



NCA4: Coastal and Marine Systems - Puerto Rico

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National Climate Assessment: All-Author meeting March 2018



NCA4: Chapter 20 - US Caribbean

Key Message 1: Freshwater is critical to life throughout the Caribbean. Increasing global carbon emissions could lead to a steep reduction in rainfall by the end of the century, constraining freshwater availability. Reservoirs could experience a permanent supply deficit by 2025. Saltwater intrusion associated with sea level rise will reduce the quantity and quality of freshwater in coastal aquifers. Increasing variability in rainfall events and increasing temperatures will likely exacerbate existing problems in water management, planning, and infrastructure capacity.

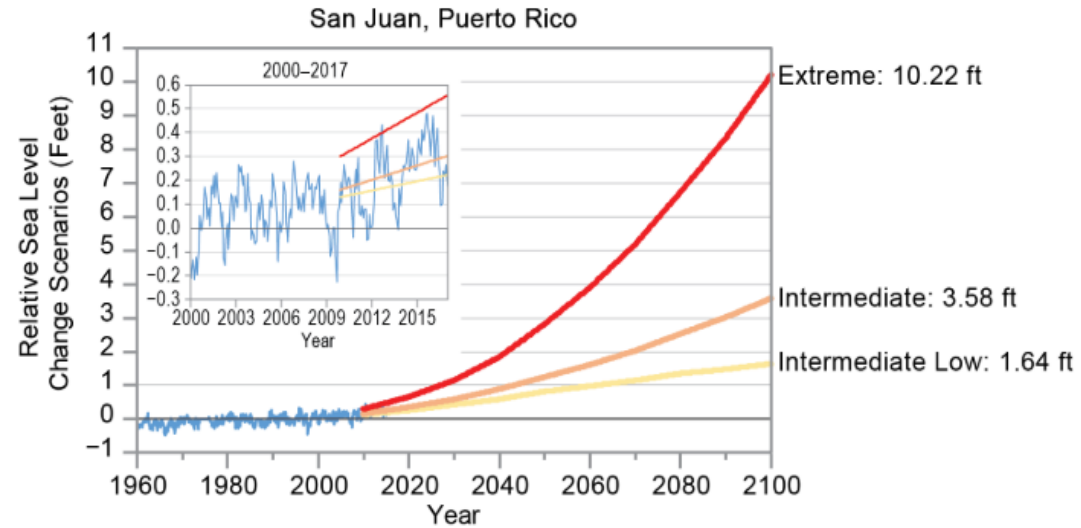
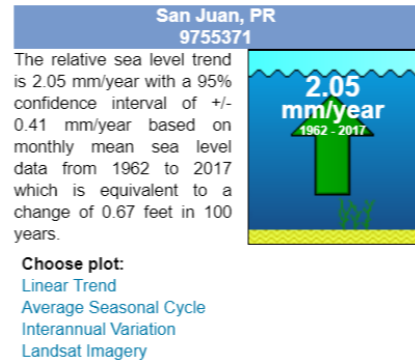
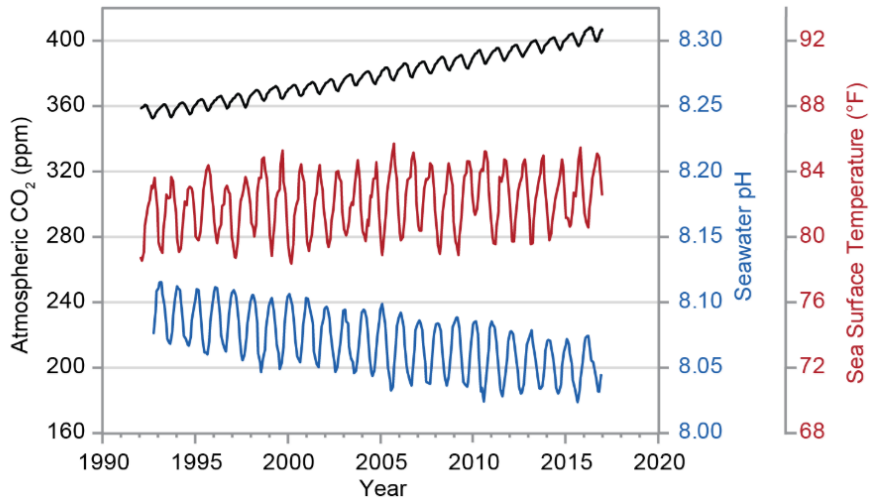
Key Message 2: Marine ecological systems provide key ecosystem services such as commercial and recreational fisheries and coastal protection. These systems are threatened by changes in ocean surface temperature and acidity, sea level rise, and changes in the frequency and intensity of storm events. Degradation of coral and other marine habitats will result in changes in the distribution of mobile species that use these habitats, including those targeted in fisheries, and loss of cover of live corals, sponges, and other key species. These changes will disrupt valuable ecosystem services, producing subsequent effects on Caribbean island economies.

