



# IMPROVING THE ACCURACY OF DRONE MEASUREMENTS ON HYDROTECHNICAL WORKS

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DOI: 10.2478/minrv-2024-0017

**Abstract:** Topographic measurements made with the drone is an alternative way for creating 3D models, point clouds, etc., but they should be considered correct placement of ground control points to complete the required works precisely. To meet these needs to have a sub millimeter precision in this publication we will treat such as positioning, verification and comparison precisions achieved by attaching ground control points to the point cloud. These ground control points are measured with two different devices, namely the robotic total station and two dual-frequency GPS receivers used in base & rover mode. Errors made on ground control points can influence the whole cloud of points and we will demonstrate the extent to which this occurs.

Keywords: drone measurement, point cloud, ground control point (GCP), error, precision

## 1. Introduction

Drones have become very popular in recent years because of rapid technological advances and falling costs of brushless motors, lithium-ion rechargeable batteries, high precision sensors, and flight controllers (FCs). Drones are actually categorized as unmanned aerial vehicles (UAVs). Their name derives from drone bees, which have no independent activity in or out of a beehive. Stable lift power is obtained using multiple rotors driven by high-speed motors controlled precisely with an FC. In contrast to a single-rotor helicopter driven by an internal combustion engine, drones fly stably using an FC combined with a global positioning system (GPS) and an inertial measurement unit (IMU). By virtue of their simplicity and versatility, drones are used today in widely diverse applications [1].

Drone utilization fields are classifiable into five categories: logistics, disaster rescue, infrastructure maintenance and management, surveying, and agriculture. Drone-based meteorological and atmospheric measurements, belong to an interdisciplinary field that is closely related to the categories of disaster response and agriculture [1].

#### 2. Description of the field work method

For this work we chose as location the Runcu Dam, which is located in the Mara Basin, Maramureş County, the duration of execution of this hydrotechnical work is the longest in Romania starting since 1987 and the work is still in progress nowadays.

The dam is a heavy dam, and the basic materials used for its construction are brought nearby, leaving a large gap in the nearby mountain.

In this hydrotechnical work we considered that due to its large size, it is a great opportunity to see what efficiency, accuracy and how long it takes for a geospatial processing to achieve the point cloud and obviously its 3D model [2].

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vol. 30, issue 2 / 2024 pp. 80-88

In order to perform the drone measurements, we previously placed the markings related to the ground control points. These were measured with two devices, namely the robotic total station and two dual frequency GPS receivers used in base & rover mode (according to Fig.1) [3] [4].



Fig.1. Ground control points (GCP) measured with two dual frequency GPS receivers used in base & rover mode

The ground control points were located on the upper, inner and outer part of the dam in the most visible areas. These were materialized by 50x50cm markings. Their location was strategic, looking for those areas that are exposed, adjacent and that can influence the achievement of a point cloud and the 3D model.

These ground control points were measured with two different devices, namely with the robotic total station and two dual frequency GPS receivers in the base & rover system. (Tab.1. and Tab.2.) The results obtained in the two measurements are very close, but there are still some differences that will completely influence the point cloud. The magnitude of this influence will be highlighted along the way [5]

con	trol poi	nts measu	red with G	PS receivers
	nr. Pct.	absN	adsE	AbsH
	A1.1	700800.3390	407835.5963	709.5453
	A1.2	700700.0867	407800.7040	709.1740
	A1.3	700585.3280	407762.0740	709.5260
	A2.1	700754.3263	407852.0303	689.5180
	A2.2	700662.6040	407820.9537	688.9087
	A2.3	700587.5337	407797.1627	689.2683
	A3.1	700690.2810	407861.9973	669.7707
	A3.2	700633.7930	407845.5327	669.5670
	A3.3	700580.7940	407828.2360	669.5240
	B1.1	700795.9523	407747.0587	709.0203
	B2.1	700801.6890	407730.5360	696.3610
	B2.2	700727.0257	407689.6647	685.4760
	B3.1	700655.2950	407697.9190	707.4807
	B3.2	700660.5817	407682.0083	695.2600
	P1	700672.9490	407860.6120	670.0227
	P2	700604.5497	407833.4660	669.8143
	T1	700813.5847	407816.4287	714.0220
	T2	700820.5697	407772.4753	713.3817
	T3	700672.6253	407769.5133	714.2400
	T4	700682.9795	407716.9365	713.0500
	T5	700577.9577	407735.2813	714.3630
	T6	700584 8460	407693,2007	714,1880

Table 1. The absolute coordinates of the ground control points measured with GPS receivers

Table 2. The absolute coordinates of the ground	
control points measured with the robotic total static	on

nr. Pct.	absN	adsE	AbsH
A1.1	700800.31950	407835.58240	709.54260
A1.2	700700.09440	407800.70380	709.16030
A1.3	700585.34240	407762.06890	709.53440
A2.1	700754.30980	407852.01450	689.52350
A2.2	700662.61910	407820.93730	688.88490
A2.3	700587.54380	407797.16170	689.23910
A3.1	700690.27580	407851.98310	669.75380
A3.2	700633.80390	407845.52920	669.56130
A3.3	700580.81130	407828.23280	669.51380
B1.1	700795.90050	407747.04230	709.02270
B2.1	700801.64100	407730.51930	696.38400
B3.1	700655.26000	407697.91920	707.48330
B3.2	700660.54650	407682.01860	695.28080
т1	700813.56590	407816.43170	714.02430
т2	700820.54940	407772.46390	713.39350
тз	700672.63450	407769.50190	714.24060
т4	700682.99010	407716.93770	713.04770
T5	700577.97590	407735.27630	714.35830
Т6	700584.84860	407693.21560	714.18240
Α4	700578.79970	407856.25840	649.94530
B3.3	700668.96560	407657.48170	676.61320
B3 4	700575 40250	407633 32130	660 89480

We approached the measurement with the drone during fog over the dam, in order to have a natural sunlight dispersion filter, which helps a lot in the post-processing phase of the data and brings an advantage to the project, by the fact that the results will be closer to real values in the field [6].

All markings of the ground control points (GCPs) measured with the robotic total station and two dual frequency GPS receivers used in base & rover mode were located and measured by the drone. In order not to confuse the two working processes, the two devices measure the stationary points as such, and the drone itself takes image captures according to the route, settings, density of frames chosen for a higher image overlap, and on this basis in a post-processing program will create the point cloud [7].

#### 3. Description of post-processing operations

The post-processing program takes from the drone measurement resulting shots, the data from the exif (properties) of the images, namely data about longitude, latitude, altitude. These geographical coordinates must be brought into the reference system in which we want to work. After that, the images are aligned to create the point cloud, in this stage the program recognizes based on the above-mentioned properties data about the time the shots were taken and the pattern (the path on which the drone flew) to reconstruct the three-dimensional shape of dam.

Based on the above-mentioned properties, the program reconstructs the external orientation elements in relation to the behavior of the drone during the execution of the shots, namely the roll angle, pitch angle and rotation.

We created the point cloud in the first stage without adding GCPs measured with the robotic total station or those measured with two dual frequency GPS receivers used in base & rover mode. From this stage the following results emerged according to Tab.3, In which it can be seen that we have a fairly large error in overlapping images without having ground control points (GCP) attached. These measurements may be used for information purposes only.

Cameras	East err (m)	North err (m)	Alt. err (m)	Accuracy (m)	Error (m)	- Yaw	err (*)	Pitch err (*)	Roll err (*)	Accuracy (*)	Error (*)	Projections	Error (pix)
V HE DR.002	5 1.117132	9.505353	-1.765349	3.000000	9.732224	1	2.223	0.242	-2.302	10.000	3.209	3281	1.641
V M DJL_099	8 5.808887	7.854338	-0.743333	3.000000	9.797261	1	-2.032	-1.069	-4.976	10.000	5.480	9304	0.746
V M DA_082	7 2.483912	9.003959	-3.229020	3.000000	9.882696	1	4.378	0.653	-3.322	10.000	5.535	7809	1.387
V M DJ 015	0 -3.603261	-8.312058	-4.257012	3.000000	10.009793	1	-4.520	0.398	-7.223	10.000	8.530	7087	0.778
V M DJL_090	2 4.872892	8.323863	-3.061284	3.000000	10.119448	1	8.082	-0.648	-3.560	10.000	8.855	7813	1.416
V B DA_007	5 -9.816842	2.603873	-0.942123	3.000000	10.199909	1	-0.671	1.287	-3.267	10.000	3.575	7419	0.504
V 🖬 D.R_014	9 -3.489776	-9.047322	-3.617455	3.000000	10.349810	1	-3.233	0.495	-6.571	10.000	7.340	6466	0.877
V M DJ 093	0 -4.908425	-8.353831	-3.979933	3.000000	10.474683	1	1.351	0.211	-2.638	10.000	2.971	8881	1.876
V BE D.M_066	1 3.286496	10.028981	0.358238	3.000000	10.559823	1	0.978	0.566	-2.935	10.000	3.145	7204	0.950
V BE D.H_013	3 4.385743	9.436213	-1.952728	3.000000	10.587256	1	-1.535	-0.178	-7.780	10.000	7.932	8798	0.774
V BE DJ.028	7 4.021315	9.402928	-3.139159	3.000000	10.697679	1	-2.318	1.556	-5.560	10.000	6.222	10473	0.545
🗸 📶 D.Я_013	2 4.341100	9.598615	-2.131900	3.000000	10.748188	1	-1.546	-0.176	-7.626	10.000	7.783	9884	0.731
V M D.H_093	2 -1.566083	-9.554182	-4.692666	3.000000	10.759002	1	0.620	0.291	-2.537	10.000	2.628	3660	1.571
V M DJL_093	1 -4.050630	-9.172087	-4.277824	3.000000	10.901127	1	0.897	0.264	-2.598	10.000	2.761	6320	1.707
V BE D.R_022	6 4.877245	10.269030	-3.336251	3.000000	11.847829	1	-2.370	0.792	-4.776	10.000	5.390	6706	0.649
V B DJ_028	8 4.622968	10.593182	-3.156491	3.000000	11.981267	1	-2.510	1.529	-5.398	10.000	6.145	9347	0.518
V M DR_022	7 5.202201	10.636272	-3.626651	3.000000	12.383286	1	-2.836	0.890	-4.637	10.000	5.508	6817	0.593
V M DJ 022	9 5.125911	10.705091	-3.874108	3.000000	12.485298	1	-5.348	0.927	-5.901	10.000	8.017	7110	0.599
V 🖩 DJI_023	0 5.115225	10.974737	-3.911960	3.000000	12.724536	1	-6.097	0.946	-6.159	10.000	8.718	7355	0.670
Total Error	1.679594	2.378965	2.187257		3.642060	7.88	2	1.082	7.823		11.158		

Table 3. Image reference data and their error after performing the image alignment process (creating the model)

The shape of the dam was obtained with an accuracy of 3.00 m and a total error of 3,642 m.

