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Volunteering for the future – Geospatial excellence for a better living

DETERMINATION OF A NEW GRAVIMETRIC QUASIGEOID FOR ROMANIA

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INTRODUCTION

The project aims to improve the transformation grid on altitudes and to improve the digital elevation model and orthophotomap through which the Romania's topographical reference plan (TOPRO 5) is updated – support for the implementation of the National Programme for Cadaster and Land Book

MATERIALS AND METHODS

Planning Gravimetric Works

MATERIALS AND METHODS

Equipment

Scintrex – Autograv CG5 Relative gravimeter	**Scintrex – Autograv CG6 Relative gravimeter**	**GS15 GNSS – RTK Leica rovers**	**Leica electronic level**
Reading resolution 1 microGal	Reading resolution 0. 1 microGal	Facilitates (after post processing) linear combinations between phase measurements	Transmitting elevation to new determined points

ADJUSTMENT OF GRAVIMETRIC MEASUREMENTS (1)

Reduced gravimetric data were inserted in a functional model which includes independent readings and is presented as the following type of equation:

$$l(t) + v = g + N_0 + \Delta F(z) + D(t)$$

where:

-t: measuring time;

-l: the value of the reduced reading of the instrument ;

-v: l correction

-g: station gravity value;

-N_0: constant of the relative level of the instrument;

-ΔF(z): calibration function;

-z: gravimeter reading;

-D(t): drift function of the gravimeter.

The calibration correction applied to Scintrex – Autogav CG5 gravimeters has the form of a polynomial equation (Torge, 1989):

$$\Delta F(z) = \sum_{l=1}^{\gamma} b_l z^l$$

where:

- b_l polynom coeficient;

- z_l gravimeter readings.

The drift function of the gravimeter was modeled with a polynomial of this type:

$$D(t) = \sum_{p=1}^{a} d_p (t - t_0)^p$$

where: t_0 initial epoch; a polynomial power; d_p drift parameters.

ADJUSTMENT OF GRAVIMETRIC MEASUREMENTS (2)

Supposing that we have several (n) measurements, the equations for observations are written in matrix form:

$$L^b + V = AX$$

where:

L^b: a vector containing relative gravity measurements;

V: a vector containing corrections;

A: coefficients matrix;

X: a vector containing unknowns;

Using the method of minimum squares, we can obtain estimated values of the unknowns:

$$X = (A^T PA)^{-1} A^T PL^b$$

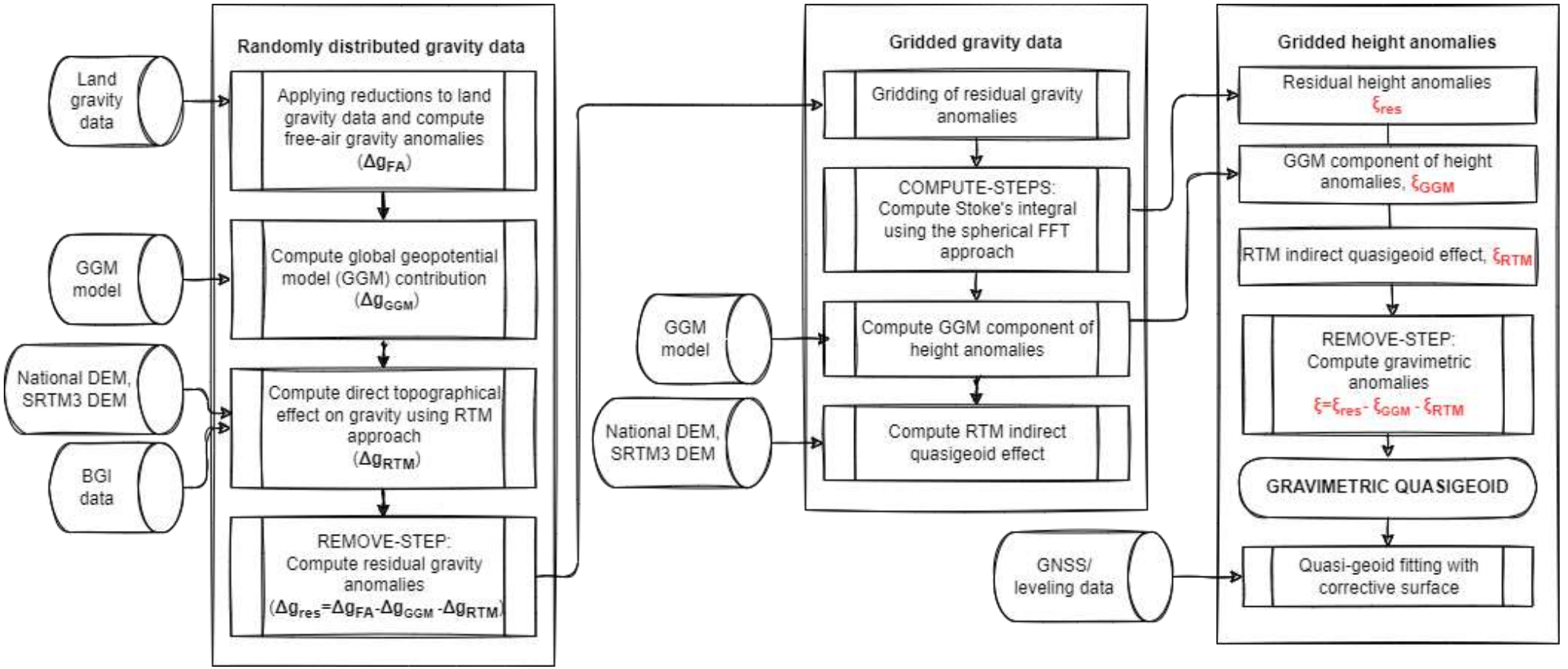
The a posteriori covariance matrix of X:

