

Development of a Geoid Model for Luzon Island Using Least Squares Modification of the Stokes' Formula with Additive Corrections (LSMSA)

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Abstract

This study presents a local geoid model (LGM) for Luzon Island developed using the Least Squares Modification of the Stokes' Formula with Additive Corrections (LSMSA) method to contribute to the unification of the vertical reference system of the Philippines. Multiple gravity datasets—NAMRIA terrestrial, airborne, and DTU10 satellite altimetry-derived marine gravity data—were integrated with the GOCO2025s global geopotential model and IFSAR digital elevation model. Five satellite-only global geopotential models were evaluated, with GOCO2025s selected based on its lowest RMS of 0.802 m against GNSS/leveling-derived orthometric heights.

The gravimetric geoid was computed through sequential additive corrections and validated against 37 GNSS/leveling control points, yielding geoid heights ranging from 14.147 m to 66.051 m with a mean of 39.999 m. Validation against independent control points produced an RMS of 0.223 m and a mean bias of -0.052 m, comparable to the current Philippine Geoid Model 2018 (RMS: 0.245 m; mean bias: -0.169 m). The developed geoid model is a step in offering a physically meaningful height reference for geodetic and engineering applications. The results confirm an alternative geoid solution for Luzon and establish a replicable framework extensible to Visayas and Mindanao.

Keywords: Global Geopotential Model, Gravity Anomaly, GNSS/leveling-derived Orthometric Heights, Vertical Reference System, Mean Sea Level