Attaching coordinates to the ground control points measured with the two devices, it can be seen on the error column (pix) that there is a small difference between the measurements made with the two devices when making the connection between the ground control points and the point cloud / 3D model.

In the next step we will analyze the differences between the errors due to the attachment of the ground control points to the point cloud, and we will determine the location and number of ground control points needed to generate a more accurate model of the hydrotechnical work. Exactly the same way must be done in the case of measurements at a tailings pond, there are no differences in processing, but rather a difference in the shape of the work, here I mean the geometric shape of the hydrotechnical construction.

First of all, we chose that all the ground control points be activated to see the difference in the achievement of the point cloud by the program, namely to be able to observe how and to what extent its shape changes. After performing these activations of the ground control points, we noticed that the entire North, East and Altitude position of the entire point cloud was changed, namely a translation of the point cloud was made exactly on these control points whose coordinates have previously determined.

At a first analysis it can be seen that for the same set of data (images) to which the ground control points measured with two different classical devices were attached, differences are obtained in the errors resulting from the constraint of the point cloud on these ground control points

By checking the errors that occurred after attaching the control points to the ground, it can be highlighted that the reporting deviations on the ground markings are millimetric as can be seen in Tab. 4. At the same time it can be observed that these errors are higher at the points measured with GPS receivers than at those measured with the robotic total station. In both cases we are talking about millimeter errors, but there is a difference that must be emphasized.