$$\hat{\sum}_X = \hat{\sigma_0}^2 (A^T PA)^{-1}$$

Global model test and detection of outliers:

- The global bilateral model test (if $\chi^2 = \frac{R}{\sigma_0^2} < \chi_c^2(1-\alpha; m)$ then the adjustment model is correct and complete)
- Pope's τ-test method (if $\frac{|v_i|}{\sigma_{v_i}} > \tau_c(1-\frac{\alpha}{n}; 1, m)$ then the i^{th} observation is an outlier

QUASIGEOID MODELLING



QUASIGEOID TESTING

The gravimetric quasigeoid was tested by computing and analyzing the differences $\Delta\zeta$ in the height anomalies using the relation,

$\Delta\square = \square_{geom} - \square_{grav}$

where $\square_{geom}$ is the geometric height anomaly computed at the check and control

points, and $\square_{grav}$ is the gravimetric height anomaly computed at the same points.

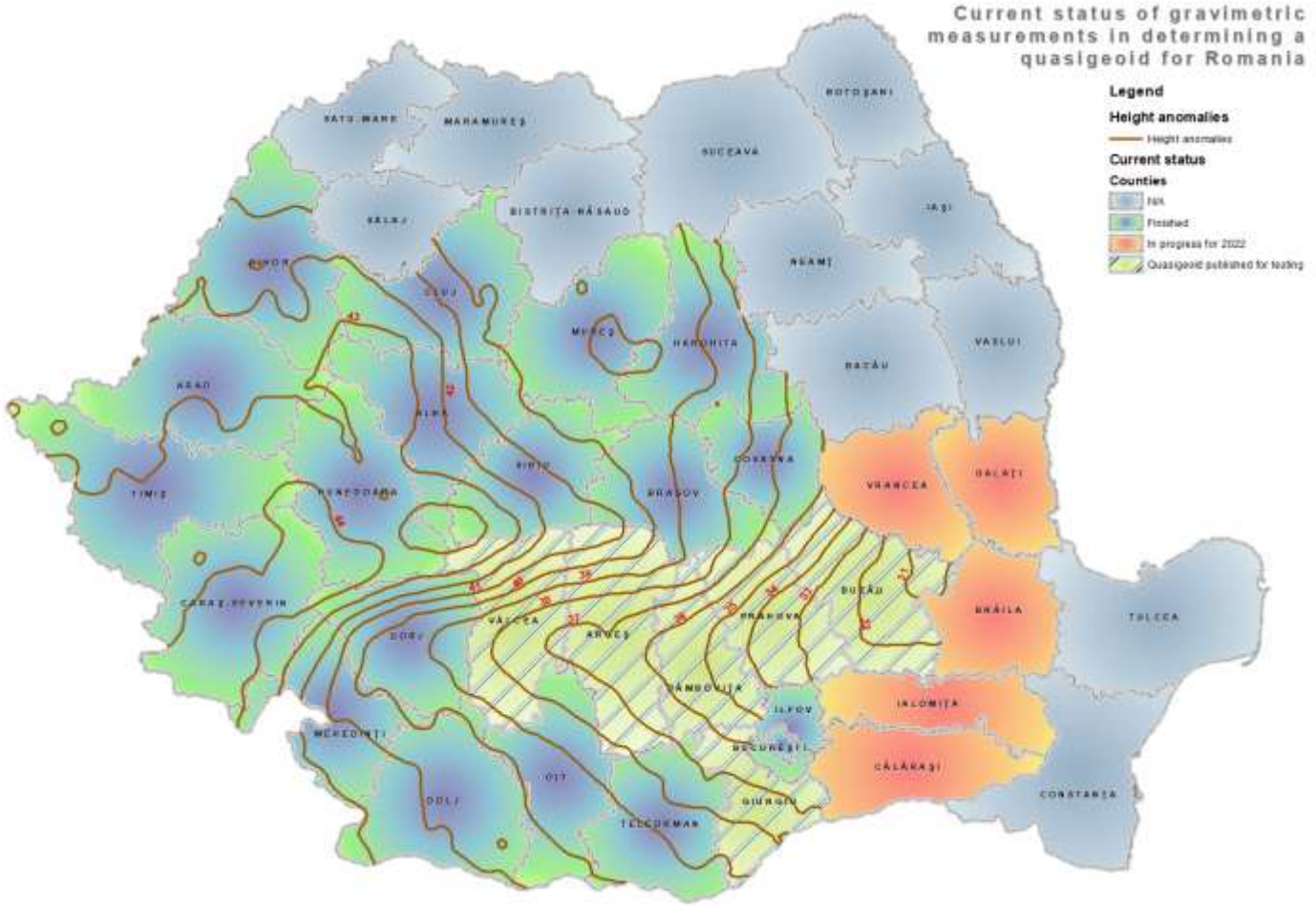
The statistical situation of differences in height anomalies $\Delta\square$ is presented in the

