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Elbasan City's Local Geodesic Network Construction Using Gnss Surveys

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Abstract
This abstract describes how the city of Elbasan's local geodetic support network is being built using GNSS measurements, which will have a favorable effect on the city's economic and social development. The acquired information will be used as a fundamental point of reference for all geodetic projects, as well as for engineering, urban, and scientific designs, as well as geological and geographical studies. In order to determine the three-dimensional position of the points in the official KRGJSH frame—which is based on the ETRF2000 reference frame of reference to the European continental coordinate system ETRS89—as well as the official frame KRGJSH (Albanian Geodetic Reference Framework), in which all the coordinates—it will be necessary to build the local geodetic support network and implement GNSS (Global Navigation Satellite System) measurements.
Keywords: GNSS; KRGJSH; ETRF2000; ETRS89; ASIG; ASHK.

1. Introduction

The establishment of a local Geodesic Network through the utilization of Global Navigation Satellite System (GNSS) data is very important for Elbasan City's infrastructure development and urbanization. Geodesic networks, which provide precise position, are the cornerstone of modern geospatial data collection and processing.
The Global Navigation Satellite System (GNSS) technology use a constellation of satellites to broadcast signals to receivers on Earth, allowing for the exact determination of positions in three dimensions
. This capability has revolutionized surveying methodologies, offering accuracy and efficiency in data collection. The Elbasan City authorities intends to use GNSS surveys to create a comprehensive geodetic framework that supports many municipal activities, including as infrastructure development, environmental monitoring, land management, and disaster management.
The construction of a local geodesic network in Elbasan is a complex undertaking that involves surveying, data processing, network correction, and the establishment of geodetic control stations. To achieve optimal coverage and geometric distribution, city officials collaborate with surveying experts to methodically position GNSS receivers in strategic locations.
The collected GNSS data is carefully processed and analyzed to determine the precise coordinates of every control point in the geodesic network. This process ensures the accuracy and reliability of spatial data, also it makes it easier to create the geodetic reference frames which are essential for geospatial analysis.
This study examines the benefits, process and implications of using GNSS surveys to create a local geodesic network in Elbasan City. It goes into the technical aspects of surveying and data processing and demonstrates how the geodetic network has revolutionized urban planning and governance.

2. Case Study

The district of Elbasan is one of the 12 districts in Albania, it has an area of 3,278 km². The District Center of Elbasan is located in the city of Elbasan.
The district of Elbasan is bordered by:
• district of Dibra to the north
• District of Tirana to the northwest
• District of Fier to the west
• District of Berat to the south
• Distrit of Korça to the southeast
• Republic of North Macedonia to the east
The city of Elbasan, which is located in Central Albania, is the third largest city in Albania. This city is located between latitudes 41° 27' North, 40° 10' South, 20° 34' East and 19° 03' West and is located at an average altitude of 125 m above sea level. It lies in the plain of Elbasan, on the right side of the middle flow of the Shkumbin river, surrounded to the east by Krasta e Madhe and Krasta e Vogël, to the north and northwest by the hills of Ullishta, to the west by the stream of Zaranika, to the south it is bordered from the river Shkumbin. On the western side of the city, the stream of Zaranika passes, and on the east, that of Manazderia. The city of Elbasan has a castle located in its center. The castle of Elbasan, together with the surrounding walls, shows the military importance of the city of Elbasan in the early Ottoman period.

Figure 1: Elbasan city

2.1. Elbasan city's local Geodesic Network

The local geodetic network in the city of Elbasan covers the area of the entire city, the castle area as well as the part from the southern side, where the river Shkumbin lies, which are the primary areas for their development (construction) by the Municipality of Elbasan, referring to the urban plan of Elbasan and consultations with the specialists of the urban planning sector in Elbasan Municipality.

