

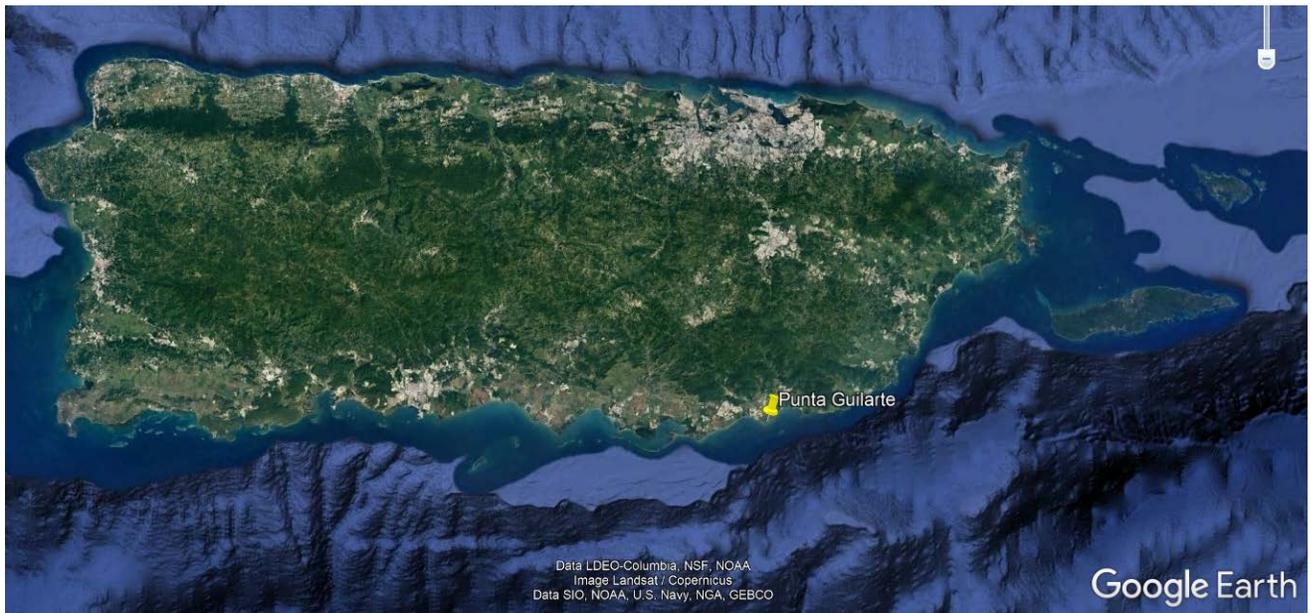
Day 1: Puerto Rico, Living Shorelines/Green Infrastructure Working Session Case Studies

PUNTA GUILARTE- ARROYO

Issue: Coastal Erosion at Municipal property-Centro Vacacional Punta Guilarte

Punta Guilarte National Park is a property of the Municipality of Arroyo located on the southeast coast of Puerto Rico composed of several rental villas and a camping area.

In recent years, erosion of the coast has occurred in front of the buildings, while accretion has occurred at the other extreme (western part) of the coast.



Yellow pin on map shows location of Punta Guilarte in Puerto Rico



Zoomed in view of location



Zoomed in view of Vacation Center facilities

The photos below show coastal erosion and accretion comparing 2004 and 2019.



