




Current Climate and Ocean Conditions, Trends and Projections:
A Blueprint for the Next Generation of Puerto Rico's Coastal Infrastructure

2019

PUERTO RICO

Overview

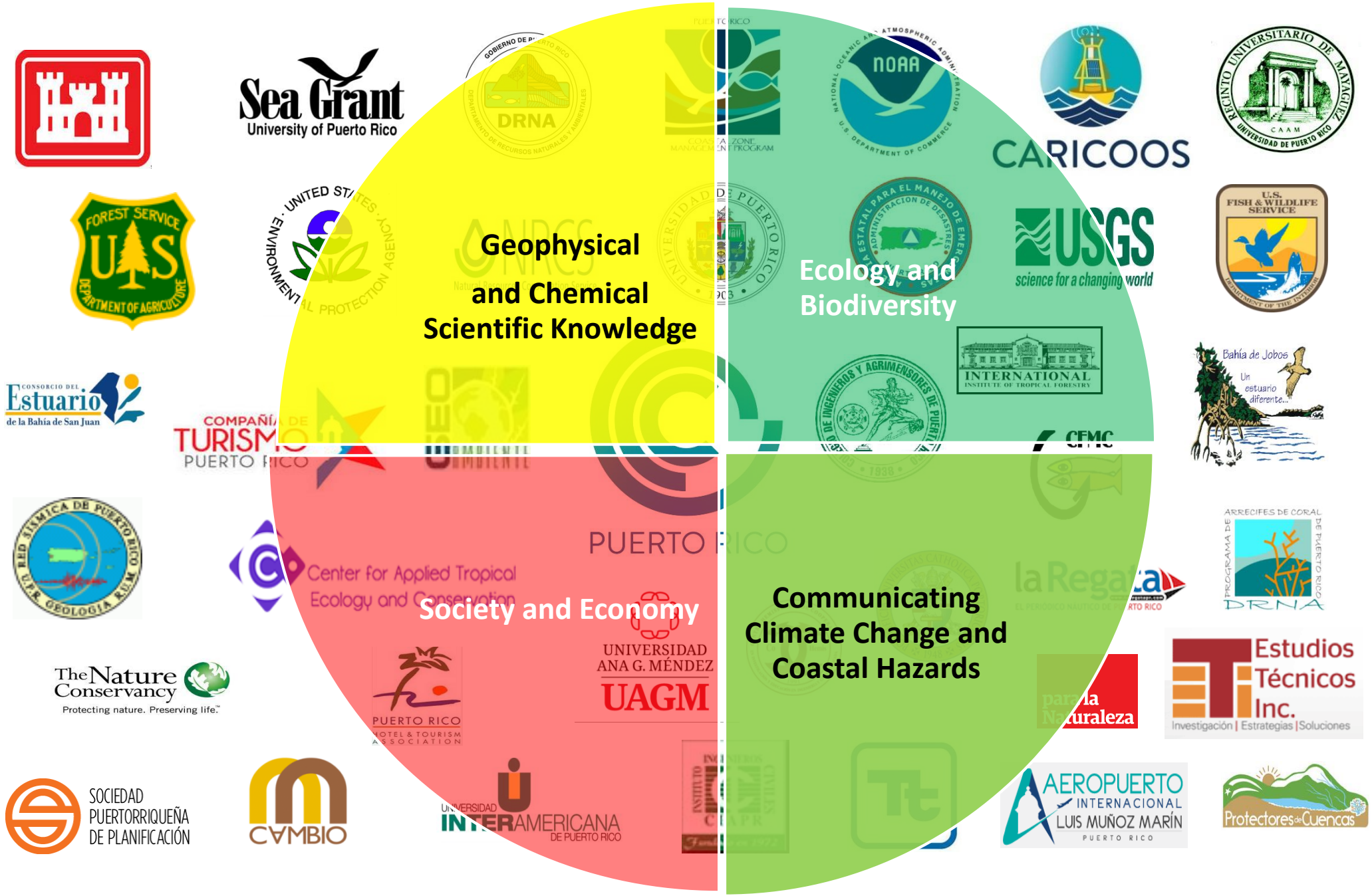
- Puerto Rico Climate Change Council
- Global and Caribbean climate context, trends and projections
- Coastal communities, critical infrastructure and natural assets at risk
- Examples of natural infrastructure at work: Coral Reefs!
- Blueprint for resilient coasts and the next generation of coastal infrastructure and systemic interventions

