NOAA COASTAL MAPPING PROGRAM
PROJECT COMPLETION REPORT

PROJECT PR0804

Approaches to San Juan, Puerto Rico

Introduction

NOAA Coastal Mapping Program (CMP) Project PR0804 provides a highly accurate database of new digital shoreline data for the coastal areas of Puerto Rico in the vicinity of San Juan, between Punta Fraile in the west and Laguna de Pinones in the east.

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

Project PR0804 was designed per a request from the Navigation Services Division (NSD) of the Office of Coast Survey (OCS) to provide new shoreline to support the creation of a new 1:20,000 scale nautical chart covering the approaches to San Juan Harbor. 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 Procedure. 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's flight management system.

Field Operations

The field operations consisted of the collection of kinematic Global Positioning System (GPS) and Inertial Measurement Unit (IMU) data and the acquisition of digital aerial imagery. The photographic mission operations were conducted on April 09, 2008, with the NOAA Cessna Citation II (N52RF) aircraft. All imagery was acquired through the use of an Applanix DSS-439 dual camera system (RGB/IR) with dual 60 mm lenses at an approximate ground sample distance (GSD) of 0.34 meters. The project consisted of

three flight lines, with 114 images acquired by each camera. All imagery was flown in coordination with the MLLW tide stage.

Airborne kinematic GPS/IMU data was collected to determine precise camera positions and orientations in order to establish a control network necessary for aerotriangulation. Data collection operations were conducted in accordance with the GPS Controlled Photogrammetry Field Operations Manual. No ground control survey operations were required for this project.

GPS Data Reduction

GPS and IMU data was processed by RSD personnel to provide precise positions of camera centers for application as photogrammetric control in the aerotriangulation phase of project completion. 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 Report (APOR) on file with other project data within the RSD Applications Branch (AB) Project Archive.

Aerotriangulation

Routine softcopy aerotriangulation methods were applied to establish a network of precise camera positions and other control for mapping, and to provide model parameters and orientation elements required for digital compilation. This work was initiated by RSD personnel in September 2009 utilizing a Digital Photogrammetric Workstation (DPW), which is a configuration of computer hardware, modular software components, and other associated peripheral devices. The digital images were measured and adjusted as a single block using BAE Systems SOCET SET (version 5.4.1) photogrammetric suite in conjunction with the Multi-Sensor Triangulation (MST) software module. Upon successful completion of the aerotriangulation process, the MST software provided the standard deviations for each aerotriangulated ground point, which were used to compute a predicted horizontal circular error of 0.50 meters based on a 95% confidence level. An Aerotriangulation Report was written and is on file with other project data within the RSD Project Archive.

The project database consists of project parameters and options, camera calibration data, interior orientation parameters, ground control parameters, adjusted exterior orientation parameters, and positional listing of all measured points. Positional data is referenced to the North American Datum of 1983 (NAD 83).

Compilation

The data compilation phase of this project was initiated by RSD in October 2009. Digital mapping was performed using a DPW in conjunction with 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 appropriate NOAA nautical charts, 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 PR0804 were determined according to standard Federal Geographic Data Committee (FGDC) practices. Cartographic features were compiled to meet a horizontal accuracy of 1.0 meters at the 95% confidence level. This predicted accuracy of compiled, well defined points is derived by doubling the circular error calculated from the aerotriangulation statistics.

The following table provides information on the digital imagery used in the project completion:

Date	Time (UTC)	Roll Number	Photo Numbers	GSD (Nominal)	Tide Level*
04-09-08	19:32-19:37	08NC03	0669-0699	0.34 m.	-0.03
04-09-08	19:40-19:47	08NC03	0700-0750	0.34 m.	-0.04
04-09-08	19:52-19:56	08NC03	0751-0782	0.34 m.	-0.05
04-09-08	19:32-19:37	08NR02	0300-0330	0.34 m.	-0.03
04-09-08	19:40-19:47	08NR02	0331-0381	0.34 m.	-0.04
04-09-08	19:52-19:56	08NR02	0382-0413	0.34 m.	-0.05

*Tide levels are given in meters above MLLW and are based on verified observations recorded by the NOS gauge at San Juan, PR. The height of Mean High Water at the San Juan gauge is 0.40 m.

Quality Control / Final Review

Quality control tasks were conducted during all phases of project completion by a senior member of AB. The final QC review was completed in January 2010. 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 9.2 software. All project data was evaluated for compliance to CMP requirements.

