



River discharge and its intimate relationship with beach morphology in two beach systems at Puerto Rico

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Abstract

A citizen science project was conducted in order to understand the role of a river system impacting the beach geomorphology in a coastal area in a Tropical Island. The study includes an evaluation of geomorphologic components as beach width and sediment composition distributions in two beach systems (La Boca and Machuca Beaches) located near of Rio Grande de Manatí river mouth, at Manatí municipality, Puerto Rico. The main objective of this study is to evaluate the possible association between beach morphology (beach width and sediment composition) with river discharge. Beach width and sediment were collected in eight permanent stations in a monthly basis from 2013 to 2014. Beach width and sediments were collected by volunteers (citizen scientists) in all permanent stations. River discharge data was collected from published data by US Geological Survey (USGS) station 50038100. Results showed that beach width ranged from 6.05 to 82.5 meters, with wider beach width at La Boca Beach, located on the western site of the river mouth. A narrower beach was identified at Machuca Beach, located on the eastern site of the river. Formations of sand bars were observed in the near shore area mainly during high river discharge in this study site. Spearman correlation analysis showed as river discharge increased, beach width in both beach systems was decrease. Also, results showed that wider beaches are mainly composed of higher terrigenous sediment. In general, evaluation of beach geomorphology and river discharge showed that this river system has an important influence over the beach width and composition mainly at La Boca Beach.

Introduction

For many decades important geomorphologic beach changes were identified in many geographic areas in Puerto Rico. Geomorphologic changes were related with oceanographic, climatologically and hydrological variables. Also man-made activities are one of the important variables that are causing many of the geomorphologic changes producing in many cases erosion. This study was worked out using a citizen science model to incorporate scientist and volunteers to combine their knowledge to study and understand the geomorphic changes occurring in beaches at Puerto Rico. We understood that the citizen model is a very useful and effective tool that helps to understand in detail this geomorphic change due to the valuable contribution of both parties. Also, the participation of volunteers and scientists helps to maintain a continuous data collection that helps to understand in detail the process occurring in the study site. In this citizen science project we evaluate the possible association of river dynamic in the geomorphic changes in two beach system in Puerto Rico.

Objectives

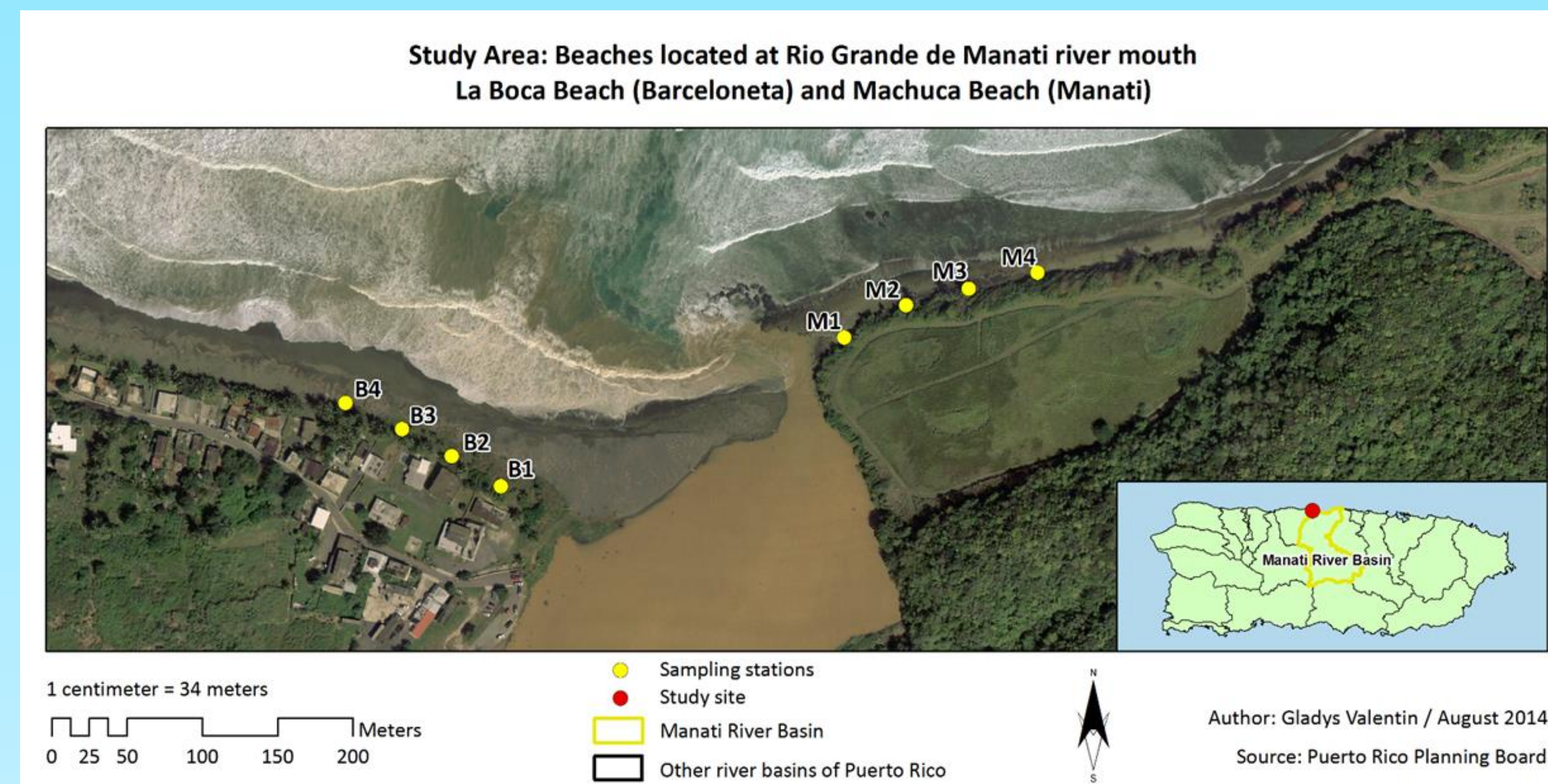
- Identify the association between river discharges and beach geomorphology (beach width and sediment composition).
- Describe beach width changes in a year period.
- Describe the beach sediment composition distribution (swash zone) before and after river discharge event.