Key Message 3: Island economies, critical infrastructure, property, cultural heritage, and natural ecological systems are all threatened by sea level rise, coastal erosion, and extreme weather. Stronger wave action and higher storm surges will worsen coastal flooding and increase coastal erosion, leading to diminished beach area, loss of coastal protection, decreased tourism revenue, impairment of public services, and negative effects on communities' livelihoods and well-being. The U.S. Caribbean could experience a near 3-foot rise in sea level by 2050 and about 10 feet by 2100. Puerto Rico and the U.S. Virgin Islands could lose up to 3.6% and 4.6% of total coastal land area respectively under a 6.5 feet sea level rise scenario.

Key Message 4: Social well-being, terrestrial ecosystems, agricultural services and socio-ecological and technological systems are threatened by rising temperatures. Increased temperatures are likely to lead to decreases in agricultural productivity, changes in habitat functionality and wildlife distributions, and increased risk to human health in vulnerable populations. As maximum and minimum temperatures increase, there are likely to be fewer cool nights and more frequent hot days that will affect the quality of life in the U.S. Caribbean.

Key Message 5: Increasing frequency of extreme events threatens life, property, and economy in the Caribbean. The frequency and intensity of extreme events such as hurricanes, tropical storms, flooding, heat waves, and droughts are expected to increase, affecting human health and well-being, economic development, conservation, and agriculture. Resiliency will depend on collaboration and integrated planning, preparation, and responses across the region.

Key Message 6: Shared knowledge, collaborative research and monitoring, and building institutional adaptive capacity can reduce the need for disaster relief, enhance food security, and improve economic opportunity in the U.S. Caribbean. International cooperation and strengthening partnerships in the Caribbean reduces vulnerability and can reduce risks associated with climate change uncertainty.



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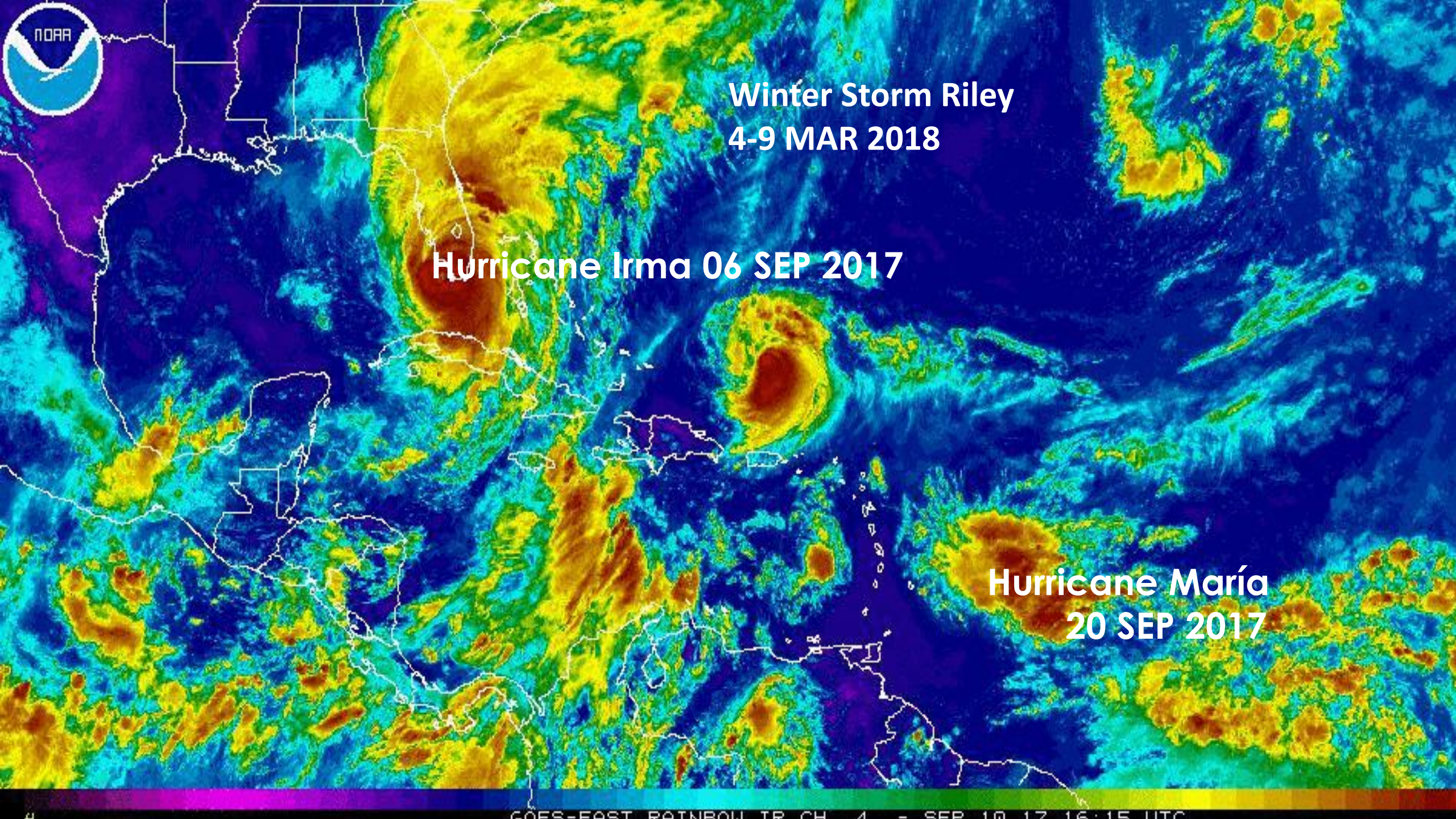