			Ground	Control Points measu	ured with R	obotic Tota	l Station				
#Label	X/Easting	Y/Northing	Z/Altitude	Accuracy_X/Y/Z_(m)	Error_(m)	X_error	Y_error	Z_error	X_est	Y_est	Z_est
A1.1	407835.5963	700800.339	709.5453	0.0001	0.00026	-0.00018	-0.00011	-0.00016	407835.5961	700800.3389	709.54514
A1.2	407800.704	700700.0867	709.174	0.0001	0.00002	-0.00001	-0.00002	-0.00001	407800.704	700700.0867	709.17399
A1.3	407762.074	700585.328	709.526	0.0001	0.0001	0.00008	-0.00003	-0.00005	407762.0741	700585.328	709.52595
A2.1	407852.0303	700754.3263	689.518	0.0001	0.00026	-0.00022	-0.00008	-0.00013	407852.0301	700754.3262	689.51787
A2.2	407820.9537	700662.604	688.9087	0.0001	0.0001	-0.00006	0	0.00008	407820.9536	700662.604	688.90878
A2.3	407797.1627	700587.5337	689.2683	0.0001	0.0002	0.00017	-0.00005	-0.0001	407797.1629	700587.5337	689.2682
A3.1	407861.9973	700690.281	669.7707	0.0001	0.00021	-0.0002	-0.00006	-0.00001	407861.9971	700690.2809	669.77069
A3.2	407845.5327	700633.793	669.567	0.0001	0.0001	-0.00007	0.00006	0.00006	407845.5326	700633.7931	669.56706
A3.3	407828.236	700580.794	669.524	0.0001	0.00021	-0.00002	0.00021	-0.00001	407828.236	700580.7942	669.52399
B1.1	407747.0587	700795.9523	709.0203	0.0001	0.00037	0.00012	-0.00004	0.00035	407747.0588	700795.9523	709.02065
B2.1	407730.536	700801.689	696.361	0.0001	0.00028	-0.00011	0.00012	-0.00023	407730.5359	700801.6891	696.36077
B2.2	407689.6647	700727.0257	685.476	0.0001	0.00322	-0.00036	0.0021	-0.00242	407689.6643	700727.0278	685.47358
B3.1	407697.919	700655.295	707.4807	0.0001	0.00079	0.00022	0.00073	0.00019	407697.9192	700655.2957	707.48089
B3.2	407682.0083	700660.5817	695.26	0.0001	0.00042	-0.00017	-0.00038	-0.00005	407682.0081	700660.5813	695.25995
T1	407816.4287	700813.5847	714.022	0.0001	0.00019	-0.0001	-0.00013	-0.00011	407816.4286	700813.5846	714.02189
T2	407772.4753	700820.5697	713.3817	0.0001	0.00094	-0.00019	-0.00082	0.00042	407772.4751	700820.5689	713.38212
Т3	407769.5133	700672.6253	714.24	0.0001	0.00021	-0.00003	-0.00007	-0.0002	407769.5133	700672.6252	714.2398
т4	407716.9365	700682.9795	713.05	0.0001	0.00269	0.00112	-0.00064	0.00237	407716.9376	700682.9789	713.05237
T5	407735.2813	700577.9577	714.363	0.0001	0.0004	0.00023	-0.00014	-0.0003	407735.2815	700577.9576	714.3627
Т6	407693.2007	700584.846	714.188	0.0001	0.00077	-0.00023	-0.00068	0.00029	407693.2005	700584.8453	714.18829
otal err	0.0003	0.00058	0.00078		0.00102						
			Ground Cor	ntrol Points measured	with dual	frequency (	GPS Receiver				
#Label	X/Easting	Y/Northing	Z/Altitude	Accuracy_X/Y/Z_(m)	Error_(m)	X_error	Y_error	Z_error	X_est	Y_est	Z_est
#Label A1.1	X/Easting 407835.5824	Y/Northing 700800.3195	Z/Altitude 709.5426	Accuracy_X/Y/Z_(m) 0.0001	Error_(m) 0.000375	X_error -0.000216	Y_error -0.000135	Z_error -0.000275	X_est 407835.5822	Y_est 700800.3194	Z_est 709.542325
#Label A1.1 A1.2	X/Easting 407835.5824 407800.7038	Y/Northing 700800.3195 700700.0944	Z/Altitude 709.5426 709.1603	Accuracy_X/Y/Z_(m) 0.0001 0.0001	Error_(m) 0.000375 0.000042	X_error -0.000216 -0.000021	Y_error -0.000135 -0.000016	Z_error -0.000275 -0.000033	X_est 407835.5822 407800.7038	Y_est 700800.3194 700700.0944	Z_est 709.542325 709.160267
#Label A1.1 A1.2 A1.3	X/Easting 407835.5824 407800.7038 407762.0689	Y/Northing 700800.3195 700700.0944 700585.3424	Z/Altitude 709.5426 709.1603 709.5344	Accuracy_X/Y/Z_(m) 0.0001 0.0001 0.0001	Error_(m) 0.000375 0.000042 0.000118	X_error -0.000216 -0.000021 0.000081	Y_error -0.000135 -0.000016 -0.000053	Z_error -0.000275 -0.000033 -0.000068	X_est 407835.5822 407800.7038 407762.069	Y_est 700800.3194 700700.0944 700585.3423	Z_est 709.542325 709.160267 709.534332
#Label A1.1 A1.2 A1.3 A2.1	X/Easting 407835.5824 407800.7038 407762.0689 407852.0146	Y/Northing 700800.3195 700700.0944 700585.3424 700754.3098	Z/Altitude 709.5426 709.1603 709.5344 689.5235	Accuracy_X/Y/Z_(m) 0.0001 0.0001 0.0001 0.0001	Error_(m) 0.000375 0.000042 0.000118 0.000403	X_error -0.000216 -0.000021 0.000081 -0.000305	Y_error -0.000135 -0.000016 -0.000053 -0.0001	Z_error -0.000275 -0.000033 -0.000068 -0.000244	X_est 407835.5822 407800.7038 407762.069 407852.0143	Y_est 700800.3194 700700.0944 700585.3423 700754.3097	Z_est 709.542325 709.160267 709.534332 689.523256
#Label A1.1 A1.2 A1.3 A2.1 A2.2	X/Easting 407835.5824 407800.7038 407762.0689 407852.0146 407820.9373	Y/Northing 700800.3195 700700.0944 700585.3424 700754.3098 700662.6191	Z/Altitude 709.5426 709.1603 709.5344 689.5235 688.8849	Accuracy_X/Y/Z_(m) 0.0001 0.0001 0.0001 0.0001 0.0001	Error_(m) 0.000375 0.000042 0.000118 0.000403 0.000083	X_error -0.000216 -0.000021 0.000081 -0.000305 -0.000039	Y_error -0.000135 -0.000016 -0.000053 -0.0001 0.000016	Z_error -0.000275 -0.000033 -0.000068 -0.000244 0.000071	X_est 407835.5822 407800.7038 407762.069 407852.0143 407820.9373	Y_est 700800.3194 700700.0944 700585.3423 700754.3097 700662.6191	Z_est 709.542325 709.160267 709.534332 689.523256 688.884971
#Label A1.1 A1.2 A1.3 A2.1 A2.2 A2.3	X/Easting 407835.5824 407800.7038 407762.0689 407852.0146 407820.9373 407797.1617	Y/Northing 700800.3195 700700.0944 700585.3424 700754.3098 700662.6191 700587.5438	Z/Altitude 709.5426 709.1603 709.5344 689.5235 688.8849 689.2391	Accuracy_X/Y/Z_(m) 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001	Error_(m) 0.000375 0.000042 0.000118 0.000403 0.000083 0.000192	X_error -0.000216 -0.000021 0.000081 -0.000305 -0.000039 0.000148	Y_error -0.000135 -0.000016 -0.000053 -0.0001 0.000016 0	Z_error -0.000275 -0.000033 -0.000068 -0.000244 0.000071 -0.000122	X_est 407835.5822 407800.7038 407762.069 407852.0143 407820.9373 407797.1618	Y_est 700800.3194 700700.0944 700585.3423 700754.3097 700662.6191 700587.5438	Z_est 709.542325 709.160267 709.534332 689.523256 688.884971 689.238978
#Label A1.1 A1.2 A1.3 A2.1 A2.2 A2.3 A3.1	X/Easting 407835.5824 407800.7038 407762.0689 407852.0146 407820.9373 407797.1617 407861.9831	Y/Northing 700800.3195 700700.0944 700585.3424 700754.3098 700662.6191 700587.5438 700690.2758	Z/Altitude 709.5426 709.1603 709.5344 689.5235 688.8849 689.2391 669.7538	Accuracy_X/Y/Z_(m) 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001	Error_(m) 0.000375 0.000042 0.000118 0.000403 0.000083 0.000192 0.000438	X_error -0.000216 -0.000021 0.000081 -0.000305 -0.000039 0.000148 -0.000368	Y_error -0.000135 -0.000016 -0.000053 -0.0001 0.000016 0 -0.000144	Z_error -0.000275 -0.000033 -0.000068 -0.000244 0.000071 -0.000122 -0.000189	X_est 407835.5822 407800.7038 407762.069 407852.0143 407820.9373 407797.1618 407861.9827	Y_est 700800.3194 700700.0944 700585.3423 700754.3097 700662.6191 700587.5438 700690.2757	Z_est 709.542325 709.160267 709.534332 689.523256 688.884971 689.238978 669.753611
#Label A1.1 A1.2 A1.3 A2.1 A2.2 A2.3 A3.1 A3.2	X/Easting 407835.5824 407800.7038 407762.0689 407852.0146 407820.9373 407797.1617 407861.9831 407845.5292	Y/Northing 700800.3195 700700.0944 700585.3424 700754.3098 700662.6191 700587.5438 700690.2758 700633.8039	Z/Altitude 709.5426 709.1603 709.5344 689.5235 688.8849 689.2391 669.7538 669.5613	Accuracy_X/Y/Z_(m) 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001	Error_(m) 0.000375 0.000042 0.000118 0.000403 0.000083 0.000192 0.000438 0.000233	X_error -0.000216 -0.000021 0.000081 -0.000305 -0.00039 0.000148 -0.000368 -0.00053	Y_error -0.000135 -0.00016 -0.00013 -0.0001 0.000016 0 -0.000144 0.00002	Z_error -0.000275 -0.000033 -0.000068 -0.000244 0.000071 -0.000122 -0.000189 -0.000226	X_est 407835.5822 407800.7038 407762.069 407852.0143 407820.9373 407797.1618 407861.9827 407845.5291	Y_est 700800.3194 700700.0944 700585.3423 700754.3097 700662.6191 700587.5438 700690.2757 700633.8039	Z_est 709.542325 709.160267 709.534332 689.523256 688.884971 689.238978 669.753611 669.561074
#Label A1.1 A1.2 A1.3 A2.1 A2.2 A2.3 A3.1 A3.2 A3.3	X/Easting 407835.5824 407800.7038 407762.0689 407852.0146 407820.9373 407797.1617 407861.9831 407845.5292 407828.2328	Y/Northing 700800.3195 700700.0944 700585.3424 700754.3098 700662.6191 700587.5438 700690.2758 700633.8039 700580.8113	Z/Altitude 709.5426 709.1603 709.5344 689.5235 688.8849 689.2391 669.7538 669.5613 669.5138	Accuracy_X/Y/Z_(m) 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001	Error_(m) 0.000375 0.000042 0.000118 0.000403 0.000083 0.000192 0.000438 0.000233 0.000233	X_error -0.000216 -0.000021 0.000081 -0.000305 -0.00039 0.000148 -0.000368 -0.00053 0.000053	Y_error -0.000135 -0.000016 -0.000053 -0.00016 0 -0.000144 0.0000275	Z_error -0.000275 -0.000033 -0.000068 -0.000244 0.000071 -0.000122 -0.000189 -0.000226 -0.000179	X_est 407835.5822 407800.7038 407762.069 407852.0143 407820.9373 407797.1618 407861.9827 407845.5291 407845.5291	Y_est 700800.3194 700700.0944 700585.3423 700754.3097 700662.6191 700587.5438 700690.2757 700633.8039 700580.8116	Z_est 709.542325 709.160267 709.534332 689.523256 688.884971 689.238978 669.753611 669.561074 669.513621
#Label A1.1 A1.2 A1.3 A2.1 A2.2 A2.3 A3.1 A3.2 A3.3 B1.1	X/Easting 407835.5824 407800.7038 407762.0689 407852.0146 407820.9373 407797.1617 407861.9831 407845.5292 407828.2328 407747.0423	Y/Northing 700800.3195 700700.0944 700585.3424 700754.3098 700662.6191 700587.5438 700690.2758 700633.8039 700580.8113 700795.9005	Z/Altitude 709.5426 709.1603 709.5344 689.5235 688.8849 689.2391 669.7538 669.5613 669.5138 709.0227	Accuracy_X/Y/Z_(m) 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001	Error_(m) 0.000375 0.000042 0.000118 0.000403 0.000083 0.000192 0.000438 0.000233 0.000233 0.000332	X_error -0.000216 -0.000021 0.000081 -0.000305 -0.000039 0.000148 -0.000053 0.000053 0.000053	Y_error -0.000135 -0.00016 -0.00053 -0.00016 0 -0.000164 0.0000275 -0.0000275	Z_error -0.000275 -0.000033 -0.000068 -0.000244 0.000071 -0.000122 -0.000189 -0.000226 -0.000179 0.000157	X_est 407835.5822 407800.7038 407762.069 407852.0143 407820.9373 407797.1618 407861.9827 407845.5291 407845.5291 407847.0424	Y_est 700800.3194 700700.0944 700585.3423 700754.3097 700662.6191 700587.5438 700690.2757 700633.8039 700580.8116 700795.9005	Z_est 709.542325 709.160267 709.534332 689.523256 688.884971 689.238978 669.753611 669.561074 669.513621 709.022857
#Label A1.1 A1.2 A1.3 A2.1 A2.2 A2.3 A3.1 A3.2 A3.3 B1.1 B2.1	X/Easting 407835.5824 407800.7038 407762.0689 407852.0146 407820.9373 407797.1617 407861.9831 407845.5292 407828.2328 407747.0423 407730.5193	Y/Northing 700800.3195 700700.0944 700585.3424 700754.3098 700662.6191 700587.5438 700690.2758 700633.8039 700580.8113 700795.9005 700801.641	Z/Altitude 709.5426 709.1603 709.5344 689.5235 688.8849 689.2391 669.7538 669.5613 669.5138 709.0227 696.384	Accuracy_X/Y/Z_(m) 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001	Error_(m) 0.000375 0.000042 0.000118 0.000403 0.000083 0.000192 0.000438 0.000233 0.000233 0.000332 0.00032	X_error -0.000216 -0.000021 0.000081 -0.000305 -0.00039 0.000148 -0.000053 0.000053 0.000053 0.000038	Y_error -0.000135 -0.00016 -0.00053 -0.00016 0 -0.000164 0.0000275 -0.0000275 -0.000028	Z_error -0.000275 -0.000033 -0.000068 -0.000244 0.000071 -0.000122 -0.000189 -0.000226 -0.000179 0.000157 -0.000031	X_est 407835.5822 407800.7038 407762.069 407852.0143 407820.9373 407797.1618 407861.9827 407845.5291 407845.5291 407828.2329 407747.0424	Y_est 700800.3194 700700.0944 700585.3423 700754.3097 700662.6191 700587.5438 700690.2757 700633.8039 700580.8116 700795.9005 700801.641	Z_est 709.542325 709.160267 709.534332 689.523256 688.884971 689.238978 669.753611 669.561074 669.513621 709.022857 696.383969