Imagery date: 9/30/2004



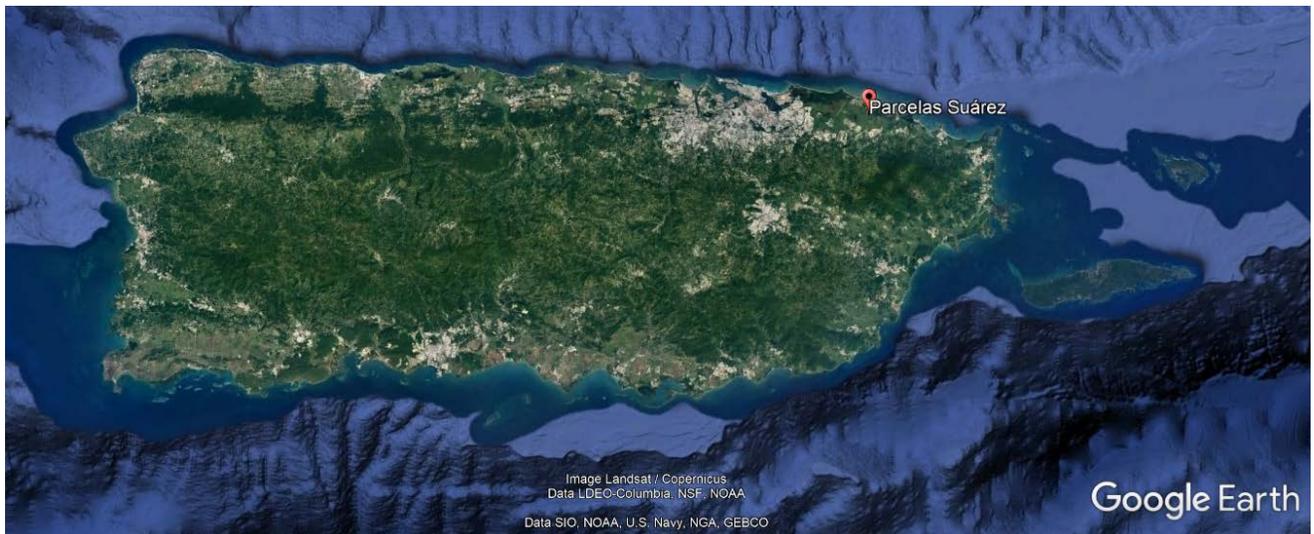
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Day 1: Puerto Rico, Living Shorelines/Green Infrastructure Working Session Case Study

PARCELAS SUÁREZ- LOÍZA

Issue: Coastal Erosion

Parcelas Suárez is located on the northeast coast of Puerto Rico in the Municipality of Loiza. The erosion in this area is threatening critical infrastructure, including a public road, a public school and a community center, along approximately 1,050 feet of shoreline. The erosion in Loíza was further exacerbated by impacts from Hurricane Irma and Hurricane Maria. Road protection is an immediate critical need because the 2017 hurricanes worsened shoreline erosion, causing partial failure of the public road (see photos below). The U.S. Army Corps of Engineers (USACE) and the Department of Natural and Environmental Resources (DNER) have been working on an Integrated Feasibility Report and Environmental Assessment for this area and a draft of the report was published in March 2018. The assessment recommends the construction of a continuous rock revetment along approximately 1,050 feet of shoreline in front of the public road, Head Start public school, and community center to provide emergency shoreline protection at Loíza. Due to existing public sidewalk damage, the remaining sidewalk may need to be demolished and replaced with an over-wash protection zone. The over-wash protection zone would consist of a high performance turf reinforcement mat between the existing road and the proposed revetment. However, DNER and the Municipality want a living shoreline design for some of this area rather than the recommended continuous rock revetment.



Red point on image shows location of Parcelas Suárez in Puerto Rico



Zoomed in view of area



Photos showing problems with coastal erosion, including damage to roads and recreational areas near the beach

Day 2: Puerto Rico, Adaptation Planning Working Session Case Study

MUNICIPALITY OF SAN JUAN

Issue: Sea Level Rise/ "nuisance" flooding; stormwater management, water quality; erosion