Winter Storm Riley
4-9 MAR 2018

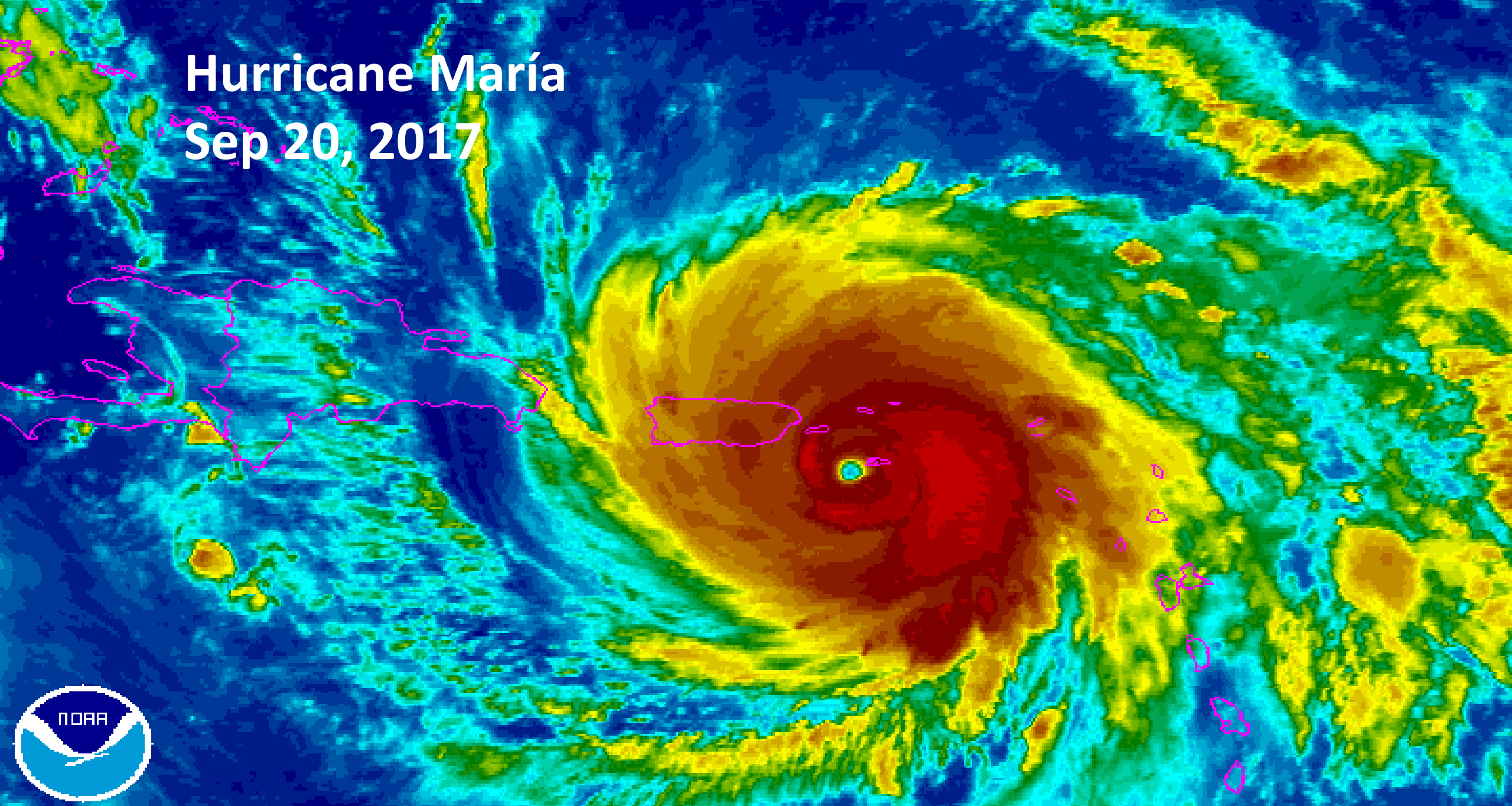
Hurricane Irma 06 SEP 2017

