NOAA COASTAL MAPPING PROGRAM
PROJECT COMPLETION REPORT

PROJECT NJ1303-TB-N

Great Egg Harbor Inlet, New Jersey

Introduction

NOAA Coastal Mapping Program (CMP) Project NJ1303-TB-N provides a highly accurate database of new digital shoreline data for Great Egg Harbor Inlet, New Jersey. The project area includes the Great Egg Harbor Inlet, Ocean City, Longport, Margate City as well as portions of Great Egg Harbor Bay. 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

The Requirements Branch (RB) of the Remote Sensing Division (RSD) formulated the photographic mission instructions for this project following the guidelines of the Photo Mission Standard Operating Procedures. The instructions discussed the project's purpose, geographic area of coverage, scope and priority, imagery and lidar data acquisition requirements, orthophoto creation, tide-coordination, Global Positioning System (GPS) and Inertial Measurement Unit (IMU) data collection procedures and guidelines, instructions for data recording and handling, and mission communication protocols. RB created a Project Layout Diagram, flight maps and input files for the aircraft flight management system.

Field Operations

The field operations consisted of acquisition of topobathy lidar data, digital aerial imagery, static GPS data, and kinematic GPS and 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.

Lidar Data Acquisition

Fifty-three (53) lines of Topographic/Bathymetric (topobathy) lidar were acquired on September 25th, 28th, and 29th of 2013 using a Riegl VQ820G LIDAR system on board the NOAA Twin Otter aircraft (N46RF). The topobathy lidar data were collected within a two hour time window of the Mean Lower Low Water (MLLW) tide stage at a nominal altitude of 1,000 feet with a 50% swath overlap resulting in a single swath point density of eighteen points per square meter.

Digital Aerial Imagery Acquisition

Six (6) lines of natural color (NC) and near-infrared (NIR) digital aerial imagery (378 images of each type) were collected on September 27, 2013 using an Applanix Digital Sensor System 439 (DSS439) dual camera onboard the NOAA King Air aircraft (N68RF). The imagery was collected at a mid-tide stage and at a nominal altitude of 4,000 feet with a ground sample distance (GSD) of 0.14m. The NIR imagery was not used in the compilation of this project.

For both acquisitions, base stations were established at the Atlantic City airport (KACY) and within the project site, using static GPS. Airborne kinematic GPS/IMU data were collected to determine precise sensor positions for both the lidar and camera systems.

GPS/IMU Data Processing and Direct Georeferencing

GPS and IMU data were processed by RSD personnel to yield precise positions and orientations of the digital camera and lidar sensor to support direct georeferencing (DG) of the aerial imagery and further processing of the lidar data. A local GPS base station was established for use as a reference station for kinematic GPS processing operations. The position of the base station was 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. 5.4) software in October of 2013. For further information refer to the Airborne Positioning and Orientation Report (APOR) on file with other project data within the RSD Electronic Data Library.

The processed GPS/IMU data were used to derive precise exterior orientation (EO) values of the camera centers required for digital feature extraction. The predicted horizontal accuracy of the imagery was determined by propagating sensor EO and image measurement uncertainties through the photogrammetric collinearity equations using an Excel spreadsheet based Exterior Orientation Total Propagated Uncertainty (EO-TPU) tool developed by NGS. Using this tool, the predicted horizontal uncertainty at the 95% confidence level was calculated to be 0.4 meters.

An NGS third order geodetic control point ("Flanders Hotel Cupola") was used to verify the horizontal integrity of the DG data. All stereo-models were examined and found to have acceptable levels of parallax for mapping purposes.

LIDAR Data Processing

Lidar point cloud data were processed in October 2013. Riegl RiProcess software was utilized to transform the lidar point cloud into a mapping projection, check the calibration stability, and perform refraction corrections to bathymetric returns. Terrasolid software was utilized for editing of the lidar point cloud, and for classification of water surface, erroneous returns, bathymetric surface and bare earth points. NOAA VDatum software was used to convert the vertical datum of the lidar points from NAD83 ellipsoid to local Mean High Water (MHW) and local MLLW tidal datums. GeoCue lidar processing software was used to produce bare earth MHW and MLLW digital elevation models (DEMs) at 1 meter grid resolution.

