Luquillo, Puerto Rico, 2021, imagen CoRePI

Using Geospatial Analysis to assess Post-Hurricane coastal changes at Puerto Rico

El estado de las playas de Puerto Rico post-María
FEMA HMGP Subgrantee: 4339-0007-P

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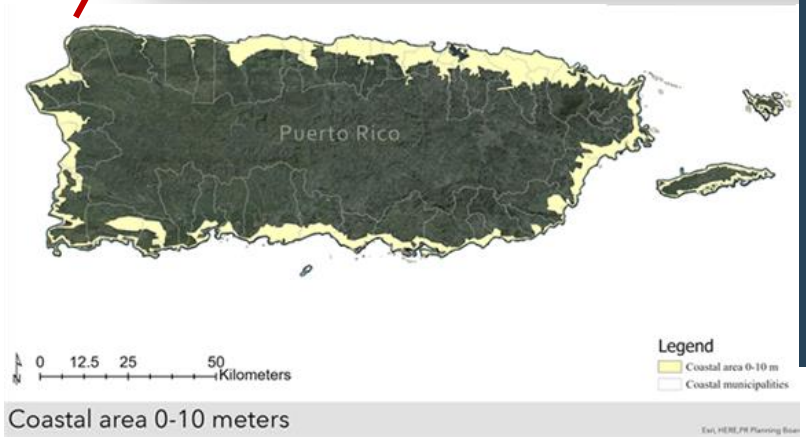
Major Challenges in the PR Coast

- Increase of beach erosion in selected coastal sites at the Island since 2012.
- Hurricane Maria affected the coastline producing diverse and complex geomorphic effects especially over the beach systems.
- Loss of beach width and elevation in the majority of beaches at the Island after Hurricane María (Barreto, M, 2017)
- Approximately, 22% of population (2020) was located in a 10m Low Elevation Coastal Zone (LECZ); 13% of population (2020) was located in the Coastal Zone at the Island (Barreto 2023 in publication process).
- Approximately, 32% of the critical infrastructure was located in a 10m Low Elevation Coastal Zone (LECZ).
- Few updated data was available of coastal erosion at island-wide/municipality level at PR
- Needs of increase of reliable data to use as a baseline for decision-making processes at the Island.

Aguadilla, Puerto Rico, 2019, photo by CoRePI



Reference: Coastal Research and Planning Institute of Puerto Rico (CoRePI)

Major Challenges in the PR Coast

"Beach erosion reduce the degree of protection of the coast producing an increase exposition and vulnerability of the coastal communities, critical infrastructure and services at the Island."

January 2017

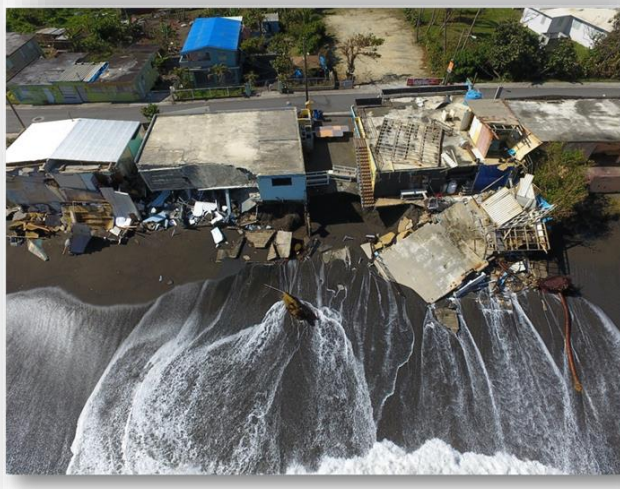
November 2017

La Boca, Barceloneta, PR

March 2018 (Swells produced by Riley)

Video Mastache

April 2018



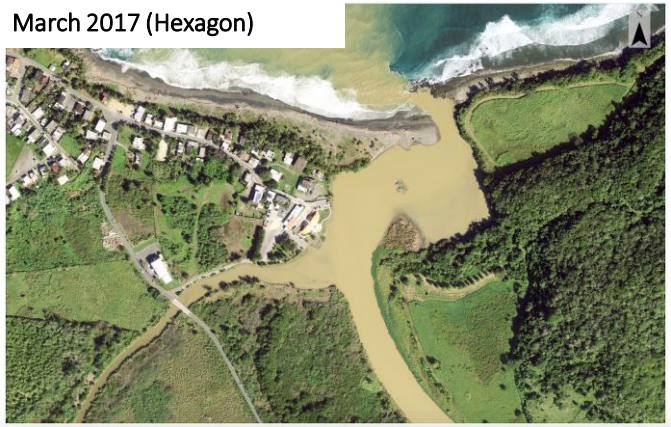
La Pared Beach. Luquillo, PR, 2020 Foto CoRePI

The Project

- Develop a baseline data (geodatabase) to assess the post-storm stage of beach systems in Puerto Rico for the 44 coastal municipalities.
- Based on this baseline, listing a coastal erosion ranking for the island (2018) and listing Course of Actions (COAs) to reduce beach erosion in some of the sites (state and municipality level).
- The main objective of this activity is bring to stakeholder formal information about coastal erosion. This will helpful for stakeholders in terms of promote best practice decisions and coastal planning .

