

COORDONATE DETERMINATION POSSIBILITIES FOR TOPOGRAPHIC NETWORKS IN FORESTRY BY MEANS OF COORDINATE TRANSFORMATIONS

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Abstract

The Romanian forestry fond is characterized by frequent situations when known coordinate points cannot be aimed because the incomplete visibility, or some of these points are destroyed. Under these circumstances calculus alternatives are possible using the transformation of common points. Although the problem of coordinate transformation (also path transformations) was recognized long time ago, calculus facilities limited the large scale utilization and generalization of this method. The emergence of special software dedicated to terrestrial measurements and calculus opened the possibility to solve efficiently the coordinate transformations problems. Results are precise and can be utilized successfully to obtain different final products in analogical or digital format. In order to underline the efficiency of the method, same data were processed using two specialized software based on different calculus methods. The differences between the two sets of results were statistically not significant at centimeter and millimeter scale.

Key words: data, coordinates, coordinate transformation, topographical networks, details, calculus software

INTRODUCTION

National forest is characterized as a highly heterogeneous, being asymmetrically distributed geographically. As a result, the achievement of related infrastructure for forestry works, the land is a highly complex being characterized encountered a number of cases, most often caused by lack of visibility, destruction or absence of geodetic points of support network.

As a result, modern technologies of the earth measurement data collection, data processing and the production end, enabling the development of land under works measurement related regarding limit of visibility and density of the points that support network.

MATERIAL AND METHODS

The case study was done in the UP I Sâniob, OS Săcuieni, DS Oradea, the bodies of forest Iepurești, Plopiș, Little Valley.

To determine the networks we used mature lifting details of common points, determined with GNSS technology, when became more frequent support network. Were determined from three points lift network traversing with central point, calculated in local system and then transformed into a national system of reference.

To have a coupon comparison, the three traversing with central point were calculated as traversing on the known points (measured with GNSS technology) with visa guidance, and offset block, using the theory of minimum squares.

The source is the inventory and the local system of coordinates determined destination is the inventory system coordinates the same points in the national reference system.

For a detailed analysis we have developed four versions of calculation, common in forest related situations, using the common ground plane transformation as follows:

- a variant with 3 points in common;
- a variant with 4 points in common;
- a variant with 5 points in common;
- a variant with 6 points in common;

The general scheme of the proposed solutions to address the theme is presented in figure 1.

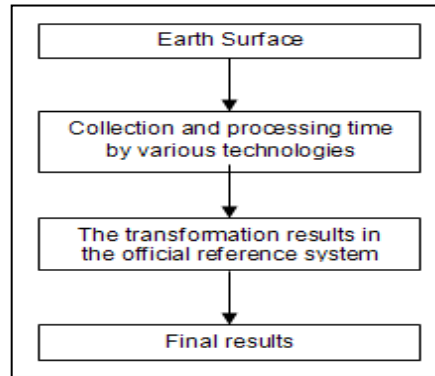


Fig. 1. Schema transformation of data from one reference system to another

Algorithms of calculation used is based on the system trans-calculation geodetic surveying system using the theory of least squares.

We consider n points of known coordinates in both systems XOY and xoy (fig. 1,2,3).

Suppose we have j points with coordinates only xoy system and we want to determine the coordinates of these points in the system XOY .

We start from the relations of trans-known calculation (1):

$$X = X_0 + x \cdot K \cdot \cos \alpha + y \cdot K \cdot \sin \alpha \quad (1)$$

$$Y = Y_0 + y \cdot K \cdot \cos \alpha - x \cdot K \cdot \sin \alpha$$

Relations (1) underlines the roto-translation and scale factor implementation.

