It becomes obvious that the gravimetric correction is the largest at the immediate neighbourhood of the terrace, where the height and gravity values change rapidly between levelling station points. This means that the 1.2 mm cumulative gravity correction is in fact distributed only within 300 meters, the immediate neighbourhood of the terrace.

To investigate further the correlation between the gravity change between two stations and the gravimetric correction, the following is done. The change in geometric heights ΔH between stations and the change in normal heights ΔH^n between stations are compared. The difference is plotted against the average distance of the two stations from the terrace (Figure 8). On the same graph, the change in gravity value between stations dg is shown.

A strong correlation is seen between the gravimetric correction and the gravity change. To a 1 mGal change in the gravity value corresponds roughly a 0.2 mm gravity correction.

A similar graph is plotted for the change of height ΔH against the gravimetric correction (Figure 9). Similarly, a strong correlation is found. To a change of height by 5 meters corresponds a 0.2 mm gravimetric correction value.

For numeric data and further information on the subject matters, please refer to the author's MSc thesis (Talvik, 2012).

Discussion

The gravimetric corrections calculated empirically have proved to be very significant – within 300 meters from the upper edge of the terrace (which corresponds to the actual length of the descent), the gravimetric correction can cumulate to 1.2 mm. This proves that the use of gravimetric corrections is vital in precise levelling data processing. The gravity data need to be known in levelling areas or collected alongside with the levelling fieldwork. Thus the quality of gravimetric data affects levelling accuracy directly.

The results are immense in terms of precise levelling. The existence of the gravimetric effect on precise levelling tends to be known among the geodesists but often neglected in practise. Therefore, the subject calls for further investigation to give more examples of the necessity of gravimetric corrections and to predict the magnitude of the gravimetric effect. In the current study the terrace reached a height of 30 meters. However the effect of higher terraces would be larger. A more extended discussion and numerical examples on the relation of height change and the gravity field change can be found in Talvik (2012). Using known information on the magnitude of the gravimetric correction, the effect of landforms with a different height can be predicted.

As mentioned, during the re-levelling of the Tallinn height network, a levelling section crossed the terrace on the same route. In their data processing, the gravimetric corrections were also used. It would be useful to compare the results of current research to the values obtained with the real levelling data. This would permit higher confidence in predicting the gravitational effect to precise levelling in similar areas elsewhere, also outside Estonia.

Summary

To evaluate the effect of gravity change along a levelling section, a field experiment on a terraced landform was conducted. Gravity data were acquired using a relative spring gravimeter; uncertainty of 0.07 mGal was achieved. Positioning was proceeded by using GPS technology; the uncertainty of achieved coordinates was likely not exceeding 0.15 m. Data collected were processed as if they had the accuracy of precise levelling.

Differences of height were converted into differences of geopotential number and later calculated into conventional normal height values. This process eliminates the effect of the Earth's gravity field from levelling results. By comparing the measured geometrical height differences with the gravimetrically corrected

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ones, the magnitude of the gravimetric effect was found. The results indicate a strong correlation between both the height change and gravity change along the levelling profile and the gravimetric correction.

The change of gravity values along the levelling profile proved to have a significant effect on the levelling results – 1.2 mm in case of the current Tabasalu example. This result is the basis on which to continue investigating the magnitude of the gravimetric effect to levelling in more challenging regions.

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