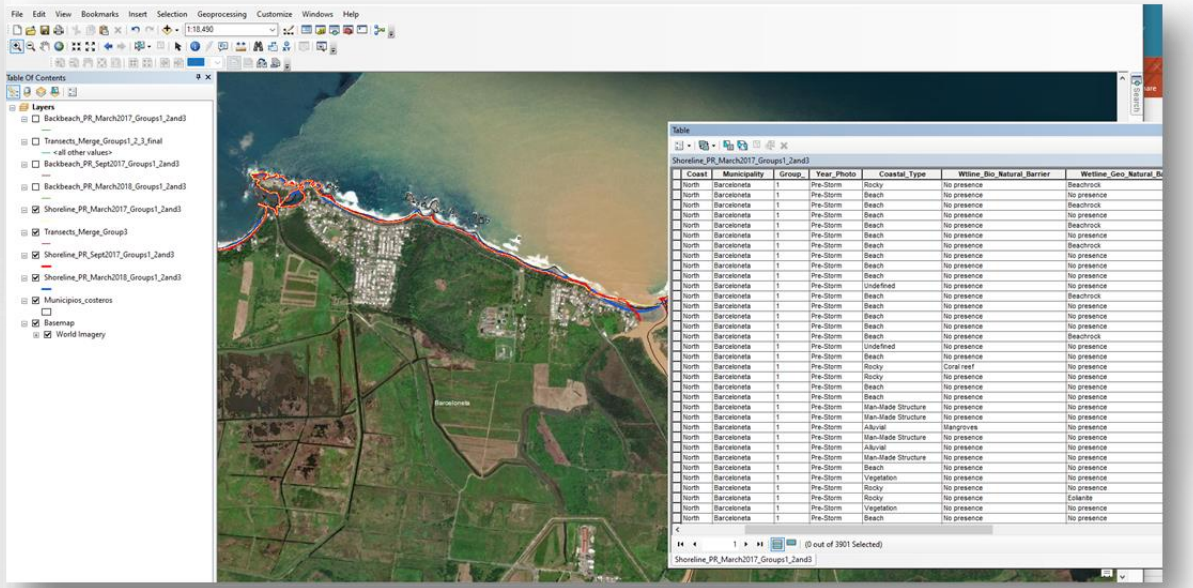
The Coastal Geodatabase was develop using data extraction from high spatial resolution images March 2017; September 2017 (NOAA) and July 2018 (USACE); GIS tools; DSAS app (USGS); field work and Previous published geodatasets/feature class (JP;NOAA)

March 2017 (Hexagon)



September 2017 (NOAA)

July 2018 (USACE)

