Proposal Scheme for CiLab Projects Maritza Barreto Orta

Project: A study of coastal sediment component and grain size as an indicator to identify impact of urban expansion along Rio Grande de Manatí watershed.

Introduction

- **Background (Resumes recent events that developed the problem)**

Coastal erosion has occurred in many beaches in the Island of Puerto Rico in recent decades. Many factors have caused beach erosion on beaches around the island (Morelock and Barreto, 2003). These factors are: 1) increase of the magnitude and occurrences of tropical storm in the vicinity of the Island; 2) human activities; 3) lack of sand deposits in the nearshore area; 4) variability of wave regime; 5) flood events of all magnitudes and frequencies; and 6) presence of submarine canyons producing loss of sand to offshore, among others (Barreto, 1997). In the last decades, manmade activities as sand extraction, coastal and river watershed modifications, land use changes, and other activities related with urban expansion along the coast have affected the input of local sediment budget causing important loss of sand in beach systems (Barreto, 1997).

Loss of sand in beaches may cause damage in properties as roads, buildings, coastal structures and vegetation in many coastal sites. At the same time, beach erosion may increase risk vulnerability due to the coastal exposition to storm impact, storm wave attack and coastal flooding especially in Island Systems (Daniel and Abkowitz, 2005). Erosion in coastal areas is very critical when population and economic activities occur near coastlines areas. According to Surfrider Foundation, for 2007 approximately 3.8 million people live in the coastal areas in Puerto Rico. This population is concentrated mainly in the north and northeast coastal areas of the Island (Surfrider Foundation, 2003). Due to this scenario, academic, community and government groups are very concern of the coastal risk and vulnerability that these residents are exposed due to increase of occurrence and magnitude of storm (Morelock and Barreto, 2003), regional sea level rise (Schwarts, 2005) and intensification of man-made activities in coastal areas. These groups are requesting that local government and private agencies delineate practices and plans to help to decrease coastal vulnerability based on actual scenarios.

Based on world coastal vulnerability, experts delineate actions that could help to define strategies to deal with actual coastal risk scenarios. Actions such as prevent loss (adopt measures that reduce vulnerability), tolerate the loss (absorb the cost of loss), changes in the land uses in the coast and relocating use and activities are some of the planning alternatives defined by the experts (McCulloch et al., 2002; Boateng and Bray, 2007). It is very important to emphasize that these actions will be useful only if we understand beach morphological and river system dynamics in a local geographic area.

A description of coastal sediment characteristic as grain size and component is an effective indicator to identify possible impact of man-made activities as a urban expansion in the beach area. This information helps to identify sediment sources, quality and changes in the amount of sediment arriving to the beach. As an example, statistical parameters of grain size as sorting, skewnnes, mode and median work as an indicator to identify beach sediment behavior and its relationship with river sources. These information helps to delineate a precise and accurate coastal management plan based on real geomorphic process (Ruggiero, P. et al., 2000). For this reason, academic and local communities and groups were continuously requesting from the government agencies to use and support the scientific data collected by scientific groups and citizens to prepare local coastal plans based in population distribution.

- **Project Summary**
  - **Problem Statement (Identifies the specific problems that are to be solved)**

Previous research data indicated that beach sediment grain size and composition were continuously change in the subaereal beaches at La Hacienda La Esperanza coastline areas from 2008 to 2011 (Barreto, M, Informal Science project FCPR, 2008-2011). Based on findings from this study, sediment characteristics were mainly related with changes in wave regime and the occurrence of storm events in the area. No data was acquired in this study to evaluate the possible relation between river behavior (river discharge) and beach sediment characteristics at La Hacienda Esperanza coastline. Therefore, qualitative observations indicated that apparently continuous changes in sediment composition from biogenic, mixed to terrigenous, and vice versa were occurred especially near of the river mouth. Also, fishermen from the area indicated that apparently changes in the river dynamic were affecting nearshore sites in the coastal site affecting fishing activities (Barreto, 2011 and Figueroa, 2012).

We conduct this study to identify possible relationships between beach sedimentology (Grain size and component) and The Rio Grande de Manati dynamic (river discharge and river modification). We need collect beach sediment samples in the nearshore and swash zone in beaches of the study area, measure grain size and component of these samples, and related these findings with published data of river discharge, land use, river modifications, among others. This new information will helps to understand how sediment composition changes may be related with river discharge and its hydrological dynamic through seasonal periods, and how possible river modification (natural or man-made types) may affect the coastal geomorphology. This information is valuable to define risk vulnerability and management plans for the study site.

