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CREATION OF A DIGITAL TOPOGRAPHIC MODEL IN EXTREME AREAS ON THE TERRITORY OF SOUTH-WESTERN BULGARIA-RILA MOUNTAIN

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ABSTRACT: *The subject of the research is to create a digital topographic model (DTM) on the territory of Rila Mountain in order to further local modeling of the geoid. The data obtained from this model, in the form of planar and altitude coordinates, are used to determine the terrain correction and calculate the complete Bougue anomalies. The information from the DTM in terms of altitude can serve as an initial value of the normal altitude in the interpolation calculations and determination of the transformation parameters when filling in the data for modelling the geoid (quasi-geoid).*

KEYWORDS: *DTM, extreme area, geoid, quasi-geoid*

1. Introduction

The process for the construction of a DTM surface is called digital terrain modeling. It is also a process of mathematical modeling. In such a process, points are sampled from the terrain to be modeled with a certain observation accuracy, density, and distribution; the terrain surface is then represented by the set of sample points. If attributes on locations on the digital surface other than the sample points need to be obtained, interpolation is then applied by forming a DTM surface from the sampled data points [1, 2, 4].

Figure 1 of Li (1990) describes the whole process of digital terrain modeling. It can be seen clearly that there are six different stages, in each of which one or more actions are needed to move to the next one [4].

The creation of a digital topographic model is extremely important for the further local modeling of the geoid on the territory of South-western Bulgaria-

Rila mountain. The data obtained from this model, in the form of planar and altitude coordinates, are used to determine the terrain correction and calculate the complete Bougue anomalies.

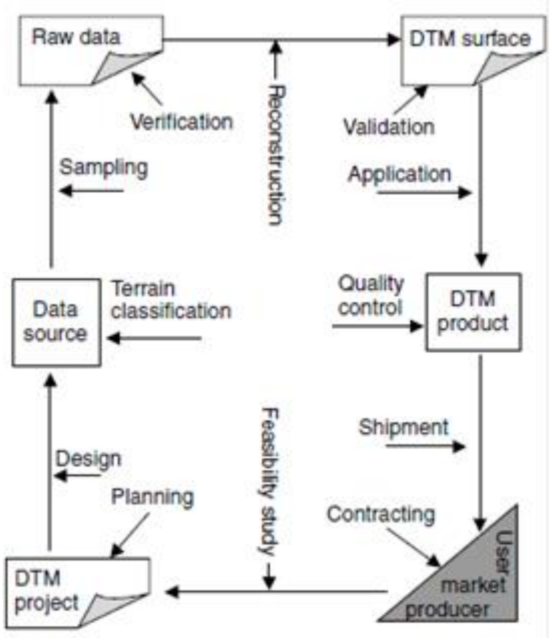

Fig. 1. The process of digital terrain modelling (Li 1990).

2. Experimental results and discussion

2.1. Creating a database of GNSS points in the study area.

Based on many years of experience in classical measurements with GNSS technology, the company "YANKI" Ltd. has performed precise GNSS measurements in South-western Bulgaria. The GNSS campaigns conducted in 2015 year by the Law on Obligations and Contracts "Affordable Rila" and "Rila Consultants" in the region of Rila Mountain, in which the author also participates, provide a basis for creating a digital topographic terrain on the territory of Rila Mountain (DTM-RM), as well as a basis for determining the geoid by a geometric relationship between the ellipsoidal heights derived from the GNSS definitions and the normal heights determined by levelling. The measurements were performed with modern two-frequency equipment for geodetic GNSS measurements and software for analysis and processing of measurement results. As a result of these measurements, the area in South-western Bulgaria was studied and limited ($41^{0}52'06''N<\varphi<42^{o}21'22''N$ and $23^{0}01'11''E<\lambda<24^{o}01'05''E$), for which a high data density is available [3].

The number of points used is 46,121 in number with GNSS/levelling data. The measurements were performed with a dual-frequency GNSS receiver in

RTK mode using a user base station. The points were evenly distributed on the study area with a total area of 2933 km^2 (Fig. 3).

Fig. 2. Preparation for GNSS measurements
in the area of top Musala - 2925 m.

The density of the points is 16 points $/km^2$. The coordinates of the GNSS points are in the Geodetic Reference System 1980 (GRS80). The determination of normal altitudes is related to the Baltic Altitude System. The accuracy of ellipsoidal heights from GNSS does not exceed 10 cm. The accuracy of normal heights is better than 10 cm [3].