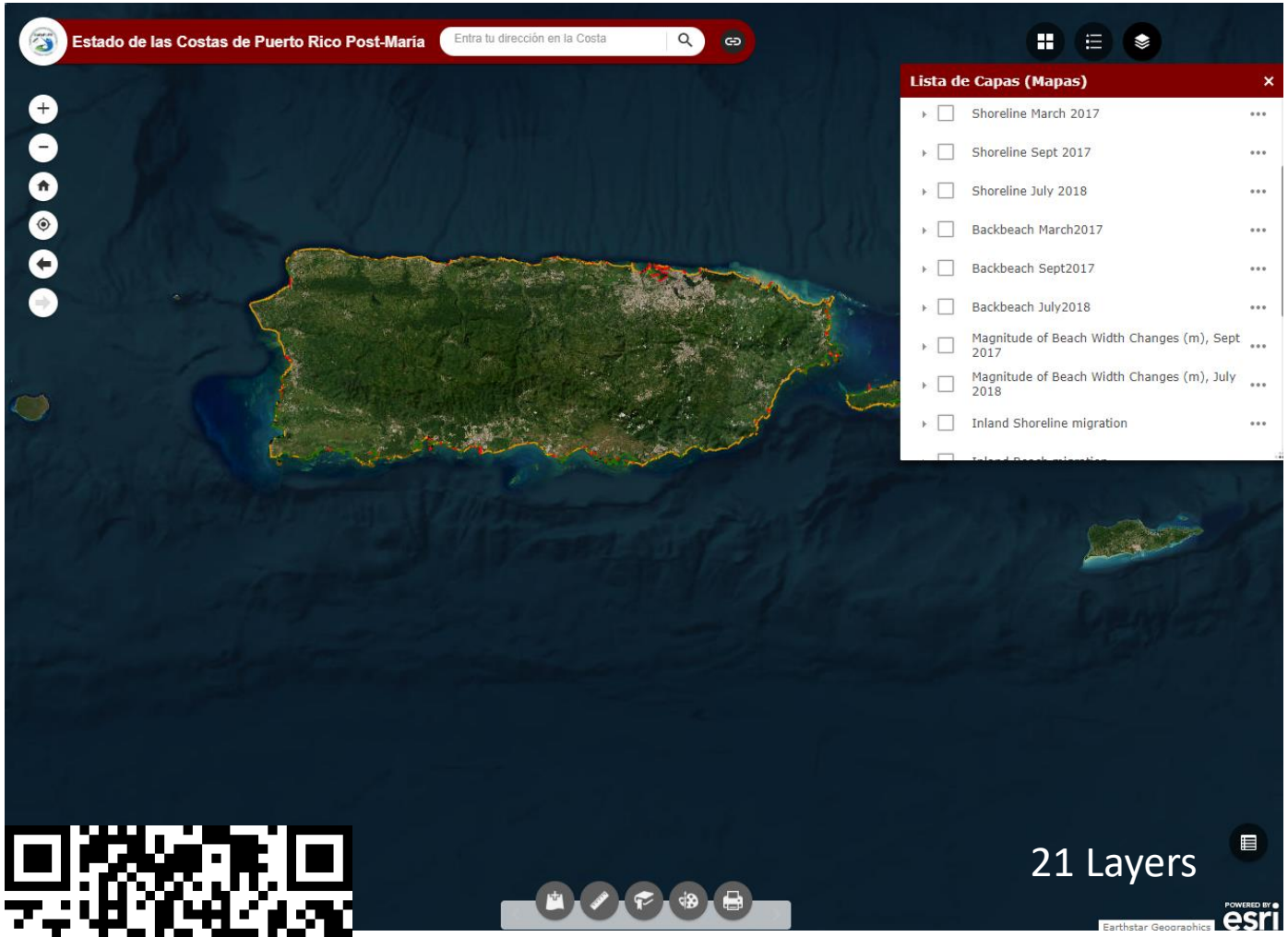


PR coastal geodatabank (Coastal Research and Planning Institute of Puerto Rico-CoRePI)

Beach width changes (erosion and accretion) at La Boca Barceloneta (Sept 2017-Post Hurricane María; transects each 10 meters)

Field work at Barceloneta (drones; beach measurements)

2017-2018 Puerto Rico Beach WebMap



Positional accuracy shoreline: 2017 (March): uncertainty: 3.44 meters;
2017 (September): uncertainty: 6.29 meters; 2018 (July): uncertainty: 3.53 meters.