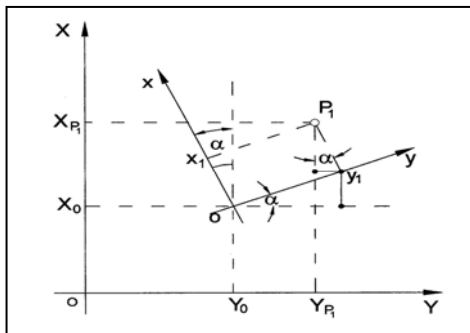


Fig. 2. Roto-translation of coordinate axes (Onose, 2004)

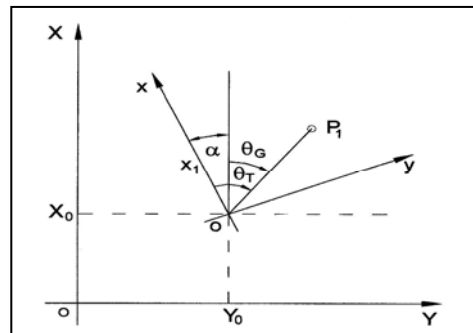
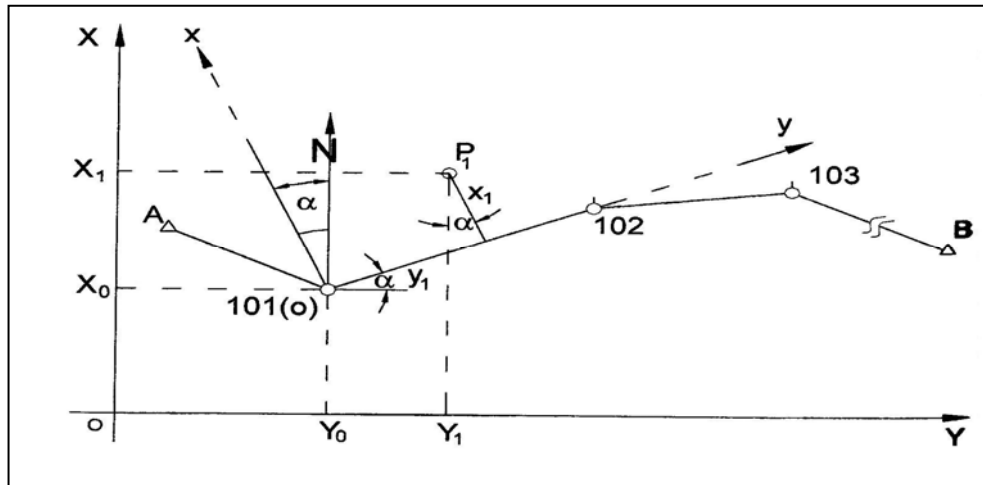


Fig. 3. Topographic trans-calculation (Onose, 2004)



To calculate the coordinates of points of roads was being used to transform coordinates TERRAMODEL and 10.3 were used programs TopoSys 5.0 Map Sys 7.0 - for verification.

RESULTS AND DISCUSSION

Transforming the coordinates of the camera coordinate system to the national reference system with high efficiency was achieved using specialized software (Topo Sys and Map Sys).