Methodology

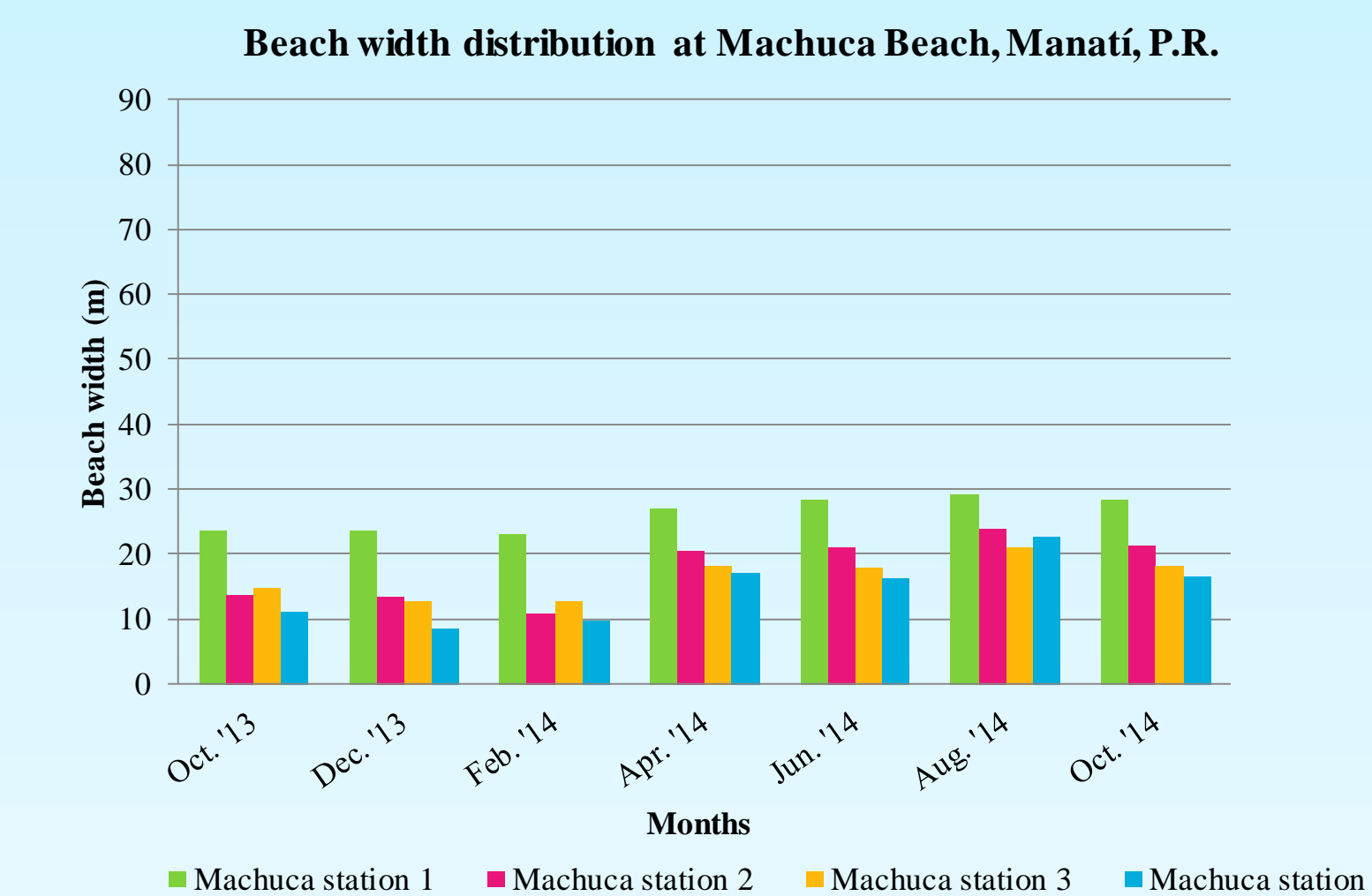
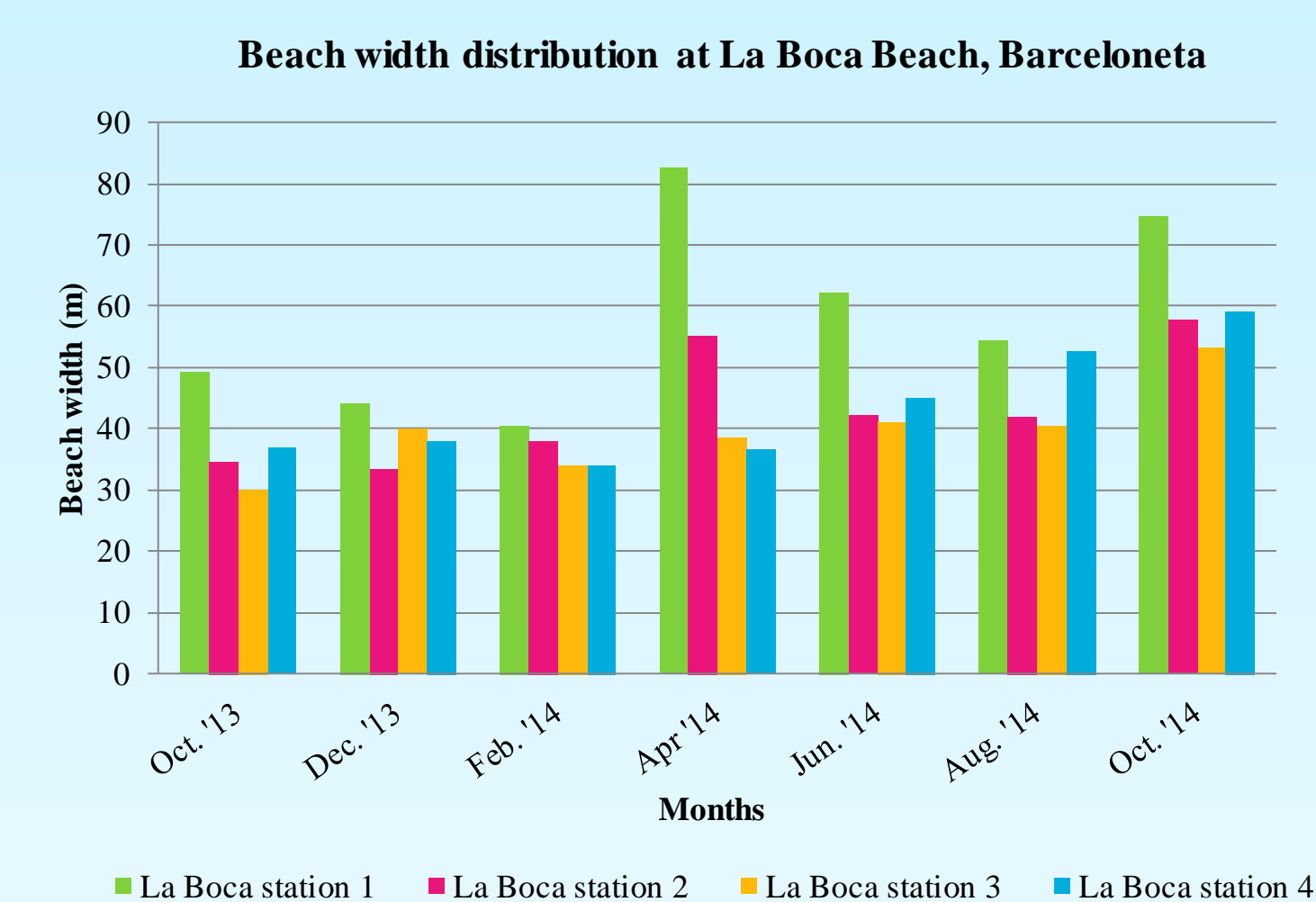
Field work was conducted in two beaches located in the Río Grande de Manatí river mouth. These are Machuca (Manatí municipality) and La Boca (Barceloneta municipality) Beaches. Beach width measurement and sediment samples (swash zone) were collected in bimonthly basis from October 2013 to October 2014 in both beach systems. Beach width and sediments were collected in each beach system for four permanent stations in each beach for a total of eight permanent stations. Beach width was measured using a tape measure from the vegetation line (back beach) to the swash zone for each station. Beach sediment was collected in the swash zone for the same stations. Sediment samples were collected in the swash zone because is one of the more dynamic area of the beach.

