GRAVITY NETWORKS FOR THE GEODETIC REFERENCE FRAMEWORK OF ALBANIA

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Abstract: This paper presents a general overview of gravimetric measurements carried out for the first order gravimetric network of Albania. Data compensation, correction methodologies, interpretation and related results have been presented as well. Relative gravimetric measurements were carried out in 42points, with two CG-5 instruments. Real Vertical Gradients have been measured at all the points of first order network which together with other corrections, are used in the final data compensation in order to bring the final values at reference point as absolute ones. The measurements were carried out during the period from August to October 2018, in collaboration with Aristotle University of Thessaloniki, Department of Geophysics. The project was supported by the Agency of Geospatial Information of Albania.

Introduction

Several studies deal with the investigations of the gravity field and its influence on the geodetic observations. Precise gravity measurements are an important tool for the establishment of reference geodetic networks, for precise measurements of geodetic coordinates and height systems, and also for other related scientific studies such as geodetic, geodynamic, geophysics, navigation and other scientific or practical purposes [1-3].

In the framework of the project "Albanian Geodetic Reference System", a project related to the establishment of the first order gravity network of Albania was launched, by the Albanian Geospatial Information System. The measurements were realized from August to October 2018.

Relative gravimetric measurements were carried out by Albanian experts in collaboration with Aristotle University of Thessaloniki, Department of Geophysics. This paper presents the data collection procedure carried out for the first order gravimetric network, their compensation, the methodology that followed in data corrections, interpretation and related results. Apart from the first order network, other 38 second order and 138 third order gravimetric points have been measured in a grid 2x2 km, in the flat and most dense area (Tirana-Durresi) of Albania, with the scope the determination of Geoid Gravimetric Height on that region, which is not treated in this article (Figure 1). The gravimetric measurements were realized with two Scintrex CG-5 gravimeters for three orders. For the first order points were used two gravimeters simultaneously, whereas for the points of second and third order only one. In this paper we present the results for only the first order measurements. In the first order gravimetric networks Real Vertical Gradients have been measured, which are used for data compensation.