Table 1

Variant calculation processing on three points with known coordinates

Nr. crt.	Transformation plane				Unitaryan compensation	
	Transformation Helmert		Relatively transformation			
	x(m)	y(m)	x(m)	y(m)	x(m)	y(m)
0	1	2	3	4	5	6
101	644977.725	281607.132	-	-	644977.740	281607.112
102	645476.094	281927.895	645476.169	281927.879	645476.079	281927.850
103	644952.040	278711.078	-	-	644951.974	278711.079
104	644775.503	278752.291	644775.420	278752.290	644775.456	278752.297
109	646215.042	278303.444	-	-	646214.916	278303.551
110	646415.337	278284.530	646415.408	278284.551	646415.199	278284.651
200	645123.543	278660.092	645123.493	278660.095	645123.471	278660.105
201	645269.309	279082.023	645269.285	279082.025	645269.192	279082.027
202	645315.742	279235.317	645315.727	279235.318	645315.608	279235.319
203	645367.605	279387.064	645367.600	279387.065	645367.455	279387.067
204	645438.617	279618.584	645438.625	279618.585	645438.444	279618.582
205	645485.268	279809.007	645485.286	279809.006	645485.084	279808.999
206	645461.954	279992.969	645461.975	279992.966	645461.770	279992.954
207	645424.087	280147.150	645424.108	280147.146	645423.909	280147.131
208	645401.750	280368.190	645401.775	280368.185	645401.588	280368.164
209	645411.771	280474.275	645411.800	280474.269	645411.618	280474.246
210	645348.605	280571.256	645348.630	280571.248	645348.466	280571.232
211	645305.741	280694.088	645305.764	280694.079	645305.620	280694.066
212	645265.701	280834.389	645265.725	280834.378	645265.603	280834.369
213	645222.362	280928.739	645222.383	280928.727	645222.278	280928.723
214	645001.931	281536.522	645001.947	281536.503	645001.940	281536.501
300	645219.800	278632.791	645219.759	278632.795	645219.722	278632.812
301	645535.182	278525.334	645535.170	278525.343	645535.089	278525.382
302	645668.836	278482.360	645668.836	278482.371	645668.736	278482.420
303	645735.410	278458.739	645735.416	278458.751	645735.307	278458.805
304	645785.994	278443.828	645786.005	278443.841	645785.889	278443.898
306	645861.092	278358.751	645861.108	278358.766	645860.987	278358.832
305	645823.446	278425.979	645823.461	278425.992	645823.340	278426.053
307	645902.307	278365.993	645902.328	278366.007	645902.199	278366.076
308	645927.196	278349.925	645927.219	278349.940	645927.088	278350.010
309	646000.103	278297.792	646000.132	278297.809	645999.992	278297.886
310	646060.197	278300.398	646060.232	278300.416	646060.082	278300.496
311	646194.384	278312.020	646194.433	278312.038	646194.259	278312.124
312	646206.251	278322.322	646206.302	278322.341	646206.124	278322.427
400	644965.847	278717.455	644965.782	278717.456	644965.784	278717.458
2101	645340.588	280577.977	645340.613	280577.969	645340.449	280577.958

Table 2

Variant calculation processing on four points with known coordinates

Nr. crt.	Transformation plane				Unitaryan compensation	
	Transformation Helmert		Relatively transformation			
	x(m)	y(m)	x(m)	y(m)	x(m)	y(m)
0	1	2	3	4	5	6
101	644977.722	281607.109	644977.713	281607.101	644977.740	281607.112
102	645476.087	281927.870	645476.103	281927.860	645476.079	281927.850
103	644952.041	278711.081	644952.010	278711.089	644951.974	278711.079
104	644775.505	278752.293	644775.466	278752.301	644775.456	278752.297
109	646215.032	278303.451	646215.055	278303.462	646214.916	278303.551
110	646415.325	278284.538	646415.357	278284.548	646415.199	278284.651
200	645123.542	278660.095	645123.519	278660.104	645123.471	278660.105
201	645269.307	279082.023	645269.293	279082.029	645269.192	279082.027
202	645315.739	279235.315	645315.728	279235.320	645315.608	279235.319
203	645367.601	279387.061	645367.594	279387.066	645367.455	279387.067
204	645438.612	279618.580	645438.610	279618.583	645438.444	279618.582
205	645485.262	279809.000	645485.263	279809.002	645485.084	279808.999
206	645461.949	279992.961	645461.950	279992.961	645461.770	279992.954
207	645424.082	280147.141	645424.082	280147.140	645423.909	280147.131
208	645401.745	280368.179	645401.746	280368.178	645401.588	280368.164
209	645411.766	280474.263	645411.768	280474.261	645411.618	280474.246
210	645348.600	280571.242	645348.600	280571.240	645348.466	280571.232
211	645305.736	280694.074	645305.735	280694.071	645305.620	280694.066
212	645265.697	280834.373	645265.695	280834.370	645265.603	280834.369
213	645222.357	280928.723	645222.354	280928.718	645222.278	280928.723
214	645001.928	281536.500	645001.919	281536.492	645001.940	281536.501
300	645219.798	278632.794	645219.779	278632.803	645219.722	278632.812
301	645535.177	278525.339	645535.172	278525.348	645535.089	278525.382
302	645668.831	278482.366	645668.830	278482.375	645668.736	278482.420
303	645735.404	278458.744	645735.406	278458.754	645735.307	278458.805
304	645785.988	278443.834	645785.993	278443.844	645785.889	278443.898
306	645861.085	278358.758	645861.092	278358.768	645860.987	278358.832
305	645823.439	278425.985	645823.446	278425.994	645823.340	278426.053
307	645902.300	278365.999	645902.309	278366.009	645902.199	278366.076
308	645927.189	278349.931	645927.199	278349.942	645927.088	278350.010
309	646000.095	278297.800	646000.109	278297.810	645999.992	278297.886
310	646060.188	278300.406	646060.204	278300.416	646060.082	278300.496
311	646194.374	278312.027	646194.396	278312.037	646194.259	278312.124
312	646206.241	278322.329	646206.264	278322.340	646206.124	278322.427
400	644965.847	278717.458	644965.817	278717.466	644965.784	278717.458
2101	645340.584	280577.964	645340.583	280577.961	645340.449	280577.958

