

# Evaluation of the parcels positions according to IPRO's cadastral maps and Orthophotos through field survey with Total Station and GNSS receiver

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**Abstract**— Cadastral maps are essential for performing assessment functions such as enabling to locate the site and provide information about it. It also assists users of local government, public works departments and private businesses in terms of planning. Based on the mapping technologies until 1993, the theoretical accuracy of the so-called cadastral maps of scale 1:2500 has been predicted to correspond to the accuracy of the scale of 1:5000. After 1993, for the initial registration of assets for rural areas, the originals of these maps, that were magnified manually, were used to update in the field the property boundaries. From 1996 to 1999 the basic maps of the cities and rural important centers were produced through the analytical photogrammetry. The usage of the Orthophotos as a basic map for updates of the properties boundaries have been very limited. The purpose of the study is to compare the positions and identify the changes in the horizontal positions of parcels presented in the cadastral maps issued by Immovable Property Registration Office and the Orthophoto of 2007/ 2015 with the respective positions measured with Total Station or GNSS receiver in the locations of Orikum-Vlorë, Rilë-Lezhë and Cërrik-Elbasan as well as to give recommendations regarding the cadastral data (subdivision, merger or fixing of the parcels boundaries..

**Keywords** — Property boundaries, IPRO, Coordinates, Accuracy, Total Station, GNSS receiver.

## Acronyms:

IPRO - Immovable Property Registration Office.

GNSS - Global Navigation Satellite System.

ALBPOS – Albania Positioning System.

ALUIZNI - Agency for Legalization, Urbanization and Integration of Informal Areas and Buildings.

## 1. INTRODUCTION

The scope of the study is the comparison of the positions and the identification of changes in the horizontal position of the parcels vertexes represented in the cadastral maps according to IPRO and the Orthophoto of the year 2007/2015

with the positions obtained by field surveys with Total Station and GNSS receivers in various locations in Albania (Table 1).

TABLE 1: SURVEY LOCATION POINTS

Location Name/District Name	Number of Survey Points
Orikum- Vlora District	63
Rilë- Lezha District	46
Cërrik- Elbasan District	53

Coordinates of the properties boundaries represented in the cadastral maps issued by ZRPP are based on the Albanian reference system ALB-1986 (Krassowsky ellipsoid, central meridian 21°, distortion coefficient  $k_0 = 1$ , TM or "Gauss-Krüger" projection) [1]. The theoretical accuracy  $M$  of the position of a point throughout topographical surveys is predicted to be  $M = 0.2 \text{ mm} \cdot \text{map scale}$ . In terms of accuracy, the cadastral maps of scale 1:2500 are expected to have a theoretical accuracy coinciding the maps of scale 1:5000. Therefore, the absolute theoretical accuracy of surveys cannot be better than  $0.2 \text{ mm} \cdot 5000 = \pm 1 \text{ m}$ .

Regarding the maps of the Albanian urban areas, that are represented at scale of 1:500, the theoretical accuracy in the horizontal position at survey points designated (considering the technological limitations of the time) had been  $\pm 20 \text{ cm}$ , if we refer to the local networks build in every city and major rural centers of Albania. As for the accuracy, these maps coincide with the theoretical accuracy of the 1:1000 scale. The accuracy of the polygonal support network of these local networks was  $\pm 2 \text{ cm}$ .

The cadastral maps dating before the year 1990 were prepared by applying methodologies or technologies limited by the capabilities of the time period in Albania. After the

year 1993, for the property registration in the rural areas the following methods were used:

- on the existing magnified original maps, the boundaries of the field properties have been updated.
- as the maps (prepared in transparent paper, located at the archives of the former Land-use Institute and local archives) are magnified from scale 1:5000 to 1:2500 the properties boundaries have been updated in the local system of the 1:5000 maps.
- in the cadastral zones where there were no maps of scale 1:5000, the topographical surveys were performed based on

the State Triangulation Network (on reference ALB-1986) by using of either tachometric or total station surveys.

In the time between years 1995-1999, the base maps prepared by the analytical photogrammetric methods, where the

positional errors were  $\pm 70$  cm, covered a considerable part of the Albanian territory.