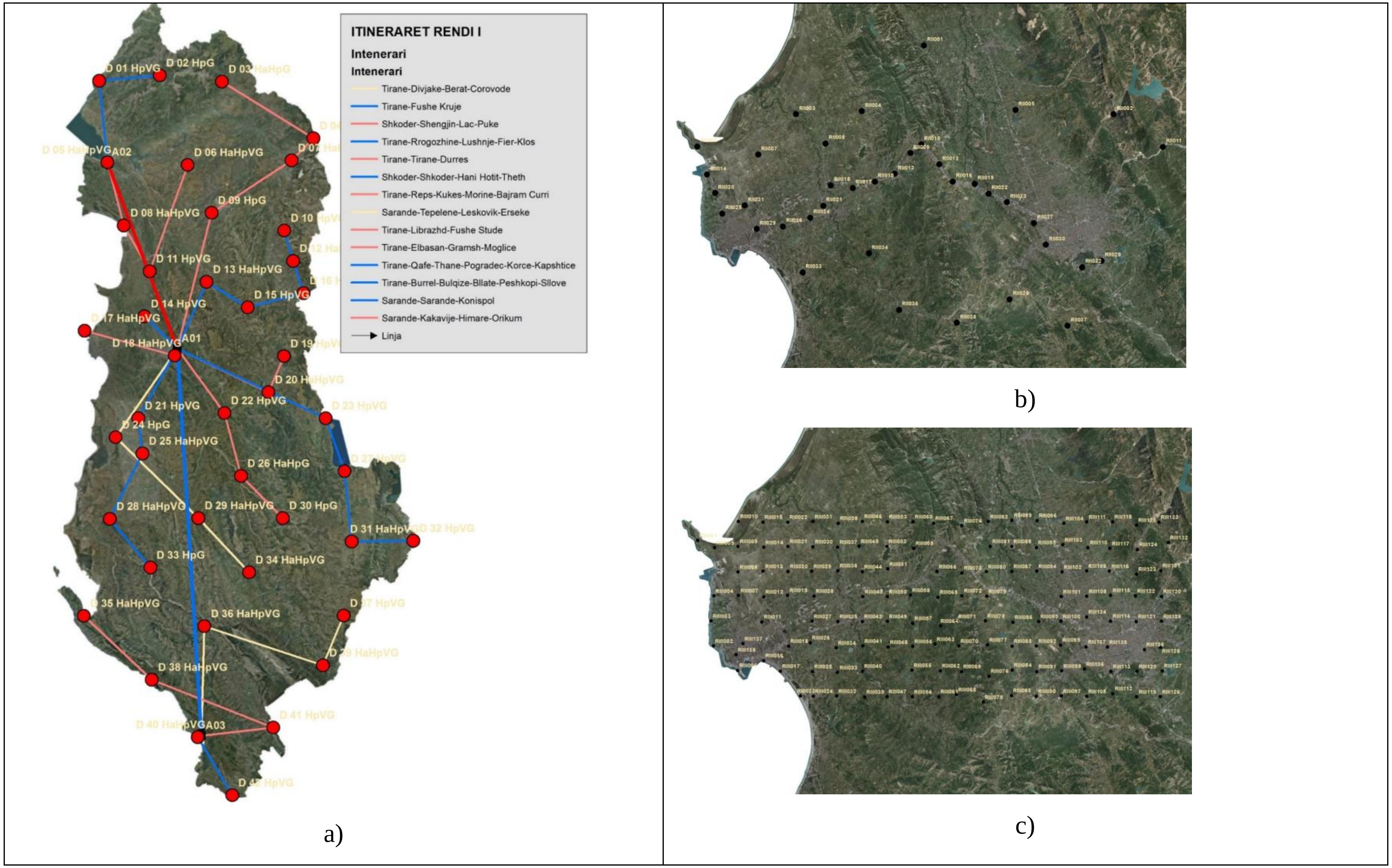

Figure 1: a) Schematic view of gravimetric days of the first order gravimetric measurements. Location of second (b) and third order gravity points (c) in the Tirana-Durresi Area.

Gravity measurements and their corrections

The measurements were carried out using the line method, as the most suitable for the Albanian territory, due to limitations by the existing road network (figure 1).
During the gravimetric measurements campaign, calibration of relative gravimeters has been carried out. For the estimation of the instruments calibration constant, the gravitational acceleration difference between absolute stations AGP 01 (Tirana), AGP 02 and AGP 03 (Saranda) (3 days, at the beginning, the middle and the end of the campaign) was measured four times within one day [4].
The measurements were performed with two CG-5 gravimeters, simultaneously, located at about 36cm apart from each other and oriented towards the magnetic north. The center of first gravimeter was positioned above the mark, while the other about 36cm in the west. After this measuring cycle ends, the positions were changed (change of places), and the same measurement procedure was performed, 10 cycles of 60 seconds (figure 2a). For each first order station, the Vertical Gravitational Gradient (VGG) was measured. The instrument was placed at two different altitudes (~ 0.4m and 1.4m, measured from the top of CG5) and five sequent measurements were taken (bottom, top, bottom, top, bottom). For each measuring step five 60-second cycles were recorded (figure 2b).

a

b

Figure 2: A) Gravimetric field measurements of firs order points, with two gravimeters placed next to each other. B) Example from a gradient measurement.

Compensation and correction of relative gravimetric measurements was carried out with the matlab script, SRGM v.1, which is a program for comparing the relative gravimetric data collected with Gravimeter CG-5 instruments, and used for adjustments and corrections of gravimetric state networks. The program functions include: Adjustment of relative gravity measurements of Scintrex CG-5 with elimination of instrumental drift approximated by a polynomial of appropriate degree; Calculation of absolute gravity values at given stations; Testing the goodness of fit using Pearson´s χ^2-test of normality; Controlling the quality of data and rejection of outliers; Reduction of gravity on the reference mark; Updating the tidal correction in corrected gravity; Displaying the results of adjustment. Atmospheric and pressure correction have been taken in two account.