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

25668, North Coast of Puerto Rico, PR, 1:100,000, 20th Ed., Oct. 2008
25670, Bahia de San Juan, PR, 1:10,000, 43rd Ed., Jul. 2005

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 Aerotriangulation Report
- Hardcopy of the Project Completion Report (PCR)
- Page-size graphic plot of GC10797 file contents, attached to PCR

Remote Sensing Division Electronic Data Library

- Project database
- GC10797 in shapefile format
- Digital copy of the PCR in Adobe PDF format
- Chart Evaluation File in shapefile format

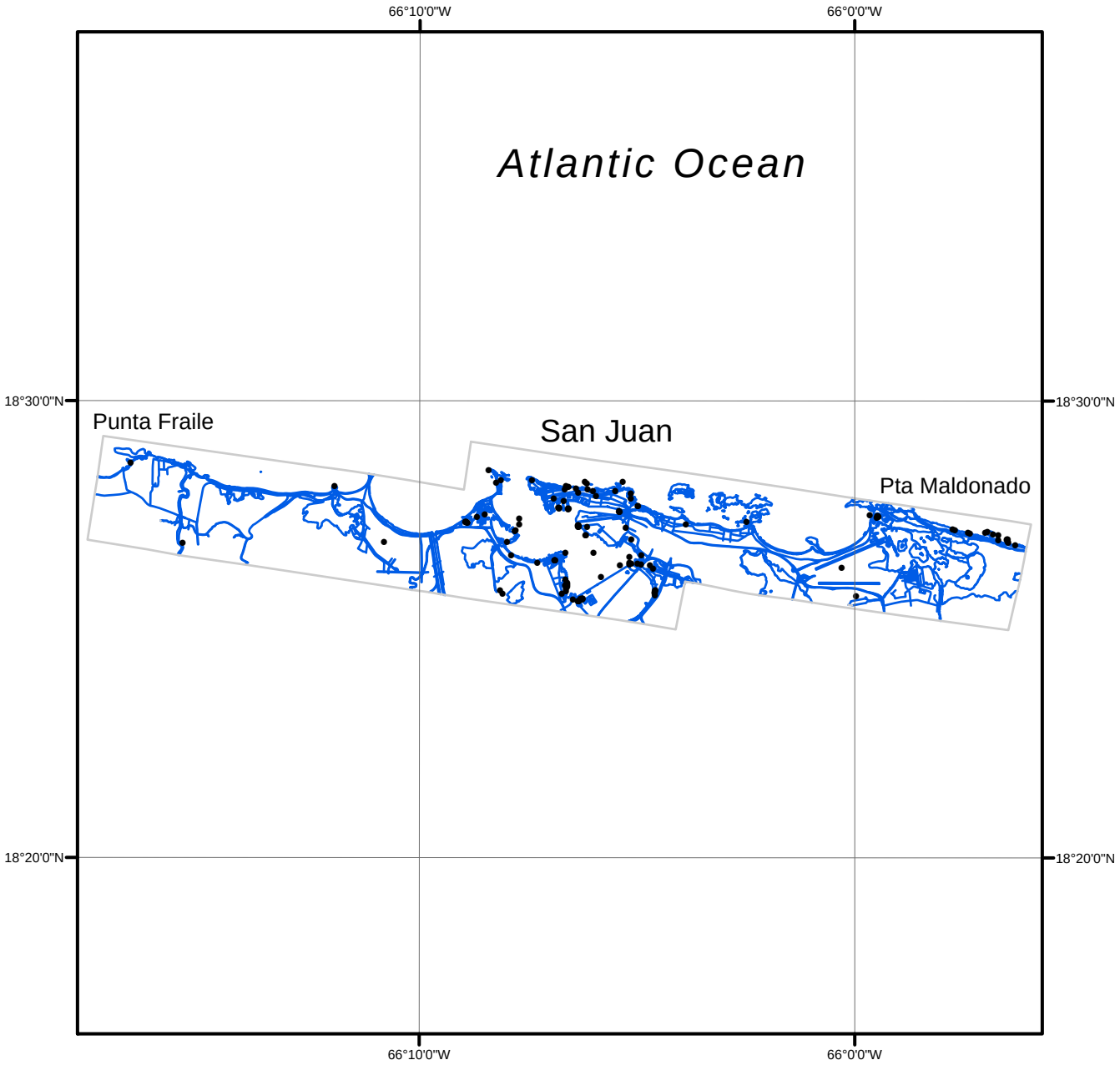
NOAA Shoreline Data Explorer

- GC10797 in shapefile format
- Metadata file for GC10797
- Digital copy of the PCR in Adobe PDF format

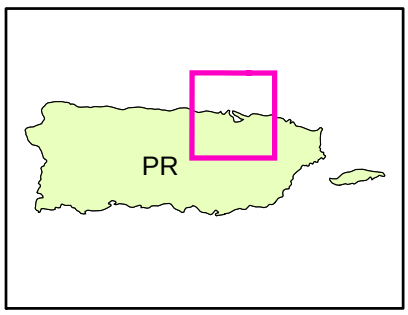
End of Report

APPROACHES TO SAN JUAN

PUERTO RICO



Overview



PR0804

GC10797