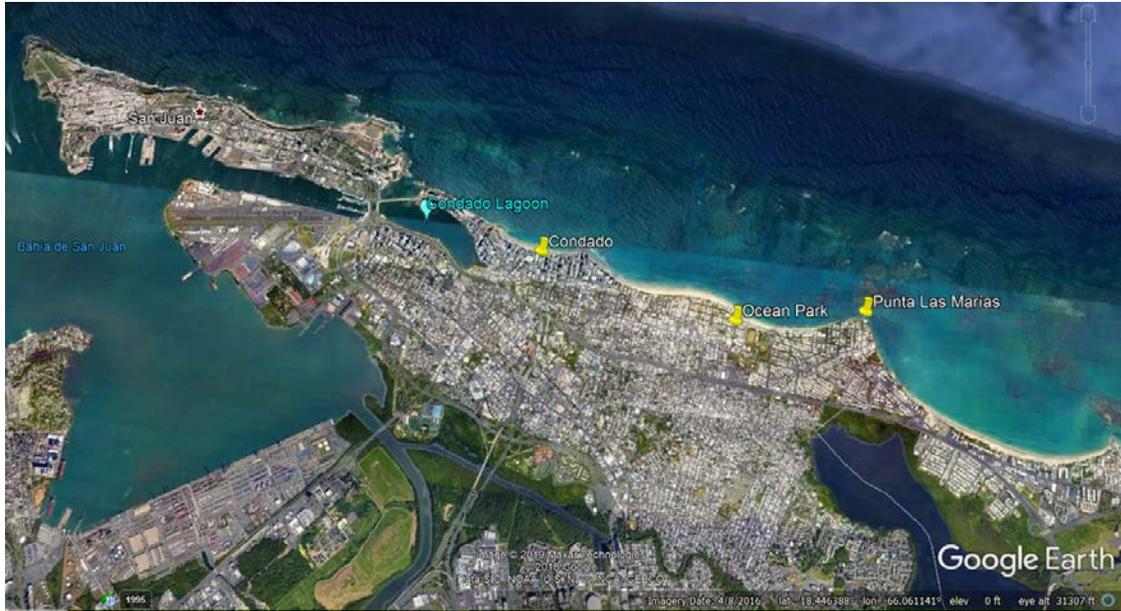
The case study area includes the area from Condado Lagoon to Punta Las Marías in the Municipality of San Juan. The area has been impacted by erosion; water quality and stormwater management; flooding from storm surges, swells, and sea level rise, among others.

Condado Lagoon is a marine coastal lagoon located in the Municipality of San Juan. In 2013, it was designated as an Estuarine Natural Reserve through the approval of the Estuarine Natural Reserve of Laguna del Condado Law, Act No. 112 of 2013. The lagoon has an average depth of 4 meters (m) and a maximum depth of 10.4 m (DNER, 2015). The lagoon receives freshwater inputs from the storm drainage system in the area, as well as runoff from adjacent lands. An evaluation carried out by the Municipality in 2014 identified 15 storm sewer system drains that discharge into the southern portion of the lagoon.

Stormwater management is also an issue in Ocean Park and Punta Las Marías. The Department of Natural and Environmental Resources (DNER) has flood control pump stations; however, this area still suffers flooding from stormwater runoff, in addition to flooding from swells and storm surge. Some of the residents have identified discharge in the stormwater drainage channels to the coast that appears to be contaminated or have waste discharge (Condado in Action).

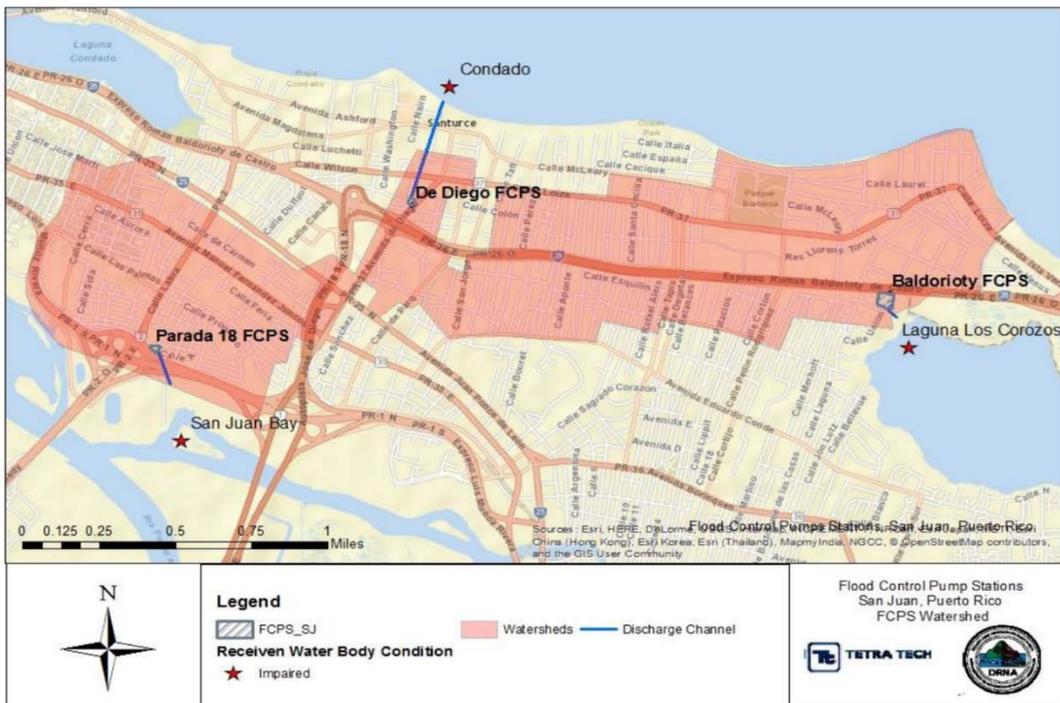
Other pluvial pipes that discharge into the lagoon from the residential complexes in the north-northeast of the lagoon were also identified. When the tide rises, the water enters through these pipes, flooding the area. With an increase in sea level, it is expected that floods will be more frequent if adequate adaptation strategies are not developed and implemented. In addition, the backup and release of storm drains and flooding of lands adjacent to the lagoon present sources of contamination to the reserve.