Results

Based on the methodology described above, The relative gravimetric measurements at all first-order gravimetric stations were processed, compensated, and corrected to absolute gravity values. Table 1, presents the absolute g values and their gradients for all the first order points.

Table 1: Absolute g values and vertical gradients on the points of first order gravimetric network of Albania.

Stations	ID	G (miliGal)	STD (miliGal)	VGG (mGal/m)	Stations	ID	G (miliGal)	STD (miliGal)	VGG (mGal/m)
1	RI001	980244.2554	0.0091	0.320738	22	RI022	980141.1351	0.0053	0.387856
2	RI002	979942.4239	0.0144	0.498427	23	RI023	980003.9842	0.0029	0.320455
3	RI003	980187.9627	0.0025	0.274342	24	RI024	980158.6999	0.0011	0.345494
4	RI004	980243.1801	0.0014	0.268274	25	RI025	980156.148	0.0037	0.294714
5	RI005	980269.7807	0.0041	0.300898	26	RI026	980104.9904	0.0035	0.323885
6	RI006	980104.3259	0.0081	0.316196	27	RI027	980036.3957	0.0016	0.3353
7	RI007	980201.2638	0.0021	0.314813	28	RI028	980144.7434	0.0022	0.314301
8	RI008	980255.5618	0.0035	0.32919	29	RI029	980142.1389	0.0053	0.284424
9	RI009	980195.8919	0.0033	0.278371	30	RI030	980016.3449	0.0023	0.31179
10	RI010	980057.6628	0.0035	0.300212	31	RI031	979967.3146	0.0077	0.325
11	RI011	980219.4192	0.0062	0.379739	32	RI032	979949.0285	0.0021	0.268599
12	RI012	980084.4941	0.0031	0.27087	33	RI033	980166.6667	0.0057	0.346051
13	RI013	980181.6279	0.0023	0.344584	34	RI034	980046.6713	0.0007	0.262613
14	RI014	980204.5724	0.0009	0.32619	35	RI035	980180.895	0.0252	0.317084
15	RI015	980093.5456	0.0039	0.270517	36	RI036	980066.8254	0.0063	0.3301
16	RI016	980099.4778	0.0174	0.298062	37	RI037	979868.783	0.0087	0.274907
17	RI017	980194.9274	0.0089	0.287676	38	RI038	980108.2346	0.0217	0.363504
18	RI018	980149.6007	0.0056	0.330272	39	RI039	979902.1537	0.0081	0.401273
19	RI019	979988.1435	0.0132	0.282102	40	RI040	980115.9725	0.0038	0.285654
20	RI020	980155.8281	0.0202	0.345806	41	RI041	980007.9054	0.0100	0.309019
21	RI021	980153.6265	0.0014	0.326423	42	RI042	980055.31	0.0123	0.292266

Conclusions

Within this project, gravimetric measurements were performed in 42 first order stations, 38 of second order and 138 of third order. These measurements were carried out with the round-trip method, with the aim of achieving high precision. The measurements were carried out in a two-month period. The best practices used today in the world for gravimetric networks were applied, both in data collection and in their processing.

From the experience gained, related to the topography of the territory, the road network, as well as the best global practices of construction and use of local and regional gravimetric networks, we come to some conclusions and recommendations as follows:

- Extending the gravimetric network of the 2nd order to cover the entire territory of the country will enable the assessment and approximation of a better regional model.

- The mountainous and steep terrain suggests that a careful distribution of the network needs to be planned. Certainly these points can not be placed in remote areas where there is no road network coverage. But at the same time is much easier and more feasible to have a dense network in low terrain areas as in the Adriatic Lowlands.

Acknowledgement

Many thanks goes to the Agency for Geospatial informations System of Albania, which in the framework of the project "Albanian Geodetic Reference System", supported the gravimetric measurements.

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