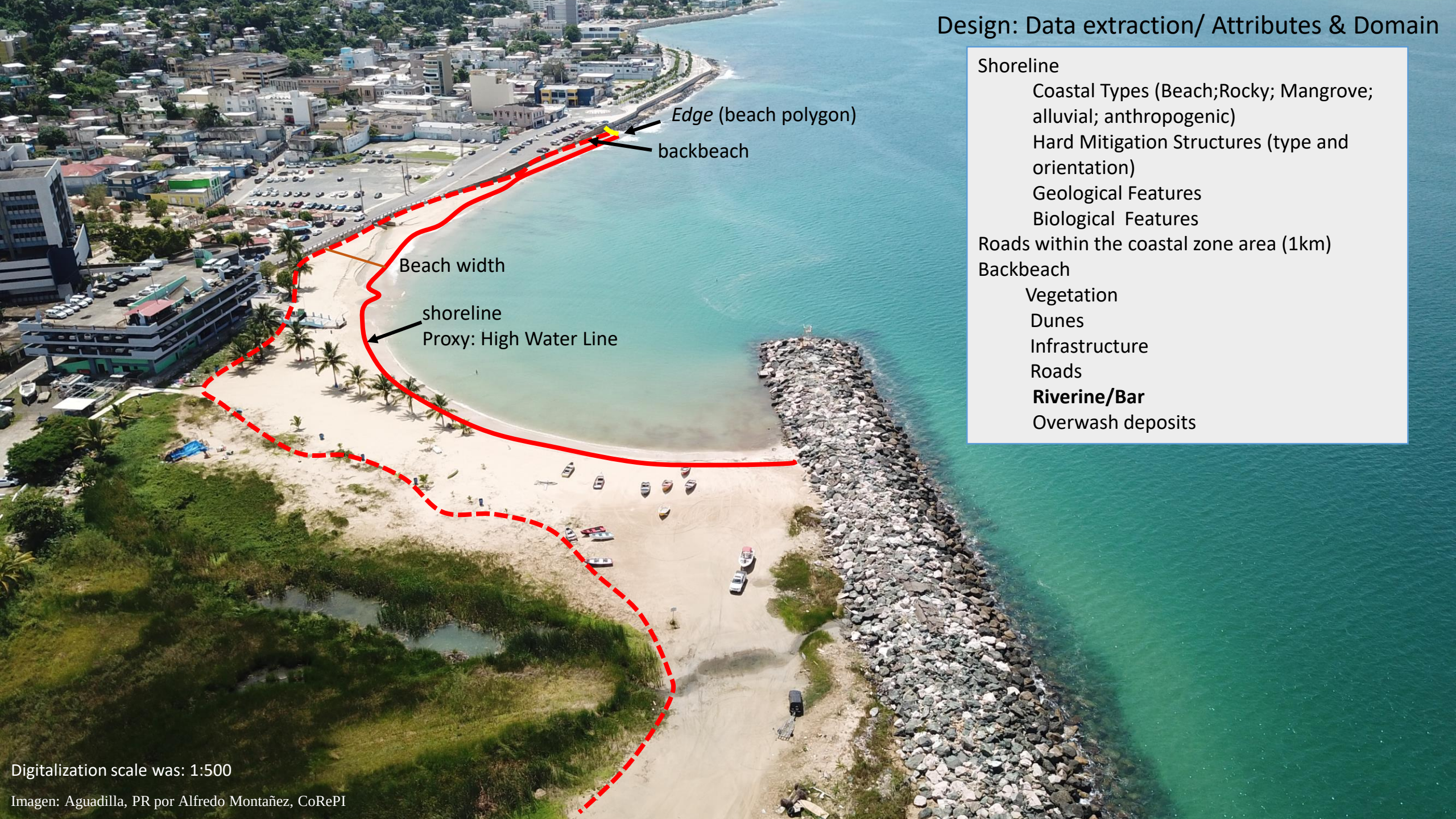
Total views 5 story Maps and WebMaps : 32,909 counts (February 19 2023)

[Puerto Rico Beach changes (2017-2018) WebMap https://redplayaspr.maps.arcgis.com/apps/webappviewer/index.html?id=339d8926f36a4db1ba3aecc0cd6fac3d](https://redplayaspr.maps.arcgis.com/apps/webappviewer/index.html?id=339d8926f36a4db1ba3aecc0cd6fac3d)

21 Data Layers for the entire island

- Coastal types March 2017
- Coastal types September 2017
- Coastal types March 2018
- Shoreline March 2017
- Shoreline September 2017
- Shoreline July 2018
- Backbeach March 2017
- Backbeach September 2017
- Backbeach July 2018
- Beach Width Changes September 2017
- Beach Width Changes July 2018
- Shoreline inland Migration 2018
- Beach inland Migration 2018
- Hard Mitigation Structures March 2017
- Hard Mitigation Structures September 2017
- Hard Mitigation Structures July 2018
- Roads_1Km from the shoreline/floodzone July 2018
- PR mosaic March 2017
- PR mosaic September 2017
- PR mosaic July 2018

Design: Data extraction/ Attributes & Domain



Shoreline
- Coastal Types (Beach;Rocky; Mangrove; alluvial; anthropogenic)
- Hard Mitigation Structures (type and orientation)
- Geological Features
- Biological Features

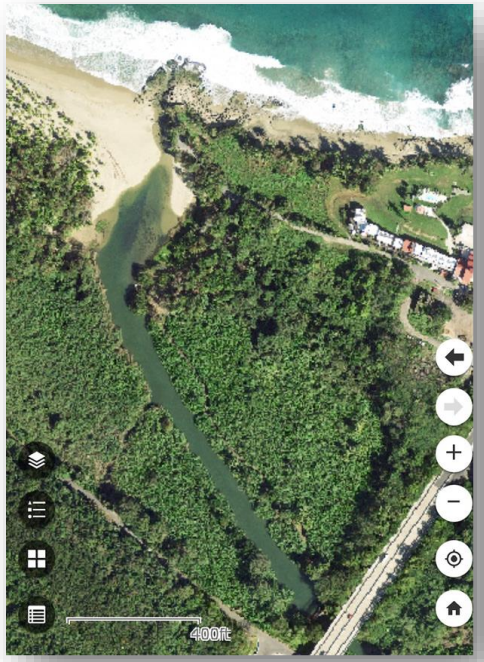
Roads within the coastal zone area (1km)

Backbeach
- Vegetation
- Dunes
- Infrastructure
- Roads
- **Riverine/Bar**
- Overwash deposits