next table

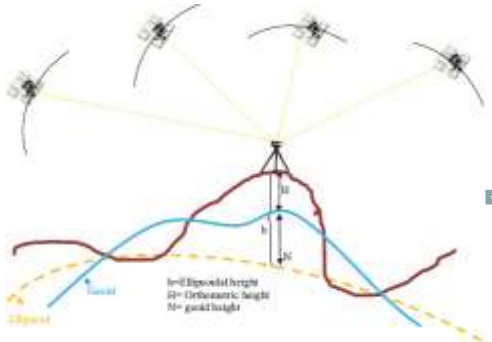
Data	Mean [m]	Standard dev. [m]	Min. [m]	Max. [m]
1664 check and control points	-0.003	0.030	-0.153	0.167

RESULTS AND DISCUSSIONS

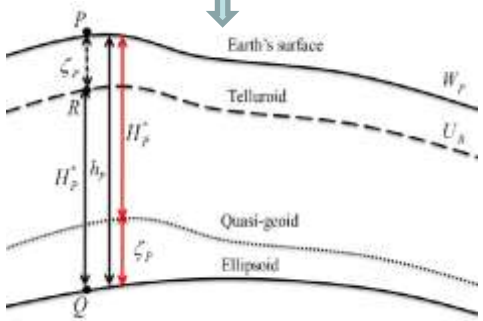
The progress of the works for the determination of the quasigeoid:

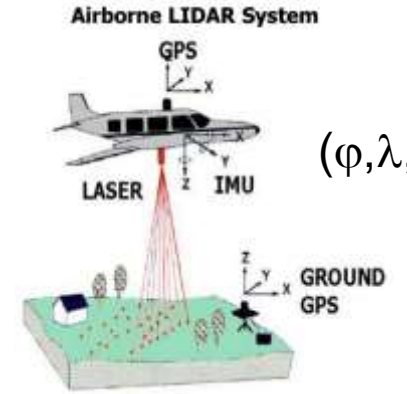


THE NEW QUASIGEOID MODEL AND ITS APPLICATIONS

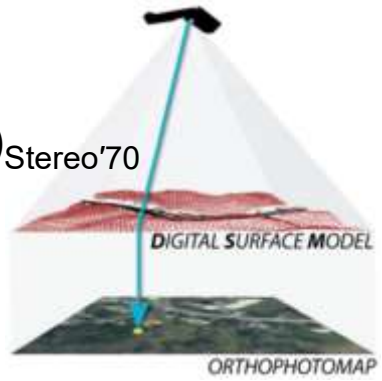


$$h_P = H_P + N = H_P^* + \zeta_P$$





$(\varphi,\lambda,h)_{ETRS89} \dashrightarrow (x,y,H)_{Stereo'70}$



2D Cadaster

3D Cadaster

CONCLUSIONS

- Will provide Romanian users a precise **coordinate transformation** for elevation
- Important steps for creating a more accurate **digital terrain model**
- The workflow of gravimetric measurements uses **fewer resources** – cost, materials, and human resources are notably reduced
- Will have effects in most of the fields related to **investments and national projects**

Thank You!