After the sediments are collected they were analyzed in a lab facility to evaluate composition based on Morelock and Folk (1956) protocol. The beach sediment samples were washed and dried. We use hydrochloric acid (HCL) at .10M to calculate the amount of biogenic vs terrigenous component based on weight differences in one gram of the beach sediment sample. Biogenic sediments was a chemical reaction with HCL (dissolution).

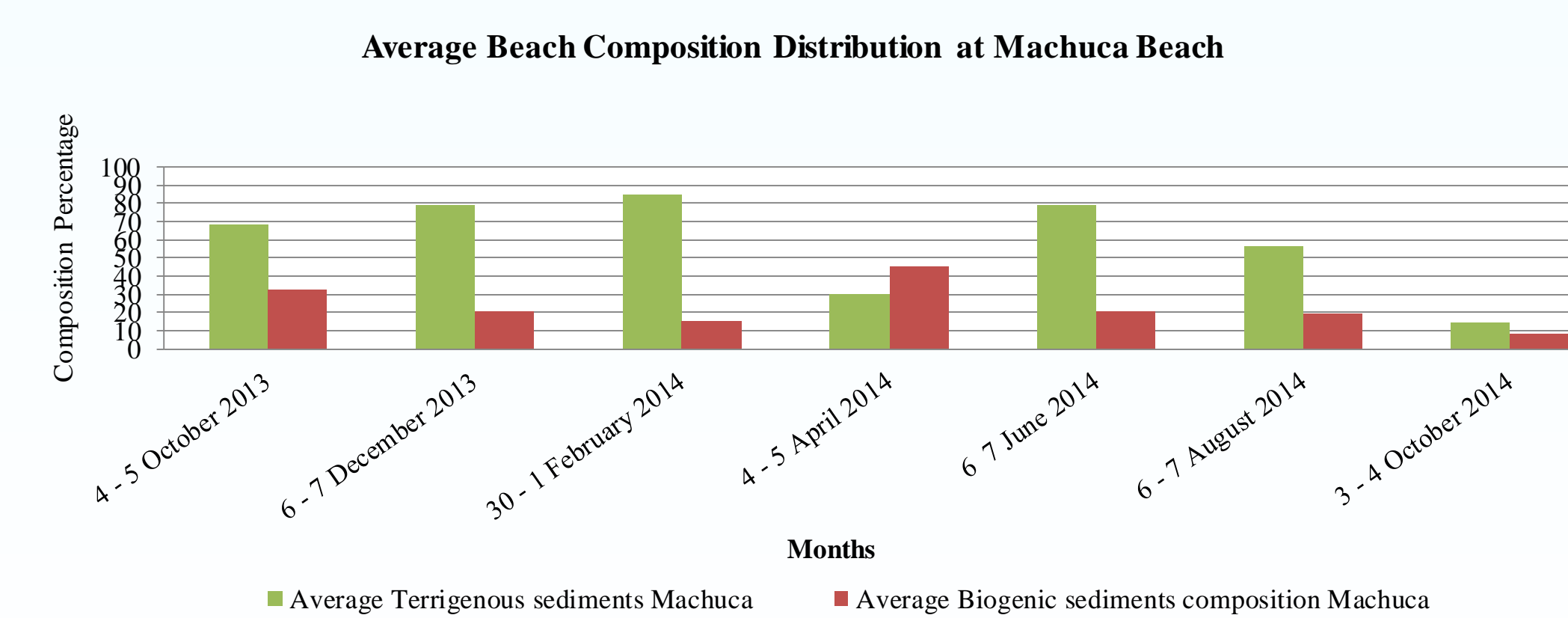
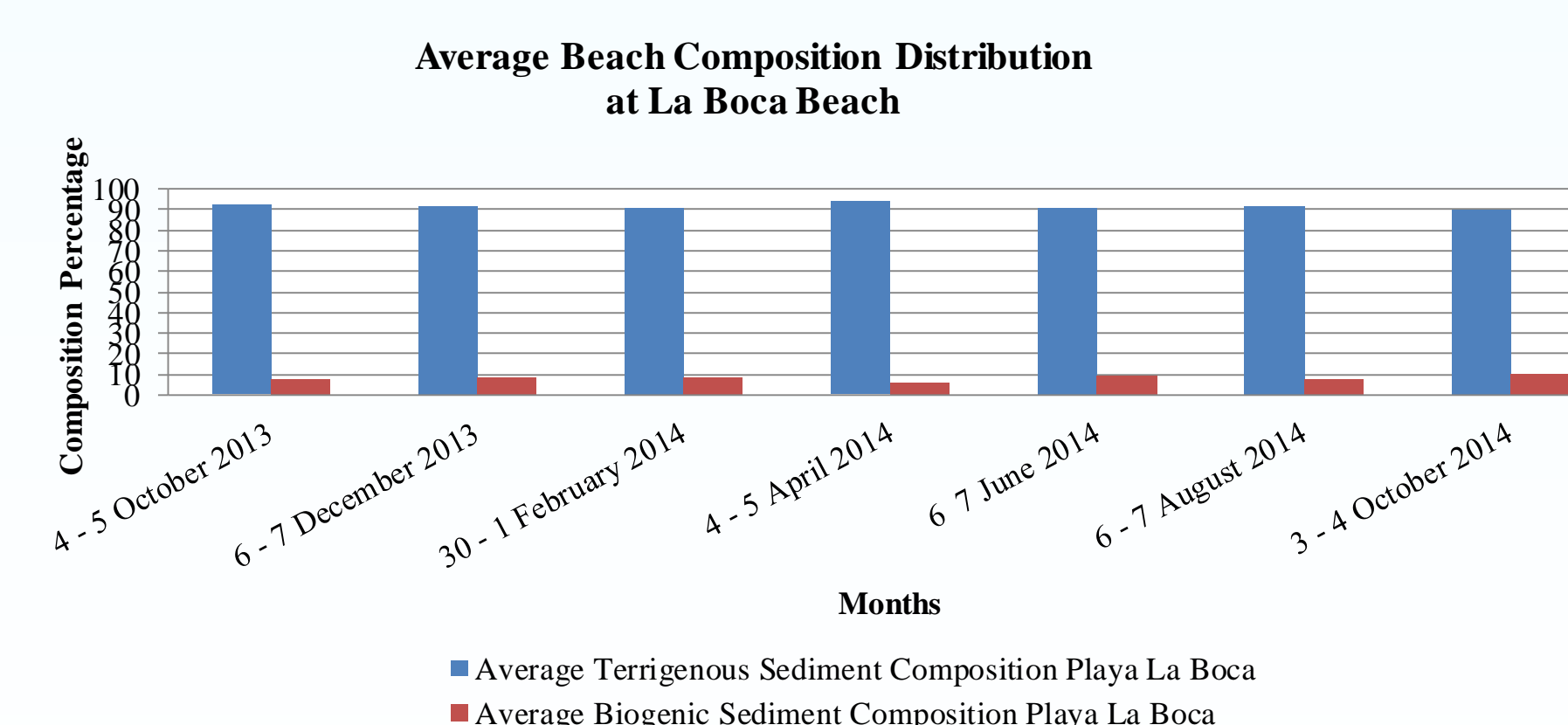