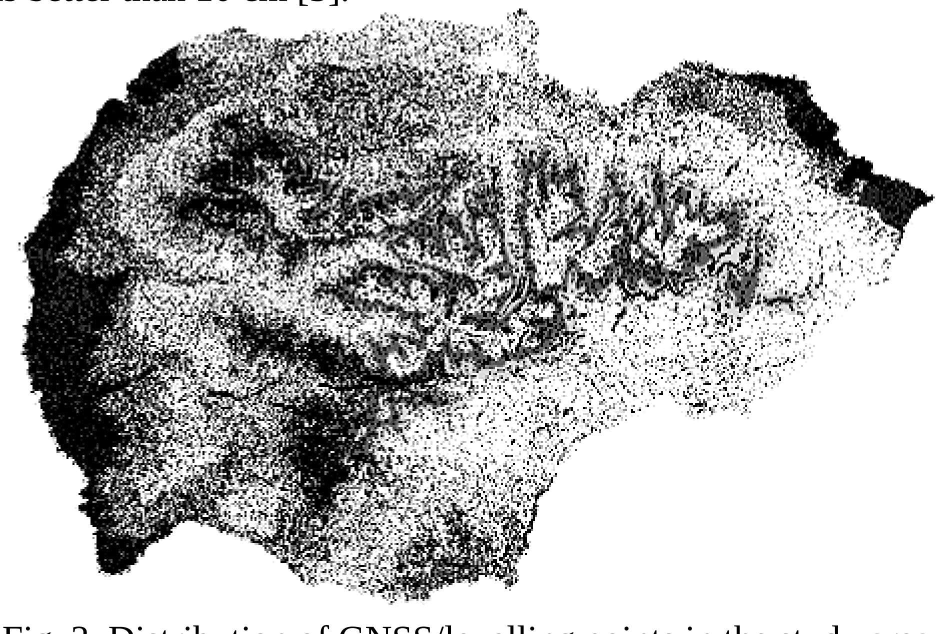

Fig. 3. Distribution of GNSS/levelling points in the study area –
Rila mountain

Normal heights are determined by height transformation using previously included in the measurements benchmarks or points that have defined elevations.

Fig. 4 Scheme of levelling network I and II class on the territory of Rila Mountain

The measurements are not loaded with normal corrections. The determination of normal altitudes is in the Baltic Altitude System. For the transition from the Baltic Altitude System to EVRF2007, all data are processed with BGSTrans data transformation software.

2.2. Creating a digital topographic model (DTM - RM)

Based on information about the normal heights of 46 121 points, a TIN (Triangulation Irregular Network) vector model (DTMRM_H^N) was built. Contours (horizontals) of the relief with a section height of 100 m are modeled (Fig. 5).

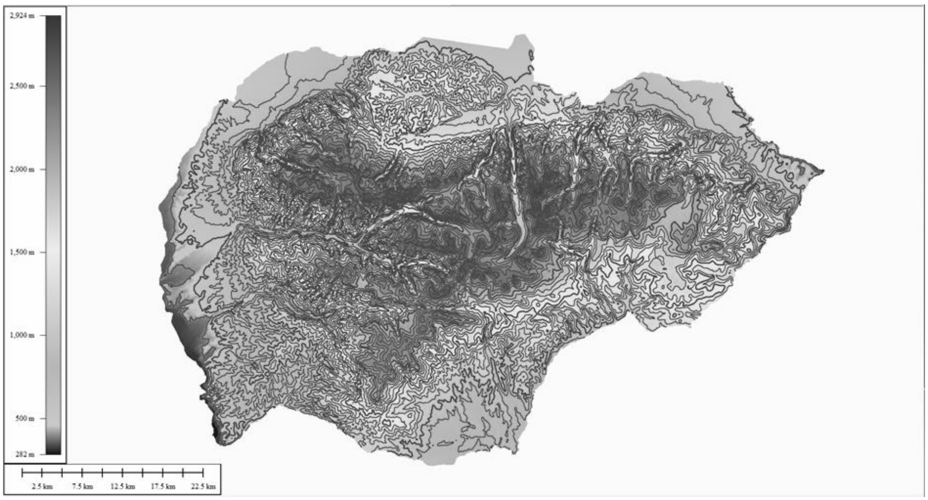

Fig. 5 TIN model of DTM - RM with a section height of 100 m.

The heights vary from 282 m to 2925 m. The modeling of DTM - RM (Digital topographic model - Rila mountain) was performed in ArcGIS environment, creating a 3D surface model TIN (Fig. 6). The control measurements made to assess the accuracy of the height determination by the model have an accuracy of $m_{DTM-RM} = \pm 0.05$m. This accuracy satisfies the requirements when calculating the field correction.

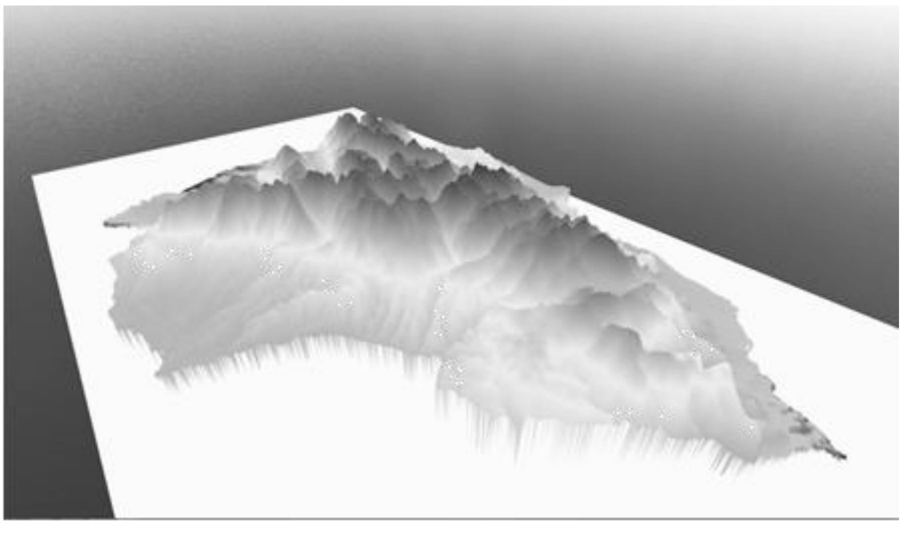

Fig. 6. 3D Digital Topographic Model DTM-RM

3. Conclusion

The creation of a digital topographic model is extremely important for local modelling of the geoid. Data extraction from this model in the form of planar and elevation coordinates is used to determine the terrain correction and calculate the total Bougue anomalies. The information from the DTM in terms of height can be used as an initial value H^N in the interpolation calculations and determination of the transformation parameters when filling in the data for modelling the geoid (quasi-geoid).

From the conclusions made, the need to create a DTM for the study area is established.

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