Table 3

Variant calculation processing on five points with known coordinates

Nr. crt.	Transformation plane				Unitaryan compensation	
	Transformation Helmert		Relatively transformation			
	x(m)	y(m)	x(m)	y(m)	x(m)	y(m)
0	1	2	3	4	5	6
101	644977.720	281607.111	644977.705	281607.100	644977.740	281607.112
102	645476.084	281927.875	645476.109	281927.861	645476.079	281927.850
103	644952.054	278711.076	644951.993	278711.085	644951.974	278711.079
104	644775.517	278752.288	644775.445	278752.296	644775.456	278752.297
109	646215.049	278303.453	646215.068	278303.462	646214.916	278303.551
110	646415.343	278284.540	646415.375	278284.549	646415.199	278284.651
200	645123.555	278660.092	645123.505	278660.100	645123.471	278660.105
201	645269.318	279082.021	645269.284	279082.026	645269.192	279082.027
202	645315.749	279235.314	645315.721	279235.318	645315.608	279235.319
203	645367.612	279387.061	645367.589	279387.064	645367.455	279387.067
204	645438.621	279618.580	645438.607	279618.581	645438.444	279618.582
205	645485.271	279809.001	645485.263	279809.001	645485.084	279808.999
206	645461.956	279992.961	645461.950	279992.960	645461.770	279992.954
207	645424.088	280147.142	645424.081	280147.139	645423.909	280147.131
208	645401.750	280368.180	645401.745	280368.177	645401.588	280368.164
209	645411.770	280474.264	645411.768	280474.260	645411.618	280474.246
210	645348.604	280571.244	645348.599	280571.239	645348.466	280571.232
211	645305.739	280694.075	645305.733	280694.070	645305.620	280694.066
212	645265.699	280834.375	645265.692	280834.369	645265.603	280834.369
213	645222.359	280928.724	645222.351	280928.717	645222.278	280928.723
214	645001.926	281536.502	645001.912	281536.491	645001.940	281536.501
300	645219.812	278632.791	645219.768	278632.799	645219.722	278632.812
301	645535.192	278525.337	645535.168	278525.345	645535.089	278525.382
302	645668.846	278482.365	645668.830	278482.373	645668.736	278482.420
303	645735.419	278458.744	645735.408	278458.752	645735.307	278458.805
304	645786.004	278443.834	645785.995	278443.842	645785.889	278443.898
306	645861.101	278358.758	645861.097	278358.766	645860.987	278358.832
305	645823.456	278425.984	645823.450	278425.993	645823.340	278426.053
307	645902.316	278365.999	645902.315	278366.008	645902.199	278366.076
308	645927.205	278349.932	645927.205	278349.940	645927.088	278350.010
309	646000.112	278297.800	646000.116	278297.809	645999.992	278297.886
310	646060.205	278300.407	646060.214	278300.415	646060.082	278300.496
311	646194.391	278312.028	646194.409	278312.037	646194.259	278312.124
312	646206.258	278322.331	646206.277	278322.339	646206.124	278322.427
400	644965.860	278717.454	644965.800	278717.462	644965.784	278717.458
2101	645340.587	280577.965	645340.582	280577.960	645340.449	280577.958