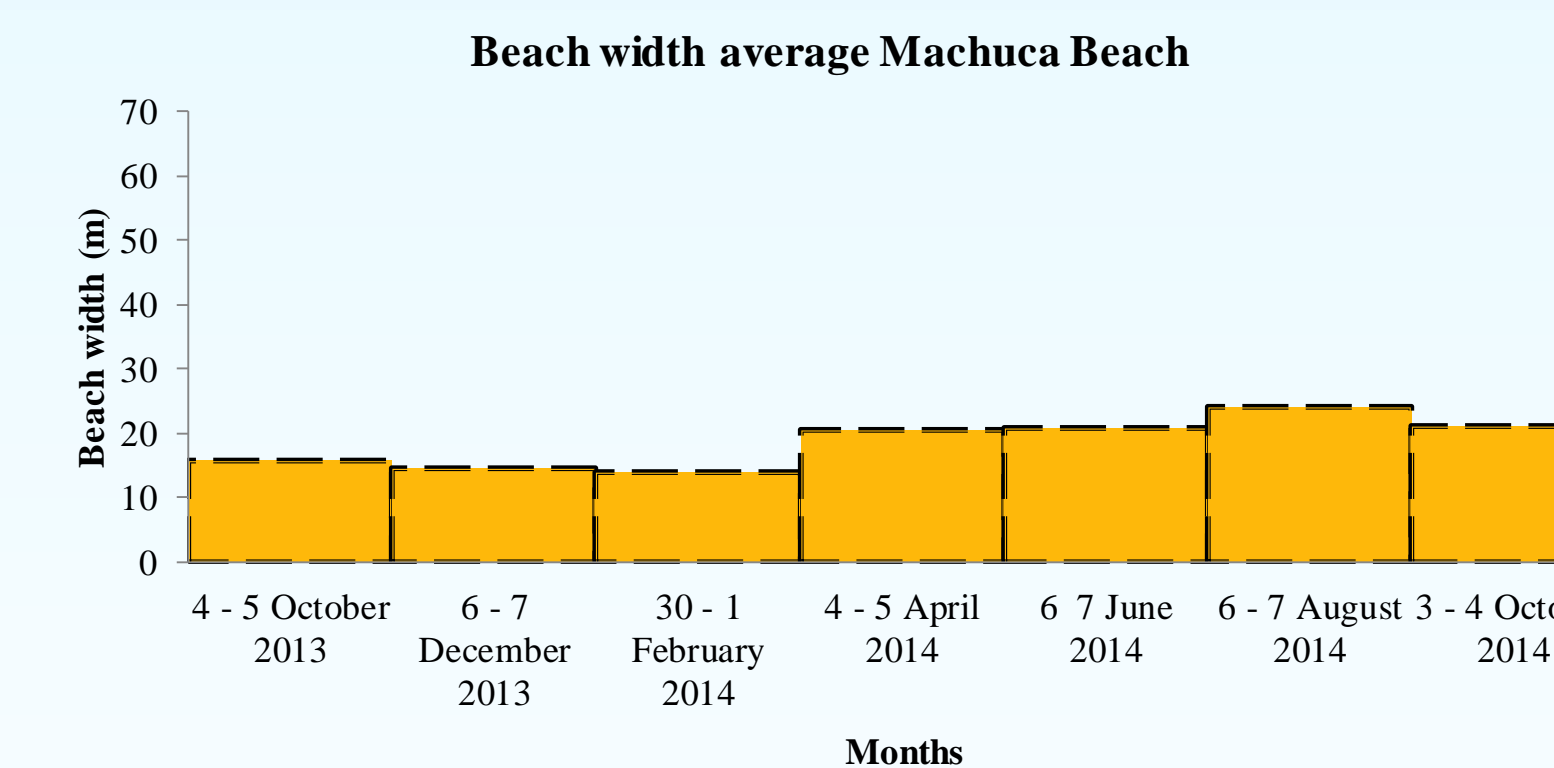
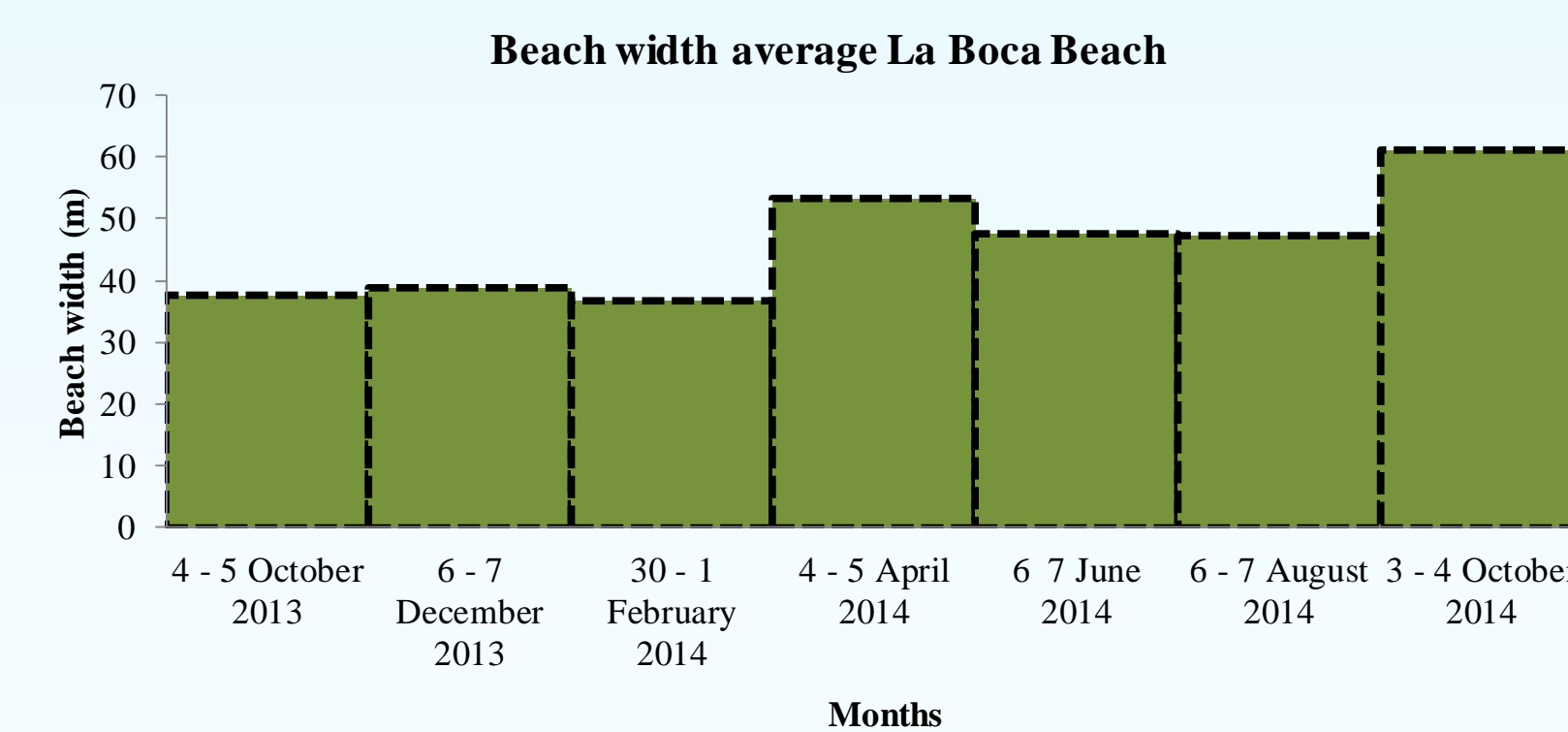
River discharges data published by US Geological Survey (USGS) was used to evaluate the discharge dynamic of the hydrological system for a year period. The station #50038100 located at Manatí was used for data acquisition. Descriptive statistical analysis as mean, mode and correlation analysis was conducted to evaluate the association between geomorphic variables and river discharge during study period.