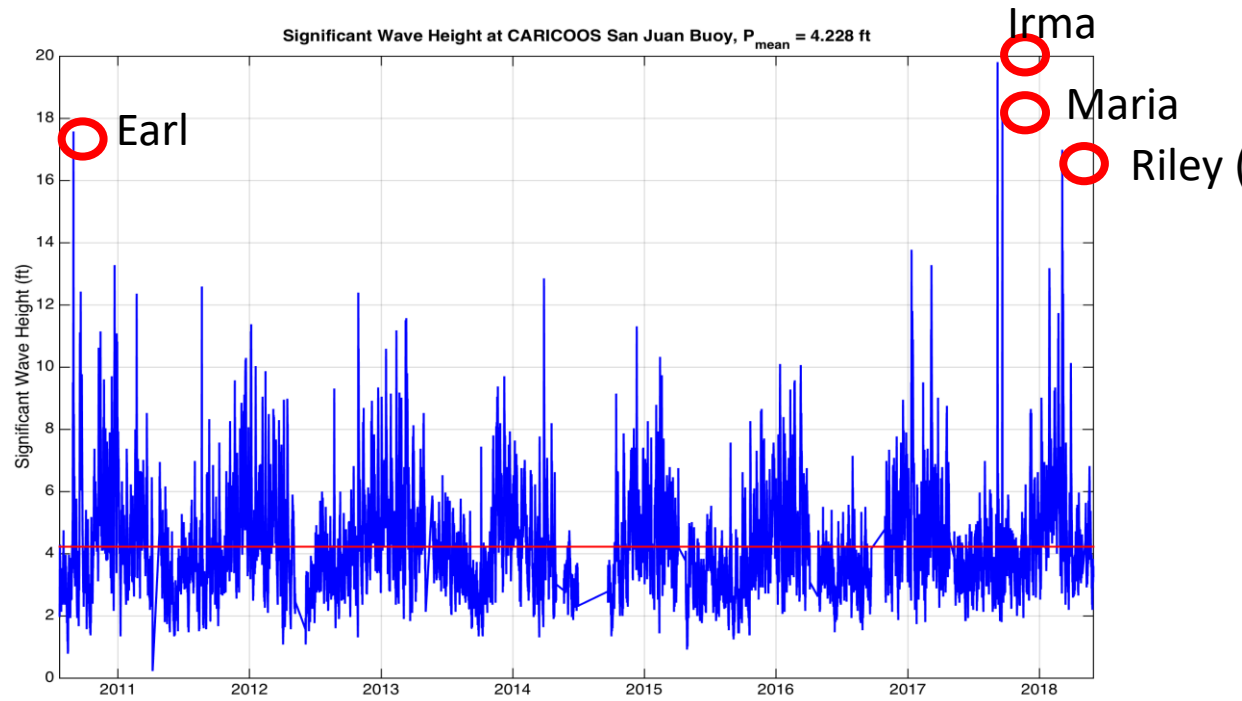
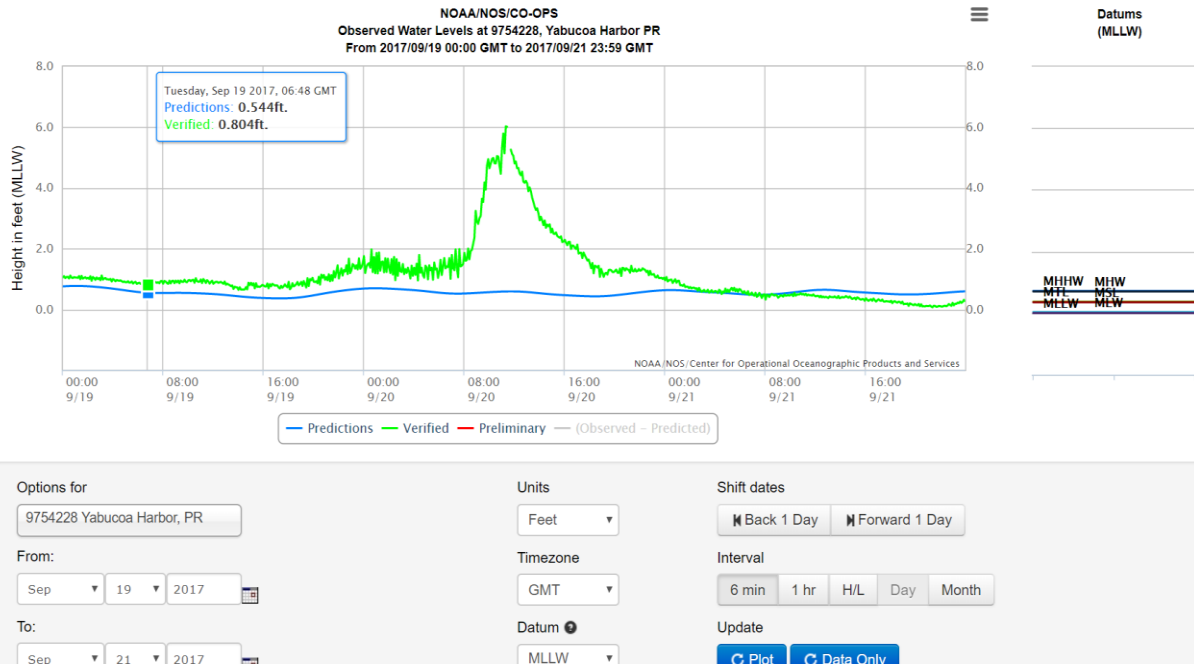
Hurricane María
20 SEP 2017