#Label A1.1 A1.2 A1.3 A2.1 A2.2 A2.3 A3.1 A3.2 A3.3 B1.1 B2.1 B3.1	X/Easting 407835.5824 407800.7038 407762.0689 407852.0146 407820.9373 407797.1617 407861.9831 407845.5292 407828.2328 407747.0423 407730.5193 407697.9192	Y/Northing 700800.3195 700700.0944 700585.3424 700754.3098 700662.6191 700587.5438 700690.2758 700633.8039 700580.8113 700795.9005 700801.641 700655.26	Z/Altitude 709.5426 709.1603 709.5344 689.5235 688.8849 689.2391 669.7538 669.5613 669.5138 709.0227 696.384 707.4833	Accuracy_X/Y/Z_(m) 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001	Error_(m) 0.000375 0.00042 0.000118 0.000403 0.000032 0.000192 0.000438 0.000233 0.000233 0.00021 0.000032 0.000154	X_error -0.000216 -0.000021 0.000081 -0.000305 -0.00039 0.000148 -0.000053 0.000053 0.0000138 0.00003 0.000055	Y_error -0.000135 -0.00016 -0.00053 -0.00016 0 -0.000164 0.0000275 -0.0000275 -0.000028 0.0000904	Z_error -0.000275 -0.000033 -0.000068 -0.000244 0.000071 -0.000122 -0.000189 -0.000226 -0.000179 0.000157 -0.000031 0.000443	X_est 407835.5822 407800.7038 407762.069 407852.0143 407820.9373 407797.1618 407861.9827 407845.5291 407845.5291 407845.5291 407747.0424 407730.5193 407697.9198	Y_est 700800.3194 700700.0944 700585.3423 700754.3097 700662.6191 700587.5438 700690.2757 700633.8039 700580.8116 700795.9005 700801.641 700655.2609	Z_est 709.542325 709.160267 709.534332 689.523256 688.884971 689.238978 669.753611 669.561074 669.513621 709.022857 696.383969 707.483743
#Label A1.1 A1.2 A1.3 A2.1 A2.2 A2.3 A3.1 A3.2 A3.3 B1.1 B2.1 B3.1 B3.2	X/Easting 407835.5824 407800.7038 407762.0689 407852.0146 407820.9373 407797.1617 407861.9831 407845.5292 407828.2328 407747.0423 407730.5193 407697.9192 407682.0186	Y/Northing 700800.3195 700700.0944 700585.3424 700754.3098 700662.6191 700587.5438 700690.2758 700633.8039 700580.8113 700795.9005 700801.641 700655.26 700660.5465	Z/Altitude 709.5426 709.1603 709.5344 689.5235 688.8849 689.2391 669.7538 669.5613 669.5138 709.0227 696.384 707.4833 695.2808	Accuracy_X/Y/Z_(m) 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001	Error_(m) 0.000375 0.00042 0.000118 0.000403 0.000033 0.000192 0.000438 0.000233 0.00023 0.00023 0.00021 0.00032 0.000154 0.004365	X_error -0.000216 -0.000021 0.000081 -0.000305 -0.00039 0.000148 -0.000053 0.000053 0.000053 0.00003 0.000055 0.0001272	Y_error -0.000135 -0.00016 -0.000053 -0.00016 0 -0.000144 0.0000275 -0.0000275 -0.000028 0.000904 -0.000752	Z_error -0.000275 -0.000033 -0.000068 -0.000244 0.0000122 -0.000129 -0.000129 -0.000157 -0.0000157 -0.000031 0.000443 0.004107	X_est 407835.5822 407800.7038 407762.069 407852.0143 407820.9373 407797.1618 407861.9827 407845.5291 407845.5291 407845.5291 407747.0424 407730.5193 407697.9198 407682.0199	Y_est 700800.3194 700700.0944 700585.3423 700754.3097 700662.6191 700587.5438 700690.2757 700633.8039 700580.8116 700795.9005 700801.641 700655.2609 700660.5457	Z_est 709.542325 709.160267 709.534332 689.523256 688.884971 689.238978 669.753611 669.561074 669.513621 709.022857 696.383969 707.483743 695.284907
#Label A1.1 A1.2 A1.3 A2.1 A2.2 A2.3 A3.1 A3.2 A3.3 B1.1 B2.1 B3.1 B3.2 T1	X/Easting 407835.5824 407800.7038 407762.0689 407852.0146 407820.9373 407797.1617 407861.9831 407845.5292 407828.2328 407747.0423 407747.0423 4077697.9192 407682.0186 407816.4317	Y/Northing 700800.3195 700700.0944 700585.3424 700754.3098 700662.6191 700587.5438 700690.2758 700633.8039 700580.8113 700795.9005 700801.641 700655.26 700860.5465 700813.5659	Z/Altitude 709.5426 709.1603 709.5344 689.5235 688.8849 689.2391 669.7538 669.5138 669.5138 709.0227 696.384 707.4833 695.2808 714.0243	Accuracy_X/Y/Z_(m) 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001	Error_(m) 0.000375 0.00042 0.000118 0.000403 0.00083 0.00092 0.000438 0.000233 0.000233 0.000232 0.000154 0.0004365 0.000252	X_error -0.000216 -0.000021 0.000081 -0.000305 -0.000039 0.000148 -0.000053 0.000053 0.000053 0.000053 0.000055 0.000138 0.000055 0.0001272 -0.00019	Y_error -0.000135 -0.00016 -0.00016 0.000016 0 -0.000144 0.000025 -0.000025 -0.000028 0.000904 -0.000088 0.000904 -0.000752 -0.000064	Z_error -0.000275 -0.000033 -0.000068 -0.000244 0.0000122 -0.000189 -0.000226 -0.000157 -0.0000157 -0.0000157 0.0004130 0.000443 0.004107 -0.000152	X_est 407835.5822 407800.7038 407762.069 407852.0143 407797.1618 407861.9827 407845.5291 407845.5291 4077847.0424 407730.5193 407697.9198 407682.0199 407816.4315	Y_est 700800.3194 700700.0944 700585.3423 700754.3097 700662.6191 700587.5438 700690.2757 700633.8039 700580.8116 700795.9005 700801.641 700655.2609 700660.5457 700813.5658	Z_est 709.542325 709.160267 709.534332 689.523256 688.884971 689.238978 669.753611 669.513621 709.022857 696.383969 707.483743 695.284907 714.024148
#Label A1.1 A1.2 A1.3 A2.1 A2.2 A2.3 A3.1 A3.2 A3.3 B1.1 B2.1 B3.1 B3.2 T1 T2	X/Easting 407835.5824 407800.7038 407762.0689 407852.0146 407820.9373 407797.1617 407861.9831 407845.5292 407842.5292 407782.2328 407747.0423 407730.5193 407697.9192 407682.0186 407816.4317 407772.4639	Y/Northing 700800.3195 700700.0944 700585.3424 700754.3098 700662.6191 700587.5438 700690.2758 700633.8039 700580.8113 700795.9005 700801.641 700665.266 700813.5659 700820.5494	Z/Altitude 709.5426 709.1603 709.5344 689.5235 688.8849 689.2391 669.7538 669.5138 669.5138 709.0227 696.384 707.4833 695.2808 714.0243 713.3935	Accuracy_X/Y/Z_(m) 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001	Error_(m) 0.000375 0.00042 0.000118 0.000403 0.000083 0.000192 0.000438 0.000233 0.000233 0.000232 0.000032 0.000032 0.000152 0.000252 0.000866	X_error -0.000216 -0.000021 0.000081 -0.00039 0.000148 -0.000368 -0.000053 0.000053 0.0000138 0.0000565 0.001272 -0.00019 -0.000483	Y_error -0.000135 -0.00016 -0.00016 0.000016 0 -0.000144 0.000025 -0.000025 -0.000028 -0.000084 -0.000904 -0.000904 -0.00064 -0.000697	Z_error -0.000275 -0.000033 -0.000068 -0.000244 0.0000122 -0.000189 -0.000226 -0.000157 -0.000157 -0.0000157 0.000443 0.004407 -0.000152 0.000174	X_est 407835.5822 407800.7038 407762.069 407852.0143 407797.1618 407861.9827 407845.5291 407845.5291 407845.5293 407747.0424 407730.5193 407697.9198 407682.0199 407816.4315	Y est 700800.3194 700700.0944 700585.3423 700754.3097 700662.6191 700587.5438 700690.2757 700633.8039 700580.8116 700795.9005 700801.641 700655.2609 700860.5457 700813.5658 700820.5487	Z_est 709.542325 709.160267 709.534332 689.523256 688.884971 689.238978 669.753611 669.551074 669.513621 709.022857 696.383969 707.483743 695.284907 714.024148 713.393674
#Label A1.1 A1.2 A1.3 A2.1 A2.2 A2.3 A3.1 A3.2 A3.3 B1.1 B3.1 B3.2 T1 T2 T3	X/Easting 407835.5824 407800.7038 407762.0689 407852.0146 407820.9373 407797.1617 407861.9831 407845.5292 4078428.2328 407747.0423 407697.5193 407682.0186 407816.4317 407772.4639 407769.5019	Y/Northing 700800.3195 700700.0944 700585.3424 700754.3098 700662.6191 700587.5438 700690.2758 700633.8039 700580.8113 700795.9005 700801.641 700665.266 700860.5465 700813.5659 700820.5494	Z/Altitude 709.5426 709.1603 709.5344 689.5235 688.8849 689.2391 669.7538 669.5613 669.5138 709.0227 696.384 707.4833 695.2808 714.0243 713.3935 714.2406	Accuracy_X/Y/Z_(m) 0.0001 0.	Error_(m) 0.000375 0.00042 0.000118 0.000403 0.000083 0.000192 0.000438 0.000233 0.000213 0.000032 0.0001154 0.000436 0.0001252 0.000866 0.000242	X_error -0.000216 -0.000021 0.000081 -0.00039 0.000148 -0.000368 -0.000053 0.000053 0.0000138 0.0000565 0.001272 -0.00019 -0.000483 0.00009	Y_error -0.000135 -0.00016 -0.000016 0 -0.00014 0.00002 0.000275 -0.00002 -0.00008 0.000904 -0.000052 -0.000064 -0.000697 -0.000095	Z_error -0.000275 -0.000033 -0.000068 -0.000244 0.0000122 -0.000189 -0.000126 -0.000179 -0.000157 -0.0000151 0.000443 0.004107 -0.000152 0.000174 -0.000122	X_est 407835.5822 407800.7038 407762.069 407852.0143 407797.1618 407861.9827 407845.5291 407845.5291 407845.5291 407747.0424 407730.5193 407697.9198 407682.0199 407816.4315 407772.4634	Y_est 700800.3194 700700.0944 700585.3423 700754.3097 700662.6191 700587.5438 700690.2757 700633.8039 700580.8116 700795.9005 700801.641 700655.2609 700801.6457 700813.5658 700820.5487	Z_est 709.542325 709.160267 709.534332 689.523256 688.884971 689.238978 669.753611 669.561074 669.513621 709.022857 696.383969 707.483743 695.284907 714.024148 713.393674 714.240378
#Label A1.1 A1.2 A1.3 A2.1 A2.2 A2.3 A3.1 A3.2 A3.3 B1.1 B2.1 B3.1 B3.2 T1 T2 T3 T4	X/Easting 407835.5824 407800.7038 407762.0689 407852.0146 407820.9373 407797.1617 407861.9831 407845.5292 407842.82328 407747.0423 407797.9192 407682.0186 407816.4317 407772.4639 407769.5019	Y/Northing 700800.3195 700700.0944 700585.3424 700754.3098 700662.6191 700587.5438 700690.2758 700633.8039 700580.8113 700795.9005 700801.641 700665.266 700813.5659 700813.5659 700820.5494 700672.6345	Z/Altitude 709.5426 709.1603 709.5344 689.5235 688.8849 669.7538 669.5613 669.5138 709.0227 696.384 707.4833 695.2808 714.0243 713.3935 714.2406 713.0477	Accuracy_X/Y/Z_(m) 0.0001 0.	Error_(m) 0.000375 0.00042 0.000118 0.000403 0.000083 0.000192 0.000438 0.000233 0.000233 0.000213 0.000032 0.0001154 0.000436 0.000252 0.000866 0.000242 0.000804	X_error -0.000216 -0.000021 0.000081 -0.00039 0.000148 -0.000368 -0.000053 0.000053 0.0000565 0.0001272 -0.00019 -0.000483 0.00009 0.0000684	Y_error -0.000135 -0.00016 -0.00016 0 -0.00014 0.00002 0.000275 -0.00002 -0.00008 0.000904 -0.000752 -0.000064 -0.000697 -0.0000697 -0.000095 -0.000095	Z_error -0.000275 -0.000033 -0.000068 -0.000244 -0.000122 -0.000189 -0.000226 -0.000179 -0.000157 -0.000031 0.00443 0.004107 -0.000152 0.000174 -0.000152 0.000174	X_est 407835.5822 407800.7038 407762.069 407852.0143 407797.1618 407861.9827 407845.5291 407845.5291 407845.5291 407782.0399 407777.0424 407730.5193 407682.0199 4077816.4315 407772.4634 407769.5019	Y_est 700800.3194 700700.0944 700585.3423 700754.3097 700662.6191 700587.5438 700690.2757 700633.8039 700580.8116 700795.9005 700801.641 700655.2609 700801.6457 700813.5658 700820.5487 700672.6344 700682.9893	Z_est 709.542325 709.160267 709.534332 689.523256 688.884971 689.238978 669.753611 669.561074 669.513621 709.022857 696.383969 707.483743 695.284907 714.024148 713.393674 714.240378