Table 4

Variant calculation processing on six points with known coordinates

Nr. crt.	Transformation plane				Unitaryan compensation	
	Transformation Helmert		Relatively transformation			
	x(m)	y(m)	x(m)	y(m)	x(m)	y(m)
0	1	2	3	4	5	6
101	644977.715	281607.118	644977.707	281607.100	644977.740	281607.112
102	645476.082	281927.881	645476.107	281927.861	645476.079	281927.850
103	644952.039	278711.078	644951.998	278711.085	644951.974	278711.079
104	644775.503	278752.290	644775.451	278752.297	644775.456	278752.297
109	646215.036	278303.449	646215.068	278303.462	646214.916	278303.551
110	646415.330	278284.536	646415.375	278284.549	646415.199	278284.651
200	645123.541	278660.092	645123.510	278660.100	645123.471	278660.105
201	645269.306	279082.022	645269.288	279082.026	645269.192	279082.027
202	645315.738	279235.315	645315.724	279235.318	645315.608	279235.319
203	645367.600	279387.062	645367.592	279387.064	645367.455	279387.067
204	645438.611	279618.581	645438.609	279618.581	645438.444	279618.582
205	645485.261	279809.003	645485.264	279809.001	645485.084	279808.999
206	645461.947	279992.964	645461.951	279992.960	645461.770	279992.954
207	645424.080	280147.144	645424.083	280147.139	645423.909	280147.131
208	645401.742	280368.183	645401.746	280368.177	645401.588	280368.164
209	645411.763	280474.268	645411.769	280474.260	645411.618	280474.246
210	645348.597	280571.248	645348.600	280571.239	645348.466	280571.232
211	645305.732	280694.080	645305.734	280694.070	645305.620	280694.066
212	645265.693	280834.380	645265.693	280834.369	645265.603	280834.369
213	645222.353	280928.729	645222.352	280928.717	645222.278	280928.723
214	645001.922	281536.509	645001.914	281536.491	645001.940	281536.501
300	645219.798	278632.791	645219.772	278632.799	645219.722	278632.812
301	645535.179	278525.336	645535.171	278525.346	645535.089	278525.382
302	645668.832	278482.363	645668.833	278482.373	645668.736	278482.420
303	645735.406	278458.742	645735.410	278458.752	645735.307	278458.805
304	645785.990	278443.832	645785.997	278443.842	645785.889	278443.898
306	645861.088	278358.755	645861.099	278358.767	645860.987	278358.832
305	645823.442	278425.982	645823.451	278425.993	645823.340	278426.053
307	645902.303	278365.997	645902.317	278366.008	645902.199	278366.076
308	645927.192	278349.929	645927.207	278349.941	645927.088	278350.010
309	646000.099	278297.797	646000.118	278297.809	645999.992	278297.886
310	646060.192	278300.403	646060.215	278300.415	646060.082	278300.496
311	646194.378	278312.025	646194.409	278312.037	646194.259	278312.124
312	646206.245	278322.327	646206.277	278322.339	646206.124	278322.427
400	644965.846	278717.455	644965.805	278717.462	644965.784	278717.458
2101	645340.580	280577.969	645340.583	280577.960	645340.449	280577.958