Hurricane María

Sep 20, 2017



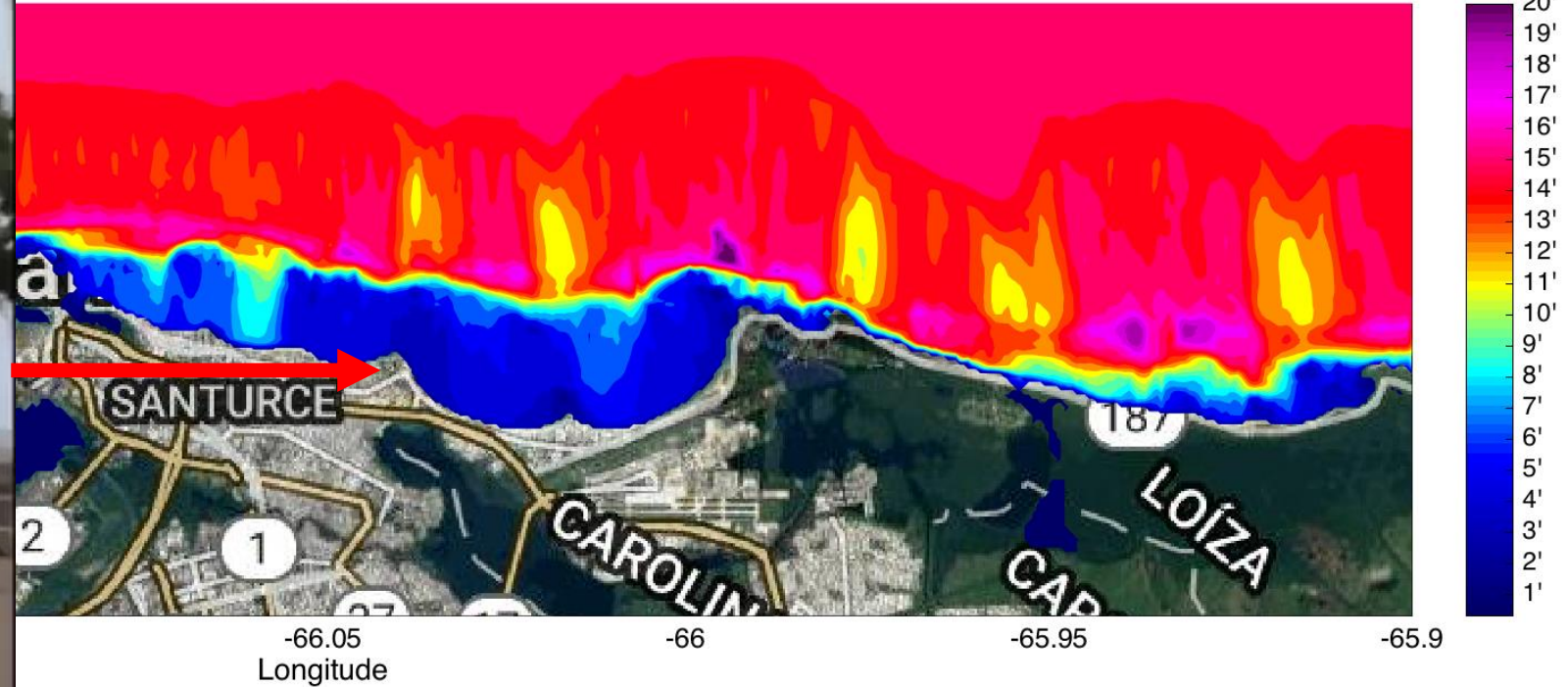


Hurricane Maria
Storm Surge: 6.5 ft

MAX WAVE HEIGHT @ SJ / CAROLINA- STORM RILEY



Significant wave height (Hs, ft) for Winter Storm Riley (March 4-9, 2018)







ENVIRONMENTAL STUDIES

Coral reef structural complexity provides important coastal protection from waves under rising sea levels

Daniel L. Harris,^{1,2,3*} Alessio Rovere,^{1,2,4} Elisa Casella,² Hannah Power,⁵ Remy Canavesio,⁶ Antoine Collin,^{7,8} Andrew Pomeroy,^{9,10,11} Jody M. Webster,¹² Valeriano Parravicini⁶

Coral reefs are diverse ecosystems that support millions of people worldwide by providing coastal protection from waves. Climate change and human impacts are leading to degraded coral reefs and to rising sea levels, posing concerns for the protection of tropical coastal regions in the near future. We use a wave dissipation model calibrated with empirical wave data to calculate the future increase of back-reef wave height. We show that, in the near future, the structural complexity of coral reefs is more important than sea-level rise in determining the coastal protection provided by coral reefs from average waves. We also show that a significant increase in average wave heights could occur at present sea level if there is sustained degradation of benthic structural complexity. Our results highlight that maintaining the structural complexity of coral reefs is key to ensure coastal protection on tropical coastlines in the future.

Coral reefs for coastal protection: A new methodological approach and engineering case study in Grenada

Borja G. Reguero^{a, b, *}, Michael W. Beck^{b, a}, Vera N. Agostini^c, Philip Kramer^{b, d}, Boze Hancock^e

Hurricane Irma 06 SEP 2017

DNER, NOAA and volunteers initiated damage assessment and triage. [Over 5,000 fragments reattached.](#)

Hurricane María 20 SEP 2017

A total of 414,354 m² of coral reef and over 80,000 corals were surveyed at 153 sites across Puerto Rico between February 25 and May 7, 2018. Approximately, [5,400 coral fragments or broken coral colonies were reattached](#) (triage) to the reef at 32 sites in the Northeast, North, and Vieques regions.



