Quality of Microgravimetric networks’ base stations

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SUMMARY

Summary. Aim of this paper is to analyze and evaluate quality of base stations of Micro gravimetric network. Study enveloped two areas: one mountainous and one lowlands area, with overall 30 stations which of 3 absolute gravimetric stations, 6 eccentric stations and 1 station located to Geodetic Network of First Order. Observed area was chosen as suitable for the analysis considering possibility of measuring points of different Order in just one gravimetric figure. These gave opportunity to explore impact value of each particular point in the figure and to find the best optimized adjustment process. Absolute measurements were made in 2003, while relative measurements were repeatedly done so the results can be compared. The accent in this evaluation has been put on calculation of eccentric points variations in observed period. Due to significance of these eccentric points for further studies and network densification that are already made regarding them as base points, this study proved to be necessary in standard deviation estimation of base stations.

Key words: Micro gravimetric network, eccentric points, repeated observations, analysis, standard deviation.

INTRODUCTION

Introduction. Basic Gravimetric Network of Republic of Croatia consisted of 6 absolute gravimetric stations (Figure 1). Due to location mismanagement during last 10 years, one station (AGT01) is not in its full function. In situations like this, eccentric absolute stations are points with highest accuracy for attachment of future (micro)gravimetric network. Regarding this issue, two locations are observed closer: Zagreb microlocation, with eccentric stations of two absolute stations (AGT02 and AGT03), and Osijek microlocation, where is one absolute station (AGT01) and three corresponding eccentric station (Fig. 1 right).

METHODS AND MEASUREMENTS

Field work. Field gravimetric measurements were made using two methods depending which one fitted better in the time frame of a day. Used methods were star and profile method (Fig. 2, Fig. 3). Overall figure line distances covered 390 kilometers. Microgravimetric network in Zagreb was closed in three days, while Osijek microgravimetric network was closed with just one day measurement.

During measurements at Zagreb city area, another station was enveloped: GT117. Station belongs to Gravimetric Network of First Order. It is situated on the rather suburban area of City of Zagreb, equally distanced of both AGT02 and AGT03 stations. It is also pulled through the adjustment analysis to explore its possibility for being a stable fixed station.

Relative measurements are made with Sontrex CGS AutoGrav relative gravimeter, during summer time 2012.

Time span corresponds to same time span in year 2006, when the same stations were observed in project of the establishment of Basic Gravimetric Network of Republic of Croatia of First Order. Time span factor was interesting due to almost the same atmospheric conditions (temperature and pressure values) in both measuring cycles: 2006th and 2012th.

Adjustment. Figures are adjusted regarding their corresponding absolute station. In Zagreb microlocation (Figure 3), situation is rather unusual due to two absolute stations with very small (in absolute station distances context) mutual horizontal distance but rather large vertical distance (even 843m). Consequently, it was decided that these two absolute stations share their three eccentric stations. Therefore, adjustment for Zagreb microlocation was made in three modes: regarding both absolute stations separately (mode 1 and 2), and regarding both of them at the same time (mode 3).

ANALYSIS

Observing gravity values at Zagreb absolute eccentric stations obtained from different adjustment modes (Fig. 4), difference is not negligible even though it could seemed like that on a first sight. Actually, it varies from 11,9 µGal positive shift on all stations regarding AGT03 to AGT02 fixed case, to -3,2 to 2,4 µGal variations in common AGT02 and AGT03 fixed solution regarding previous two cases.

Table 1. Gravity differences of 3 adjustment modes

<table>
<thead>
<tr>
<th>Mode</th>
<th>AGT01</th>
<th>AGT02</th>
<th>AGT03</th>
<th>AGT01-AGT02</th>
<th>AGT02-AGT03</th>
<th>AGT03-AGT01</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-0.19</td>
<td>0.31</td>
<td>-0.50</td>
<td>0.50</td>
<td>-0.50</td>
<td>-0.19</td>
</tr>
<tr>
<td>2</td>
<td>-0.20</td>
<td>0.32</td>
<td>-0.50</td>
<td>0.50</td>
<td>-0.50</td>
<td>-0.20</td>
</tr>
<tr>
<td>3</td>
<td>-0.19</td>
<td>0.31</td>
<td>-0.50</td>
<td>0.50</td>
<td>-0.50</td>
<td>-0.19</td>
</tr>
</tbody>
</table>

Figure 5. Standard deviations in 3 adjustment modes

It could be justified by several possible impacts: one is longer measurement line between AGT02 and other stations then it is when AGT03 is fixed (but then it would be expected of AGT02E1 to have neglected standard deviation), second is noise at AGT02 station (even though measurements were made rather early, around 6 a.m.), and third is impact of height differences of stations, which varies between 100-843 m.

The main objective of this study was to detect possible movement of eccentric absolute stations. It is done by comparison of two epoch: 2006.6 and 2012.7 where the same figures were measured and adjusted in the same mode (Table 2).

Table 2. Adjusted gravity values in epoch 2006.6. and 2012.7 (left: Osijek, right: Zagreb) in µGal

<table>
<thead>
<tr>
<th>Station</th>
<th>2006.6</th>
<th>2012.7</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGT01</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>AGT02</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>AGT03</td>
<td>0.4</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Results have shown significant gravity shift at stations situated in Zagreb microlocation, in which gravity rised for 30-50 µGals regarding 2006 year, unlike stations in Osijek where gravity stayed stabled, varying from -1 µGal to 1.5 µGal (Fig. 6, Fig. 7).

Figure 6. Gravity differences in two epoches for Osijek area

Figure 7. Gravity differences in two epoches for Zagreb area

DISCUSSION

As shown in this analysis, no gravity trend could be established observing time gravity variations on eccentric absolute stations in period covered in this study. Regarding given results, assumption is that in these kind of micro gravimetric networks, with short observation lines (400 m – 10 km), quality of value on most distanced station from the referenced one is threatened.

Furthermore, impact of great height differences between stations taken together in common adjustment appeared as possible significant factor. As seen in Osijek case study, it would be advisable to attach several micro gravity networks in area of large height slopes.

Additionally, due to noticed unidirectional shift in adjustment made by fixing AGT02 regarding adjustment made by fixing AGT03 absolute station, it could be concluded that even one of the absolute stations is not absolutely stable.

REFERENCES