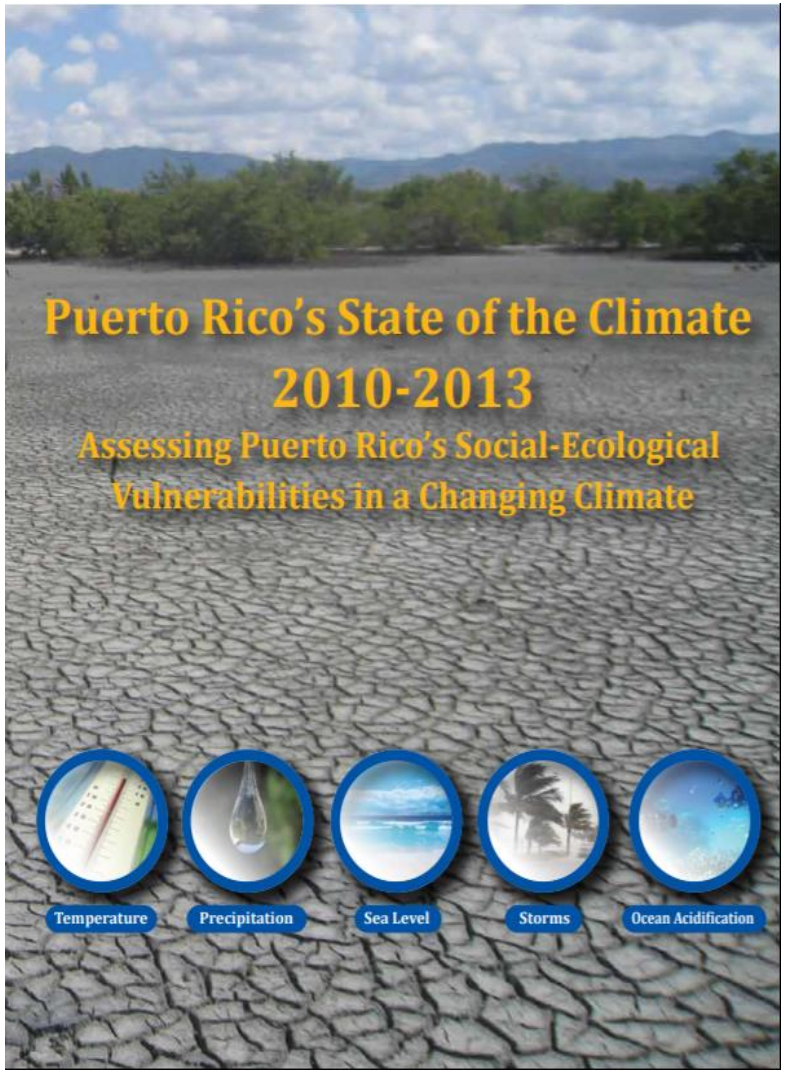
Puerto Rico Climate Change Council

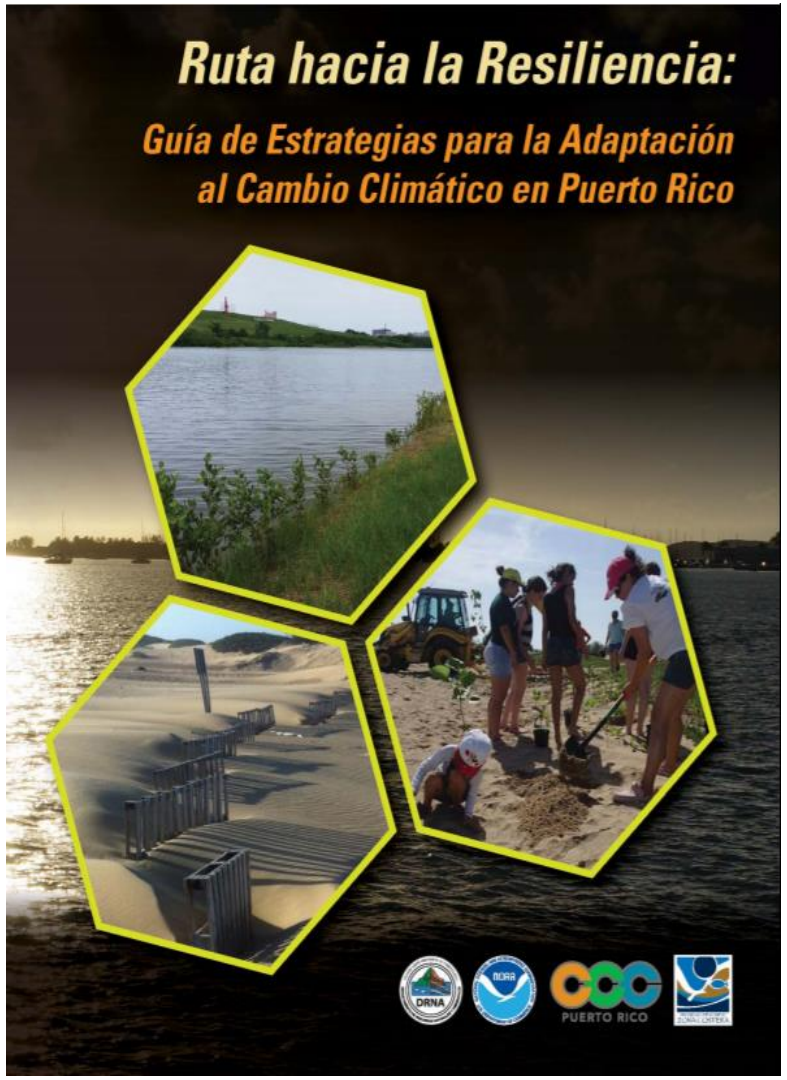
Mission

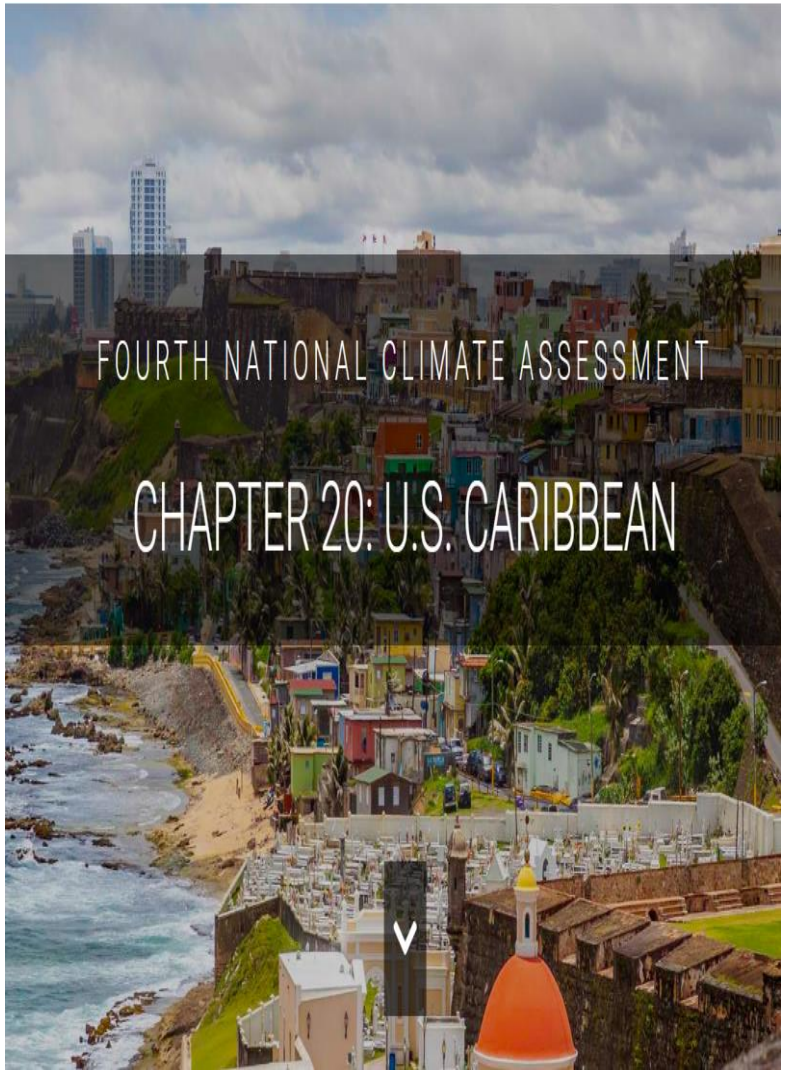
…assess the state of Puerto Rico's climate, using the best science and knowledge available, understand Puerto Rico's social-ecological vulnerabilities and develop adaptation strategies to build a resilient society.