#Label A1.1 A1.2 A1.3 A2.1 A2.2 A2.3 A3.1 A3.2 A3.3 B1.1 B3.1 B3.1 B3.2 T1 T2 T3 T4 T5	X/Easting 407835.5824 407830.7038 407762.0689 407852.0146 407820.9373 407797.1617 407861.9831 407845.5292 407842.3288 407747.0423 407730.5193 40769.5019 407782.0186 407716.9377 40775.2763	Y/Northing 700800.3195 700700.0944 700585.3424 700754.3098 700662.6191 700587.5438 700690.2758 700633.8039 700580.8113 700795.9005 700801.641 700655.26 700801.5659 700820.5494 700672.6345 700682.9901	Z/Altitude 709.5426 709.1603 709.5344 689.5235 688.8849 669.7538 669.5613 669.5138 709.0227 696.384 707.4833 695.2808 714.0243 713.3935 714.2406 713.0477 714.3583	Accuracy_X/Y/Z_(m) 0.0001 0.	Error_(m) 0.000375 0.00042 0.000118 0.000403 0.000083 0.000192 0.000438 0.000233 0.00032 0.00032 0.00032 0.00032 0.000325 0.000325 0.000252 0.000866 0.000242 0.000804 0.000402	X_error -0.000216 -0.000021 0.000081 -0.00039 0.000148 -0.000368 -0.000053 0.000053 0.0000138 0.0000138 0.00001272 -0.00019 -0.000483 0.00009 0.000684 0.00018	Y_error -0.000135 -0.00016 -0.000016 0 -0.00014 0.00002 0.000275 -0.00002 -0.000028 0.000904 -0.000647 -0.000064 -0.000697 -0.0000657 -0.0000621 -0.0000821 -0.000349	Z_error -0.000275 -0.000033 -0.000068 -0.000244 0.000071 -0.000122 -0.000189 -0.000226 -0.000179 0.000157 -0.0000433 0.004430 0.0004430 -0.000152 0.000154 -0.000222 0.001454 -0.00086	X_est 407835.5822 407800.7038 407762.069 407852.0143 407820.9373 407797.1618 407861.9827 407845.5291 407845.5291 407842.2329 407747.0424 407730.5193 40769.5198 407782.4634 407769.5019 407716.9384 407735.2765	Y_est 700800.3194 700700.0944 700585.3423 700754.3097 700662.6191 700587.5438 700690.2757 700633.8039 700580.8116 700795.9005 700801.641 700655.2609 700660.5457 700681.5658 700820.5487 700672.6344 700682.9893 700577.9756	Z_est 709.542325 709.160267 709.534332 689.523256 688.884971 689.238978 669.753611 669.561074 669.513621 709.022857 696.383969 707.483743 695.284907 714.024148 713.393674 714.240378 713.049154
#Label A1.1 A1.2 A1.3 A2.1 A2.2 A2.3 A3.1 A3.2 A3.3 B1.1 B3.1 B3.1 B3.2 T1 T2 T3 T4 T5 T6	X/Easting 407835.5824 407800.7038 407762.0689 407852.0146 407820.9373 407797.1617 407861.9831 407845.5292 407842.0282 407747.0423 407703.5193 40769.5019 407716.9377 407769.5019 407769.5019 407769.5019	Y/Northing 700800.3195 700700.0944 700585.3424 700754.3098 700662.6191 700587.5438 700690.2758 700633.8039 700580.8113 700795.9005 700801.641 700655.26 700810.5455 700813.5659 700820.5494 700672.6345 700682.9901 700577.9759	Z/Altitude 709.5426 709.1603 709.5344 689.5235 688.8849 669.7538 669.5613 669.5138 709.0227 696.384 707.4833 695.2808 714.0243 713.3935 714.2406 713.0477 714.3583 714.1824	Accuracy_X/Y/Z_(m) 0.0001 0.	Error_(m) 0.000375 0.00042 0.000118 0.000403 0.000083 0.000192 0.000438 0.00032 0.00	X_error -0.000216 -0.000021 0.000081 -0.000305 -0.00039 0.000148 -0.000368 -0.000053 0.0000138 0.0000138 0.0000138 0.00001272 -0.00019 -0.0001483 0.00009 0.000684 0.00018 -0.000081	Y_error -0.000135 -0.00016 -0.000053 -0.00016 0 -0.000144 0.000022 0.0000275 -0.000022 -0.0000904 -0.0000944 -0.0000697 -0.0000697 -0.0000697 -0.0000697 -0.0000821 -0.0000493	Z_error -0.000275 -0.000033 -0.000068 -0.000244 0.000071 -0.000122 -0.000189 -0.000226 -0.000179 0.000157 -0.0000157 -0.00004107 -0.000152 0.000174 -0.000152 0.000174 -0.000222 0.001745 -0.000086 0.000785	X_est 407835.5822 407800.7038 407762.069 407852.0143 407820.9373 407797.1618 407861.9827 407845.5291 407845.5291 407747.0424 407770.5193 40769.5019 407716.9384 407769.5019 407716.9384 407769.2155	Y_est 700800.3194 700700.0944 700585.3423 700754.3097 700662.6191 700587.5438 700690.2757 700633.8039 700580.8116 700795.9005 700801.641 700655.2609 700660.5457 700813.5658 700820.5487 70082.9484 700682.9893 700577.9756 700584.8481	Z_est 709.542325 709.160267 709.534332 689.523256 688.884971 689.238978 669.753611 669.561074 669.513621 709.022857 696.383969 707.483743 695.284907 714.024148 713.393674 714.240378 713.049154 714.358214
#Label A1.1 A1.2 A1.3 A2.1 A2.2 A3.1 A3.2 A3.3 B1.1 B3.1 B3.1 B3.2 T1 T2 T3 T4 T5 T6 A4	X/Easting 407835.5824 407800.7038 407762.0689 407852.0146 407820.9373 407797.1617 407861.9831 407845.5292 407828.2328 407747.0423 407730.5193 407697.9192 407782.0186 407716.9377 407769.5019 407769.5019 407769.5019 407769.519 40	Y/Northing 700800.3195 700700.0944 700585.3424 700754.3098 700662.6191 700587.5438 700690.2758 700633.8039 700580.8113 700795.9005 700801.641 700655.26 700810.5455 700810.5455 700810.5455 700810.5454 700657.26345 700682.9901 700577.9759 700584.8486 700578.7997	Z/Altitude 709.5426 709.1603 709.5344 689.5235 688.8849 669.7538 669.5613 669.5138 709.0227 696.384 707.4833 707.4833 707.4833 714.0243 713.3935 714.2406 713.0477 714.3583 714.1824 649.9453	Accuracy_X/Y/Z_(m) 0.0001 0.	Error_(m) 0.000375 0.00042 0.000118 0.000403 0.000083 0.000192 0.000438 0.000233 0.00032 0.00032 0.00032 0.00032 0.00032 0.00032 0.00032 0.00032 0.00032 0.00032 0.00032 0.000402 0.000804 0.000402 0.000402 0.000931 0.000402	X_error -0.000216 -0.000021 0.000081 -0.000305 -0.00039 0.000148 -0.00053 0.000053 0.00003 0.00003 0.00003 0.00003 0.0000483 0.0000483 0.0000483 0.0000684 0.000081 -0.000081 -0.000041	Y_error -0.000135 -0.00016 -0.000053 -0.00016 0 -0.000144 0.000022 0.000275 -0.00002 -0.000088 0.0000904 -0.0000697 -0.0000597 -0.0000597 -0.0000597 -0.0000597 -0.0000597 -0.0000597 -0.0000591 -0.000055 -0.00055 -0.0005 -0.00055 -0.00055 -0.0005	Z_error -0.000275 -0.000033 -0.000068 -0.000244 0.0000122 -0.000189 -0.000226 -0.000179 0.000157 -0.00004107 -0.00004107 -0.000152 0.000174 -0.000152 0.000174 -0.000222 0.001745 -0.000086 0.000785 -0.000083	X_est 407835.5822 407800.7038 407762.069 407852.0143 407820.9373 407797.1618 407861.9827 407845.5291 407845.5291 407747.0424 407770.5193 407697.9198 407762.0199 407716.9384 407776.5019 407716.9384 407735.2765 407856.2584	Y_est 700800.3194 700700.0944 700585.3423 700754.3097 700662.6191 700587.5438 700690.2757 700633.8039 700580.8116 700795.9005 700801.641 700655.2609 700660.5457 70081.5658 70082.05457 70082.05487 70062.9484 700672.6344 700578.7998	Z_est 709.542325 709.160267 709.534332 689.523256 688.884971 689.238978 669.753611 669.561074 669.513621 709.022857 696.383969 707.483743 695.284907 714.024148 713.393674 714.024148 713.049154 714.358214 714.183185 649.945217
#Label A1.1 A1.2 A1.3 A2.1 A2.2 A3.1 A3.2 A3.3 B1.1 B3.1 B3.2 T1 T2 T3 T4 T5 T6 A4 B3.3	X/Easting 407835.5824 407800.7038 407762.0689 407852.0146 407820.9373 407797.1617 407861.9831 407845.5292 407845.5292 407747.0423 407770.5193 407697.9192 407682.0186 407816.4317 407772.4639 407769.5019 407769.5019 407769.5019 407769.5019 407769.5019 407765.2763 40785.2763 407856.2584 407657.4817	Y/Northing 700800.3195 700700.0944 700585.3424 700754.3098 700662.6191 700587.5438 700690.2758 700633.8039 700580.8113 700795.9005 700801.641 700655.26 700801.645 700801.5659 700820.5494 700657.26345 700682.9901 700577.9759 700584.8486 700578.7997	Z/Altitude 709.5426 709.1603 709.5344 689.5235 688.8849 669.7538 669.5613 669.5613 669.5138 709.0227 696.384 707.4833 695.2808 714.0243 713.3935 714.2406 713.0477 714.3583 714.1824 649.9453 676.6132	Accuracy_X/Y/Z_(m) 0.0001 0.	Error_(m) 0.000375 0.00042 0.000118 0.000403 0.000033 0.000192 0.000438 0.000233 0.00032 0.00032 0.00032 0.00032 0.000154 0.000402 0.000402 0.001804 0.000402 0.000168 0.0002273	X_error -0.000216 -0.000021 0.000081 -0.000305 -0.00039 0.000148 -0.000368 -0.000053 0.000053 0.0000138 0.000003 0.0000138 0.0000138 0.0000138 0.0000143 0.0000483 0.0000483 0.0000684 0.000088 -0.000081 -0.000085 -0.000085 -0.000085 -0.000085 -0.000085 -0.000085 -0.000085 -0.000085 -0.000085 -0.	Y_error -0.000135 -0.00016 -0.000053 -0.00016 0 -0.000144 0.000022 0.000275 -0.00002 -0.000082 -0.000095 -0.000057 -0.000057 -0.000057 -0.000057 -0.0000597 -0.000055 -0.000055 -0.000055 -0.00055	Z_error -0.000275 -0.000033 -0.000068 -0.000244 0.0000122 -0.000189 -0.000226 -0.000179 0.000157 -0.0000157 -0.00004107 -0.000152 0.000174 -0.000152 0.000174 -0.000222 0.001454 -0.000086 0.000785 -0.000083 -0.001242	X_est 407835.5822 407800.7038 407762.069 407852.0143 407820.9373 407797.1618 407861.9827 407845.5291 407845.5291 407747.0424 407770.5193 407697.9198 407782.639 407716.9384 407776.5019 407716.9384 407735.2765 40785.2584 407657.4817	Y_est 700800.3194 700700.0944 700585.3423 700754.3097 700662.6191 700587.5438 700690.2757 700633.8039 700580.8116 700795.9005 700801.641 700655.2609 700660.5457 70081.5658 700820.5487 700820.5487 700672.6344 700652.6344 700577.9756 700584.8481 700578.7998	Z_est 709.542325 709.160267 709.534332 689.523256 688.884971 689.238978 669.753611 669.561074 669.513621 709.022857 696.383969 707.483743 695.284907 714.024148 713.393674 713.393674 714.240378 713.049154 714.358214 714.183185 649.945217 676.611958
#Label A1.1 A1.2 A1.3 A2.1 A2.2 A2.3 A3.1 A3.2 A3.3 B1.1 B3.1 B3.1 B3.2 T1 T2 T3 T4 T5 T6 A4 B3.3 B3.4	X/Easting 407835.5824 407800.7038 407762.0689 407852.0146 407820.9373 407797.1617 407861.9831 407845.5292 407845.5292 407782.2328 407747.0423 407797.1619 407780.5193 407682.0186 407816.4317 407772.4639 407765.5019 407765.5019 407765.2763 407653.2156 407856.2584 407657.4817 407633.3213	Y/Northing 700800.3195 700700.0944 700585.3424 700754.3098 700662.6191 700587.5438 700690.2758 700633.8039 700580.8113 700795.9005 700801.641 700655.26 700801.641 700655.26 700801.5659 700820.5494 700652.6345 70062.6345 700577.9759 700584.8486 700578.7997 700668.9656 700675.4025	Z/Altitude 709.5426 709.1603 709.5344 689.5235 688.8849 669.7538 669.5613 669.5138 709.0227 696.384 707.4833 695.2808 714.0243 713.3935 714.2406 713.0477 714.3583 714.1824 649.9453 676.6132 660.8948	Accuracy_X/Y/Z_(m) 0.0001 0.	Error_(m) 0.000375 0.00042 0.000118 0.000403 0.000083 0.000192 0.000438 0.000233 0.000233 0.00032 0.00032 0.000154 0.000402 0.00154 0.000402 0.001884 0.000402 0.000402 0.000168 0.0002273 0.0004287	X_error -0.000216 -0.000021 0.000081 -0.000305 -0.00039 0.000148 -0.00033 0.000053 0.000053 0.000053 0.000053 0.00003 0.000056 0.000272 -0.00019 -0.000483 0.0000684 0.000088 -0.000081 -0.000081 -0.000131	Y_error -0.000135 -0.00016 -0.000053 -0.00016 0 -0.000144 0.000022 0.000275 -0.00002 -0.000088 0.000904 -0.000095 -0.0000697 -0.0000697 -0.0000697 -0.0000697 -0.0000697 -0.0000697 -0.0000697 -0.0000697 -0.0000491 0.000140 0.000140 0.0001491	Z_error -0.000275 -0.000033 -0.000068 -0.000244 0.0000122 -0.000129 -0.000129 -0.000157 -0.0000157 -0.0000152 0.000174 -0.000152 0.001744 -0.000222 0.001454 -0.00086 0.000785 -0.00083 -0.000242 -0.0004052	X_est 407835.5822 407800.7038 407762.069 407852.0143 407820.9373 407797.1618 407861.9827 407845.5291 407845.5291 407845.5291 407782.2329 407747.0424 407730.5193 407697.9198 407682.0199 407716.9384 407769.5019 407761.9384 407765.2584 407653.2155 407653.4817 407633.32	Y_est 700800.3194 700700.0944 700585.3423 700754.3097 700662.6191 700587.5438 700690.2757 700633.8039 700638.08116 700795.9005 700801.641 700655.2609 700660.5457 70081.5638 700820.5487 700872.6344 700682.9893 700577.9756 700584.8481 700578.7998 700668.9675 700675.403	Z_est 709.542325 709.160267 709.534332 689.523256 688.884971 689.238978 669.753611 669.561074 669.513621 709.022857 696.383969 707.483743 695.284907 714.024148 713.393674 714.240378 713.049154 714.358214 714.183185 649.945217 676.611958 660.890748