Marzo 2008

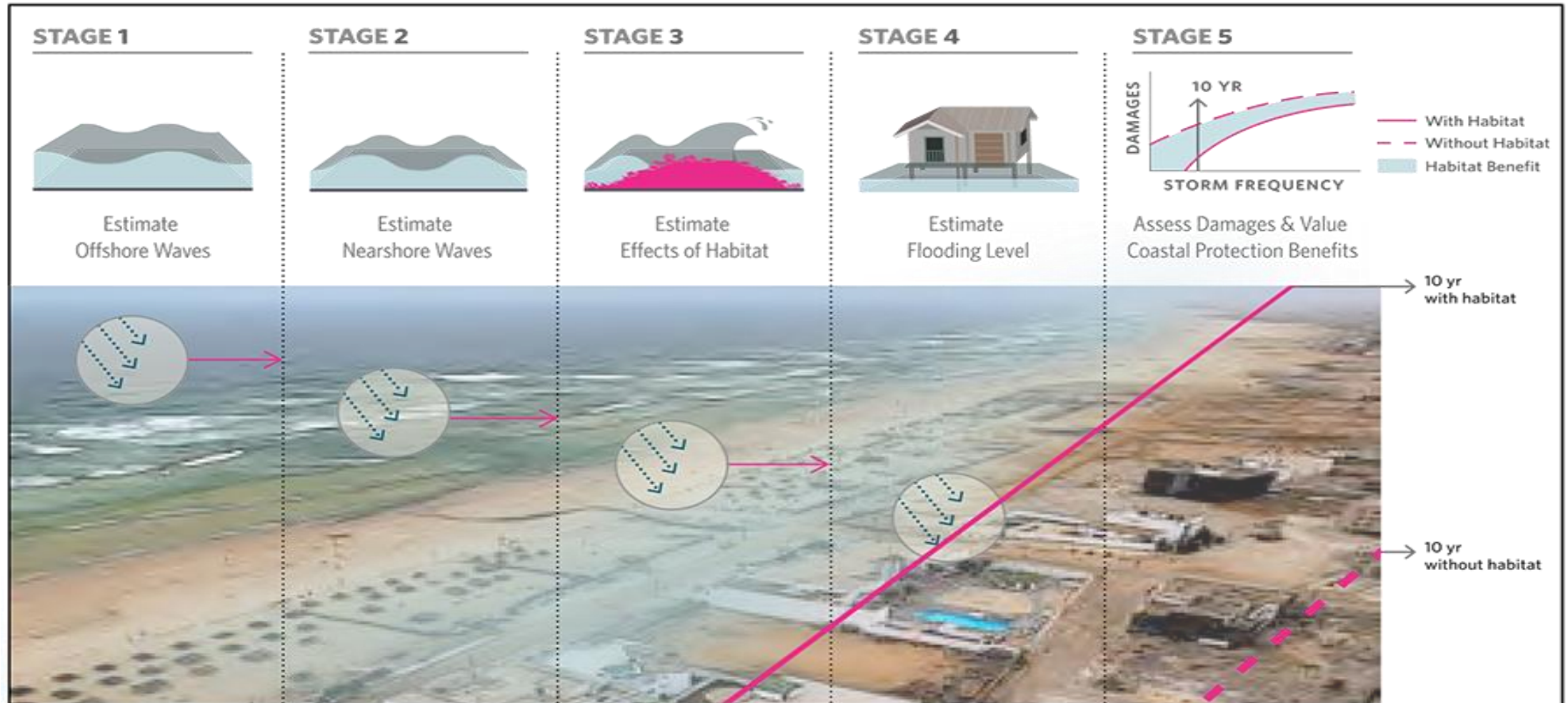


Octubre 2017



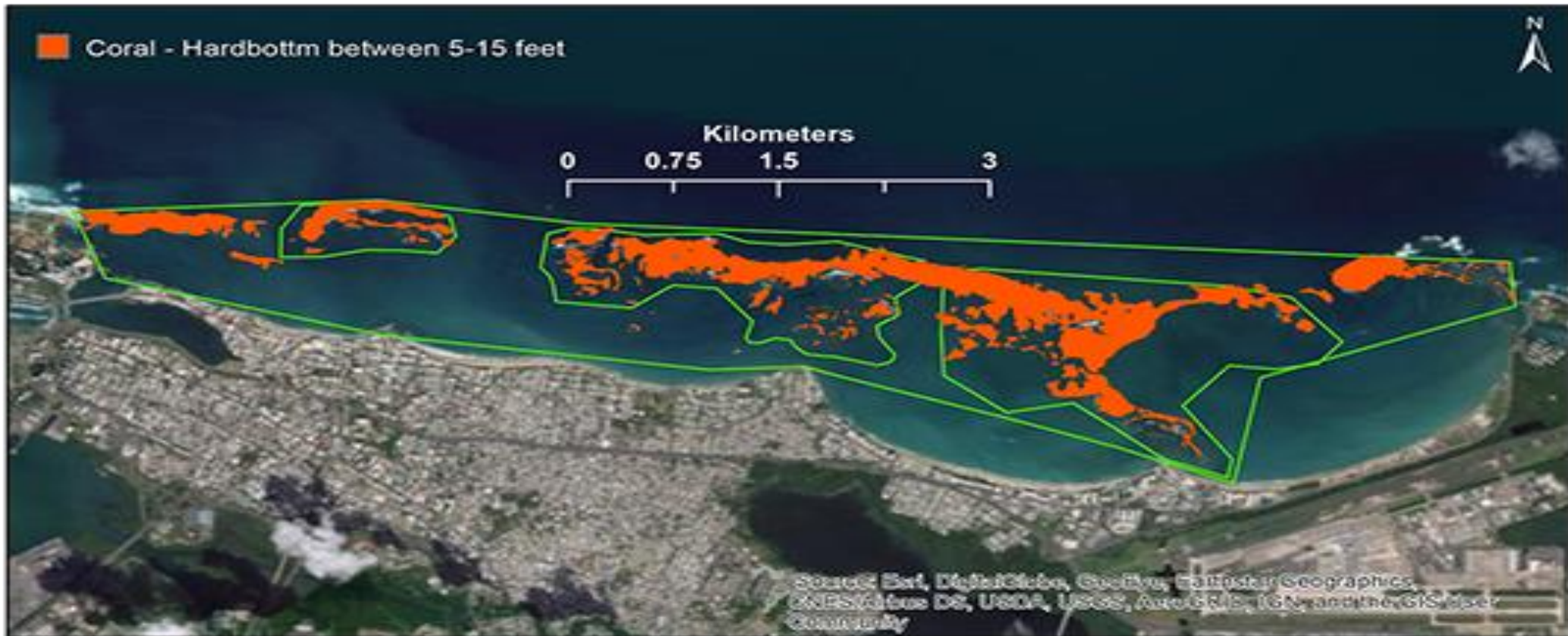
Junio 2018

Damage caused by storm surge and wave action: **Beach erosion, coral reefs damage and floods** resulting in major public and private infrastructure loss



Reef and Beach Intervention to enhance coastal protection in Puerto Rico - Pilot projects at San Juan metro and Rincón

SITE: San Juan



Total Site Area: 3,015 acres

Estimated area of reef between 5-15 feet: 520 acres

Beaches and coral reefs of the future

Status of Puerto Rico's Coral Reefs in the Aftermath of Hurricanes Irma and Maria

Assessment Report Submitted by NOAA to the FEMA Natural and Cultural Resources Recovery Support Function



DNER/UPR-USACE Regional sediment management

From: Keiser, Jacqueline J CIV USARMY CESAJ (US) <Jacqueline.J.Keiser@usace.army.mil>
Sent: Friday, February 16, 2018 8:23 AM
To: Ernesto L. Diaz; Sasso, Johann M CIV USARMY CESAJ (US)
Cc: Mora, Millan A CIV USARMY CESAJ (US); Schrader, Matthew H CIV USARMY CESAJ (US); Legault, Kelly R CIV USARMY CESAJ (US)
Subject: RE: RSM and Beach nourishment initiatives

Ernesto,
Thank you for your email and your continued collaboration! The coastal response in Puerto Rico is of immediate concern to our team as well. As you mentioned, the Supplemental Bill passed and as you know it includes 100% Federal coverage of ALL work in Puerto Rico. Two things must happen before we can begin to expend dollars under those long term projects for areas in the Supplemental bill: 1) A list of projects to be covered under the bill will be coordinated/approved