NOAA COASTAL MAPPING PROGRAM
PROJECT COMPLETION REPORT

PROJECT FL1422A-TB-N

Dry Tortugas, Florida

Introduction

Coastal Mapping Program (CMP) Project FL1422A-TB-N provides highly accurate digital shoreline data for Dry Tortugas, Florida. Project FL1422A-TB-N is a subproject of a larger acquisition project, FL1422-TB-N, which extends from Dry Tortugas to Molasses Key, in Florida. The Geographic Cell (GC) may be used in support of the NOAA Nautical Charting Program (NCP) as well as geographic information systems (GIS) for a variety of coastal zone management applications.

Project Design

Project FL1422-TB-N was designed to provide topographic/bathymetric (topobathy) lidar data and vector Mean High Water (MHW) and Mean Lower Low Water (MLLW) contour data. Imagery acquisition was planned for the purpose of reviewing and verifying lidar, so the images were not captured with sufficient overlap for stereo coverage. The Requirements Branch (RB) of the Remote Sensing Division (RSD) formulated the mission instructions, which discussed the project's purpose, geographic area of coverage, scope and priority, imagery and lidar requirements, Global Positioning System (GPS) data collection procedures and guidelines, instructions for data recording and handling, and mission communication protocols. For further information, refer to the Project Instructions and Layout Diagrams, on file with other project data within the RSD Electronic Data Library.

Field Operations

The field operations consisted of acquisition of topobathy lidar data, digital aerial imagery, static and kinematic GPS data, and Inertial Measurement Unit (IMU) data. Static GPS data were collected to support aerial data acquisition and processing operations, as well as to assess the accuracy of post-processed lidar data.

Seven flight missions were conducted between March 14th and 23rd, 2015 with a NOAA Twin Otter Aircraft (N56RF) in which approximately 170 lines of topobathy lidar data and natural color aerial imagery were acquired concurrently at a nominal altitude of 1,000 feet. The lidar data was acquired using a Riegl VQ-820-G lidar system, and the aerial imagery was acquired with an Applanix Digital Sensor System (DSS) camera. The orthomosaic created from the imagery has an approximate ground sample distance (GSD) of 15 cm. All data was planned to be collected within a +/- 2 hour time window of the MLLW tide stage.

GPS/IMU Data Processing

GPS and IMU data were processed by RSD personnel to yield precise sensor positions and orientations for direct georeferencing (DG) of the imagery. Local GPS base stations were

established for use as a reference stations for kinematic GPS processing operations. The position of the base stations were determined using the NGS Online Processing User Service (OPUS), which computed fixed baseline solutions from nearby CORS stations. The airborne kinematic data was processed using Applanix POSPAC (ver. 7.1) software in March 2015.

Orthoimage Processing

Given the very large number of individual images acquired (more than 10,000) and the lack of stereo overlap between images, a single image orthomosaic was generated from the project imagery using a 30 meter digital elevation model (DEM) from the USGS National Elevation Dataset (NED). To assess the accuracy of the orthomosaic, the published locations of U.S. Coast Guard maintained navigational aids within the project area were compared with their positions as measured within the imagery. This assessment resulted in a calculated accuracy of 5.0 meters at the 95% confidence level. Positional data for this project is referenced to the North American Datum of 1983 (NAD 83).

Lidar Data Processing

Processing of lidar point cloud data was completed in November 2016 using the following steps:

1) Riegl's *RiProcess* pre-processing software to place the raw lidar into a point cloud with respect to a mapping projection,
2) Terrasolid's suite of lidar calibration and editing software to correct alignment, remove erroneous returns, and classify bare earth points,
3) NOAA's VDatum software to convert the vertical datum of the bare earth points from ellipsoidal NAVD88 to local tidal datums, and
4) GeoCue lidar processing software to produce MHW and MLLW DEMs at 1-meter grid resolution.

The journal article "Lidar-Derived National Shoreline: Empirical and Stochastic Uncertainty Analyses" (2010), published in the *Journal of Coastal Research*, contains more detailed information, and is on file in the RSD Project Archive.

Compilation

The data compilation phase of this project was completed in January 2019 by RSD personnel, and included both automated feature extraction from lidar and manual extraction from orthomosaic imagery. During the automated extraction phase, shoreline vectors were delineated using MHW and MLLW DEMs and a contouring script implemented within Esri's ArcGIS software environment. The orthomosaic image was subsequently used to review, edit, and attribute the lidar shoreline vectors. Based on the study referenced in the lidar processing section above, the lidar derived shoreline vectors were compiled to meet a horizontal accuracy of 1.4 meters (MHW) and 1.8 meters (MLLW) at the 95% confidence level.

Manual compilation was performed for the remaining portions of the project. Features were compiled from the orthomosaic image described above. Features extracted from this imagery were tested to have a horizontal accuracy of 8.0 meters at the 95% confidence level based on comparison to at least 20 checkpoints of higher accuracy.

Quality Control / Final Review

Quality control tasks were conducted during all phases of project completion by senior members of RSD. The final QC review was completed in March 2019. The review process included analysis of the DG results and assessment of the identification and attribution of digital feature data within the GC according to image analysis and criteria defined in C-COAST. The quality control process concluded with an inspection of topological connectivity within the GC using ArcGIS 10.5.1 software. All project data was evaluated for compliance to CMP requirements.

Comparisons of the largest scale NOAA nautical charts with source imagery and compiled project data resulted in creation of the Chart Evaluation File (CEF). The following nautical chart was used in the comparison process:

- 11438, 14th Ed., Nov. 2012

End Products and Deliverables

The following specifies the location and identification of the products generated during the completion of this project:

Remote Sensing Division Electronic Data Library

- Project database
- GC11471 in shapefile format
- Project Completion Report (PCR)
- CEF in shapefile format

NOAA Shoreline Data Explorer

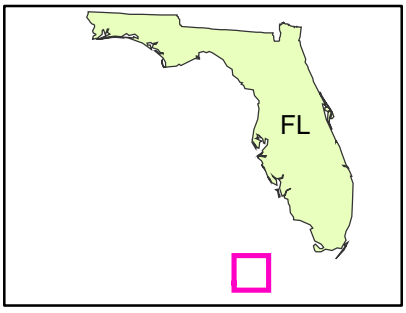
- GC11471 in shapefile format
- Metadata file for GC11471
- PCR in Adobe PDF format

End of Report

DRY TORTUGAS

FLORIDA

Overview



FL1422A-TB-N

GC11471