To determine accuracy the lidar point cloud was compared to higher accuracy ground control points and the morphologic slope around the derived shoreline for 391 sample sites in the project area (117 for MHW and 274 for MLLW vectors). Based on this assessment the MHW lidar derived shoreline vectors are tested to have a circular error at the 95% confidence level (CE95) of 0.6 meters, and the MLLW lidar derived shoreline vectors are tested to have a CE95 of 1.6 m.

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 Electronic Data Library.

Compilation

The data compilation phase of this project was completed in August 2015 by RSD personnel and accomplished in two phases: Automated extraction from topobathy lidar and manual extraction using digital stereo imagery.

1) Lidar Shoreline approach: MHW and MLLW shoreline vectors (in shapefile format) for the outer coastline were delineated using the DEMs discussed above with a Raster-to-Vector (R2V) script implemented within ESRI ArcGIS 10.2 software. Subsequently, the September 27, 2013 stereo imagery was used to review, edit, and attribute the lidar shoreline vectors. The lidar derived shoreline data were limited to terrain features at the land/water interface and did not include engineered, elevated features such as bulkheads, piers, bridges, Landmarks, etc. The MHW ("Shoreline") and MLLW ("Contour") shape files were then imported into BAE Systems SOCET SET (SS) software, and a Feature Database (FDB) was created.

2) Manual Compilation approach: The FDB, created above, was subsequently populated with additional features compiled using the SS Feature Extraction software module in combination with the stereo-images. This served to integrate all coastal features within a single FDB. The manual data compilation phase utilized the traditional RSD digital mapping approach of manual interpretation integrated within a "heads-up" digitizing environment.

Spatial data accuracies for Project NJ1303-TB-N were determined using the methods described above. The lidar derived MHW and MLLW features are tested to have horizontal accuracies of 0.6 meters and 1.6 meters respectively at the 95% confidence level. Cartographic features derived manually from the stereo imagery were compiled to meet a horizontal accuracy of 0.8 meters at the 95% confidence level; double the uncertainty calculated using the EO-TPU tool.

The following table provides information on the aerial imagery used to complete this project:

Date	Time (UTC)	Roll Number	Strip	Photo Numbers	GSD (nominal)	Tide Level *
9/27/2013	13:12 – 13:16	13NC71	120009	21209 – 21271	0.14 m	0.4, 0.7
9/27/2013	13:20 – 13:24	13NC71	120010	21272 – 21334	0.14 m	0.5, 0.7
9/27/2013	13:29 – 13:33	13NC71	120011	21335 – 21397	0.14 m	0.5
9/27/2013	13:37 – 13:41	13NC71	120012	21398 – 21460	0.14 m	0.5
9/27/2013	13:45 – 13:49	13NC71	120013	21461 – 21523	0.14 m	0.5
9/27/2013	14:41 – 14:45	13NC71	120020	21371 – 21793	0.14 m	0.7

* Tide levels are given in meters above MLLW and are based on verified observations at the Atlantic City reference station, with corrections applied to various substations in the vicinity of the project. When two tide levels are given, the first number is the tide level on the outer coast, and the second number is the tide level in the back bay. Photo strips with just one listed tide level cover only the back bay area. The height of the MHW tidal datum in the overall project area varies between 0.9 – 1.5 meters above MLLW.

Quality Control / Final Review

Quality control tasks were conducted by RSD personnel and the final QC review was completed in February, 2016. The review process included analysis of aerotriangulation 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 10.2 software. All project data was evaluated for compliance to CMP requirements.

Comparisons of the largest scale NOAA nautical charts with natural color photographs and compiled project data resulted in creation of the Chart Evaluation File (CEF). The following nautical charts were used in the comparison process:

12316, Little Egg Harbor to Cape May, NJ, 1:40,000 scale, 35th edition, 10/12
12318, Little Egg Inlet to Herefod Inlet, NJ, 1:80,000 scale, 45th edition, 04/10

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

- Airborne Positioning and Orientation Report (APOR)
- Project Completion Report (PCR)
- Project database
- GC11179 in shapefile format
- CEF in shapefile format