The utilization of the ortophotos as a base map for boundary updates has been very limited. During the years 2007 and 2015 based on the aerial photographs has been produced an "Ortophoto" at three levels of accuracy or categories: LOT-1 covering urban areas, LOT-2 covering all the western lowland and major road corridors and LOT-3 covering all the highland areas, respectively with resolutions 8 cm, 20 cm and 40 cm (Figure 1), (Table 2) [2].

The original ortophoto was produced in ITRF2007.2 reference and transformed into local reference ALB-1986 via 4P Helmert transformation.

TABLE 2: AREAS COVERED BY ORTOPHOTO

LOT	Category	Surface (km <sup>2</sup> )	Resolution (cm)
1	Urban Area	1 143	8
2	Lowlands and Corridors	12 762	20
3	Highland area	15 610	35

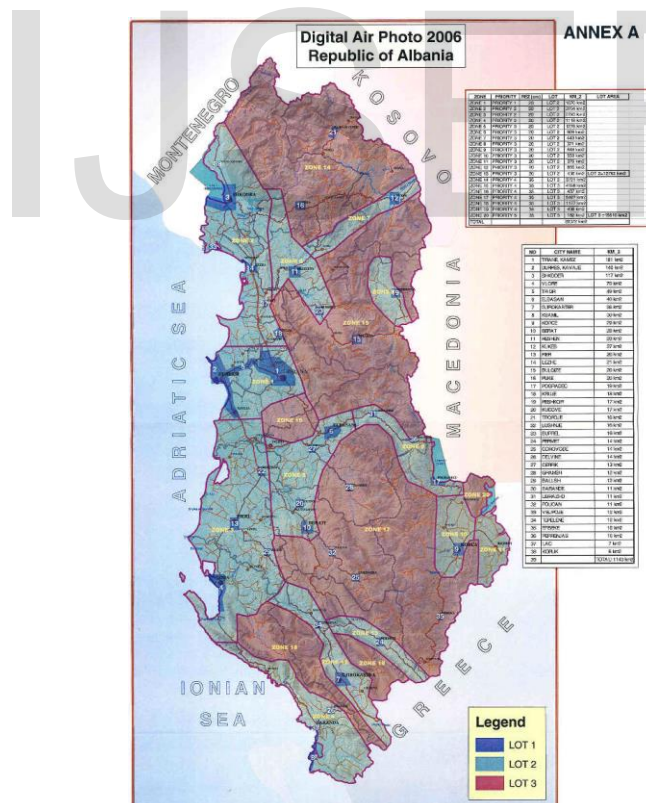


Fig. 1: Ortophoto 2007 divided into LOT-1, LOT-2, LOT-3 [4]

The accuracy of the Ortophoto is directly related with the relief type, e.g. in flat areas the ortophoto accuracy is higher compared with a sloping terrain, where the accuracy is very low. Considering the mountainous composition of the Albania's terrain, at a great part of the territory the ortophoto

is of a low resolution, where the plain error reaches up to 0.5 m. In Table 3 are given the final technical report data regarding the accuracy of the ortophoto based on the aerial photography performed for the territory of the Albanian Republic [2].

TABLE 3: ORTOPHOTO ACCURACY

LOT	Accuracy (m)	Flight Altitude (m)
1	0.15	1:1000
2	0.35	1:2000
3	0.75	1:5000

Based on the Ortophoto of the year 2007/2015, as well as the software packages, the vectorial maps were produced for a part of the Lot-1 for an area of approximately 700 km<sup>2</sup> composed of the following layers: road network,

hydrography, buildings and surrounding walls. The accuracy of the vectorial maps based on ALB-1986 reference is represented at Table 4.

TABLE 4: ACCURACY OF THE VECTORIAL MAPS

LOT	Accuracy (m)	Scale
1	0.10	1:500
2	0.20	1:1000
3	0.35	1:2000

Field measurements of selected parcels in the cadastral maps and ortophotos of year 2007/2015 were performed with total station Sokkia CX-103 or Trimble M3, as well as Trimble R8 GNSS receiver in the locations of Oriku-m-Vlorë, Rilë-Lezhë

and Cërrik-Elbasan. The accuracies of measured points or parcel corners has been  $\pm 3 \div 5$  cm based on the ALB-1986 reference.