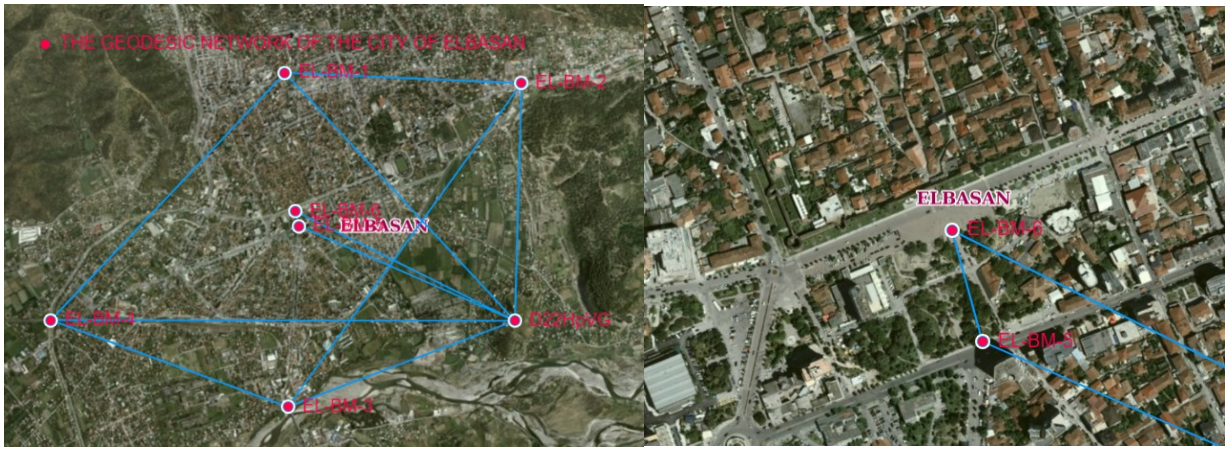


Figure 2: Elbasan Local Geodetic Network

3. Material and Methods

3.1 The projection of passive gnss points

To determine the points, we based initially on two basic documents, where we pre-determined the positioning of the points of the Elbasan local geodetic network: the urban plan of the city of Elbasan and the orthophoto of 2015. We also respected the basic criteria for solving the position of points which are:

1. The optimal visibility of satellites should not have obstacles above 20° degrees to avoid blocking the satellite signal.
2. Elimination of possible reflective surfaces that cause "multipath" of the satellite signal.

3. The fixing of new points should be done in places where there are no developments (constructions) and in stable formations such as rock, stone blocks, bridges, etc.
4. Avoidance of high voltage poles, unstable or temporary buildings and objects.
5. Positioning in suitable places that enable the measurement process.
6. Mutual viewing between network points (to work with traditional Teodelit/Total Station methods as well).

Figure 3: Elbasan Urban plan

3.2 Field recognition and fixing of points in the field

After designing the GNSS points on the map, we continued with the field recognition phase, where, within the conditions that the area allows, we showed great care in determining the position of the network points, respecting the basic design conditions for GNSS points, determined during design phase.

Figure 4: Moments during field recognition and point fixation

4. Results

4.1 GNSS measurements process

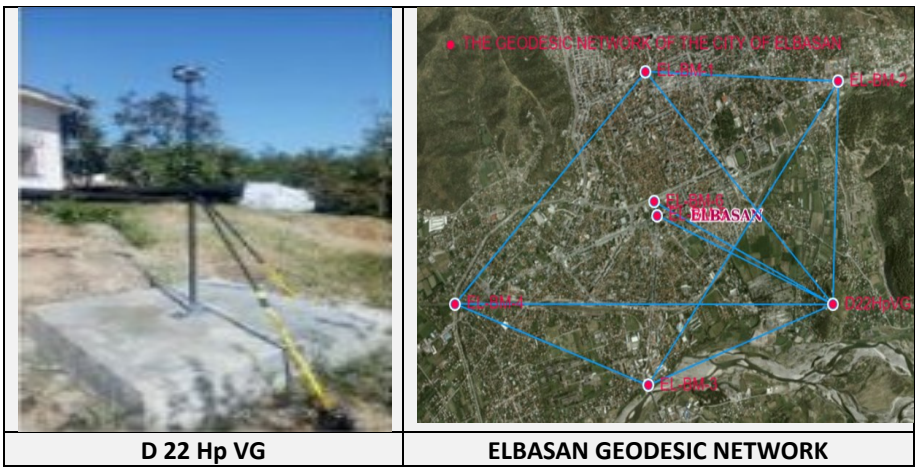
GNSS surveys of 7 points of the Elbasan local geodetic network were carried out according to the following criteria:

- The survey strategy should be implemented according to the multi-station concept (three receivers that simultaneously track satellite data).
- The viewing time for each session should be 120 minutes.
- Measurements are carried out according to the "Fast static" service.
- The data collection speed should be 1 seconds.

For the processing of GNSS measurements, we are based on 5 (five) reference stations of the ALBCORS global positioning system.

The coordinates of the ALBCORS system are based on the realization of the reference frame ETRF2000 of the reference European continental coordinate system ETRS89.

The ALBCORS system guarantees for users the following services: RTK, ≤ ± 2÷3 cm and PP, ≤ ±1 cm.



D 22 Hp VG	ELBASAN GEODESIC NETWORK

Figure 5: Moments during GNSS surveys

4.2 Processing of gnss observations and point coordinates

The processing and compensation of GNSS data was carried out through the program "Trimble Business Center" (TBC) where the coordinates of the GNSS measured points of the local geodetic network ELBASAN were calculated based on the coordinates of 5 (five) reference stations of the positioning system global ALBCORS.

