	-	-	-
21	X	-	-	-	-	-
22	X	-	-	-	-	-
23	X	-	-	-	-	-
24	X	-	-	-	-	-
40	-	X	-	-	-	-
41	-	X	-	-	-	-
42	-	X	-	-	-	-
43	-	X	-	-	-	-
50	-	-	-	X	-	-
51	-	-	-	X	-	-
52	-	-	-	X	-	-
53	-	-	-	X	-	-
54	-	-	-	X	-	-
55	-	-	-	X	-	-
56	-	-	-	X	-	-
57	-	-	-	X	-	-
58	-	-	-	X	-	-
59	-	-	-	X	-	-
60	-	-	-	X	-	-
61	-	-	-	X	-	-
62	-	-	-	X	-	-
63	-	-	-	X	-	-
125	-	-	-	-	-	-
128	-	-	-	X	-	-
149	-	-	-	-	-	X
248	-	-	-	-	-	X
345	-	-	-	-	-	X
446	-	-	-	-	-	X
314	-	-	-	X	-	-
315	-	-	-	X	-	-
800	-	X	X	-	-	X
801	-	-	X	-	-	-
802	-	-	X	-	-	-
803	-	-	-	X	-	-
5000	X	-	X	-	-	-
5001	X	-	X	-	-	-
5002	X	-	X	-	-	-
5003	X	-	X	-	-	-
5004	X	-	X	-	-	-
5005	X	X	-	X	-	-
5006	X	X	-	X	-	-
5007	X	X	-	-	-	-
5008	X	-	-	-	-	-
5009	-	X	-	X	X	X
5010	-	X	-	X	X	X
5011	-	X	-	X	X	X
5012	-	X	-	X	X	X
5013	-	X	-	X	X	X
50131	-	-	-	-	-	X
50081	X	X	-	-	-	-
5111	-	X	-	-	-	-

Table 4

Inventory of point coordinates determined by traverse with independent station in local reference system

No. point	X(m)	Y(m)	Z(m)	No. point	X(m)	Y(m)	Z(m)
0	1	2	3	0	1	2	3
21	5105.546	4932.728	150.042	446	5202.555	4686.189	150.123
22	5105.546	4932.728	150.042	5000	5141.989	4976.187	151.334
23	5101.455	4959.311	148.851	5001	5068.723	5003.544	149.758
24	5099.324	4958.534	148.732	5002	5042.662	4910.969	144.472
40	5177.908	4931.696	147.971	5003	5074.504	4904.036	148.178
41	5175.210	4932.086	148.053	5004	5121.370	4915.008	151.632
42	5166.280	4902.128	147.972	5005	5170.503	4896.917	149.401
43	5164.018	4902.265	147.963	5006	5176.959	4911.727	149.675
58	5055.324	4938.805	147.954	5007	5141.045	4962.558	151.643
59	5056.968	4939.884	147.851	5008	5132.929	4928.360	151.719
60	5047.292	4951.961	149.771	5009	5146.270	4775.609	150.038
61	5050.927	4953.830	149.704	5010	5161.113	4772.296	149.782
62	5053.599	4948.715	149.266	5011	5173.613	4739.412	148.570
63	5050.200	4946.472	149.162	5012	5165.514	4759.349	149.775
128	5156.096	4836.850	150.607	5013	5186.298	4746.450	148.347
149	5199.165	4684.505	150.283	5111	5180.265	4729.597	147.959
248	5201.976	4680.242	150.128	8031	5202.478	4683.231	150.000
315	5050.305	4949.944	149.678	50081	5140.672	4937.639	148.162
345	5205.186	4682.417	149.959	50131	5186.352	4746.489	152.365

Table 5

Coordinates calculated by traverse with independent station in national reference system