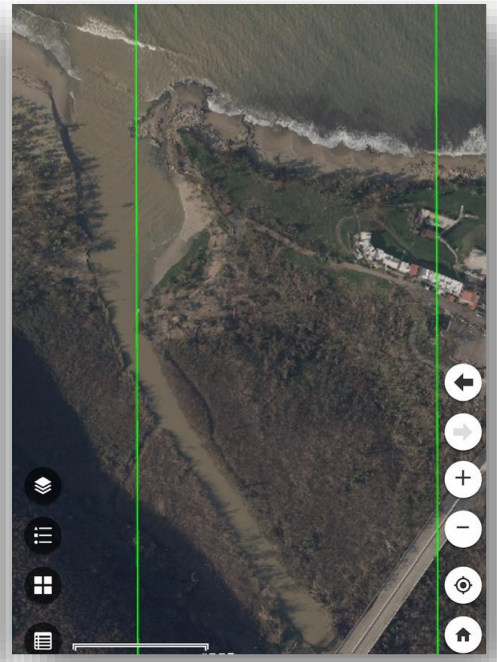
Digitalization scale was: 1:500

Imagen: Aguadilla, PR por Alfredo Montañez, CoRePI

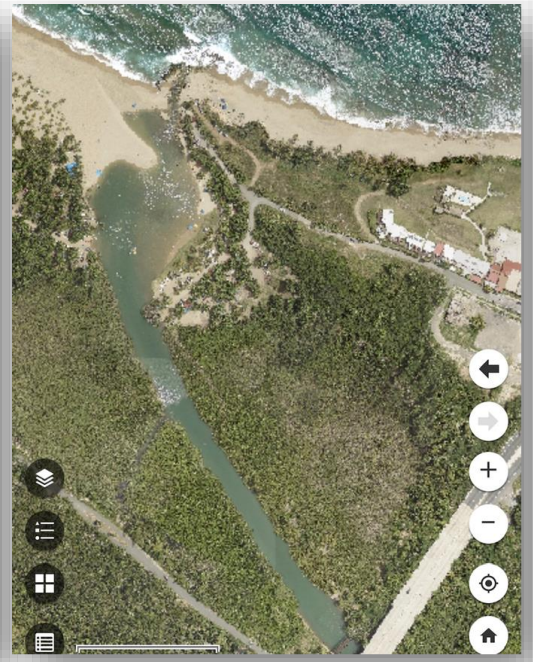
Importance of assess Riverine/Bar Geological feature