Membership: 150+

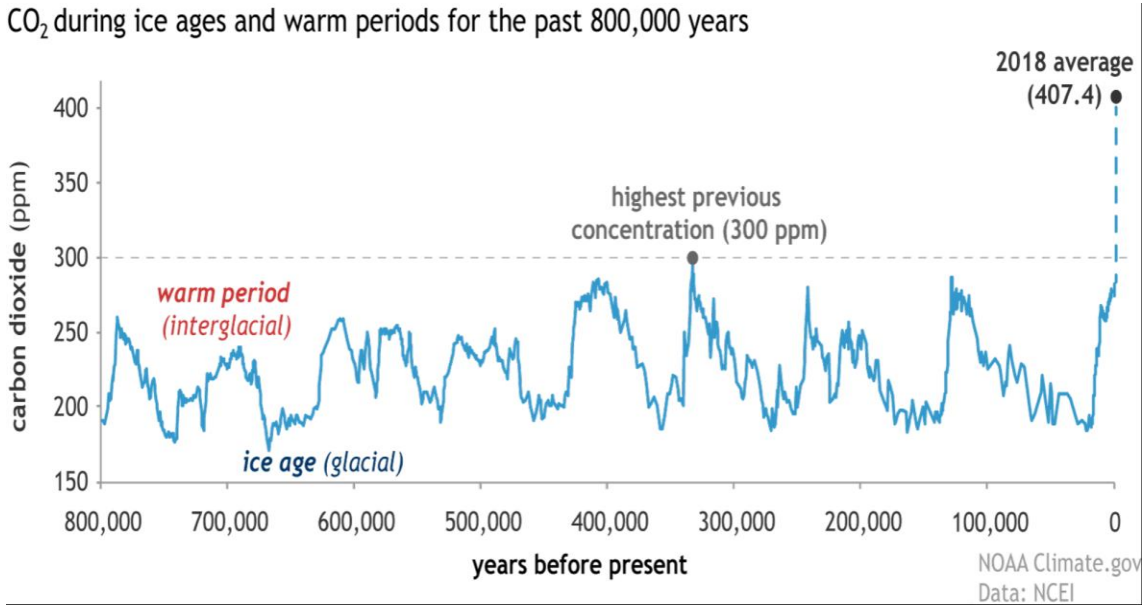

Geophysical and Chemical Scientific Knowledge
Ecology and Biodiversity
Society and Economy
Communicating Climate Change and Coastal Hazards
Sea Grant
University of Puerto Rico
DRNA
NOAA
CARICOOS
USGS
science for a changing world
U.S. FISH & WILDLIFE SERVICE
FOREST SERVICE
Consorcio del Estuario de la Bahía de San Juan
INTERNATIONAL INSTITUTE OF TROPICAL FORESTRY
Bahía de Jobos
Un estuario diferente...
Center for Applied Tropical Ecology and Conservation
UNIVERSIDAD ANA G. MÉNDEZ
UAGM
PUERTO RICO HOTEL & TOURISM ASSOCIATION
The Nature Conservancy
Protecting nature. Preserving life.
Estudios Técnicos Inc.
Investigación | Estrategias | Soluciones
SOCIEDAD PUERTORRIQUEÑA DE PLANIFICACIÓN
CAMBIO
UNIVERSIDAD INTERAMERICANA DE PUERTO RICO
AEROPUERTO INTERNACIONAL LUIS MUÑOZ MARÍN
PUERTO RICO
Protectores de Cuencas



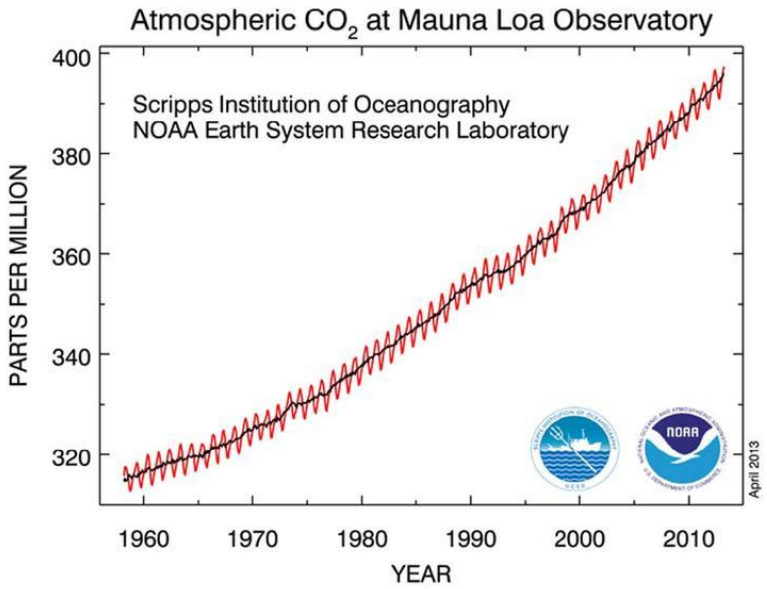




http://pr-ccc.org



Intergovernmental Panel on Climate Change (IPCC)

