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Validating the vertical quality of SRTM digital elevation model of the Mirim Lagoon hydrographic basin

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This work is part of a research project that aims at the automatic determination of knickpoints and the assessment of morphometric and hypsometric parameters of Mirim Lagoon Hydrographic Basin, using Shuttle Radar Topography Mission digital elevation model (SRTM-DEM) and spatial analyses.

The analysis of geomorphologic systems is done using computational treatment of data obtained by remote sensing, especially those obtained by SRTM. These data permit the elaboration of a topographic model for the Earth surface and provide a base for studies in several units of geomorphologic analyses (geomorphologic systems), such as hydrographic basins.

The most usual technique for derivation of relief morphologic attributes is based on digital elevation models (DEMs) and digital hydrographic nets. Computational routines are applied on those data for acquisition of the hydrography and drainage anomalies. The DEMs and the hydrographic nets must have either morphologic or hydrologic consistency to validate the results obtained in the morphometric analyses.

More specifically, this study aims at describing the method and related results regarding the validation of the vertical accuracy of SRTM-DEM through a kinematic positioning based on the Global Navigation Satellite System (GNSS), in the Mirim Lagoon Hydrographic Basin region. Mirim Lagoon Hydrographic Basin is as cross-border basin located on the Atlantic coast of South America, and covers an area of 58,407.78km^2, where 47% of this area is in Brazil and 53% in Uruguay.

Several studies deal with the validation of Digital Elevation Models (DEMs) and SRTM data using different GNSS surveying methods and receivers. The innovation of this work is the methodology developed to achieve the suitable accuracy for the control points coordinates to validate the SRTM-DEM of Mirim Lagoon Hydrographic Basin. The study used the kinematic relative positioning method with a recording rate of 1 second and without reference stations for post-processing with the precise point positioning (PPP) method. This methodology allowed covering a large area with reference stations being very far from the surveyed region and with different geodetic reference systems (two countries).

The methodology entails the GNSS data acquisition and post-processing, the transformation from geometric heights into orthometric heights, the SRTM-DEM mosaic, the extraction of homologous points in the SRTM-DEM and the statistical analyses for validating the model.

The study used a GNSS receiver of dual-frequency with recording rate of 1 second to collect a total of 275,916 points with 3D coordinates. Those points were post-processed using the PPP method with the Canadian Spatial Reference System – Precise Point Positioning (CSRS-PPP), and the ellipsoidal height was converted into orthometric height through the software INTPT geoid. During this work, we used the geopotential model (EGM96) to transform height differences between two countries, Brazil and Uruguay.

In order to obtain the SRTM-DEM we used 15 SRTM images, version 3, band C, with a spatial resolution of 1 arcsecond (approximately 30 m). These images were individually processed to obtain the Digital Elevation Model Hydrologically Consistent (DEMHC) and to treat the inconsistencies. Afterwards, we created a mosaic with the 15 images.

In the statistical analysis we examined the magnitude of absolute errors in the SRTM data. These errors were named discrepancies between the SRTM heights and the heights of GNSS survey points. After the post-processing and the heights conversion, the GNSS survey points were considered accurate and used as a reference for SRTM-DEM validation. The goal of the statistical analysis was to verify if the absolute vertical precision of the DEM data exceeds 16 m, according to the precision specifications of the DEM SRTM.

Results showed that the vertical mean absolute error of the SRTM-DEM vary from 0.07m to ± 9.9m with average of -0.28 m. This vertical accuracy is better than the absolute vertical accuracy value of ±16m published in the SRTM data

specification and validates the SRTM-DEM. Besides that, even considering different slopes and different heights the statistics showed that SRTM-DEM could be validated, in spite of the results for lower and flat area were more accurate than the ones for a higher area with high slope.

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