

NOAA COASTAL MAPPING PROGRAM PROJECT COMPLETION REPORT

PROJECT PR0801

Las Mareas, Puerto Rico

Introduction

NOAA Coastal Mapping Program (CMP) Project PR0801 provides a highly accurate database of new digital shoreline data for the southern coastal areas of Puerto Rico from Playa de Salinas to Puerto Arroyo. Other significant geographical features include Bahia de Jobos and the port of Las Mareas.

Successful completion of this project resulted in a densification of the National Spatial Reference System (NSRS), a set of controlled metric-quality aerial photographs, and digital feature data of the coastal zone which complements the Nautical Charting Program (NCP) as well as geographic information systems (GIS) for a variety of coastal zone management applications.

The project database consists of information measured and extracted from digital aerial images and metadata related to photogrammetric compilation. Base mapping was conducted in a digital environment using stereo softcopy photogrammetry and associated cartographic practices.

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, image requirements, flight line priority, Global Positioning System (GPS) data collection procedures and guidelines for both kinematic and static surveys, data recording and handling instructions, and contact and communication information. RB created a Project Layout Diagram, flight maps and input files for the aircraft flight management system. Note that the flight lines were re-planned in the field to accommodate a different camera and lens configuration than was originally intended in the project instructions.

Field Operations

The field operations consisted of the collection of static and kinematic Global Positioning System (GPS) data and Inertial Measurement Unit (IMU) data, and the acquisition of digital aerial imagery. Aerial survey operations were conducted on 4/9/2008 and 4/18/2008 with the NOAA Cessna Citation II aircraft. All imagery was acquired using an Applanix DSS-439 dual camera system (RGB & IR) with 60 mm lenses. The imagery was acquired in two overlapping blocks at different flying heights. Lines 48-001 through 48-003 were flown on 4/9/2008 between 18:50 and 19:09 (UTC) in coordination with the MLLW tide stage, at a nominal altitude of 13,000 feet, resulting in an approximate ground sample distance (GSD) of 0.45 meters. Lines 66-001 through 66-005 were flown on 4/18/2008 between 19:58 and 20:26 (UTC), at a nominal altitude of 17,500 feet, resulting in an approximate GSD of 0.60 meters. Lines 66-001 through

66-005 were not tide-coordinated. Additional lines were planned in the higher altitude block to cover the inland portion of the Jobos Bay watershed, but they were not successfully acquired.

GPS Data Reduction

The GPS/IMU data were processed by RSD personnel to yield precise camera positions and orientations for use in the georeferencing phase of the project. The San Juan WAAS 1 (ZSU1) CORS station was used as a reference station for kinematic GPS processing operations. The airborne kinematic data was processed using Applanix POSPAC (ver. 4.4) software in May 2008. For further information refer to the Airborne Positioning and Orientation Reports (APOR) on file with other project data within the RSD Applications Branch (AB) Project Archive.

Georeferencing

Direct Georeferencing (DG) methods using the processed kinematic GPS/IMU data were applied to establish precise exterior orientation (EO) values of the camera centers required for digital feature extraction. This work was accomplished by AB personnel in November 2009 using BAE Systems SOCET SET (version 5.4.1) photogrammetric software with the BINGO frame import module. The horizontal accuracy of well-defined image features 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. The predicted horizontal uncertainty at the 95% confidence level was determined to be 1.8 meters for the April 9th photos, and 2.6 meters for the April 18th photos, using the EO-TPU tool.

Six NGS 3rd- Order geodetic control stations were used as check points to test the horizontal integrity of the DG data. Measurements of the check points in the stereo-models were compared to their published coordinates resulting in an average offset of 0.7 meters. All stereo-models were examined and found to be free of excessive parallax and suitable for mapping purposes.

A Georeferencing Report containing further information regarding this process was written and is on file with other project data within the RSD Project Archive.

Compilation

The data compilation phase of this project was initiated by RSD in November 2009. Digital mapping was performed using the SOCET SET Feature Extraction software module. Feature identification and attribution within the Geographic Cell (GC) were based on image analysis of the aerial photographs and information extracted from the largest scale NOAA nautical charts, the US Coast Guard Light List, and other ancillary sources. Feature attribution was assigned in compliance with the Coastal Cartographic Object Attribute Source Table (C-COAST), which provides the definition and attribution scheme for the full range of cartographic features pertinent to the CMP. Selected features were further modified with additional descriptive information to refine general classification.

Spatial data accuracies for project PR0801 were determined according to standard Federal Geographic Data Committee (FGDC) practices. Cartographic features compiled from the April 9th imagery were compiled to meet a horizontal accuracy of 3.6 meters and features compiled from the April 18th imagery were compiled to meet a horizontal accuracy of 5.2 meters. These

predicted accuracies of compiled, well-defined points are derived by doubling the CE95 values computed from the EO-TPU tool.

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

Date	Time (UTC)	Roll Number	Photo Numbers	GSD (Nominal)	Tide Level*
4/09/2008	18:50 – 19:09	08NC03	0615 – 0668	0.45 m.	-0.1
4/09/2008	18:50 – 19:09	08NR02	0246 – 0299	0.45 m.	-0.1
4/18/2008	19:58 – 20:26	08NC08	2262 – 2340	0.60 m.	0.1
4/18/2008	19:58 – 20:26	08NR06	1508 – 1586	0.60 m.	0.1

*Tide levels are given in meters above MLLW, and were calculated using the Pydro software tool with a TCARI grid referenced to verified water level observations at NOS gauges. The height of Mean High Water above the MLLW datum in the project area is about 0.2 meters.