Table 4. Comparative table of errors in attaching the point cloud to the ground control points

In conclusion, up to this step we can say that the ground control points measured with the robotic total station have a greater effect in terms of the translation of the point cloud, and results in a lower value of errors when fixing them t the point cloud, compared to the errors obtained by the control points measured with two dual frequency GPS receivers used in base & rover mode.

In the following steps I will develop the idea of strategic selection of certain ground control points that I will attach to the point cloud to see what is the minimum number of ground control points to correctly and accurately achieve this point cloud, the 3D model and those positions that are favorable ground to form correctly work. Certain points that could not be measured with both classic devices we used as such, comparing the differences from those points. In Fig. 2 you can see the ground checkpoints and their position for an easier understanding of what we will describe in the following steps.



Figure. 2. Location of ground control points on the surface of the dam

# 3. Methods of comparison of the obtained errors

We chose the following combination of ground control points for the test, which we divided into two groups, namely:

- Group 1: 3GCP: A31, T6, B21 ßGPS
  - A4, T3, B34 ß GPS
  - A31, T6, B21 ßST
  - A32, T3, B22 ß ST
- Group 2: 4GCP: A33, T1, T6, B32 βGPS
  - A33, T5, T6, B32 ß GPS
  - A31, T1, T2, B21 ß GPS
  - A33, T1, T6, B32 ßST
  - A33, T5, T6, B32 β ST
  - A31, T1, T2, B21 ß ST

The abbreviations used previously represent: ST = robotic total station, GPS = two dual frequency GPS receivers used in base & rover mode, GCP = ground control point.

These groups of ground control points were chosen based on the tests performed by combining them and we highlighted those that we considered to be more relevant to perform future work, and to have a predefined model to follow [8].

After analyzing Group 1 with three ground control points can show the following:

When selecting ground control points measured with two dual frequency GPS receivers used in base & rover mode: A31, T6, B21, which form a triangle it can be shown that these points have a negligible error, but instead changes the positioning of the other ground control points, and the total error is 0.168 cm. Regarding the points A4, T3, B34 it can be observed according to the previous table (Tab.5.) That the error of these points is sub millimetric, but instead the total error calculated by the program is 0.345 m, these being a significant error.

When selecting the ground control points measured with the robotic total station: A31, T6, B21, which form a triangle, it can be shown that these points have a negligible error, but instead change the positioning of the other ground control points, and the total error is 0.072 cm. Regarding the points A4, T3, B34 it can be seen according to Tab. 6 that these points have a negligible error, but instead the total error calculated by the program is 0.196 m, this being a significant error.

From the two tests with three ground control points each, it emerged that the errors obtained are related to the specific choice of points, namely their mutual arrangement. We noticed that those points - A31, T6, B21 - which form as a geometric shape a triangle that covers as much of the surface of the hydrotechnical work, had less influence on the other control points on the ground, and the error obtained in this mode was much smaller than that group of points - A4, T3, B34 - which were located approximately collinear. It also turned out that the ground control points measured with the robotic total station have a much better accuracy, compared to those measured with the dual frequency GPS receiver, the errors obtained for the ground control points measured with two times less than the errors obtained for the points measured with two dual frequency GPS receivers used in base & rover mode, according to Tab.5 and Tab. 6.

Table :	5. Comparison	between a	ictivated	points ai	ıd obtained	errors -	3GCP -	GPS K	eceiver

					Compari	son betweer	n active points	and obtained	errors - GPS	Receiver					
		All Ground C	Control Points	activated			Active	GCP: A3.1, T6, I	B2.1			Active	GCP: A4, T3, B	3.4	
#Label	Active GCP	X/Easting	Y/Northing	Z/Altitude	Error_(m)	Active GCP	X/Easting	Y/Northing	Z/Altitude	Error_(m)	Active GCP	X/Easting	Y/Northing	Z/Altitude	Error_(m)
A1.1	1	407835.5824	700800.3195	709.5426	0.00038	0	407835.5877	700800.3256	709.5306	0.01446	0	407835.6680	700800.1947	709.22722	0.34980
A1.2	1	407800.7038	700700.0944	709.1603	0.00004	0	407800.7121	700700.0866	709.1566	0.01196	0	407800.8711	700700.0363	709.11202	0.18362
A1.3	1	407762.0689	700585.3424	709.5344	0.00012	0	407762.0719	700585.3392	709.5128	0.02203	0	407762.3222	700585.3828	709.75955	0.34133
A2.1	1	407852.0146	700754.3098	689.5235	0.00040	0	407852.0141	700754.3284	689.5141	0.02088	0	407852.0357	700754.2201	689.24521	0.29316
A2.2	1	407820.9373	700662.6191	688.8849	0.00008	0	407820.9472	700662.6231	688.8974	0.01647	0	407821.0391	700662.5884	688.86288	0.10862
A2.3	1	407797.1617	700587.5438	689.2391	0.00019	0	407797.1756	700587.5529	689.2340	0.01736	0	407797.3261	700587.5805	689.38518	0.22297
A3.1	1	407861.9831	700690.2758	669.7538	0.00044	1	407861.9831	700690.2758	669.7538	0.00002	0	407861.9600	700690.2078	669.56505	0.20196
A3.2	1	407845.5292	700633.8039	669.5613	0.00023	0	407845.5334	700633.8101	669.5535	0.01083	0	407845.5529	700633.7861	669.50157	0.06671
A3.3	1	407828.2328	700580.8113	669.5138	0.00033	0	407828.2411	700580.8219	669.5067	0.01522	0	407828.3016	700580.8412	669.58773	0.10530
B1.1	1	407747.0423	700795.9005	709.0227	0.00021	0	407747.1104	700795.8934	709.0309	0.06900	0	407747.2771	700795.7259	709.01695	0.29271
B2.1	1	407730.5193	700801.6410	696.3840	0.00003	1	407730.5193	700801.6410	696.3840	0.00002	0	407730.7112	700801.4513	696.40714	0.27086
B3.1	1	407697.9192	700655.2600	707.4833	0.00115	0	407697.9850	700655.3053	707.4623	0.08259	0	407698.2589	700655.2491	707.81289	0.47344
B3.2	1	407682.0186	700660.5465	695.2808	0.00437	0	407682.0646	700660.5392	695.3731	0.10342	0	407682.3130	700660.453	695.77866	0.58591
T1	1	407816.4317	700813.5659	714.0243	0.00025	0	407816.4218	700813.5528	714.0189	0.01726	0	407816.5290	700813.407	713.75295	0.32915
T2	1	407772.4639	700820.5494	713.3935	0.00087	0	407772.4700	700820.5220	713.3973	0.02837	0	407772.6147	700820.3485	713.26197	0.28357
Т3	1	407769.5019	700672.6345	714.2406	0.00024	0	407769.5037	700672.6252	714.2023	0.03947	1	407769.5026	700672.6343	714.24068	0.00075
T4	1	407716.9377	700682.9901	713.0477	0.00180	0	407716.9857	700682.9594	713.0742	0.06280	0	407717.2463	700682.8933	713.31812	0.42162
T5	1	407735.2763	700577.9759	714.3583	0.00040	0	407735.2722	700577.9657	714.3278	0.03243	0	407735.5673	700578.0114	714.66622	0.42514
T6	1	407693.2156	700584.8486	714.1824	0.00093	1	407693.2156	700584.8486	714.1824	0.00002	0	407693.5490	700584.8668	714.64438	0.57003
A4	1	407856.2584	700578.7997	649.9453	0.00017	0	407856.2505	700578.8051	649.9220	0.02521	1	407856.2581	700578.8	649.94544	0.00045
B3.3	1	407657.4817	700668.9656	676.6132	0.00227	0	407657.3862	700669.1679	676.5356	0.23682	0	407657.5945	700669.0344	677.02551	0.43297
B3.4	1	407633.3213	700675.4025	660.8948	0.00429	0	407633.0897	700675.5258	660.2763	0.67188	1	407633.3209	700675.4024	660.89457	0.00044
То	tal error	0.000465	0.000561	0.001317	0.001506	3GCP	0.000015	0.000011	0.000006	0.00002	3GCP	0.000509	0.00019	0.000159	0.000566
M. Erro	or other GCP						0.0636	0.056698	0.145519	0.168628		0.201744	0.10089	0.261149	0.345077