Table 5

Difference of coordinates of three points in common variant

Nr. crt.	Transformation plane				Unitaryan compensation	
	Transformation Helmert		Relatively transformation			
	$\Delta x(m)$	$\Delta y(m)$	$\Delta x(m)$	$\Delta y(m)$	$x(m)$	$y(m)$
0	1	2	3	4	5	6
101	0.015	-0.020	-	-	644977.740	281607.112
102	-0.015	-0.045	-0.09	-0.029	645476.079	281927.850
103	-0.066	0.001	-	-	644951.974	278711.079
104	-0.047	0.006	0.036	0.007	644775.456	278752.297
109	-0.126	0.107	-	-	646214.916	278303.551
110	-0.138	0.121	-0.209	0.1	646415.199	278284.651
200	-0.072	0.013	-0.022	0.01	645123.471	278660.105
201	-0.117	0.004	-0.093	0.002	645269.192	279082.027
202	-0.134	0.002	-0.119	0.001	645315.608	279235.319
203	-0.15	0.003	-0.145	0.002	645367.455	279387.067
204	-0.173	-0.002	-0.181	-0.003	645438.444	279618.582
205	-0.184	-0.008	-0.202	-0.007	645485.084	279808.999
206	-0.184	-0.015	-0.205	-0.012	645461.770	279992.954
207	-0.178	-0.019	-0.199	-0.015	645423.909	280147.131
208	-0.162	-0.026	-0.187	-0.021	645401.588	280368.164
209	-0.153	-0.029	-0.182	-0.023	645411.618	280474.246
210	-0.139	-0.024	-0.164	-0.016	645348.466	280571.232
211	-0.121	-0.022	-0.144	-0.013	645305.620	280694.066
212	-0.098	-0.020	-0.122	-0.009	645265.603	280834.369
213	-0.084	-0.016	-0.105	-0.004	645222.278	280928.723
214	0.009	-0.021	-0.007	-0.002	645001.940	281536.501
300	-0.078	0.021	-0.037	0.017	645219.722	278632.812
301	-0.093	0.048	-0.081	0.039	645535.089	278525.382
302	-0.1	0.060	-0.1	0.049	645668.736	278482.420
303	-0.103	0.066	-0.109	0.054	645735.307	278458.805
304	-0.105	0.070	-0.116	0.057	645785.889	278443.898
306	-0.105	0.081	-0.121	0.066	645860.987	278358.832
305	-0.106	0.074	-0.121	0.061	645823.340	278426.053
307	-0.108	0.083	-0.129	0.069	645902.199	278366.076
308	-0.108	0.085	-0.131	0.07	645927.088	278350.010
309	-0.111	0.094	-0.14	0.077	645999.992	278297.886
310	-0.115	0.098	-0.15	0.08	646060.082	278300.496
311	-0.125	0.104	-0.174	0.086	646194.259	278312.124
312	-0.127	0.105	-0.178	0.086	646206.124	278322.427
400	-0.063	0.003	0.002	0.002	644965.784	278717.458
2101	-0.139	-0.019	-0.164	-0.011	645340.449	280577.958

Table 6

Difference of coordinates of four points in common variant

Nr. crt.	Transformation plane				Unitaryan compensation	
	Transformation Helmert		Relatively transformation			
	$\Delta x(m)$	$\Delta y(m)$	$\Delta x(m)$	$\Delta y(m)$	x(m)	y(m)
0	1	2	3	4	5	6
101	-0.018	-0.027	-0.003	-0.011	644977.740	281607.112
102	0.008	0.024	0.02	0.01	645476.079	281927.850
103	0.067	0.036	0.002	0.01	644951.974	278711.079
104	0.049	0.01	-0.004	0.004	644775.456	278752.297
109	0.116	0.139	-0.1	-0.089	646214.916	278303.551
110	0.126	0.158	-0.113	-0.103	646415.199	278284.651
200	0.071	0.048	-0.01	-0.001	645123.471	278660.105
201	0.115	0.101	-0.004	0.002	645269.192	279082.027
202	0.131	0.12	-0.004	0.001	645315.608	279235.319
203	0.146	0.139	-0.006	-0.001	645367.455	279387.067
204	0.168	0.166	-0.002	0.001	645438.444	279618.582
205	0.178	0.179	0.001	0.003	645485.084	279808.999
206	0.179	0.18	0.007	0.007	645461.770	279992.954
207	0.173	0.173	0.01	0.009	645423.909	280147.131
208	0.157	0.158	0.015	0.014	645401.588	280368.164
209	0.148	0.15	0.017	0.015	645411.618	280474.246
210	0.134	0.134	0.01	0.008	645348.466	280571.232
211	0.116	0.115	0.008	0.005	645305.620	280694.066
212	0.094	0.092	0.004	0.001	645265.603	280834.369
213	0.079	0.076	0	-0.005	645222.278	280928.723
214	-0.012	-0.021	-0.001	-0.009	645001.940	281536.501
300	0.076	0.057	-0.018	-0.009	645219.722	278632.812
301	0.088	0.083	-0.043	-0.034	645535.089	278525.382
302	0.095	0.094	-0.054	-0.045	645668.736	278482.420
303	0.097	0.099	-0.061	-0.051	645735.307	278458.805
304	0.099	0.104	-0.064	-0.054	645785.889	278443.898
306	0.098	0.105	-0.074	-0.064	645860.987	278358.832
305	0.099	0.106	-0.068	-0.059	645823.340	278426.053
307	0.101	0.11	-0.077	-0.067	645902.199	278366.076
308	0.101	0.111	-0.079	-0.068	645927.088	278350.010
309	0.103	0.117	-0.086	-0.076	645999.992	278297.886
310	0.106	0.122	-0.09	-0.08	646060.082	278300.496
311	0.115	0.137	-0.097	-0.087	646194.259	278312.124
312	0.117	0.14	-0.098	-0.087	646206.124	278322.427
400	0.063	0.033	0	0.008	644965.784	278717.458
2101	0.135	0.134	0.006	0.003	645340.449	280577.958

