Probable hurricane-induced coastal erosion in Puerto Rico Legna Torres-García

United States Geological Survey, St Petersburg Coastal and Marine Science Center, Florida NOAA Hydrographic Services Review Panel U.S. Caribbean Public Meeting, March 2, 2023



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MOTIVATION: Underrepresented communities are disproportionately impacted by coastal hazards



Still in August 2021...







https://coastal.er.usgs.gov/hurricanes/research/twlviewer/

USGS-NOAA Collaboration: Total Water Level and Coastal Change Modeling Framework





(Stockdon et al. 2023, in review)



Coastal Research Challenges in Puerto Rico

- Puerto Rico has a complex coastline (rocky, vegetated, man-made structures) and a large bottom roughness from coral reefs.
- USGS has focused mainly on sandy beaches in the US East Coast



Photo Credit: Emily Himmelstoss and Priscila Vargas-Babilonia

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CariCOOS PUERTO RICO STORM SURGE ATLAS SLR = 0.5 m, Cat 4 (dP = 926 mb), (270°, 290°, 330°), Vf = 10 kn, RMW = 15 nm, Vmax = 131 kn MAXIMUM OF MAXIMUM OF MAXIMUM ENVELOPE OF WATERS ABOVE MSL (m) m





Generate a database of LIDARderived shorelines, dunes, and sea cliffs Utilize max of the max forcing conditions from large-scale storm surge and wave models developed by the University of Puerto Rico at Mayagüez

Develop XBeach models around the entire island, including bottom type/friction

Hurricane Scenario-Based Coastal Hazards Change



Aquadilla



(Benítez, J. & Aurelio-Mercado, I., 2015; Storlazzi, C. D. et al., 2019)

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Transect Classification Percentage based on North, South, East and West

Cliffs: 26%





Dunes: 63 %



*Cliffs includes walls and rocks structures

Dune	Cat 1	Cat 2	Cat 3	Cat 4	Cat 5	
Collision	95%	98%	99%	100%	100%	
Overwash	12%	25%	37%	44%	48%	
Inundation	2%	6%	12%	19%	23%	

Puerto Rico: Hurricane Scenarios

EXPLANATION Hurricane Scenario: Category 1 Probability of Collision (%)

50

75

100

(Doran, K.S. et al., 2022)

Entitistar Geographics

RESULTS: Probability for Category 4 Hurricane



USGS Coastal Change Hazards Portal: Tool Visualization



https://marine.usgs.gov/coastalchangehazardsportal/

Interested Parties Engagement Project

User-friendly Storymap: <u>"SHORELINE CHANGES IN PUERTO RICO"</u>





https://geonarrative.usgs.gov/puertoricoshorelinechange/

(Vargas-Babilonia, P. et al., 2022)

Next Steps: Development of the Total Water Level and Coastal Change Forecast in Puerto Rico

Objective: Working on expanding the TWL & CC coverage and refining our models for

reef-lined coasts, a critical component for improving resilience.



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- New approach for non-sandy beaches
- Meta-model based on phase-resolving model
- Representative profiles
- Range of wave forcing
- Meta-model produces a statistical representation of runup elevations





⁽Pearson, S. G. et al., 2017; Scott et al., 2020)

Skill Assessment: Field Campaign & Data Available for Validation







Oceanographic Instrumentations

Coastal Camera Systems





https://cmgds.marine.usgs.gov/data/dorado/

https://cmgds.marine.usgs.gov/data/islaverde/