Table 6. Comparison between activated points and obtained errors - 3GCP - Total Station

					Comparis	on between	active points	and obtaine	d errors - To	tal Station					
		All Ground C	ontrol Points	activated			Active G	CP: A3.1, T6,	B2.1			Active (	GCP: A3.2, T3,	B2.2	
#Label	Active GCP	X/Easting	Y/Northing	Z/Altitude	Error_(m)	Active GCP	X/Easting	Y/Northing	Z/Altitude	Error_(m)	Active GCP	X/Easting	Y/Northing	Z/Altitude	Error_(m)
A1.1	1	407835.5963	700800.3390	709.5453	0.00026	0	407835.6287	700800.2878	709.5715	0.06606	0	407835.5129	700800.3533	709.3364	0.22540
A1.2	1	407800.7040	700700.0867	709.1740	0.00002	0	407800.7245	700700.0607	709.1864	0.03537	0	407800.7146	700700.0839	709.1549	0.02204
A1.3	1	407762.0740	700585.3280	709.5260	0.00010	0	407762.0764	700585.3378	709.5151	0.01479	0	407762.1890	700585.3149	709.7147	0.22137
A2.1	1	407852.0303	700754.3263	689.5180	0.00026	0	407852.0465	700754.2897	689.5345	0.04327	0	407851.9486	700754.3415	689.3396	0.19684
A2.2	1	407820.9537	700662.6040	688.9087	0.00010	0	407820.9561	700662.5962	688.9239	0.01726	0	407820.9547	700662.6097	688.9139	0.00777
A2.3	1	407797.1627	700587.5337	689.2683	0.00020	0	407797.1607	700587.5409	689.2607	0.01066	0	407797.2397	700587.5261	689.3994	0.15226
A3.1	1	407861.9973	700690.2810	669.7707	0.00021	1	407861.9972	700690.2809	669.7707	0.00011	0	407861.9380	700690.2901	669.6634	0.12291
A3.2	1	407845.5327	700633.7930	669.5670	0.00010	0	407845.5263	700633.7876	669.5679	0.00838	1	407845.5326	700633.7931	669.5669	0.00012
A3.3	1	407828.2360	700580.7940	669.5240	0.00021	0	407828.2244	700580.8028	669.5176	0.01587	0	407828.2802	700580.7921	669.6152	0.10134
B1.1	1	407747.0587	700795.9523	709.0203	0.00037	0	407747.1215	700795.9413	709.1016	0.10331	0	407747.0058	700795.9108	709.0159	0.06737
B2.1	1	407730.5360	700801.6890	696.3610	0.00028	1	407730.5360	700801.6891	696.3610	0.00010	0	407730.4090	700801.6442	696.2848	0.15477
B2.2	1	407689.6647	700727.0257	685.4760	0.00322	0	407689.7537	700727.1575	685.3613	0.19613	1	407689.6647	700727.0257	685.4759	0.00012
B3.1	1	407697.9190	700655.2950	707.4807	0.00079	0	407697.9584	700655.3426	707.4925	0.06289	0	407697.9895	700655.2508	707.6928	0.22781
B3.2	1	407682.0083	700660.5817	695.2600	0.00042	0	407682.0255	700660.5943	695.2703	0.02370	0	407682.0306	700660.4676	695.4881	0.25602
T1	1	407816.4287	700813.5847	714.0220	0.00019	0	407816.4570	700813.5371	714.0461	0.06042	0	407816.3333	700813.5892	713.8227	0.22099
T2	1	407772.4753	700820.5697	713.3817	0.00094	0	407772.5258	700820.5201	713.4235	0.08225	0	407772.3917	700820.5243	713.2608	0.15386
Т3	1	407769.5133	700672.6253	714.2400	0.00021	0	407769.5133	700672.6147	714.2155	0.02673	1	407769.5134	700672.6252	714.2402	0.00022
T4	1	407716.9365	700682.9795	713.0500	0.00269	0	407717.0008	700682.9664	713.1437	0.11443	0	407717.0121	700682.9046	713.2729	0.24699
T5	1	407735.2813	700577.9577	714.3630	0.00040	0	407735.2722	700577.9627	714.3321	0.03263	0	407735.3995	700577.9178	714.5859	0.25546
Т6	1	407693.2007	700584.8460	714.1880	0.00077	1	407693.2008	700584.8460	714.1880	0.00009	0	407693.3253	700584.7509	714.4966	0.34610
To	tal error	0.0003	0.00058	0.00078	0.00102	3GCP	0.000062	0.000073	0.000018	0.000098	3GCP	0.000048	0.000054	0.000143	0.00016
M. Erro	or other GCP						0.03695	0.041955	0.044886	0.071695		0.081921	0.047176	0.171537	0.195861

Following the analysis of group 2 with the 4 ground control points, the following can be shown:

According to the tables Tab.7 and Tab.8 it can be shown that those points - A33, T1, T6, B32 - which form a rhombic geometric shape, have a better accuracy and a much smaller influence on the other ground control points. This can be seen in both classic apparatus used. The errors resulting from the measurements with the two types of devices on the other points are again higher than those measured in the field with two dual frequency GPS receivers used in base & rover mode compared to those measured with the robotic total station.

However, there is a difference in the case of the Southern point group - A33, T5, T6, B32 - and the Nordic point group - A31, T1, T2, B21 -, namely in the case of control points measured with the dual frequency GPS station the errors obtained by the group of southern points on the other deactivated points is higher than in the case of the group of northern points, S = 0.261174m, N = 0.172799m S> N.

							manna .	100 1001	100 1000	T L L L L L L L L L L L L L L L L L L L		Sanda id ann	men er o		5					
								Comparatie	intre puncte	de activate	sierorile p	ropagate - GPS								
		Toste punctele.	de control la s	vol activate			GCP activ	at a33, 11, 16,	b32			GCP actin	vat: a33, t5, t6, 1	132			GCP activ	at: a31, t1, t2, È	21	
#Label	GCP activation	X/Easting	Y/Northing	Z/Altitude	Error_(m)	GCP activat	X/Easting 1	//worthing 2	c/Altitude Er	rror_(m) 6	3CP activat	X/Easting	Y/Northing	Z/Altitude E	mor_(m) (	3CP activat	X/Easting	V/Northing 2	(Altitude E	rror_(m)
A1.1		1 407835.5824	700800.3195	709.5426	0.00038	0	407835.5780	700800.3787	709.4958	0.07556	0	07835.5349	700800.4138	709.2880	0.27563	o	407835.5927	700800.3418	709.5261	0.029652
A1.2		1 407800.7038	700700.0944	709.1603	0.00004	0	4078.00.7039	700700.1170	709.1422	0.02898	0	407800.6827	700700.1443	709.0342	0.13721	0	407800.7091	700700.0882	709.1683	0.011377
A1.3		1 407762.0689	700585.3424	709.5344	0.00012	0	407762.0651	700585.3440	709.5225	0.01263	0	407762.0693	700585.3632	709.5283	0.02172	0	407762.0597	700585.3241	709.5430	0.022199
A2.1		1 407852-0146	700754.3098	689.5235	0.00040	0	407852.0224	700754.3658	689.5026	0.06030	0	407851.9811	700754.3876	689.3271	0.21385	0	407852.0194	700754.3342	689.5122	0.027305
A2.2		1 407820.9373	700662.6191	688.8849	0.00008	0	407820.9571	700662.6397	688.9050	0.03493	0	407820.9358	700662.6542	688.8205	0.07336	0	407820.9452	700662.6154	688.9102	0.026806
A2.3		1 407797.1617	700587.5438	689.2391	0.00019	o	407797.1867	700587.5529	689.2582	0.03276	0	407797.1820	700587.5626	689.2476	0.02895	a	407797.1679	700587.5342	689.2589	0.022851
A3.1		1 407861.9831	700690.2758	669.7538	0.00044	0	407862.0080	700690.2965	669.7680	0.03536	0	407861.9726	700690.3037	669.6430	0.11479	F	407861.9831	700690.2758	669.7538	0.000038
A3.2		1 407845.5202	700633.8039	669.5613	0.00023	0	407845.5612	700633.8154	669.5822	0.03990	0	407845.5381	700633.8189	669.5121	0.05222	0	407845.5334	700633.7945	669.5662	0.011407
A3.3		1 407828.2328	700580.8113	669.5138	0.00033	Ŧ	407828.2329	700580.8111	669.5140	0.00031	1	407828.2330	700580.8112	669.5138	0.00022	0	407828.2370	700580.7985	669.5279	0.019453
81.1		1 407747.0423	700795.9005	709.0227	0.00021	0	407747.0840	700795.9382	708.9489	0.09276	0	407747.0417	700795.9535	708.7818	0.24671	0	407747.1017	700795.9113	709.0316	0.060984
B2.1		1 407730.5193	700801.6410	696.3840	0.00003	0	407730.5483	700801.6901	606.2686	0.12874	0	407730.4995	700801.6909	696.1034	0.28570	T	407730.5193	700801.6411	696.3840	0.000106
B3.1		1 407697.9192	700655.2600	707,4833	0.00115	0	407697.9611	700655.3179	707.4085	0.10347	0	1646769704	700655.3212	707.3814	0.12254	0	407697.9647	700655.3025	707,4854	0.062270
B3.2		1 407682.0186	700660.5465	8082.269	0.00437	1	407682.0193	700660.5465	605.2818	0.00123	1	407682.0187	700660.5462	605.2809	0.00030	0	407682.0413	700660.5360	605.2045	0.116433
11		1 407816.4317	700813.5659	714.0243	0.00025	T	407816.4315	700813.5661	714.0240	0.00043	0	407816.3606	700813.6434	713.7581	0.28621	Ŧ	407816.4316	700813.5659	714.0242	0.000087
12		1 407772.4629	700820.5494	713.3935	0.00087	0	407772,4442	700820.5754	713.3204	0.08005	0	407772.3583	700820.5999	713.1217	0.28415	1	407772.4639	700820.5493	713.2936	0.000146
13		1 407769-5019	700672.6345	714.2406	0.00024	0	4077 69,4887	700672.6497	714.1824	0.06156	0	407769.4757	700672.6744	714.1108	0.13826	0	407769.4953	700672.6241	714.2203	0.023780
T4		1 407716-9377	700682.9901	713.0477	0.00180	0	407716.9602	700682.9812	713.0210	0.03600	0	407716.9444	700682.9934	712.9625	0.08552	o	407716.9693	700682.9612	713.0932	0.062544
12		1 407735.2763	700577.9759	714.3583	0.00040	0	407735.2580	700577.9688	714.3265	0.03733	1	407735.2762	700577-9763	714.3582	0.00040	0	407735.2559	700577.9509	714.3612	0.032406
16		1 407693.2156	700584.8486	714.1824	0.00093	1	407693.2150	700584.8486	714.1815	0.00110	1	407693.2154	700584.8486	714.1825	0.00025	a	407693.1941	700584.8345	714.2163	0.042526
44		1 407856.2584	700578.7997	649.9453	0.00017	0	407856.2956	700578.7927	649.9745	0.04784	0	407856.2765	700578.7819	649.9467	0.02544	o	407856.2497	700578.7779	649.9390	0.024358
B3.3		1 407657.4817	700668.9656	676,6132	0.00227	0	407657.3702	700669.1677	676.4478	0.28395	0	407657.3423	700669.1357	676.4250	0.28886	0	407657.3583	700669.1639	676.5541	0.240925
B3.4		1 407633.3213	700675.4025	660.8948	0.00429	o	407633.0775	700675.5185	660.1694	0.77403	0	407633.0415	700675.4673	660.1522	0.79624	a	407633.0575	700675.5211	660.2926	0.668093
To	sal error	0.000465	0.000561	0.001317	0.0015.06	4GCP	0.0005	0.00014	0.000695	0.000867	4 GCP	0.000175	0.000229	0.000084	0.0003	4 GCP	0.000038	0.000083	0.000045	0.000102
M. Em	or other GCI						0.067396	0.062712	0.18162	0.2 03619		0.07954	0.063729	0.240466	0.261174		0.072008	0.057495	0.146181	0.172799

