Refinement of the geoid model on the islands with sparse terrestrial gravity data

Olga Bjelotomić¹, Tomislav Bašić¹, Danko Markovinović²

¹ University of Zagreb - Faculty of Geodesy, Kaćićeva 26, 10000 Zagreb, CROATIA
² State Geodetic Administration, Gruška 20, 10000 Zagreb, CROATIA

SUMMARY

Summary. Croatia has more than five hundred islands majority of which has the surface smaller than one km square, while the largest island exceeds even 400 km squares. In accordance to the large differences of the islands’ surfaces, 10 % of the islands are permanently inhabited while the rest of the islands record an increasing rate of the real estate transactions making them a subject of a great scope of the construction works, which reflects on higher demands for the geoid model on the islands to rely on. Since 2011, current Croatian geoid model have been implemented in the online service of national positioning system in order to allow the real time height transfer between ellipsoidal and orthometric heights. Its accuracy of +/- 3.5 cm was validated on the Croatian mainland stations while the estimation of its reliability on the islands was not possible due to the lack of gravity and levelling data on the islands. Regarding the new avenues that have occurred in the meantime such as more detailed bathymetric and gravity global models as well as new sparse terrestrial gravity data on the islands, the subtle gravity field modelling have been applied on the Croatian islands, within which the refinement of the geoid model for the islands and part of the Adriatic sea have been evaluated in this paper.

Key words. gravity field modelling, islands, geoid

DATA SET

ELEVATION DATA

GRAVITY DATA

GEOID COMPUTATION

The research was made on the Croatian part of North Adriatic area, between 14°-16°E and 44°-45.5°N, covering the computation area of 35 000 km². The integration area was wider for a cap size of 0.5°. Geoid was computed in resolution 30°x30°, corresponding to 1 km resolution in reality. The Least square modified Stokes’ (LSMS) method with Additive Corrections was applied. Final computed geoid model gave undulation values in 43 200 regularly grided points. Orientation and the validation of the computed geoid model were made using a GNSS/levelling points. Kotsakis and Sideris systematic parameter model was used for the 7-parameter fitting procedure, made on 112 GNSS/levelling points and resulting with the RMS of ± 4.2 cm, ranging from -7 cm minimum values to +14 cm maximum values.

RESULTS

<table>
<thead>
<tr>
<th></th>
<th>26 GNSS/lev points on the islands</th>
<th>7 GNSS/lev points on the islands</th>
</tr>
</thead>
<tbody>
<tr>
<td>max</td>
<td>-0.068</td>
<td>-0.065</td>
</tr>
<tr>
<td>min</td>
<td>-0.152</td>
<td>-0.062</td>
</tr>
<tr>
<td>rms</td>
<td>0.052</td>
<td>0.034</td>
</tr>
</tbody>
</table>

Table 1: Validation on complete 26 GNSS/lev points and separately for the islands only in [cm]

After the computed geoid model was fitted to the national height system, the external accuracy assessment had to be made in order to validate the fitting accuracy. The absolute external accuracy assessment was made on 26 GNSS/levelling points which were not used in the fitting procedure, of which 19 of them were on the mainland and 7 on the islands. Centralized statistics for the complete external accuracy assessment resulted with ± 5.2 cm, while observing only validation on the islands the RMS dropped to ± 3.4 cm. These results imply on a possible future implementation of a geoid model as a reference vertical datum on the islands. Regarding the great number of the islands without connection to a national reference vertical system, this results prove that kind of solution could provide reliable and accurate height information.

CONTACT: Olga Bjelotomić, PhD
olgabjelotomic@gmail.com
tel: +385 (1) 4639-528