

GEOID COMPUTATION USING STOKES-HELMERT'S SCHEME OVER PENINSULAR MALAYSIA

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Abstract

The establishment of a high-accuracy vertical reference surface remains challenging in regions where gravity observations are heterogeneous and unevenly distributed. This study investigates gravimetric geoid determination over Peninsular Malaysia within the classical Stokes-Helmert framework, with particular emphasis on the influence of gravity data coverage and source configuration on the resulting solution. Terrestrial, airborne, and marine gravity observations were first harmonized through three-dimensional least-squares collocation (3D-LSC) to produce a consistent gridded representation of free-air gravity anomalies for subsequent geoid computation. Multiple Stokes-Helmert solutions were then generated under different spectral configurations to identify a suitable computational setting for the study region. The derived geoid surfaces were assessed using 45 independent GNSS-levelling stations distributed throughout Peninsular Malaysia. Following the removal of systematic discrepancies by means of a four-parameter fitting model, the selected solution yielded a standard deviation of 0.0389 m relative to the GNSS-levelling data. The sensitivity of the geoid solution to gravity data availability was further examined by systematically varying the combination of terrestrial, airborne, and marine observations used in the computation. These experiments revealed that the inclusion of airborne gravity data produces a notable improvement in areas where terrestrial observations are limited, particularly across the central part of the peninsula. The results show that the quality of regional gravimetric geoid determination depends not only on the computational formulation but also on the spatial complementarity of the gravity datasets. The study therefore provides an assessment of the Stokes-Helmert approach under the heterogeneous gravity-data conditions characteristic of Peninsular Malaysia and demonstrates the value of airborne gravity observations for strengthening geoid solutions in regions affected by terrestrial data gaps.