Quality Control / Final Review

Quality control tasks were conducted during all phases of project completion by a member of the Applications Branch. The final QC review was completed in March 2010. 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 9.3 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 charts were used in the comparison process:

25677, Guanica Light To Punta Tuna Light, PR, 1:100,000, 21st Ed., Nov. /08
25687, Bahia de Jobos and Bahia de Rincon, PR, 1:20,000, 12th Ed., May /03
25689, Puerto Arroyo, PR, 1:20,000, 9th Ed., July /01

End Products and Deliverables

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

RSD Applications Branch Archive

- Hardcopy of the Airborne Positioning and Orientation Report (APOR)
- Hardcopy of the Project Completion Report (PCR)
- Page-size graphic plot of GC10811 file contents, attached to PCR

Remote Sensing Division Electronic Data Library

- Project database
- GC10811 in shapefile format
- Digital copy of the PCR in Adobe PDF format
- Chart Evaluation File in shapefile format

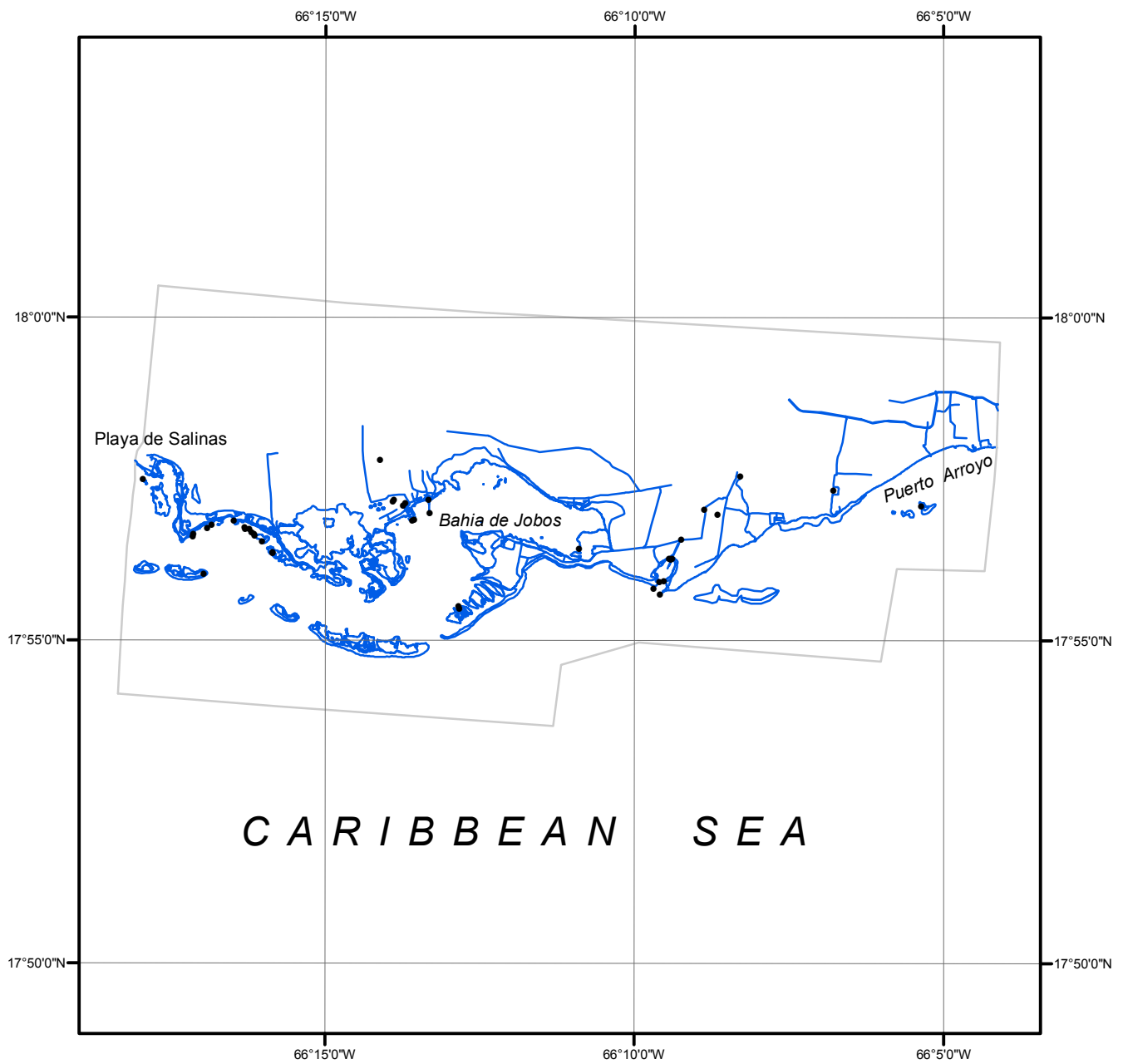
NOAA Shoreline Data Explorer

- GC10811 in shapefile format
- Metadata file for GC10811
- Digital copy of the PCR in Adobe PDF format

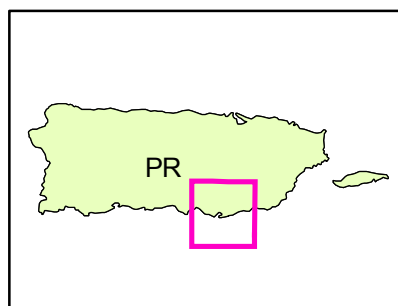
End of Report

LAS MAREAS

PUERTO RICO



Overview



PR0801

GC10811