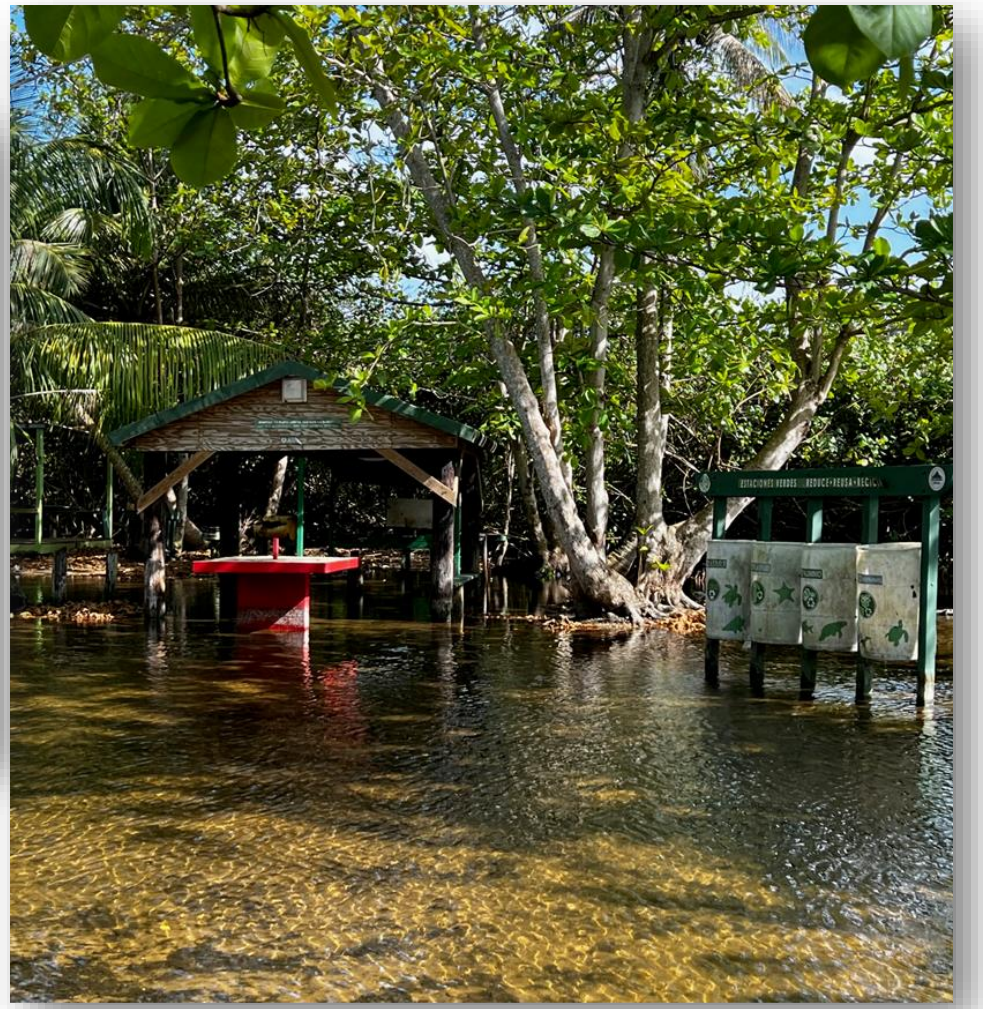
March 2017



September 2017 (NOAA)



July 2018 (USACE)



Flooded site, Guajataca, Quebradillas. Feb 19, 2023

Some results. Coastal Types (2018)

IPHOTO: HATILLO ,PR PÉREZ-VALENTÍN 2021

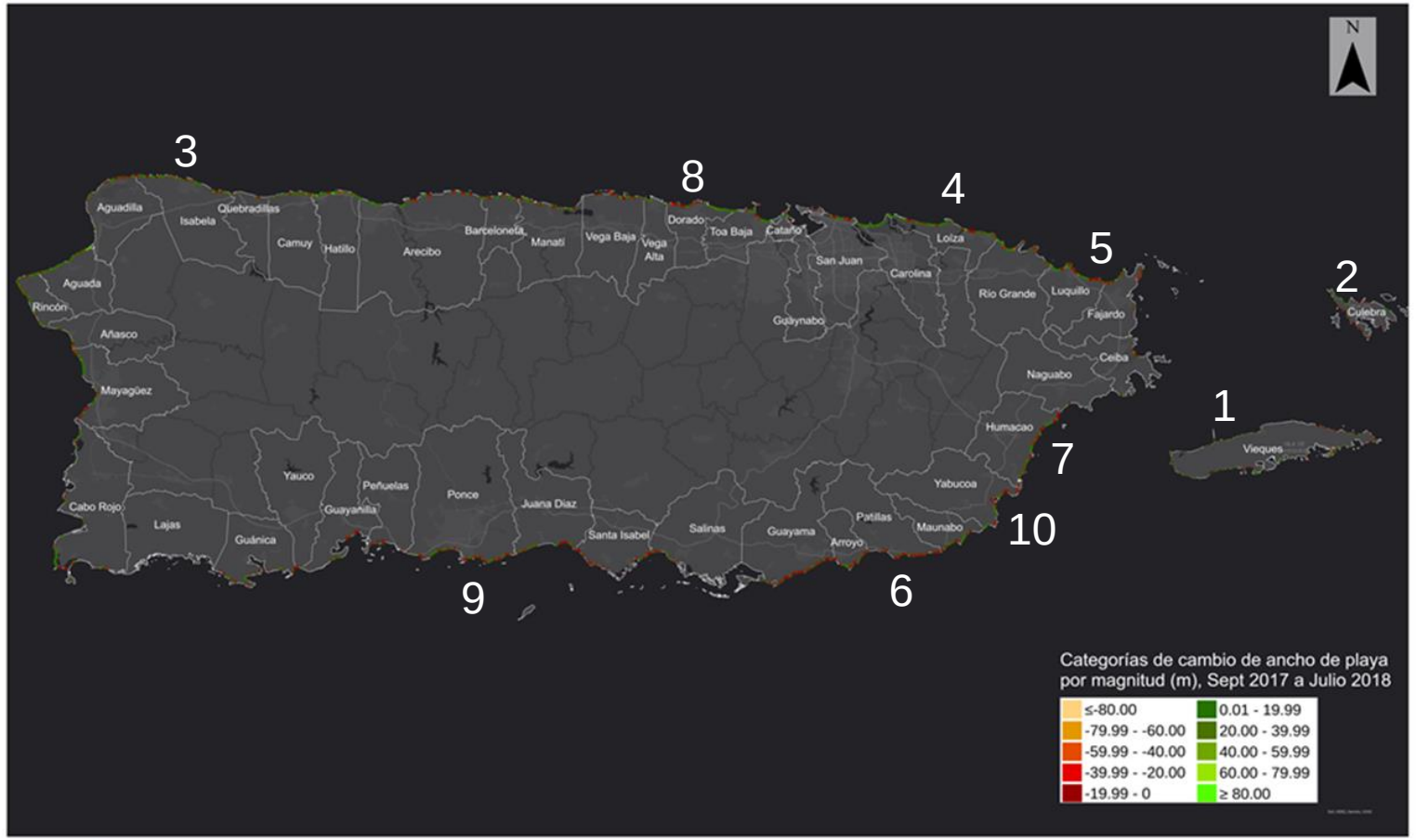
36%

28%

19%

8.1%

Cambio de ancho de playa por magnitud en PR (m), julio 2018



Municipalities with major erosion (beach width loss)

