Tidal Stations and Bench Marks: Tools for spatial information managements

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INTRODUCTION

- The Puerto Rico Seismic Network (PRSN) at the Geology Department with in the College of Arts and Sciences of the University of Puerto Rico at Mayagüez, proposes to install a Puerto Rico Tsunami Ready Tide Gauge Network which will include 6 tsunami ready tide gauge stations and a central receiving station.
- All sites will fulfill the requirements of the National Oceanographic and Atmospheric Administration (NOAA), National Ocean Service (NOS), Center for Operational Oceanographic Products and Services (CO-OPS) network and follow the guidelines of the National Tsunami Hazard Mitigation Program.

Personnel

- Christa von Hillebrandt – PI, Director PRSN
- Dr. Victor Huerfano – Co-PI, Sub-director PRSN
- Prof. Aurelio Mercado – Co-PI, Marine Science Dept.
- Prof. Linda Velez – Co-PI, Civil Eng.& Land Surveying Dept.
- Sra. Jeanette Lopez
- Sr. Juan Lugo
- Sr. Javier Santiago
- Sr. Celestino Lucena
- Analista de Sistemas
- Sr. Javier Rivera – Web Development
- Estudiante Graduado

FUNDING

- Federal Emergency Management Agency (FEMA) funded Puerto Rico Tsunami Warning and Mitigation Program
  - FEMA 1552 DR-PR, Project PR-008
  - PR Tsunami Ready Tide Gauge Stations

Budget

	Federal	UPR	Total
Personnel	$36,203	$136,778	$172,981
Fringe	2,570	47,933	51,568
Travel	3,200	15,500	18,700
Equipment	513,655		513,655
Materials	10,000		10,000
	$565,628	$200,211	$765,839

Contribution of Puerto Rico Emergency Management Office to Project: $25,000

Time Line

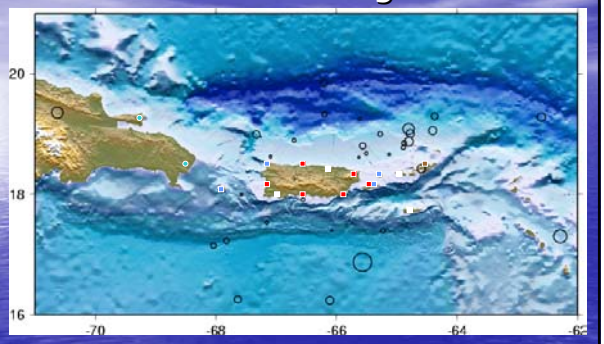
Setup account at UPRM	1 month-Oct. 2005
Bidding Process	2 months-Nov-Dec. 2005
Awarding Bid	1 month-January 2006
Reconnaissance	1 month-Feb. 2006
Civil Works at Field Stations and Base Station	4 months-March-June 2006
Installation of 6 Tide Gauge Stations, Surveying	3 months-July-Sept 2006
Installation of Base Station, Surveying	1 month-Oct. 2006
Tide Stations Testing and Training, Surveying	2 month-Nov-Dec 2006
Integration of Tide Gauges to PRSN operations	3 months-Jan-March 2007
Installation and Integration of Siren	1 month-April 2007
Development of Protocol	1 month-May 2007
Testing of Tsunami Warning System	1 month-June 2007
Fine Tuning of Network and Warning System	1 month-July 2007
Inspection	1 month-August 2007
Closing project	1 month-Sept. 2007

- **Total estimated time for project completion 2 years**

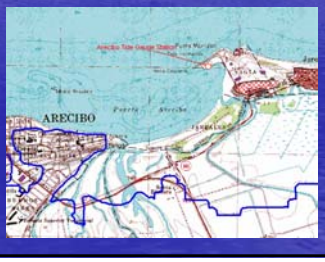
Objectives of the Project

- Install tsunami ready tide gauges in Arecibo, Mayagüez, Peñuelas, Yabucoa, Fajardo and northern Vieques.
- Install a central receiving site for the tide gauge data which will be analyzed along with earthquake information as is done in the Pacific and West Coast and Alaska Tsunami Warning Centers.
- Level and Monument the tide gauge stations according to NGS standards so that the data of the tide stations are incorporated into the systems of NOS and other agencies. This is very important because it will provide quality control for the data.
- Review the tsunami protocol for Puerto Rico
- Install a siren in a tsunami threatened community to broadcast tsunami and other emergency information.

Puerto Rico Tide Gauge Network

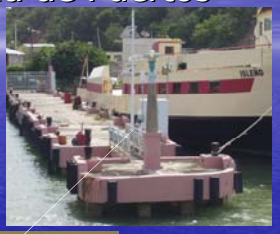


Arecibo Autoridad de Puertos



Arecibo 7809

Fajardo-Autoridad de Puertos

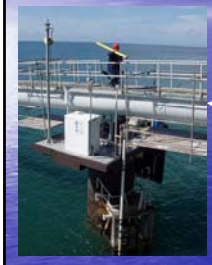


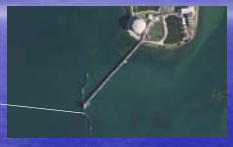
Fajardo 3216

Vieques - Isabel II, Autoridad de Transporte Maritimo (ATM)