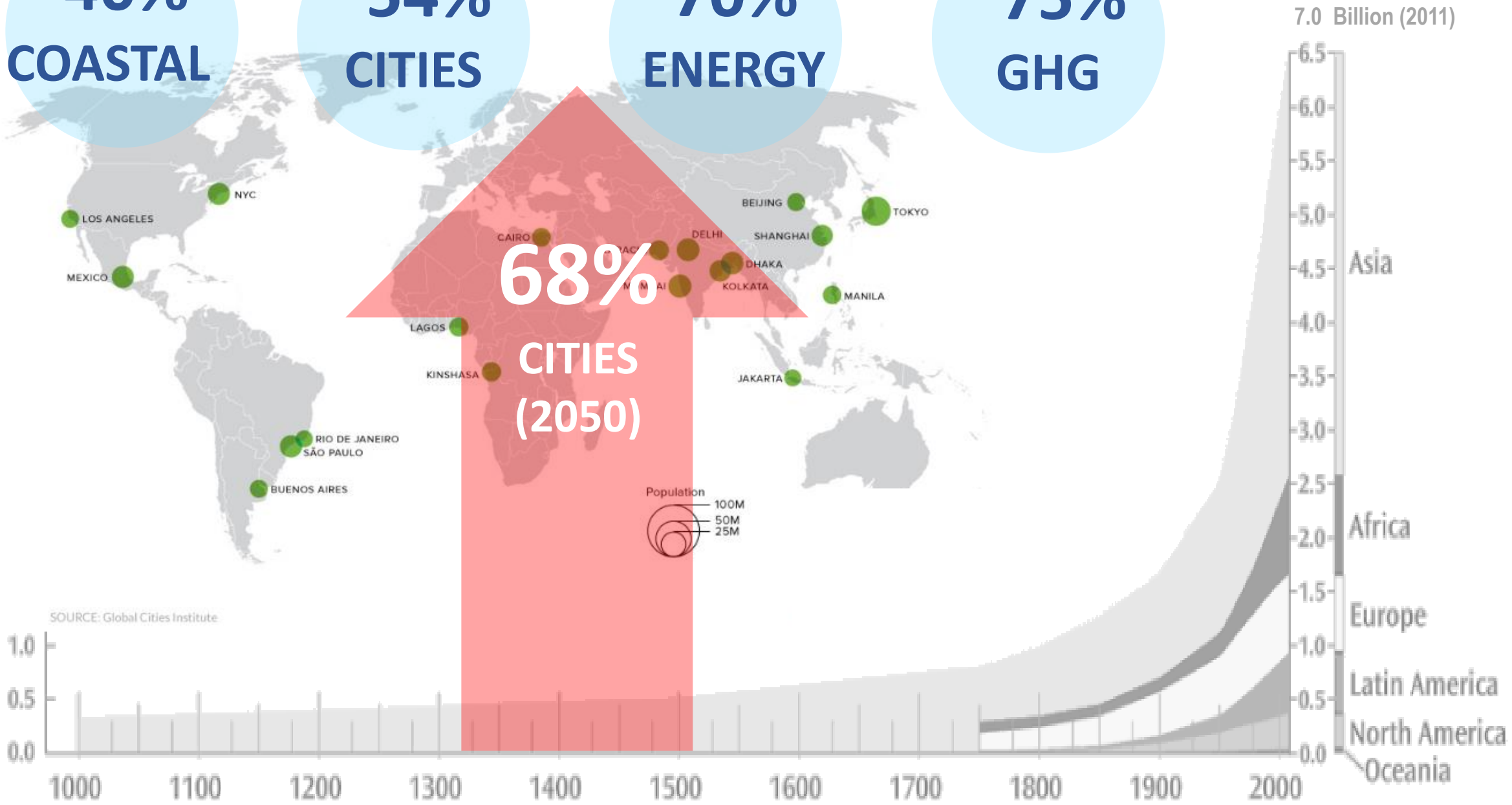


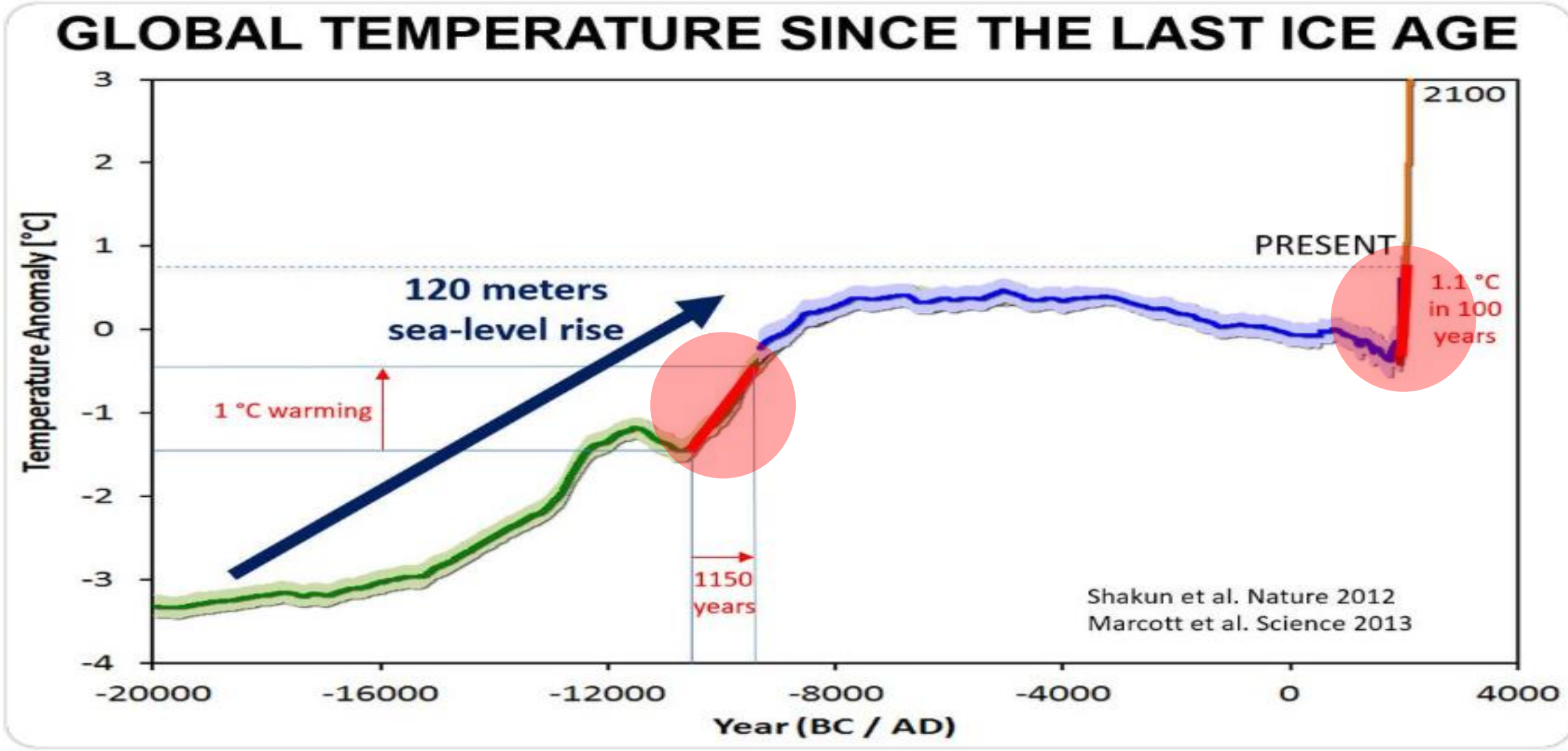
40%
COASTAL

54%
CITIES

70%
ENERGY

75%
GHG





Stefan Rahmstorf 2019

Puerto Rico's coastal uses and assets at risk

ECONOMICS

GDP: $105 billion/year (PRPB2016)
Tourism $2.5 Billion/year (7%)
Built up Areas/Coastline: 24%
Industrial Parks (81)
Commercial/Recreational Fisheries

HOUSING

Public Housing (15)
Individual Housing (xx)

TRANSPORTATION

Airports (11)
Ports (12)
Bridges, Culverts, Piers
