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Supporting Information

Supporting Information I

Bathymetry and Digital Bathymetric Model (DBM)

Planning of field activities and data acquisition were based on information obtained in the existing references and empirical knowledge of the region. For making the routes to be traveled, TrackMaker v.13.8 software (Ferreira Júnior, 2008) was used in laboratory where 33 transects were determined, spaced between the 500 meters and a length of approximately 7 km. Afterwards, certain points have been exported to the GPS receiver and navigation performed in the study area. The GPS receiver / probe was programmed to acquire bathymetric data every 10 seconds. The collection of bathymetric data was performed mainly during periods of quadrature tides, conditions in which occur the smallest variations of tide, minimizing the probability errors during the corrected data.

After carrying out the data process, bathymetric data were corrected in three steps: (1) removal of duplicate values, which occurred in cases where the trajectory of the vessel had to be interrupted; (2) tidal correction; and (3) adjustment of the vessel draft. Later, data were entered into a Geographic Information System (GIS).

The tidal correction applied in bathymetric data collected was conducted by using information from the tide gauge ruler of the Port of Natal – RN (about 60 km south of the study area), Brasil. Hourly measurements of tidal height were provided by the National Bank of Oceanographic Data (*Banco Nacional de Dados Oceanográficos* - BNDO). The correction of bathymetric data in relation to the tide height was conducted with the tidal variation in the time of collection of their bathymetric point, where it was added or subtracted to the cumulative value of depth in that sample.

From the obtained depth data *in situ* and corrected in the laboratory, a Digital Bathymetric Model (DBM) was generated. In this model, ArcMap 10.1 tool Empirical Baysian Kriging was used (ESRI, 2011). Empirical Bayesian Kriging (EBK) was utilized. EBK is a geostatistical interpolation method that automates the most difficult aspects of building a optimal model. It differs from other kriging methods because of its representation of errors introduced by estimating the underlying semivariogram. This makes the errors of prevision pattern more accurate than others kriging methods. Furthermore, the EBK stands to permit accurate predictions of moderately non-stationary data, and be more accurate than other kriging methods for small data sets (ESRI, 2011). To estimate margins of error the cross-validation of data was used. This consisted of estimating the observed annotations based upon the adjusted semivariogram model, making it possible to compare the estimated values to the real figures (Andriott, 2003). The DBM was generated with a spatial resolution of 60 m. Then, bathymetric profiles transversal to the modelled reef complex was extracted from DBM. In the analysis of these profiles, the zoning scheme described by Wright & Burchette (1996), for studies on coral reefs was utilized.

Finally, a Draping-3D was applied from the scene of the OLI/Landsat-8 (RGB-432) with the raster image generated by the DBM. Drape technique consists in generating a 3D wire model (Brooks & Whalley, 2008). In this step, ArcScene v10.1 software was used (ESRI, 2011).

References

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Supporting Information II

Orbital remote sensing products

The scene of OLI/Landsat-8 was obtained for free at the website of the US Geological Survey (USGS), via <www.earthexplorer.usgs.gov>. The scenes of MS/GeoEye-1 sensors and PAN/WorldView-1 were obtained through purchase and sale agreement, exclusively for this project (Rio do Fogo Project – Mapping of Underwater Features and Associated Benthic Habitats in "*Parrachos* of Rio do Fogo/RN": A Comparison of Remote Sensing Products and New Methods of Classification.

Tidal information was obtained from the electronic portal of the Board of Hydrography and Navigation (*Diretoria de Hidrografia e Navegação* - DHN) of the Navy of Brazil (*Marinha do Brasil* - MB), via <www.dhn.mar.mil.br>. We adopted the tide gauge of the Port of Natal-RN (about 60km south of the study area), for calibration of the tidal heights at the dates and times of imaging of the sensors studied in the area in focus. The tidal information was organized in the Table 1.

Table 1 - Tidal information on the used remote sensing products.
Tabela 1 - Informações maregráficas sobre os produtos de sensores remotos utilizados.

Sensor/satellite	Date of Imaging (dd/mm/aaa)	Time (GMT)	Local Time (GMT-03:00)	Tide height (m)	Tide
MS/GeoEye-1	3/1/2011	12:47:00	09:47:00	0.46	Low tide, rising.
PAN/WorldView-1	23/3/2011	13:03:00	10:03:00	1.21	Medium tide, decreasing.
OLI/Landsat-8	10/06/2013	12:30:00	09:30:00	0.94	Medium-low tide, decreasing.