Vieques 2619

Bahía de Tallaboa, Peñuelas Facilidades de Eco Eléctrica





Peñuelas 8053

Mayagüez
Comisión de Puertos de Mayagüez

Mayagüez 9394

Yabucoa
Sun Oil Refinery-Autoridad de Puertos

Yabucoa 4228

Equipment

- Primary Sensor
  - Aquatrack acoustic water level sensor assembly
  - Tube (air) temperature sensors (two are required for proper Aquatrack operation)
  - Water temperature sensor
  - NOS G3 Main station with Satlin II, XPert with display, 4 additional com ports, voice modem,
  - XPert analog and digital I/O modules, I/O termination card and Enclosure
  - GOES Yagi antena
  - Solar panel with regulator
  - Power supply
  - GPS antena
  - GOES satellite transmitter
  - Cables
  - Battery
  - Secondary telemetry –dialup modem or ethernet

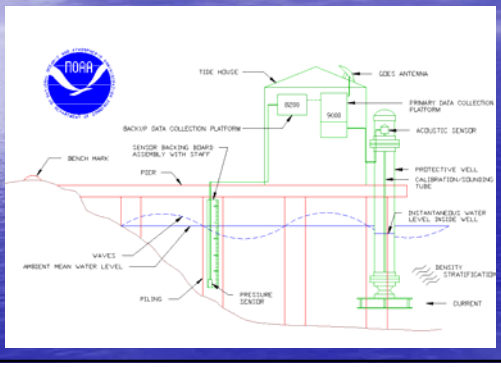
Equipment

- The redundant gauge will include the following
  - NOS G3 Redundant Gauge Expert without display, 4 additional com ports, voice modem, XPert analog and digital I/O modules and Enclosure
  - Pressure sensor or bubbler gauge and peripheral materials.
  - Battery
  - Power supply
  - Cables

Meteorology Package

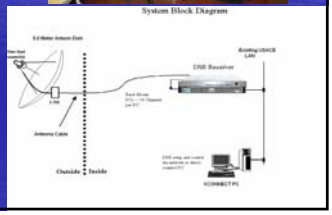
- Wind sensor
- Air temperature/relative humidity sensor
- Barometric pressure sensor
- Cables and hardware for mounting

Layout of Station



Central Receiving Site

- 5 Meter Dish
- Feed /LNB filter
- 16 channel DSR-HDDRGS
- Brackets and Cable
- Database Server
- Work station
- XConnect Software



Engineering Services

- Tide Gauge Station
  - shelter
  - stilling well
  - tower
  - telemetry package
  - sensors
- Central Site
  - Construction of concrete pad for satellite dish
  - Installation of dish, DSR and server
  - Wiring between dish, DSR and server
  - Installation of software

Peñuelas-Eco Eléctrica as an example of what was done

Recovery of Tidal Bench Marks at Peñuelas-Eco Eléctrica

Recovery of Tidal Bench Marks (TBM) at Peñuelas-Eco Eléctrica

Es necesario tener 5 BM's por primera vez, luego del quinto año se añade 1 BM por año hasta obtener 10 BM's al decimo año.

Monumentation of the Tide Gauge Stations

Monumentation – 8053E Tidal Bench Mark at Eco-Electrica



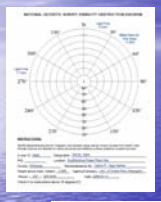

GPS Observations at the Tide Gauge Stations

5.5hr.of Observation for 3 days


NGS Forms

- GPS Station Observation Log
- Updated Station Description
- Visibility Obstruction Form
- Pencil Rubbing of BM
- Photographs of Station

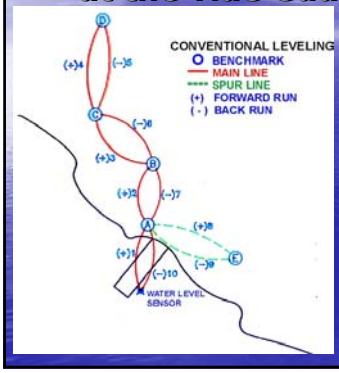
NGS Forms and Data Requirements





Leveling at the Tide Gauge Stations

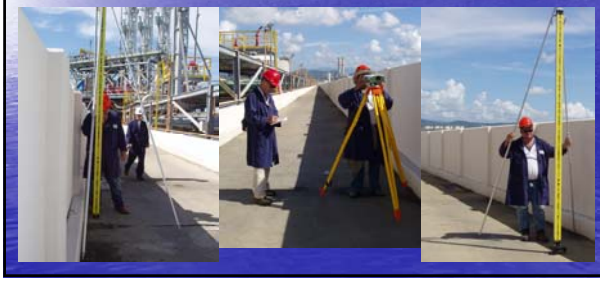
Leveling at the Tide Gauge Stations



- Second-order, class I levels shall be used in connections at all primary and secondary control stations. Although third-order levels may be used at all other stations, the on-site, self checking capability inherent in second-order levels warrants its use if at all feasible.

Leveling at the Tide Gauge Stations at Peñuelas-Eco Eléctrica

Leveling at the Tidal Bench Mark Stations Peñuelas-Eco Eléctrica



Other Components

- Siren System
  - In coordination with the emergency management agency an appropriate site in Mayagüez will be chosen to install such a system. The corresponding protocol will be established for operating such a system. Drills and orientations will be held in the community in which the siren is installed. The community chosen for the siren will also be guided towards receiving the "Tsunami Ready Community" recognition.
- Education
  - Throughout the project the PRSN will incorporate into its educational and outreach program the developments associated with this project. These efforts will include talks, workshops, training, information tables and the press (TV, radio and newspaper).

Thanks to:

- NOAA (National Oceanographic and Atmospheric Administration) Personal
- NGS (National Geodetic Survey) Personal
- RLDA (Renan Lopez de Azua) Personal
- PRSN (Puerto Rico Seismic Network) Personal
- Agrim. Renan Lopez de Azua
- Agrim. Jose Rivera Cacho
- Agrim. Carlos R. Vega
- Marcos H. Velez
- **And to all of you to be here**