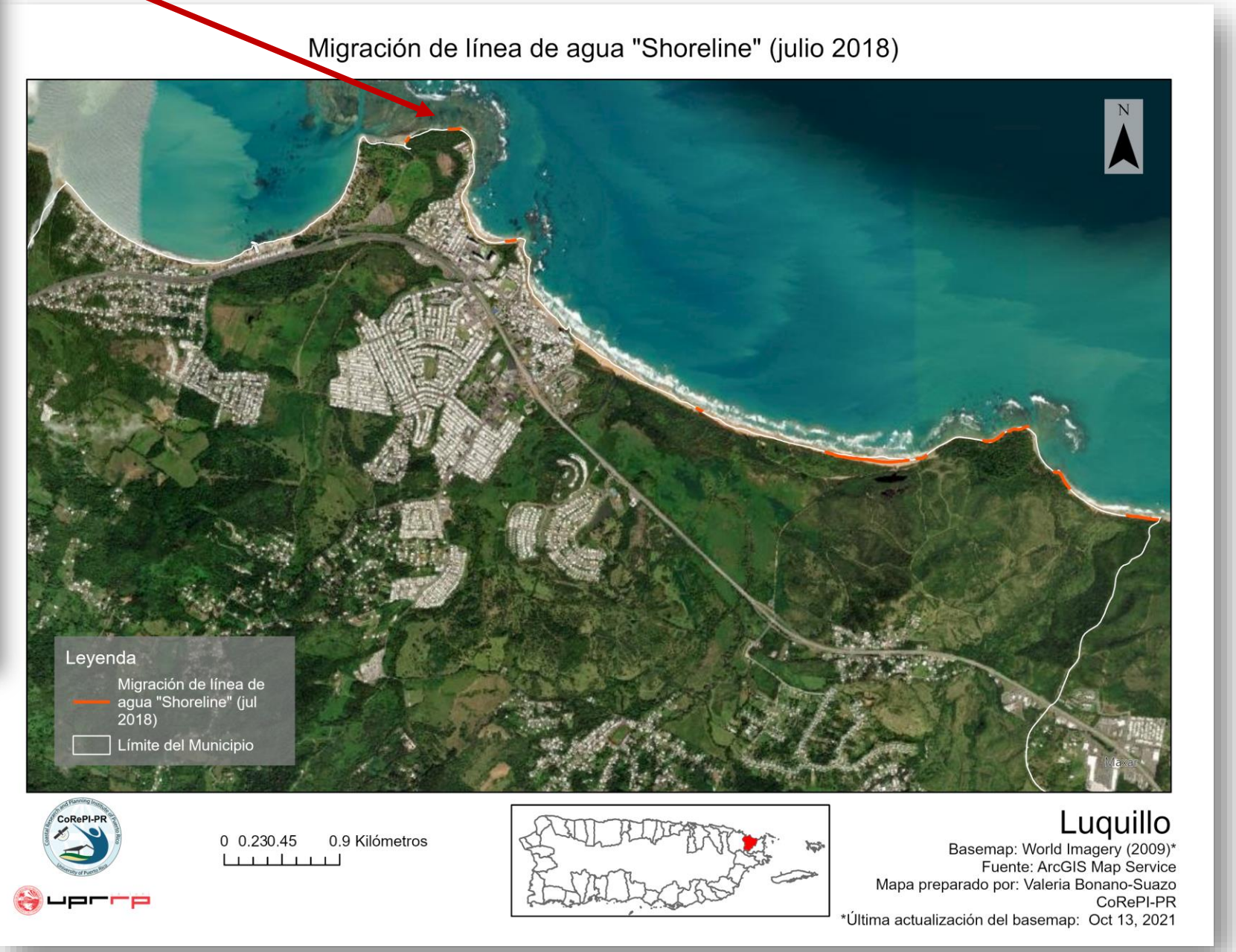
1) Vieques
2) Culebra
3) Isabela
4) Loíza
5) Luquillo
6) Patillas
7) Humacao
8) Dorado
9) Ponce
10) Yabucoa

Villa Cristiana, Loíza, PR 2019

Shoreline inland migration (PR): 99 kms

Municipalities with major shoreline inland migration(2018)