## 2. MATERIALS AND METHODS

### 2.1 Field Survey with Total Station

In the framework of this study, based on the coordinates of the State Triangulation Network points on reference ALB-

1986 (e.g. Table 5), field works have been carried out for the surveying of the selected identical parcels represented in cadastral maps and ortophoto using the Sokkia Total Station CX-103 or Trimble M3 in the areas of Oriku-m-Vlorë, Rilë-Lezhë and Cërrik-Elbasan.

TABLE 5: COORDINATES OF STATE TRIANGULATION NETWORK POINTS OF ORIKUM, VLORA

Point	Point Name	Order	E(Y) TM	N(X) TM	Z(H) NMD
12334	Sazani (Veriu)	II	487125.17	4353506.71	344.5
12335	k. Dheut të Kuq	III	486442.12	4372387.9	163.134
12336	Sazani(Jugu)	II	485036.65	4354498.62	305.93
.....	.....	.....	.....	.....	.....

After field surveys and the respective processing have been completed, based on the (N, E) coordinates (Table 6), a

layout of land parcels (e.g. Fig. 2) was prepared by the software "Autodesk AutoCAD® Civil 3D 2013".

TABLE 6: COORDINATES OF THE MEASURED POINTS BY TOTAL STATION (KRASSOWSKY, TM,  $K_0 = 1.0$ ,  $\Lambda_0 = 21^\circ$ )

Location	Orikum, Vlora		Rilë, Lezha		Cërrik, Elbasan	
Point	N(x) TM	E(y) TM	N(x) TM	E(y) TM	N(x) TM	E(y) TM
1	4464174.483	369779.441	4618813.38	385157.74	4541616.048	415960.340
2	4464382.420	369994.663	4618830.86	385206.91	4541646.877	415944.654
3	4464529.272	369852.466	4618858.93	385286.27	4541657.924	415938.670
4	4464483.817	369806.294	4618888.76	385368.07	4541667.148	415933.306
5	4464413.088	369735.433	4618902.00	385403.92	4541692.178	415918.732
6	4464314.163	369633.995	4618918.77	385452.01	4541718.050	415902.844
7	4464481.562	369443.593	4618939.08	385513.26	4541738.116	415891.307

8	4464502.011	369468.552	4618962.34	385576.58	4541763.558	415876.128
9	4464630.920	369318.191	4618706.11	385636.13	4541772.291	415870.874
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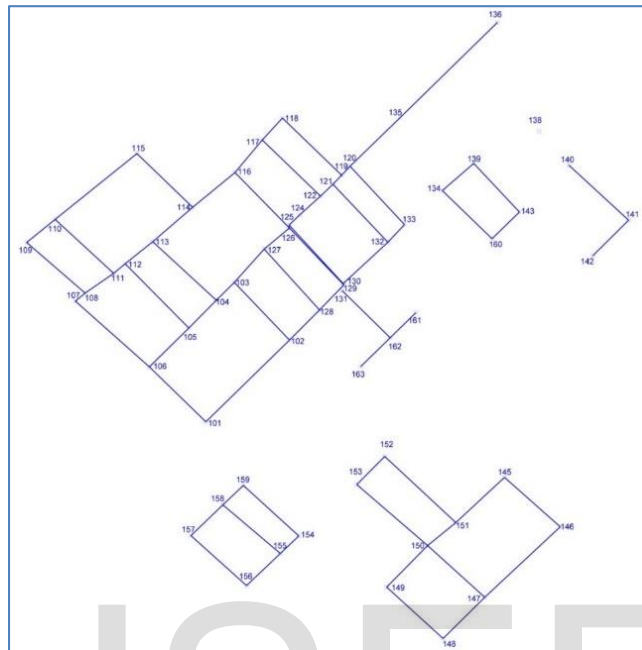


Fig. 2: The layout of the measured parcels located of Orikum, Vlorë

## 2.2 Field survey with GNSS receiver

The GNSS observations were collected by using of Trimble R8 receiver (Fig. 3) with data collection every 5 seconds based on the ALBPOS. After processing of the GNSS observations by TBC (Trimble Business Center) office software (Trimble Inc. PN 022543-256Q) are obtained the parcel vertexes coordinates (N, E) on the Albanian modern reference (ETRS89, GRS80, UTM,  $k_0 = 0.9996$ ,  $\lambda_0 = 21^\circ$ ), (Table 7).