Table 7

Difference of coordinates of five points in common variant

Nr. crt.	Transformation plane				Unitaryan compensation	
	Transformation Helmert		Relatively transformation			
	$\Delta x(m)$	$\Delta y(m)$	$\Delta x(m)$	$\Delta y(m)$	x(m)	y(m)
0	1	2	3	4	5	6
101	-0.020	-0.035	-0.001	-0.012	644977.740	281607.112
102	0.005	0.03	0.025	0.011	645476.079	281927.850
103	0.080	0.019	-0.003	0.006	644951.974	278711.079
104	0.061	-0.011	-0.009	-0.001	644775.456	278752.297
109	0.133	0.152	-0.098	-0.089	646214.916	278303.551
110	0.144	0.176	-0.111	-0.102	646415.199	278284.651
200	0.084	0.034	-0.013	-0.005	645123.471	278660.105
201	0.126	0.092	-0.006	-0.001	645269.192	279082.027
202	0.141	0.113	-0.005	-0.001	645315.608	279235.319
203	0.157	0.134	-0.006	-0.003	645367.455	279387.067
204	0.177	0.163	-0.002	-0.001	645438.444	279618.582
205	0.187	0.179	0.002	0.002	645485.084	279808.999
206	0.186	0.18	0.007	0.006	645461.770	279992.954
207	0.179	0.172	0.011	0.008	645423.909	280147.131
208	0.162	0.157	0.016	0.013	645401.588	280368.164
209	0.152	0.15	0.018	0.014	645411.618	280474.246
210	0.138	0.133	0.012	0.007	645348.466	280571.232
211	0.119	0.113	0.009	0.004	645305.620	280694.066
212	0.096	0.089	0.006	0	645265.603	280834.369
213	0.081	0.073	0.001	-0.006	645222.278	280928.723
214	-0.014	-0.028	0.001	-0.01	645001.940	281536.501
300	0.090	0.046	-0.021	-0.013	645219.722	278632.812
301	0.103	0.079	-0.045	-0.037	645535.089	278525.382
302	0.110	0.094	-0.055	-0.047	645668.736	278482.420
303	0.112	0.101	-0.061	-0.053	645735.307	278458.805
304	0.115	0.106	-0.064	-0.056	645785.889	278443.898
306	0.114	0.11	-0.074	-0.066	645860.987	278358.832
305	0.116	0.11	-0.069	-0.06	645823.340	278426.053
307	0.117	0.116	-0.077	-0.068	645902.199	278366.076
308	0.117	0.117	-0.078	-0.07	645927.088	278350.010
309	0.120	0.124	-0.086	-0.077	645999.992	278297.886
310	0.123	0.132	-0.089	-0.081	646060.082	278300.496
311	0.132	0.15	-0.096	-0.087	646194.259	278312.124
312	0.134	0.153	-0.096	-0.088	646206.124	278322.427
400	0.076	0.016	-0.004	0.004	644965.784	278717.458
2101	0.138	0.133	0.007	0.002	645340.449	280577.958