- **Ellipsoidal coordinates of the points after the processing of the Elbasan local geodetic support network in the ETRF2000 reference frame where the following are given: Geographical longitude and latitude, ellipsoidal height.**

Table 1: Ellipsoidal coordinates of the points referred to the GRS80 ellipsoid

ELLIPSOIDAL COORDINATES ETRS89/ETRF2000				
Session number	**Point Id**	**ϕ (GRS80)**	**λ (GRS80)**	**Ellipsoidal height: h (m)**
1	**D22HpVG**	N41°06'17.60535"	E20°06'08.85932"	224.704
	EL_BM-1	N41°07'20.3682"	E20°04'51.9605"	179.043
	EL_BM-2	N41°07'17.7151"	E20°06'11.1732"	172.453
2	**D22HpVG**	N41°06'17.60535"	E20°06'08.85932"	224.704
	EL_BM-3	N41°05'55.8661"	E20°04'52.8655"	144.863
	EL_BM-4	N41°06'17.8573"	E20°03'33.5367"	152.505
3	**D22HpVG**	N41°06'17.60535"	E20°06'08.85932"	224.704
	EL_BM-5	N41°06'41.6185"	E20°04'56.6970"	163.943
	EL_BM-6	N41°06'45.3408"	E20°04'55.3430"	165.934

4.3 Point coordinates catalog

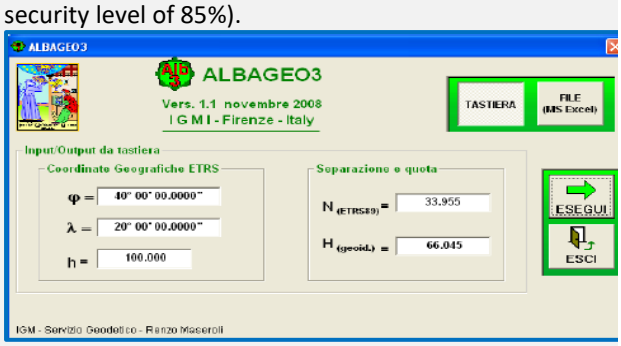
The point coordinate catalog is the final table of calculated coordinates of the points of the Local Geodetic Network in the city of Elbasan in the Albanian Geodetic Reference Frame "KRGJSH".

Table 2: Coordinates in TMzn projection of the points and orthometric elevatio

ELBASAN LOCAL GEODETIC SUPPORT NETWORK POINT COORDNATES CATALOG						
Point Id	ELLIPSOIDAL COORDINATES ETRF2000 (GRS80)			COORDINATES IN TMzn PROJECTION		
	ϕ (GRS80)	λ (GRS80)	Ellpsoidal heigh : h (m)	N(m)	E(m)	ALBAGEO3: H (m)
EL_BM-1	N41°07'20.3682"	E20°04'51.9605"	179.043	4554161.220	506810.744	141.031
EL_BM-2	N41°07'17.7151"	E20°06'11.1732"	172.453	4554081.327	508658.686	134.441
EL_BM-3	N41°05'55.8661"	E20°04'52.8655"	144.863	4551554.441	506834.291	106.851
EL_BM-4	N41°06'17.8573"	E20°03'33.5367"	152.505	4552231.351	504982.617	114.493
EL_BM-5	N41°06'41.6185"	E20°04'56.6970"	163.943	4552965.935	506922.366	125.931
EL_BM-6	N41°06'45.3408"	E20°04'55.3430"	165.934	4553080.735	506890.668	127.922
D22HpVG	N41°06'17.60535"	E20°06'08.85932"	224.704	4552226.943	508606.889	186.692

4.4 Basic geodesic data (horizontal and vertical references)

Horizontal Reference (KRGJSH)		Vertical Reference
System/Ellipsoid/Reference frame	ETRS89/GRS80/ETRF2000	Orthometric height (H_{ALB86}) is calculated according to the ellipsoidal height h_{GRS80} of every point in Albania territory referring to the report (IGUF Program: ALBAGEO3): $H_{ALB86}=h_{GRS80}+N_{EGM2008-GRS80}$ Height calculation accuracy H geoid (ALB86) goes up to 20 cm (with security level of 68%) and up to 40 cm (with security level of 85%).
a semi major axis	6378137 m	
f polar pressure	298.2572221	
Orientation:		
North ellipsoidal origin	$\Phi_0 = 0°$	
East ellipsoidal origin	$\Lambda_0 = 20°$	
Projection:	Gauss-Krüger (TMzn)	
North false orthogonal origin (m)	0	
East false orthogonal origin (m)	500 000.000	
Distortion Rate in MQ	$k_0 = 1$	



5. Conclusions

The conclusions for the work done are:

1. The local geodetic network in the city of Elbasan will serve as a basic reference for the support of all geodetic work based on the official KRGJSH framework.
2. The obtained geospatial data (coordinates of 7 points) will serve various public and private institutions that work in the field of Geodetic, GIS, Geophysical, Geographical studies, Civil constructions according to the development of the city of Elbasan.
3. The points of the local geodetic network in the city of Elbasan are built in such a way, to serve to all users, by using different positioning techniques, the classic ones (Theodolite/Total Station), as well as the contemporary GNSS technique.
4. It is recommended that all cities build the local geodetic network for the realization of their geodetic works.

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