- **Justification (Importance, urgency and contributions of project)**

As mentioned above, the use of sediment composition and grain size is a very useful tool to indicate relations between river dynamic and beach sedimentology. This tool will be helpful to identify location of sediment sources, quality and distribution along river watershed. Also, these information helps to identify possible causes that can affect sediment sources arriving to the beach as man-made activities and natural events along the river system. Actually, are not available data that helps to identify the actual sediment sources of beaches located near to the Rio Grande de Manatí. The study will contribute to collect new data and develop a databank that helps to identify actual beach-river system scenario, changes and its causes. The databank will include fields related with beach sediment grain size and components, occurrence of man-made activities along river watershed, precipitation, river discharge and river sediment discharge. The combination of this information in the databank will help to understand in an easy way possible relationships between beach-river systems. Also, this information will help to understand the actual system and possible make prediction of future coastal behaviors. The findings of this project will help to develop a sediment sources catalog for beaches of La Hacienda Esperanza coastline.

This study includes a very important education phase that can be occurring during data acquisition and evaluation process. Through this experience participants will learn the importance of the beach-river watershed dynamics especially in the developed of beach plain through time. As the same time, participants will learn the importance of understand the causes that produce beach changes resulted from the effect of river dynamic (natural and/or man-made affected). This experience will help to understand their vulnerability to natural and anthropogenic events over the site.

Hypothesis or Question

Terrigenous sediments will more abundant near of river mouth. Major amount of terrigenous sediments will related with higher river discharge events of Rio Grande de Manatí.

Major terrigenous deposits were found in the backbeach.

Main terrigenous sediment arrives from sedimentary-volcanic geologic sources located in the northward site of the Rio Grande de Manatí watershed.

Major terrigenous sediment input was produced by deforestation and land use changes along river watershed.

Project Description

- **Goals (Principal purpose of project; contributions that are obtained by the results of the project)**

Three main goals are defined for this project:

1. Delineate a possible relation between beach sedimentology (grain size and component) and river discharge produce by both natural and man-made activities occurred in the river watershed. This helps to define the role of river system feeding the coast and the impact of urban expansion over this process.
2. Educate and train participants to understand the importance of beach-river system relationships.
3. Data dissemination
4. Produce educational material as a manual about beach sediments and geology of river watershed.

    - Short Term (from starting and final stage of the project-continuous activities)
        - Scientific data collection
            - Characterize beach sediment sources (terrigenous vs biogenic)
            - Analyze sediment component in US Geological Survey labs at Buchanan by project research assistants.
            - Identify location, quality and distribution of beach sediment sources
        - Inclusion of participants in the project
            - Train to collect and analyze sediments (grain size and identification using stereoscope or microscope)
            - Train to identify minerals to relate with sediment sources
            - Train how to use geologic maps and its relation with sediment collected in the field.
            - Train to enter data of river discharge, man-made activities and precipitation in the databank.
    - Long Term
        - Evaluate relationship between sediment characteristics and river discharge
        - Evaluate land use data of the river watershed using published map, remote sensing and Geographic Information System data.
        - Evaluate data include in the databank

        - Produce an educational manual of sediment sources of beaches affected by Rio Grande de Manatí watershed including geologic characteristics of the study site
        - Finding presentation (1 yearly)

- **Objectives (Identifies how the goals are going to be met)**
    - Train participants to collect and analyze sediment (grain size and mineral)
        - Field visit: 1 visit to the beach monthly to collect sediments in the backbeach and swash zone.
        - Lab Visit: 1 activity monthly to the lab to conduct sediment analysis (grain size and use of microscope and mineral identification kit),
    - Teach participants to enter information collected in the databank
        - Train how to enter data via internet. (main training in lab visit)
    - Analyze sediment composition (biogenic vs terrigenous) using US Geological Survey Lab at Buchanan
        - Research assistant
    - Conduct a brainstorm meeting with participant to discuss findings and effects over study sites.
        - Main scientist and research assistant- 1 time each 4 months.
    - After data organization, photos, graphs, etc, will start a preparation of an educational manual of beach sediment-river system
    - Principal scientist will present a 3 conferences to disseminate findings (2 local 1 United States or Latinamerican)

- **Materials and Services needed (Complete list of materials to be used without including cost)**