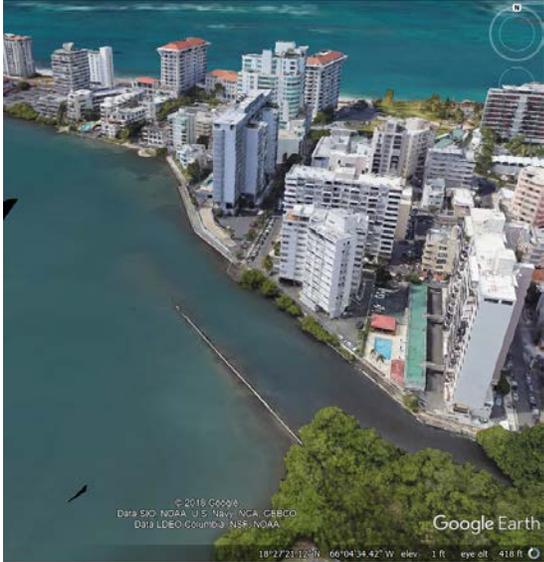
Communities like Condado, Ocean Park, and Punta Las Marías, among others in the area, have experienced a significant amount of erosion that has placed commercial and residential buildings at risk. Around 12 vertical feet and 110 horizontal feet of beach have eroded recently.



Map shows location of Condado Lagoon and the coastal communities of Condado-Ocean Park-Punta Las Marías in San Juan, Puerto Rico

San Juan Flood Control Pump Station





Aerial view of the northwestern portion of Condado Lagoon



Photos of areas of "nuisance flooding" and storm drainage system in south/southwest portion of lagoon



**Ocean Park flooded after Hurricane María (left photo); Stormwater discharge channel to the coast
Photos: Condado in Action**



Swells and Erosion in Ocean Park (photo on far right: Dr. Miguel P. Sastre, July 2019)



Aerial view of Ocean Park in June 2018 and June 2019

Day 2: Puerto Rico, Adaptation Planning Working Session Case Study

MUNICIPALITY OF TOA BAJA

Issue: Erosion, Flooding, Sea Level Rise

The Municipality of Toa Baja was one of the municipalities most affected by Hurricane María due to flooding and storm surge caused by the storm.

The northern portion of the Municipality is on a coastal plain with elevations ranging approximately 1-5 meters (m). There are marshes and mangrove areas and a substantial part of the land is flooded seasonally or permanently. The southern part of the Municipality is characterized by the presence of hills and limestone mogotes (generally isolated steep-sided residual hills with a rounded, tower-like form composed of limestone, marble, or dolomite surrounded by nearly flat alluvial plains).

Most of the Municipality is susceptible to floods. Toa Baja has large urban areas in the coastal plain, mostly in food-prone areas. The Municipality has channels to manage stormwater runoff and prevent flooding. However, the exit of some channels to the coast do not work properly due to sediment deposition and high sea level. In addition, like many coastal municipalities, Toa Baja has significant coastal erosion problems because of natural and anthropogenic impacts (swell, storms, sea level rise, and human activities).



Red point on image shows location of the Municipality of Toa Baja in Puerto Rico



Zoomed in view of the general area of the Municipality



Photos showing coastal erosion and channels through which stormwater drains