Fig. 3: GNSS Trimble R8 receiver (left) and Trimble TSC2 Controller (right) [3]

TABLE 7: COORDINATES OF THE MEASURED POINTS BY GNSS RECEIVER (ETRS89, GRS80, UTM, 0.9996)

Location	Orikum, Vlora		Rilë, Lezha		Cërrik, Elbasan	
Point	N(x) UTM	E(y) UTM	N(x) UTM	E(y) UTM	N(x) UTM	E(y) UTM
1	4462259.968	368067.252	4616834.417	385073.163	4539668.627	415863.306
2	4462467.785	368282.685	4616851.898	385122.426	4539699.447	415847.643
3	4462614.529	368140.544	4616879.947	385201.714	4539710.487	415841.621
4	4462569.099	368094.358	4616909.791	385283.521	4539719.724	415836.294
5	4462498.434	368023.500	4616923.016	385319.251	4539744.735	415821.619
6	4462399.380	367922.395	4616939.779	385367.463	4539770.600	415805.882
7	4462566.684	367731.882	4616960.065	385428.729	4539790.644	415794.392



8	4462587.172	367756.611	4616983.343	385492.099	4539816.100	415779.294
9	4462716.143	367606.364	4616727.202	385551.502	4539824.819	415773.924
.....	.....	.....	.....	.....	.....	.....

## 2.3 Extracting the coordinates of the points from the Ortophoto or vectorial maps

Because the vectorial maps based on the aerial photography of year 2007 for Orikum, Vlora location was not yet

produced by the former ALUIZNI government agency, the coordinates (N,E)TM (Table 8) of the points (parcel vertexes) were extracted from the digital Ortophoto (e.g. Fig. 4), while for the area of Rilë, Lezha and Cërrik, Elbasan the coordinates are extracted from the respective vectorial maps.

TABLE 8: COORDINATES OF POINTS EXTRACTED FROM ORTOPHOTO OR VECTOR MAPS (TM PROJECTION)

Location	Orikum, Vlora		Rilë, Lezha		Cërrik, Elbasan	
Point	N(x)TM	E(y)TM	N(x)TM	E(y)TM	N(x)TM	E(y)TM
1	4464178.28	369781.44	4618813.29	385157.27	4541616.51	415961.99
2	4464385.27	369993.34	4618832.57	385207.42	4541647.95	415944.97
3	4464530.82	369851.17	4618863.11	385294.09	4541658.81	415939.46
4	4464485.52	369805.36	4618891.69	385374.75	4541669.24	415931.90
5	4464415.74	369734.79	4618902.51	385405.03	4541693.44	415919.09
6	4464312.24	369630.11	4618911.10	385429.08	4541719.25	415903.14
7	4464478.93	369441.81	4618926.94	385473.25	4541738.72	415892.07
8	4464500.66	369469.20	4618952.68	385544.90	4541764.98	415876.13
9	4464632.68	369318.26	4618691.43	385607.31	4541774.26	415870.36
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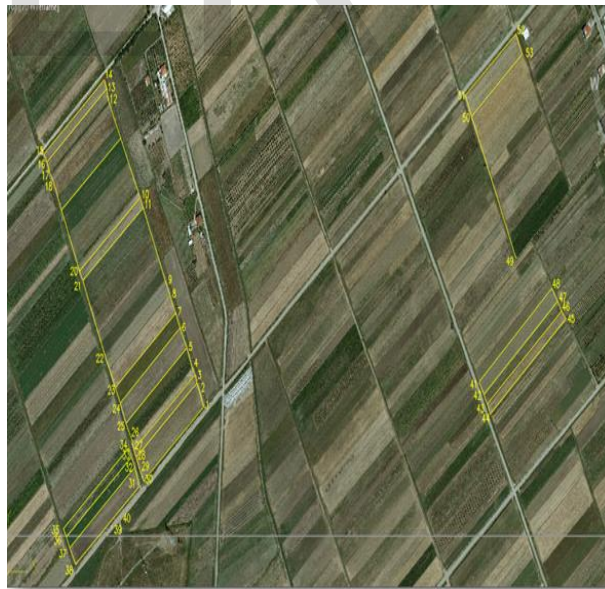


Fig. 4: The layout of parcels measured in the Ortophoto of Orikum, Vlora area (left) and of Cërrik, Elbasan area (right)

## 2.4 Extracting the coordinates of the points from the digital cadastral maps

Because the digital cadastral maps of Orikum-Vlorë, Rilë-Lezhë and Cërrik-Elbasan locations were produced by the

former IPRO, coordinates (N,E)TM (Table 9) of the points (parcel vertexes) from the relevant selected parcels in the Ortophoto were extracted.