    - Camera adapter and camera to use insert to a stereoscope from FCPR (to take images of minerals and sediments)
    - Mineral Deluxe Hardness Pick Ident kit (identify minerals)
    - General Minerals identification Guide
    - Sieves Newark 250 micrometers (fine sands)
    - Sieves Newark 125 micrometers
    - Sieves Newark 90 micrometers
    - Wirk Pak write on Collection Bags
    - Seive analysis bags
    - Geologic maps of Manatí
    - Geologic Map of Florida
    - ENVI Software (need available this software for use in this project)

- Arc Gis Software (need available this software to use in this project)
- Shapes files of the river water shed (land use, natural components, infrastructure, etc)
- Use of US Geological Survey Lab- (package define by USGS to conduct sediment component analysis)
- Digital Cameras to use in the field
- Global Positional System (GPS)
- Refractometer (2) (salinity and density) (Hand use)
- Water Thermometers (2)
- External portable disk (2 tera)-for backup of photo and maps)
- Historical aerial photo of the study site 600 dpi of resolution for coastal area (need evaluate this possibility with FCPR GIS area at San Juan)
- Land use map of the Rio Grande de Manatí watershed (shape file) verify availability with FCPR GIS area.
- Availability of use of Internet capacities at La Hacienda (?) to download precipitation, river discharge data.
- Publications of project at Rio Grande de Manatí watershed.
- Boxes to storage sediments and place to storage boxes.

Work Plan

- Work to be completed and projected dates or phase in which it will be accomplished

Phase I	**Occurrence**	**Projected Dates**
Field work Stations definitions and preparation (sticks and label)	1 (FCPR)	January 2013-2015
Databank fields definition with Victor Cuadrado	1 (FCPR) San Juan	December 2012 or January 2013
Train research assistants	2	March 2013
Participant pre-test (knowledge)	1	April 2013
Field work at the beach (Sediment samples, salinity, temperature data collection and field photos)	1 monthly (FCPR)	starting April 2013-2015 (Saturday and some activities in weekday)
Lab sediment analysis (grain size and use of stereoscope with inserted camera), map reading and data entering	1 monthly (FCPR)	starting April 2013-2015
Phase 2	**Occurrence**	**Projected day**
GIS shape file analysis	?	January 2014
Remote sensing data analysis	?	January 2014

Phase 3		
Preparation educational manual	1	Starting December 2013
Local Conference data dissemination	1	June 2014
Outside conference	1	Until Dec 2014
Learning evaluation	?	?
Scientist procedure evaluation	?	?

- Methods or Procedure
  - Field Work
    - Beach visit to collect sediments, salinity, temperature, GPS reading and field photos
  - Laboratory Activity
    - Lab FCPR
      - Grain size analysis, identification of minerals using stereoscope and camera, geologic map interpretation and analysis, data entry of data analyze and published data (precipitation and river discharge)
    - Lab US Geological Survey
      - Sediment component (terrigenous and biogenic) using HCL 10%
  - Brainstorm and Analysis
    - Discussion of finding to educate participants
  - Map and remote sensing data
    - Use shape files to prepare a river shed map with all natural and man-made characteristics to evaluate river component. This activity require a specific participant with computer a GIS skills.
  - Databank

    Discussion with Victor Cuadrado about how organize data

- Data Analysis (How the data will be analyzed)
  - Using lab facilities at FCPR and US Geological Survey Lab at Buchanan
  - Using data entry in the databank and prepare graphs
  - Brainstorm and discussion meetings
  - Use of GIS for integrate all data and map preparation

- Dissemination Plans tool kit
    - Preparation of manual of sediment characteristics of beaches located near at Rio Grande de Manatí and the geology of Rio Grande de Manatí watershed.
        - May includes:
            - The geology of the Rio Grande de Manatí watershed (with basic nomenclature). (from the analysis of geologic maps)
            - How related river geology and beach sediments
            - Methodology to evaluate beach sediments
            - The sediments of beaches near Rio Grande de Manati
    - Local Conference at FCPR (each final research period-yearly
    - 1 outside conference (Association of American Geographers or EGAL)

Volunteers

- Duties Description
    - Projected date or phase in which tasks will be done (see table above)
        - Scientist duties
            - Define study station identify by FCPR
            - Train research assistants in conduct all activities of the project (field work, labs, maps, GIS, databank)
            - Participate in major field work activities
            - Be in charge in the evaluation of all data acquired for all participants
            - Perform analysis of the data and mentoring all process
            - Prepare an educational manual
            - Prepare and conduct conferences about findings
            - Write a professional paper of the final data

        - Scientific assistants duties
            - Participate in all field trip and support main scientist
            - Conduct lab activities (grain size) at FCPR
            - Conduct lab analysis in USGS lab
            - Support scientist in data analysis (GIS, databank)
            - Support scientist in the process of dissemination activities (manual, conferences)

    - Work Schedule (see table above)

- Materials to be used (otros)
  - Other materials that can used
    - Security Vest
    - metric tape
    - video camera
    - emergency kits
    - use other maps (geologic and topographic)

- Volunteers' profile
    - Older than 14 years
    - Some of them with computer skills
    - Person with disabilities will be supported by FCPR to conduct field works in case that they have interest to conduct.

