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Derivation of Bathymetry from High-Resolution Satellite Images: Comparison of Empirical Methods through Geographical Error Analysis

Authors : Anusha P. Wijesundara, Dulap I. Rathnayake, Nihal D. Perera

Abstract : Bathymetric information is fundamental importance to coastal and marine planning and management, nautical navigation, and scientific studies of marine environments. Satellite-derived bathymetry data provide detailed information in areas where conventional sounding data is lacking and conventional surveys are inaccessible. The two empirical approaches of log-linear bathymetric inversion model and non-linear bathymetric inversion model are applied for deriving bathymetry from high-resolution multispectral satellite imagery. This study compares these two approaches by means of geographical error analysis for the site Kankesanturai using WorldView-2 satellite imagery. Based on the Levenberg-Marquardt method calibrated the parameters of non-linear inversion model and the multiple-linear regression model was applied to calibrate the log-linear inversion model. In order to calibrate both models, Single Beam Echo Sounding (SBES) data in this study area were used as reference points. Residuals were calculated as the difference between the derived depth values and the validation echo sounder bathymetry data and the geographical distribution of model residuals was mapped. The spatial autocorrelation was calculated by comparing the performance of the bathymetric models and the results showing the geographic errors for both models. A spatial error model was constructed from the initial bathymetry estimates and the estimates of autocorrelation. This spatial error model is used to generate more reliable estimates of bathymetry by quantifying autocorrelation of model error and incorporating this into an improved regression model. Log-linear model (R^2=0.846) performs better than the non- linear model (R^2=0.692). Finally, the spatial error models improved bathymetric estimates derived from linear and non-linear models up to R^2=0.854 and R^2=0.704 respectively. The Root Mean Square Error (RMSE) was calculated for all reference points in various depth ranges. The magnitude of the prediction error increases with depth for both the log-linear and the non-linear inversion models. Overall RMSE for log-linear and the non-linear inversion models were ±1.532 m and ±2.089 m, respectively.

Keywords : log-linear model, multi spectral, residuals, spatial error model
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