TABLE 9: COORDINATES OF POINTS EXTRACTED FROM THE DIGITAL CADASTRAL MAP (TM PROJECTION)

Location	Orikum, Vlora		Rilë, Lezha		Cërrik, Elbasan	
Point	N(x)TM	E(y)TM	N(x)TM	E(y)TM	N(x)TM	E(y)TM
1	4464047.96	369605.92	4618808.63	385154.78	4541624.58	415983.52
2	4464263.02	369839.63	4618827.61	385206.06	4541655.62	415963.12
3	4464407.80	369704.99	4618859.14	385291.29	4541666.26	415956.24
4	4464363.25	369644.02	4618888.61	385371.59	4541676.00	415950.03
5	4464312.69	369589.97	4618900.00	385402.33	4541698.42	415935.62
6	4464191.72	369469.24	4618918.26	385451.35	4541725.61	415917.20
7	4464364.37	369290.23	4618940.35	385512.43	4541744.87	415904.78
8	4464391.02	369311.63	4618964.45	385579.73	4541738.72	415892.07
9	4464531.23	369174.11	4618713.92	385633.00	4541778.06	415882.67
.....	.....	.....	.....	.....	.....	.....

## 2.5 Transformation of the projection coordinates

The transformation of the coordinates referenced on ALB-1986 (TM) into the Albanian modern reference (ERTS89, GRS80, UTM) or vice-versa, the Helmert linear equations of transformation were used by [4]: For the transformation from ETRF2000 (UTM), coordinates of Table 7 into ALB-1986

(TM), the linear equations of the Helmert transformation have the form:

$$N_{ALB1986(TM)} = N_0 + p \cdot N_{ETRF2000(UTM)} + q \cdot E_{ETRF2000(UTM)} + r$$

$$E_{ALB1986(TM)} = E_0 + q \cdot N_{ETRF2000(UTM)} + p \cdot E_{ETRF2000(UTM)} + s$$

with  $N_0=4551000.000$ ,  $E_0=416800.000$ ,  $p=1.000408598$ ,  $q=3.11103E07$ ,  $r=1952.142887$ ,  $s=97.55894084$ .

TABLE 10: TRANSFORMED GNSS COORDINATES (N,E)TM

Location	Orikum, Vlora		Rilë, Lezha		Cërrik, Elbasan	
Point	N(x)TM	E(y)TM	N(x)TM	E(y)TM	N(x)TM	E(y)TM
1	4464174.623	369779.261	4618813.470	385157.779	4541616.140	415960.479
2	4464382.525	369994.782	4618830.958	385207.062	4541646.973	415944.809
3	4464529.329	369852.583	4618859.018	385286.382	4541658.017	415938.785
4	4464483.880	369806.378	4618888.874	385368.223	4541667.258	415933.456
5	4464413.186	369735.491	4618902.105	385403.967	4541692.279	415918.775
6	4464314.092	369634.345	4618918.875	385452.199	4541718.155	415903.031
7	4464481.465	369443.754	4618939.169	385513.490	4541738.207	415891.537
8	4464501.961	369468.494	4618962.456	385576.886	4541763.673	415876.432
9	4464630.985	369318.185	4618706.211	385636.313	4541772.396	415871.060
.....	.....	.....	.....	.....	.....	.....

## 3. RESULTS

### 3.1 Comparison between coordinates of different kinds

Comparison between different coordinates (considering the projection, type of field survey, extracted from orthophoto, vector maps or cadastral maps), as well as the relevant

evaluations are shown for the points of the three selected areas: (a) Orikum-Vlorë, (b) Rilë-Lezha and (c) Cërrik-Elbasan (Fig. 5). Standard deviation in N(x) and E(y) is computed respectively:

$$\sigma(N) = \text{SQRT}([dNdN]/n), \quad \sigma(E) = \text{SQRT}([dEdE]/n)$$

where,  $n$  is number of points (parcel vertexes), ( $dN$ ,  $dE$ ) are the differences between two kinds of coordinates.