Table 8

Difference of coordinates of six points in common variant

Nr. crt.	Transformation plane				Unitaryan compensation	
	Transformation Helmert		Relatively transformation			
	$\Delta x(m)$	$\Delta y(m)$	$\Delta x(m)$	$\Delta y(m)$	$x(m)$	$y(m)$
0	1	2	3	4	5	6
101	S _{xh}	S _{xa}	S _{yh}	S _{ya}	644977.740	281607.112
102	-0.025	-0.033	0.006	-0.012	645476.079	281927.850
103	0.003	0.028	0.031	0.011	644951.974	278711.079
104	0.065	0.024	-0.001	0.006	644775.456	278752.297
109	0.047	-0.005	-0.007	0.000	646214.916	278303.551
110	0.120	0.152	-0.102	-0.089	646415.199	278284.651
200	0.131	0.176	-0.115	-0.102	645123.471	278660.105
201	0.070	0.039	-0.013	-0.005	645269.192	279082.027
202	0.114	0.096	-0.005	-0.001	645315.608	279235.319
203	0.130	0.116	-0.004	-0.001	645367.455	279387.067
204	0.145	0.137	-0.005	-0.003	645438.444	279618.582
205	0.167	0.165	-0.001	-0.001	645485.084	279808.999
206	0.177	0.180	0.004	0.002	645461.770	279992.954
207	0.177	0.181	0.010	0.006	645423.909	280147.131
208	0.171	0.174	0.013	0.008	645401.588	280368.164
209	0.154	0.158	0.019	0.013	645411.618	280474.246
210	0.145	0.151	0.022	0.014	645348.466	280571.232
211	0.131	0.134	0.016	0.007	645305.620	280694.066
212	0.112	0.114	0.014	0.004	645265.603	280834.369
213	0.090	0.090	0.011	0.000	645222.278	280928.723
214	0.075	0.074	0.006	-0.006	645001.940	281536.501
300	-0.018	-0.026	0.008	-0.010	645219.722	278632.812
301	0.076	0.050	-0.021	-0.013	645535.089	278525.382
302	0.090	0.082	-0.046	-0.036	645668.736	278482.420
303	0.096	0.097	-0.057	-0.047	645735.307	278458.805
304	0.099	0.103	-0.063	-0.053	645785.889	278443.898
306	0.101	0.108	-0.066	-0.056	645860.987	278358.832
305	0.101	0.112	-0.077	-0.065	645823.340	278426.053
307	0.102	0.111	-0.071	-0.060	645902.199	278366.076
308	0.104	0.118	-0.079	-0.068	645927.088	278350.010
309	0.104	0.119	-0.081	-0.069	645999.992	278297.886
310	0.107	0.126	-0.089	-0.077	646060.082	278300.496
311	0.110	0.133	-0.093	-0.081	646194.259	278312.124
312	0.119	0.150	-0.099	-0.087	646206.124	278322.427
400	0.121	0.153	-0.100	-0.088	644965.784	278717.458
2101	0.062	0.021	-0.003	0.004	645340.449	280577.958

Differences of coordinates calculation variants within the tolerances stipulated by the technical rules.

Considering the results may come off a series of conclusions and recommendations for the production of forestry related land measurements.

CONCLUSIONS

Analyzing the results obtained we can observe that the method of calculating the coordinates which is based on coordinate transformation gives satisfactory solutions in terms of accuracies that are within the tolerances stipulated by the technical survey in force.

Note that the best accuracies are obtained in working with a version number greater than common points evenly distributed on the extremities and that the heart of the work surface.

Relatively transformations compared with orthogonal transformation - Helmert ensures more accuracy, which can be seen from the differences of coordinates of the tables.

Determination of lifting networks (or even of stuff network support) using coordinate transformation method is an appropriate solution for situations when the network support of the work is poor or nonexistent.

As verification, the method of coordinate transformation, can compare details of commonalities (in the national projects) to be used with common points recalculated coordinates with local or zonal transformation parameters.

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