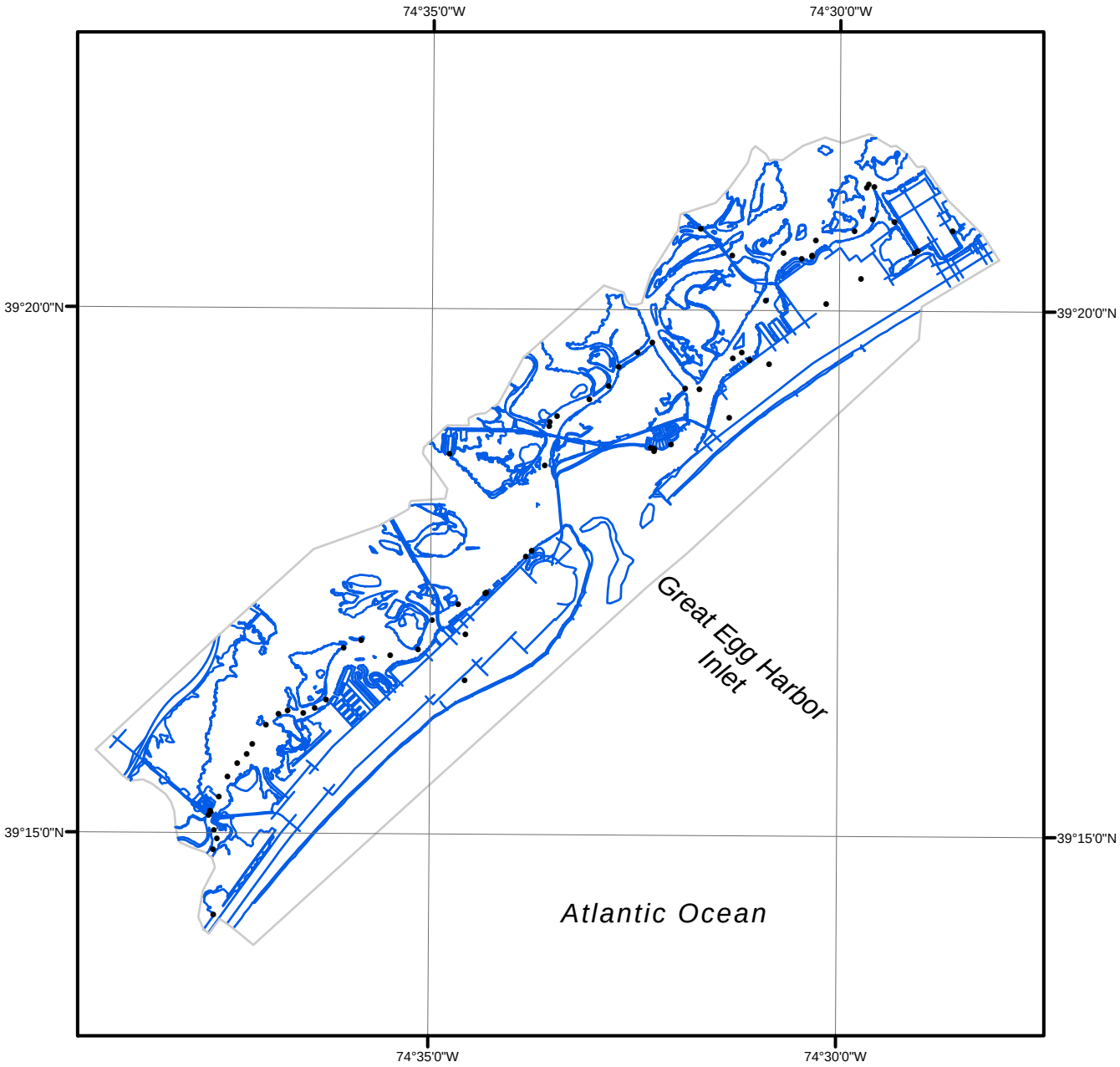
NOAA Shoreline Data Explorer

- GC11179 in shapefile format
- Metadata file for GC11179
- Digital copy of the PCR in Adobe PDF format

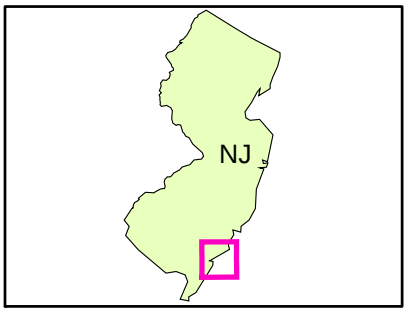
End of Report

GREAT EGG HARBOR INLET

NEW JERSEY



Overview



NJ1303-TB-N

GC11179