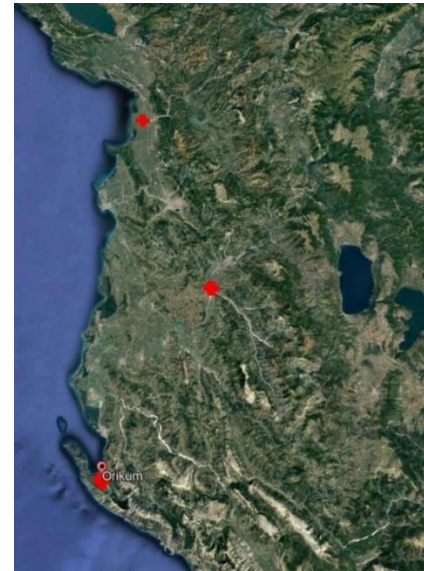


Fig. 5: Locations of three selected areas for the study (adapted from google.com)

3.1.1 Comparison between the coordinates measured with Total Station (TM), (Table 6) and coordinates extracted from Ortophoto or vector maps (TM projection) of the selected identical parcels vertexes (Table 8).

Results of comparisons are given for three selected areas of the study respectively: (a) Orikum- Vlorë, (b) Rilë- Lezhë and (c) Cërrik-Elbasan:

- (a) Standard deviation in N and E is respectively:  $\sigma(N) = \pm 3.56$  m,  $\sigma(E) = \pm 2.65$  m.
- (b) Standard deviation in N and E is respectively:  $\sigma(N) = \pm 6.70$  m,  $\sigma(E) = \pm 18.75$  m.
- (c) Standard deviation in N and E is respectively:  $\sigma(N) = \pm 4.09$  m,  $\sigma(E) = \pm 3.16$  m

TABLE 11: COMPARISON BETWEEN THE COORDINATES (TABLE 6 – TABLE 8)

Location	Orikum, Vlora		Rilë, Lezha		Cërrik, Elbasan	
Point	dN (m)	dE (m)	dN (m)	dE (m)	dN (m)	dE (m)
1	-3.797	-1.999	0.090	0.470	-0.462	-1.650
2	-2.850	1.323	-1.710	-0.510	-1.073	-0.316
3	-1.548	1.296	-4.180	-7.820	-0.886	-0.790
4	-1.703	0.934	-2.930	-6.680	-2.092	1.406
5	-2.652	0.643	-0.510	-1.110	-1.262	-0.358
6	1.923	3.885	7.670	22.930	-1.200	-0.296
7	2.632	1.783	12.140	40.010	-0.604	-0.763
8	1.351	-0.648	9.660	31.680	-1.422	-0.002
9	-1.760	-0.069	14.680	28.820	-1.969	0.514
.....	.....	.....	.....	.....	.....	.....

3.1.2 Comparison between the coordinates measured with Total Station (TM), (Table 6) and the coordinates extracted from digital cadastral map ZRPP (TM) of the selected identical parcels vertexes (Table 9).

Results of comparisons are given for three selected areas of the study respectively: (a) Orikum- Vlorë, (b) Rilë- Lezhë and (c) Cërrik-Elbasan:

- (a) Standard deviation in N and E is respectively:  $\sigma(N) = \pm 134.19$  m,  $\sigma(E) = \pm 157.74$  m.
- (b) Standard deviation in N and E is respectively:  $\sigma(N) = \pm 4.76$  m,  $\sigma(E) = \pm 14.22$  m.

- (c) Standard deviation in N and E is respectively:  $\sigma(N) = \pm 14.38 \text{ m}$ ,  $\sigma(E) = \pm 12.51 \text{ m}$ .