Vieques	19 km
Cabo Rojo	5.3 km
Arecibo	4.8 km
Humacao	4.4 km
Isabela	3.5 km
Vega Baja	3.5 km
Fajardo	3.3 km
Luquillo	**2.9 km**
Loíza	2.6 km
Hatillo	2.6 km



Roads in erosion sites/flood areas within the coastal zone area (1km)

Arecibo, 2019. Photo by Coastal Research and Planning institute of Puerto Rico (CoRePI)

Barreto. M. and Santos, A. 2023 in publication process

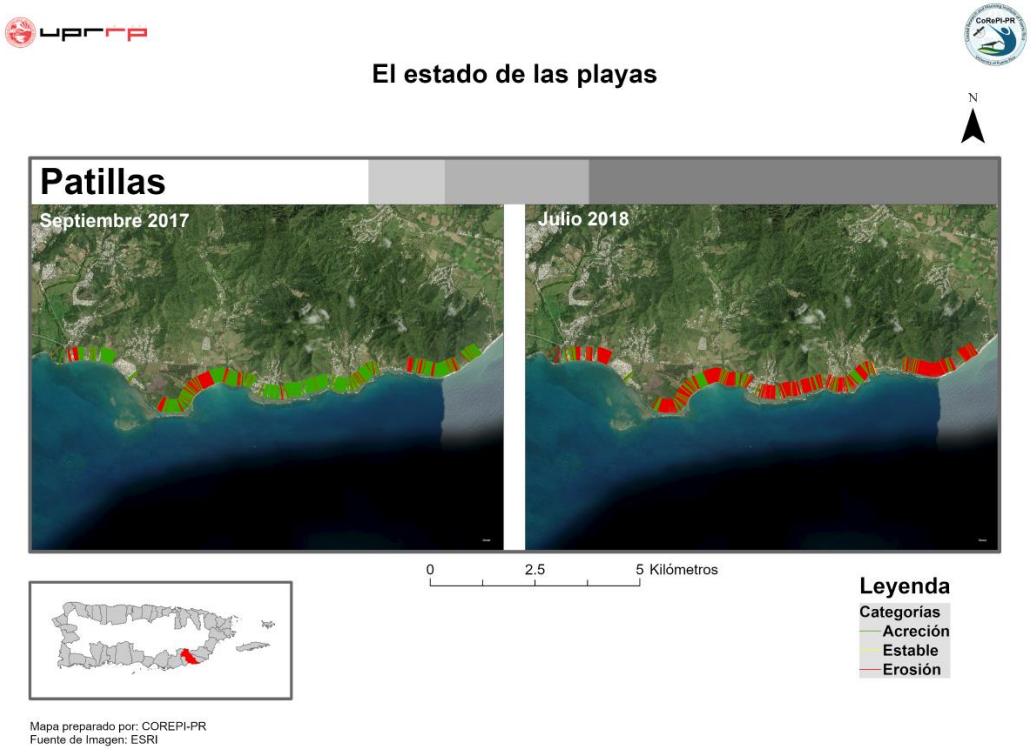
Benefits of the Project

- Estimation of post-Maria and recovery beach response (erosion/accretion) for the entire coastline of Puerto Rico (2017/2018; transects: each 10 meters).
- Estimation and analysis of selected shoreline and backbeach attributes.
- A baseline information of post-storm stage of beaches at the Island will be available to guide stakeholders in the decision-making processes.
- Assessment of beach response will help to understand coastal risk and vulnerability, especially in highly populated areas.
- This project define permanent data collection sites that can serve as a baseline for future assessment and interventions.

Needs

1. Acquire and publish an update High resolution aerial photos for the entire PR coastline (2022-2024).
2. Continuous acquisition of high resolution aerial photos for the entire island (Plan each 5 years/occurrence of extreme events).
3. Update LIDAR data (shoreline extraction)
4. Publish an update Puerto Rico DEM products (coastline).
5. Publish an update local sea-level rise projections.
6. Possible MOU with UPR Rio Piedras Campus (Coastal Research and Planning Institute; Graduate School of Planning)

Published Products



Post Maria Beach Assessment Story Map (all municipalities)

Post Maria Beach Assessment WebMap (PR)

Group 1 (Mayaguez, Rincón, Aguada, Rincón, Aguadilla; Arecibo; Barceloneta; San Juan; Loíza; Humacao

Group 2 (Mayaguez, Rincón, Aguada, Rincón, Aguadilla; Arecibo; Barceloneta; San Juan; Loíza; Humacao

Group 3 (Mayaguez, Rincón, Aguada, Rincón, Aguadilla; Arecibo; Barceloneta; San Juan; Loíza; Humacao

Group 4 (Ceiba, Naguabo, Vieques, Santa Isabel, Juana Díaz, Ponce, Peñuelas, Yauco, Lajas; Cabo Rojo

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