No. point	X(m)	Y(m)	Z(m)	No. point	X(m)	Y(m)	Z(m)
21	645.307.169	279472.267	150.042	149	645022.186	279636.453	150.283
22	645.307.169	279472.267	150.042	248	645016.138	279638.327	150.128
23	645.332.003	279450.014	148.851	315	645373.643	279499.230	149.678
24	645.333.433	279452.435	148.732	345	645014.774	279633.717	149.959
40	645.237.023	279416.327	147.971	446	645020.262	279632.173	150.123
41	645.239.915	279418.076	148.053	5000	645306.441	279401.956	151.334
42	645.224.903	279453.806	147.972	5001	645398.164	279433.383	149.758
43	645.227.178	279455.454	147.963	5002	645350.304	279542.587	144.472
50	645061.916	279617.809	147.378	5003	645314.340	279524.180	148.178
51	645062.763	279620.141	147.402	5004	645278.067	279476.796	151.632
52	645161.231	279582.624	149.926	5005	645255.897	279420.500	148.798
53	645160.206	279580.128	149.910	5006	645264.646	279395.313	149.064
54	645221.971	279556.204	148.700	5007	645296.619	279415.760	148.090
55	645222.794	279558.484	148.593	5008	645277.496	279454.909	151.719
56	645265.927	279541.950	143.993	5009	645144.532	279590.767	154.034
57	645265.182	279539.888	144.099	5010	645127.712	279582.271	153.788
58	645360.071	279505.955	147.954	5011	645089.862	279603.906	152.585
59	645359.345	279503.627	147.851	5012	645113.330	279591.220	153.774
60	645378.117	279499.668	149.771	5013	645083.218	279587.151	152.361
61	645376.105	279495.017	149.704	5111	645075.769	279608.117	147.959
62	645369.520	279497.816	149.266	8031	645018.009	279635.068	150.000
63	645371.013	279502.639	149.162	50081	645277.376	279439.927	148.162
128	645206.130	279509.537	150.000	50131	645083.226	279587.143	152.365

### CONCLUSIONS

Determination of coordinates of points of detail using traverse methods with independent stations for areas with forest vegetation, represent a beneficial solution for conditions of work.

Applying this method may be successful in connection with specialized computer programs, especially those performing coordinate transformations between different reference systems.

The accuracy of determining the characteristic points is a function of the accuracy of determining the common points on which the economic transformation and apparent precision that have measured distances and directions respectively.

It is recommended processing stations measured to the center of the work, and common points on which the economic transformation to be comfortable as possible at work over the surface.

To run efficiently traverses with independent station is a need for a clear work plan, allowing a logical sequence of measurements, due to the peculiarities of this method.

As a disadvantage, computer programs with which to carry out successive transformation of coordinates, not present on every point conversion accuracies calculated, but only common points which made the conversion.

### BIBLIOGRAPHY

1. BOȘ N., 2007, Topografie modernă, Editura C.H. Bek, București;
2. BOȘ N., 2003, Cadastru general, Editura All Bek, București;
3. BOȘ N., 1993 - Topografie, Editura Didactică și Pedagogică, București;
4. CRAINIC G. C., BODOG M., 2007 - Topografie, Note de curs, Vol. I, Universitatea din Oradea, Facultatea de Protecția Mediului;
5. HAZAY I., SZALONTAI L., 1967, Orszagos felmeres es muszaki foldrendezes, Tankonyvkiado, Budapest;
6. Amenajamentul Ocolului Silvic Săcuieni, Direcția Silvică Bihor, Studiul general;
7. Amenajamentul Unității de producție I Sîniob, Ocolul Silvic Săcuieni, Direcția Silvică Bihor, Studiul general;
8. Norme tehnice pentru introducerea cadastrului general - Aprobate prin Ordinul MAP nr.534/01.10.2001;
9. Stația totală TRIMBLE 5503 DR - Manual de utilizare;
10. Stația totală TRIMBLE 3605 - Manual de utilizare;
11. Modul de lucru cu sistemul de programe TERRAMODEL FDM - Manual de utilizare;
12. Documentație tehnică „Rețeaua geodezică de îndesire pe teritoriul județului Bihor”, Contract nr. 601/06 11 2002, beneficiar OJCGC Bihor;
13. Documentație tehnică „Rețeaua geodezică de îndesire pe teritoriul județului Bihor - zona metropolitană Oradea”, Contract nr. 12/2001, beneficiar OJCGC Bihor.