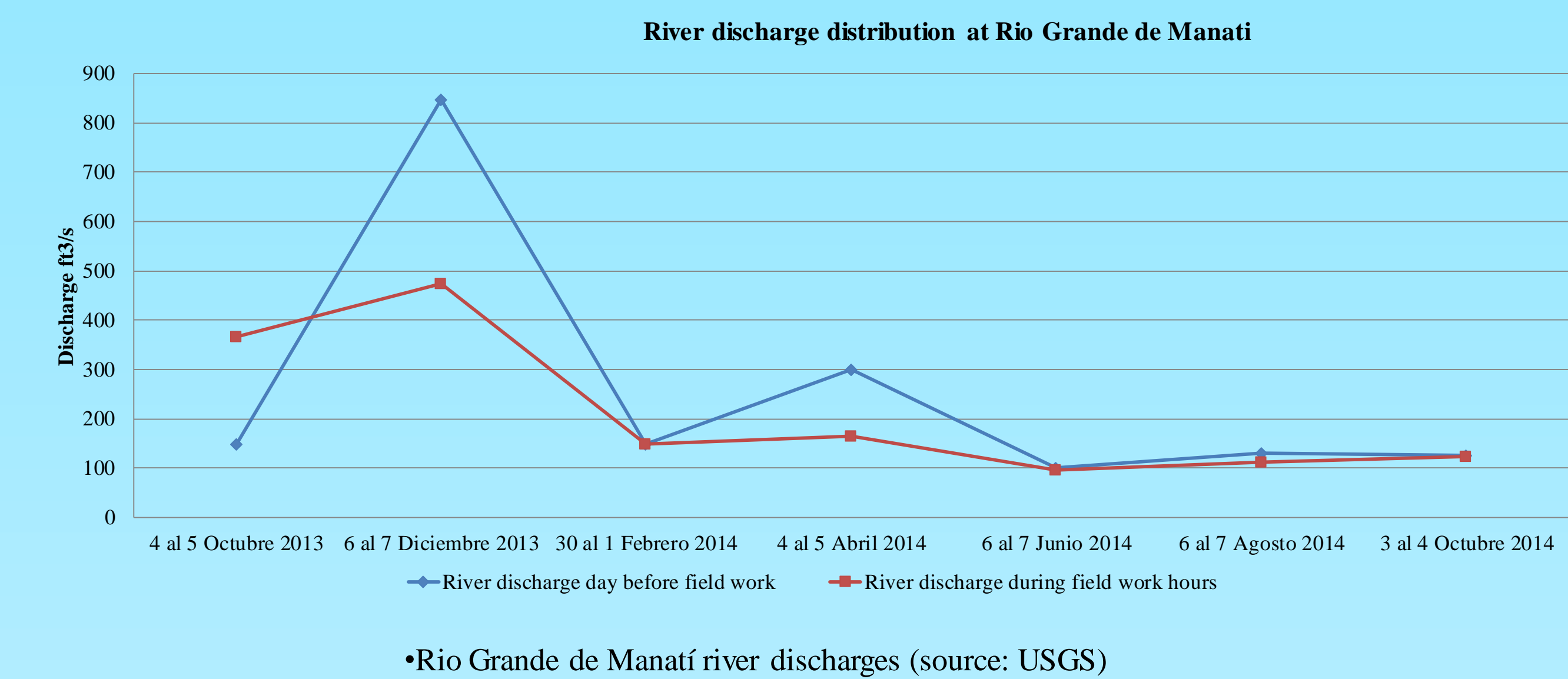
The study area was located in two beach systems in the municipalities of Manatí and Barceloneta in the north-central coast of Puerto Rico. These beaches are: Machuca Beach (18°28'55.16"N, 66°31'57.21"W) in Manatí and La Boca Beach (18°28'52.97"N, 66°32'7.07"W) in Barceloneta. Both beach systems are very dynamic and different from one another no matter the geographical proximity of both systems. In addition, Machuca Beach showed beach rocks formation in the shoreline, formation that is not identified at Playa La Boca. Both systems are connected to the Rio Grande de Manatí river mouth.



- Beach width in both beach systems increase from April (2014) to October (2014).



- La Boca Beach its completely terrigenous in terms of sediment composition This means that Rio Grande de Manatí river discharges have a direct impact on the composition of the sediments.
- Machuca Beach showed more biogenic beach sediments than La Boca Beach. On Machuca Beach biogenic sediments are located mainly at the swash zone, where beach rock formations can be found.



Findings

- Major river discharges of Rio Grande de Manatí was occurring in October 2013 and December 2013 during study period.
- Machuca and La Boca beaches are composed mainly by terrigenous sands, where La Boca Beach showed the higher terrigenous sands component.
- Beach width in both beach systems increase in April (2014) and August (2014).
- A reduction of beach width was found during higher river discharge in both beach systems. This mainly seen on October (2013) and February (2014).
- Sand bars were observed in the nearshore area at La Boca Beach. These sand bar was formed when beach width suffered loss of sand.



•Machuca Beach



•La Boca Beach

Conclusion

- Machuca and La Boca beach systems behave geomorphological different besides their geographic proximity.
- The Rio Grande de Manatí discharges affect both beach systems during the study period.
- Beach width have a strong association with the river discharges.
- This information helps to understand the association of river discharge with beach geomorphology.

Acknowledgements

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