TABLE 12: COMPARISON BETWEEN THE COORDINATES (TABLE 6 – TABLE 9)

Location	Orikum, Vlora		Rilë, Lezha		Cërrik, Elbasan	
Point	dN (m)	dE (m)	dN (m)	dE (m)	dN (m)	dE (m)
1	126.53	173.52	4.75	2.96	-8.532	-23.180
2	119.40	155.04	3.25	0.85	-8.743	-18.466
3	121.47	147.48	-0.21	-5.03	-8.336	-17.570
4	120.56	162.28	0.15	-3.52	-8.852	-16.724
5	100.40	145.46	2.01	1.59	-6.242	-16.888
6	122.44	164.76	0.51	0.66	-7.560	-14.356
7	117.19	153.36	-1.27	0.83	-6.754	-13.473
8	110.99	156.92	-2.10	-3.15	24.838	-15.942
9	99.69	144.08	-7.81	3.13	-5.769	-11.796
.....	.....	.....	.....	.....	.....	.....

3.1.3 Comparison between the coordinates measured with Total Station (TM), (Table 6) and the coordinates transformed from GNSS (TM) of the selected identical parcels vertexes (Table 10). Results of comparisons are given for three selected areas of the study respectively: (a) Orikum- Vlorë, (b) Rilë- Lezhë and (c) Cërrik-Elbasan:

- (a) Standard deviation in N and E is respectively:  $\sigma(N) = 0.12 \text{ m}$ ,  $\sigma(E) = \pm 0.18 \text{ m}$ .  
 (b) Standard deviation in N and E is respectively:  $\sigma(N) = 0.11 \text{ m}$ ,  $\sigma(E) = \pm 0.15 \text{ m}$ .  
 (c) Standard deviation in N and E is respectively:  $\sigma(N) = 0.11 \text{ m}$ ,  $\sigma(E) = 0.17 \text{ m}$ .

TABLE 13: COMPARISON BETWEEN THE COORDINATES (TABLE 6 – TABLE 10)

Location	Orikum, Vlora		Rilë, Lezha		Cërrik, Elbasan	
Point	dN (m)	dE (m)	dN (m)	dE (m)	dN (m)	dE (m)
1	-0.140	0.180	-0.090	-0.039	-0.092	-0.039
2	-0.105	-0.119	-0.098	-0.152	-0.096	-0.155
3	-0.057	-0.117	-0.088	-0.112	-0.093	-0.115
4	-0.063	-0.084	-0.114	-0.153	-0.110	-0.150
5	-0.098	-0.058	-0.105	-0.047	-0.101	-0.043
6	0.071	-0.350	-0.105	-0.189	-0.105	-0.187
7	0.097	-0.161	-0.089	-0.230	-0.091	-0.230
8	0.050	0.058	-0.116	-0.306	-0.115	-0.304
9	-0.065	0.006	-0.101	-0.183	-0.105	-0.186
.....	.....	.....	.....	.....	.....	.....

3.1.4 Comparison between coordinates extracted from Orthophoto or vector maps (TM projection), (Table 8) and coordinates extracted from digital cadastral map ZRPP (TM) of the selected identical parcels vertexes (Table 9). Results of comparisons are given for three selected areas of the study respectively: (a) Orikum- Vlorë, (b) Rilë- Lezhë and (c) Cërrik-Elbasan:

- (a) Standard deviation in N and E is respectively:  $\sigma(N) = 135.57 \text{ m}$ ,  $\sigma(E) = \pm 157.26 \text{ m}$ .  
 (b) Standard deviation in N and E is respectively:  $\sigma(N) = \pm 8.59 \text{ m}$ ,  $\sigma(E) = \pm 13.59 \text{ m}$ .  
 (c) Standard deviation in N and E is respectively:  $\sigma(N) = 14.38 \text{ m}$ ,  $\sigma(E) = 12.51 \text{ m}$ .



TABLE 14: COMPARISON BETWEEN THE COORDINATES (TABLE 8 – TABLE 9)

Location	Orikum, Vlora		Rilë, Lezha		Cërrik, Elbasan	
Point	dN (m)	dE (m)	dN (m)	dE (m)	dN (m)	dE (m)
1	130.32	175.52	4.66	2.49	-8.07	-21.53
2	122.24	153.72	4.96	1.36	-7.67	-18.15
3	123.02	146.18	3.97	2.79	-7.45	-16.78
4	122.27	161.35	3.07	3.16	-6.76	-18.13
5	103.05	144.81	2.51	2.70	-4.98	-16.53
6	120.52	160.87	-7.17	-22.27	-6.36	-14.06
7	114.57	151.58	-13.41	-39.18	-6.15	-12.71
8	109.64	157.56	-11.77	-34.83	26.26	-15.94
9	101.45	144.14	-22.49	-25.69	-3.80	-12.31
.....	.....	.....	.....	.....	.....	.....

