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Improving the terrestial gravity dataset in South-Estonia

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The only available gravity dataset covering the whole of Estonia has been observed from 1949 to 1958. This historic dataset has been used as a main input source for many applications including the geoid determination, the realization of the height system, the geological mapping. However, some recent studies have been indicated remarkable systematic biases in the dataset. For instance, a comparison of modern gravity control points with the historic data revealed unreasonable discrepancies in a large region in South-Estonia. However, the distribution of the gravity control was scarce, which did not allow to fully assess the quality of the historic data in the study area.

In 2008 a pilot project was called out as a cooperation between Estonian Land Board, Geological Survey of Estonia, Tallinn University of Technology and Estonian University of Life Sciences to densify the detected problematic area (about 2000 km^2) with new and reliable gravity data. Field work was carried out in October and November 2008, whereas GPS RTK and relative Scintrex gravimeter CG5 were used for precise positioning and gravity determinations, respectively. Altogether more than 140 new points were determined along the roads. Despite bad weather conditions and unstable observation base of the gravimeter (mostly on the bank of the road), uncertainty better than $\pm$0.1 mGal (1 mGal = 10^{-5} m/s^2) was estimated from the adjustment of gravimeter's readings. The separate gravity dataset of the Estonian Geological Survey were also incorporated into the gravity database of the project for further analysis. Those data were collected within several geological mapping projects in 1981–2007 and contain the data with uncertainty better than $\pm$0.25 mGal.

After the collection of new gravity data, a Kriging with proper variogram modeling was applied to form the Bouguer anomaly grids of the historic and the new datasets. The comparison of the resulting grids revealed biases up to -4 mGal at certain regions. Therefore it is strongly recommended to replace the historic gravity dataset with new one for forthcoming gravity field and geoid modelling works.