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Table 8. Comparison between activated points and propagated errors - 4GCP - ST

								Comparatie i	intre punde	le activate	și erorile pro	opagate - ST								
	-	Toate punctel	e de control la	sol activate			GCP adiv	rat: a33, t1, t6,	b32			GCP activ	at: a 33, t5, t6,	b32			GCP activ	at: a31, t1, t2,	b21	
#Label	I GCP activat	t X/Easting	Y/Northing	z/Altitude	Error_(m)	GCP activat	X/Easting	Y/Northing	Z/Altitude	Error_(m) (	GCP activat	X/Easting	Y/Northing	Z/Altitude E	Stror_(m) G	CP add vat	X/Easting	Y/Northing	C/Altitude	Error_(m)
AL.1		1 407835.5963	3 700800.3390	709.5453	0.00026	0	407835.6118	700800.3245	709.5519	0.022227	0	407835.6172	700800.3117	709.5271	0.038898	0	407835.6022	700800.3485	709.5144	0.03 2859
A1.2		1 407800.7040	700700.0867	709.1740	0.00002	D	407800.7179	700700-0792	709.1805	0.017086	0	407800.7189	700700.0716	709.1671	0.022279	0	407800.7304	700700.0838	709.2159	0.049601
A1.3		1 407762.0740	0 700585.3280	709.52.60	0.00010	D	407762.0817	700585.3358	709.5253	0.010950	0	407762.0775	700585.3341	709.52.48	0.007134	0	407762.1202	700585.3187	709.6432	0.126305
A2.1		1 407852.0303	3 700754.3263	689-5180	0.00026	D	407852.0407	700754.3194	689.5222	0.013191	D	407852.0413	700754.3056	689.5004	0.029346	0	407852.0315	700754.3330	689,4947	0.024256
A2.2		1 407820.9537	7 700662.6040	688.9087	0.00010	D	40782 0.9598	700662.6093	688.9243	0.017550	D	407820.9563	700662.6001	688.9128	0.006258	D	407820.9708	700662.6051	688.9628	0.056766
A2.3	-	407797.1627	7 700587.5337	689-2683	0.00020	0	407797.1724	700587.5408	689.2717	0.012502	0	407797.1655	700587.5354	689-2686	0.003260	0	407797.2006	700587.5230	689.3633	0.102840
A3.1		1 407861.997	3 700690.2810	669.7707	0.00021	D	407862.0055	700690.2788	669.7788	0.011718	D	407862.0005	700690.2648	669.76.20	0.018608	1	407861.9974	700690-2810	669.7707	0.000078
A3.2		1 407845.5327	7 700633.7930	669.5670	0.00010	D	407845.5397	700633.7972	669.5736	0.010489	0	407845.5320	700633.7860	069-5630	0.008100	0	407845.5478	700633.7868	669-6083	0.044405
A3.3		1 407828-2360	7 00580.7940	669.5240	0.00021	1	407828.2360	700580.7942	669.5240	0.000238	1	407828.2359	700580.7940	669.5241	0.000119	D	407828.2635	700580.7826	669.6031	0.084515
B1.1		1 407747.0587	7 700795.9523	709.0203	0.00037	D	407747.0938	700795-9643	709.07.28	0.064322	D	407747.1018	700795.9566	709.0562	0.056296	0	407747.0760	700795.9648	709.0958	0.07.8489
B2.1	-1	1 407730.5360	0 700801.6890	696.3610	0.00028	D	407730.5229	700801.7300	696.3195	0.059843	D	407730.5307	700801.7220	696.3042	0.065911	1	407730.5359	700801.6892	696.3609	0.000219
B2.2	-	1 407689.6647	7 700727.0257	685.4760	0.00322	0	407689.7313	700727.1590	685.3353	0.204957	0	407689.7353	700727.1547	685.3301	0.207131	0	407689.7098	700727.1258	685.42.79	0.119849
B3.1	-	1 407697.9190	7 00655.2950	707.4807	0.00079	0	407697.9452	700655.3398	707.48.29	0.052004	0	407697.9469	700655.3393	707.48.23	0.052361	0	407697.9577	700655.3124	707.6081	0.134305
B3.2		1 407682.0083	3 700660.5817	695.2600	0.00042	1	407682.0084	700660.5819	695.2599	0.000231	1	407682.0084	700660.5819	695.2569	0.000213	0	407682.0123	700660.5506	695.3883	0.132090
IT.	-1	1 407816.4287	7 700813.5847	714.02.20	0.00019	1	407816.4288	700813.5846	714.02.20	0.000111	0	407816.4423	700813.5617	713.9983	0.035737	1	407816.4287	700813.5847	714.0218	0.000201
17	-	1 407772.4753	3 700820.5697	713.3817	0.00094	0	407772,4973	700820.5507	713.3938	0.03 1473	0	407772.5063	700820.5412	713.3727	0.043042	1	407772.4754	700820.5695	713.3819	0.000326
E		407769.5133	3 700672.6253	714.2400	0.00021	0	407769.5061	700672.6259	714.2117	0.029229	0	407769.5070	700672.6213	714.2031	0.037630	0	407769.5259	700672.6221	714.2818	0.043730
47		1 407716.9365	5 700682.9795	713.0500	0.00269	D	407716.9854	700682.9710	713.1321	0.095983	0	407716.9885	700682.9689	713.1274	0.093828	0	407716.9964	700682.9541	713.2316	0.192901
۲	-1	1 407735-2813	7 00577.9577	714.3630	0.00040	D	407735.2746	700577.9566	714.3411	0.02 2877	-	407735.2814	700577.9579	714.3627	0.000320	D	407735.3154	700577.9343	714,4809	0.124949
Т6	4	407693_2007	7 700584.8460	714.1880	0.00077	1	407693.2006	700584.8457	714.1881	0.000376	1	407693.2006	700584.8457	714.1883	0.000432	0	407693.2380	700584.7970	714.3521	0.175250
Ţ	otal error	0.0003	3 0.00058	0.00078	0.00102	4GCP	0.000074	0.000229	0.000089	0.000257	4GCP	0.00009	0.000201	0.000197	0.000295	4GCP	0.000066	0.000141	0.000162	0.000224
M. En	ror other GCP						0.025435	0.037508	0.045375	0.06413		0.027791	0.037873	0.046492	0.066092		0.031348	0.031182	0.097843	0.10737

In the case of ground control points measured with the total robotic station, the situation is exactly the opposite of what we mentioned before, namely in this case the errors obtained on the other deactivated points is lower in the case of the Southern points compared to the Nordic ones. S = 0.066092m, N = 0.10737m S<N.

The more control points we select, the lower the error, but there will always be a difference between the accuracies obtained with the two devices, and we will always have a much smaller error than those measured with the total robotic station.

#### 4. Conclusions

According to the investigations, it turned out that the measurements with the drone have a fairly good accuracy if we only want information on an objective. If we want to make a precision measurement, we must choose the "auxiliary" equipment, which will be the basis of the measurements made with the drone. We need to know well the terrain where we want to make these measurements, to be able to assess the risks and potential sudden weather changes to which we need to adapt in a relatively short time, and to reduce the influence on the quality of the work proposed to be performed.

The ground control points as we saw in the discussed and detailed in this publication, it was observed that the ground control points have a variable influence on the point clouds that we generate, due to their position in key points, to obtain a shape as real and as precise as possible in the work area.

According to the tables in Tab.7 and Tab.8 we found that if the ground control points are located only on one side of the hydrotechnical work, they have a domino effect on the other points, namely the greater the distance from the obtained errors increase. If in preparation for the measurements, the location of the ground control points are made in a geometric rhombus shape, covering to some extent the highest and lowest points of the construction to be measured, then the obtained errors will be within tolerable and acceptable limits, being only 0.06m in the case of using the robotic total station for measuring the ground control points.

The errors of inactive ground control points increase exponentially the farther they are from the active ground control points, so we must consider the correct positioning of the markings in the field.

It can also be concluded that for any hydrotechnical work for which we want to make a precision model based on measurements made with drones, we must place a minimum of 4 points in the higher parts and a minimum of 4 points in the lower parts. We specify that it is not about the extremities as an extension of the hydrotechnical work, because according to the detailed studies through tables during the work, we can see that in some cases the points were not located on the extremities and still had obtained a better total error value on inactive ground control points witch was lower than in other cases.

This working model can be used both in dams, tailings ponds, stone or aggregate quarries and in civil engineering, for example in roads studies.

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