between the Assistant Secretary of the Army (ASA), the Office of Management and Budget (OMB), and Congress and 2) USACE will issue implementation guidance on how we are to carry out the programs/projects covered in the Supplemental Bill. The bottom line is that, if approved, any action specific to these projects is likely at least 60 days out and possibly more (just my guess).

We continue to express capability on the South Atlantic Coastal Study, the Puerto Rico Coastal Comprehensive Study, the San Juan Metro Area Coastal Storm Risk Management Project, and the Rincon 103 under all potential funding sources. No decisions have been made at this time but we appreciate your responsiveness should questions arise regarding Puerto Rico's support for the above.

We can absolutely schedule a call if that would be of help to you. Between 1-3 is open for me today.

Thanks!
Jackie

The National Academies of SCIENCES • ENGINEERING • MEDICINE Interventions to Increase the Resilience of Coral Reefs Workshop Agenda

May 31, 2018



Designing a new type of insurance to protect the coral reefs, economies and the planet

A new type of insurance to protect coral reefs has been announced at the 2018 World Ocean Summit in Mexico. Swiss Re is proud to have supported the design of this new product which will not only help the conservation and swift restoration of the reef, if damaged by a major hurricane, but it will also support the economic resilience of the region and offers an opportunity to create a scalable new market for the insurance



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