3.1.5 Comparison between coordinates extracted from Ortophoto or vector maps (TM projection), (Table 8) and coordinates transformed from GNSS (TM) of the selected identical parcels vertexes (Table 10).

Results of comparisons are given for three selected areas of the study respectively: (a) Orikum- Vlorë, (b) Rilë- Lezhë and (c) Cërrik-Elbasan:

- (a) Standard deviation in N and E is respectively:  $\sigma(N) = 3.46 \text{ m}$ ,  $\sigma(E) = \pm 2.75 \text{ m}$ .
- (b) Standard deviation in N and E is respectively:  $\sigma(N) = \pm 6.74 \text{ m}$ ,  $\sigma(E) = \pm 12.96 \text{ m}$ .
- (c) Standard deviation in N and E is respectively:  $\sigma(N) = 2.59 \text{ m}$ ,  $\sigma(E) = 2.40 \text{ m}$ .

TABLE 15: COMPARISON BETWEEN THE COORDINATES (TABLE 8 – TABLE 10)

Location	Orikum, Vlora		Rilë, Lezha		Cërrik, Elbasan	
Point	dN (m)	dE (m)	dN (m)	dE (m)	dN (m)	dE (m)
1	3.657	2.179	-0.180	-0.509	0.370	1.511
2	2.745	-1.442	1.612	0.358	0.977	0.161
3	1.491	-1.413	4.092	7.708	0.793	0.675
4	1.640	-1.018	2.816	6.527	1.982	-1.556
5	2.554	-0.701	0.405	1.063	1.161	0.315
6	-1.852	-4.235	-7.775	-23.119	1.095	0.109
7	-2.535	-1.944	-12.229	-40.240	0.513	0.533
8	-1.301	0.706	-9.776	-31.986	1.307	-0.302
9	1.695	0.075	-14.781	-29.003	1.864	-0.700
.....	.....	.....	.....	.....	.....	.....

## 4. CONCLUSIONS

- Comparisons between coordinates of identical parcels represented in the digital cadastral maps and the Ortophoto of years 2007/2015 results in standard deviations varying from  $\pm 8.6 \div \pm 157.3 \text{ m}$ .

- Comparisons between coordinates measured with Total Station or satellite receiver GNSS and coordinates of vertex points of the land parcels

represented in the digital cadastral map results in standard deviation values varying from  $\pm 4.8 \div \pm 157.7 \text{ m}$ .

- Comparisons between coordinates measured with Total Station or satellite receiver GNSS and coordinates extracted from Ortophoto of years

2007/2015 results in standard deviation values varying from  $\pm 2.6 \div \pm 18.8$  m.

- Comparisons between coordinates measured with Total Station and GNSS receiver results in standard deviation values varying from  $\pm 0.1 \div \pm 0.2$  m.

## 5. RECOMMENDATIONS

Based on the above-mentioned conclusions, also in accordance with European Standards of multipurpose cadastral maps development [5], as well as the main duties that the Immovable Property Registration Office should fulfill, recommended as follows:

- For centimeter accuracy, it is recommended the usage of GNSS (Global Navigation Satellite

Systems) receivers and the method of RTK (Real Time Kinematic).

- Cadastral data such as subdivisions, parcel boundaries designation or merging, should be based only on the concept of coordinates (N, E), defined by GNSS receiver or Total Station surveying.
- Orthophotos should not be used for cadastral data development such as subdivisions, parcel boundaries designation or merging.

## 6. REFERENCES

- [1] Arkiva e Institutit të Studimit të Tokave, Tiranë, 1996: Buletini No. 6.
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- [5] Standard on Digital Cadastral Maps and Parcel Identifiers, 2015; International Association of Assessing Officers (IAAO), [Standard\\_Digital\\_Cadastral\\_Maps\\_2015.pdf \(iaao.org\)](http://www.iaao.org).

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