

MBES-CARIS Data Validation for the Bathymetric Mapping of Shallow Water in the Kingdom of Bahrain on the Arabian Gulf

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Abstract : The objectives of this paper are the validation and the evaluation of MBES-CARIS BASE surface data performance for bathymetric mapping of shallow water in the Kingdom of Bahrain. The latter is an archipelago with a total land area of about 765.30 km², approximately 126 km of coastline and 8,000 km² of marine area, located in the Arabian Gulf, east of Saudi Arabia and west of Qatar (26° 00' N, 50° 33' E). To achieve our objectives, bathymetric attributed grid files (X, Y, and depth) generated from the coverage of ship-track MBSE data with 300 x 300 m cells, processed with CARIS-HIPS, were downloaded from the General Bathymetric Chart of the Oceans (GEBCO). Then, brought into ArcGIS and converted into a raster format following five steps: Exportation of GEBCO BASE surface data to the ASCII file; conversion of ASCII file to a points shape file; extraction of the area points covering the water boundary of the Kingdom of Bahrain and multiplying the depth values by -1 to get the negative values. Then, the simple Kriging method was used in ArcMap environment to generate a new raster bathymetric grid surface of 30x30 m cells, which was the basis of the subsequent analysis. Finally, for validation purposes, 2200 bathymetric points were extracted from a medium scale nautical map (1:100 000) considering different depths over the Bahrain national water boundary. The nautical map was scanned, georeferenced and overlaid on the MBES-CARIS generated raster bathymetric grid surface (step 5 above), and then homologous depth points were selected. Statistical analysis, expressed as a linear error at the 95% confidence level, showed a strong correlation coefficient ($R^2 = 0.96$) and a low RMSE (± 0.57 m) between the nautical map and derived MBSE-CARIS depths if we consider only the shallow areas with depths of less than 10 m (about 800 validation points). When we consider only deeper areas (> 10 m) the correlation coefficient is equal to 0.73 and the RMSE is equal to ± 2.43 m while if we consider the totality of 2200 validation points including all depths, the correlation coefficient is still significant ($R^2 = 0.81$) with satisfactory RMSE (± 1.57 m). Certainly, this significant variation can be caused by the MBSE that did not completely cover the bottom in several of the deeper pockmarks because of the rapid change in depth. In addition, steep slopes and the rough seafloor probably affect the acquired MBSE raw data. In addition, the interpolation of missed area values between MBSE acquisition swaths-lines (ship-tracked sounding data) may not reflect the true depths of these missed areas. However, globally the results of the MBES-CARIS data are very appropriate for bathymetric mapping of shallow water areas.

Keywords : bathymetry mapping, multibeam echosounder systems, CARIS-HIPS, shallow water

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