References

Barreto, M., Morelock, J., and Vasquez, R.1992. A coastal classification system for tropical islands. Oceans 92 Conference. New Port, Rhode Island.

Barreto, M., Morelock, J. and Vasquez, R. 1994. An Integrated mapping and databank system for coastal changes. Part A. West coast Puerto Rico. Second Thematic Conference. Remote Sensing for Marine and Coastal Environments. Louisiana, USA

Barreto, M., Morelock, J., Miller, R., and Vasquez, R. 1995. An integration of remote sensing, mapping and survey data to describe bottom sediment types in the marine nearshore. Latin-American Symposium on Remote Sensing, Puerto Vallarta, México.

Barreto, M. 1997. Shoreline of Puerto Rico. Mayaguez Campus University of Puerto Rico, unpublished dissertation

Barreto, M., 2001. Evaluación de los potenciales del Paisaje Natural en la Isla de Vieques. Las playas de Vieques. Informe sobre Proyecto el desarrollo económico sostenible de la actividad turística en la isla de Vieques. Proceso de publicación

Boateng, I., Bray, G., Bray, M. 2007. Comparative merits of adaptations policies of sea level rise and their potential impacts on coastal settlements in developing countries. Coastal zone Management and environmental Issues, China, may 2007.

Cowel, P.J., Thom, B.G., Jones, R.A., Everts, C.H. and Simanovic, D. 2006. Management of uncertainty in Predicting Climate-Change Impacts on Beaches. Journal of Coastal Research, v.22. n.1:232-245.

Daniel, E. B. and Abkowitz, M.D., 2005. Improving the design and implementation of beach setbacks in Caribbean Small Islands. URISA Journal, v. 17. n.1:53-65.

Davidson, R.G. 2005. Conceptual model of the effects of sea level rise on sandy coast. Journal of Coastal Research, v.21, n.6:1166-1172.

Figueroa, S., 2012, poster presentation, Race and ethnicity Conference, San Juan, PR

McColloch, M.M., Forbes, L.D., Shaw, W.R. 2002. Coastal Impacts of Climate Changes and Sea level Rise on Prince Edward island, systhesis report. Meteorological Service of Canada, Geological Survey of Canada and Rodshaw environmental consulting.

Morelock, J. and Barreto, M. 2003. An update of coastal erosion in Puerto Rico. Shore and Beach. v. 71 n.1:7-12.
Morelock, 1978. Shoreline of Puerto Rico, Coastal Zone Management Program. Department of Natural Resource. Puerto Rico 45p.

Morelock, Jack, and J. Trumbull. 1985. Puerto Rico Coastline. The World's Coastlines. Ed. Bird. New York: Van Nostrand Reinhold.

Morelock, J., Capella, J., Garcia, J.R. and Barreto, M. 2000. Puerto Rico - Seas at the Millennium. In: Sheppard, C.R.C. (ed.) Seas at the Millennium. Oxford Press, London.

Morelock, J. and Barreto, M. 2003. An update of coastal erosion in Puerto Rico. Shore and Beach, v.71 n.1:7-12.

Ruggiero, P., Voigt, B. and Kaminsky, G., 2000. Beach monitoring for enhancement decision-making. Coastal Society 17 th Conference. Coast at the Millenium.

Schwarts, M. 2005. Sea level Rise Influence on Caribbean Coastal erosion. Journal of Coastal research, SI 42: 279-284.

Taveira Pinto, Francisco. 2004. Coastal management: Issues and Tools. Introduction: Journal of Coastal Conservation.

Titus, J.G. 1990. Greenhouse effect, sea level rise, and land use. Land use Policy. v. 7:138-153.

Treby, Emma & Clark, Michael. 2004. Refining a Practical Approach to Participatory Decision Making: An Example from Coastal Zone Management. Journal of Coastal Management. V. 32:353-372

Snow, M.M. and Snow, R. K. 2005. GIS modeling and simulation of sea level rise scenarios. Proceedings (459) Modeling and Simulation.