Miles of Primary Roads (17,387mi/27,982km)

HEALTH AND SOCIAL SERVICES

Hospitals (3)
Treatment Centers (xx)

EDUCATION

Schools (36)

Coastal population: 2.3 million (61%) at 44 coastal municipalities

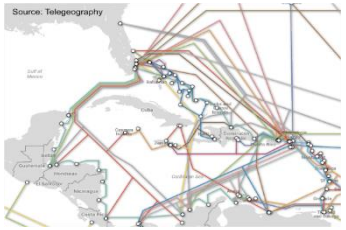
Territorial waters: 9 nm (A=5,078 mi^2)

Coastline: 799 mi/1,225 beaches

Puerto Rico's coastal uses and assets at risk

ENERGY

Power generation systems
(5 public, 2 private)
Substations
Distribution and transmission lines



COMMUNICATIONS

Fiber Optic Cables (15)
Internet Infrastructure
Public comm systems

WATER

PRASA infrastructure at coastal zone:
200km potable water
260km sanitary infrastructure
6 water systems
Pump stations
Wastewater Treatment Plants (28)

NATURAL AND CULTURAL RESOURCES

Protected Areas (Land) DRNA 8.7% (2015) – PA-CAT 16% (2016)
Protected Areas (Marine) 27.2%
Shallow coral reefs and associated communities designated for protection 49%
Historical Properties (22+)

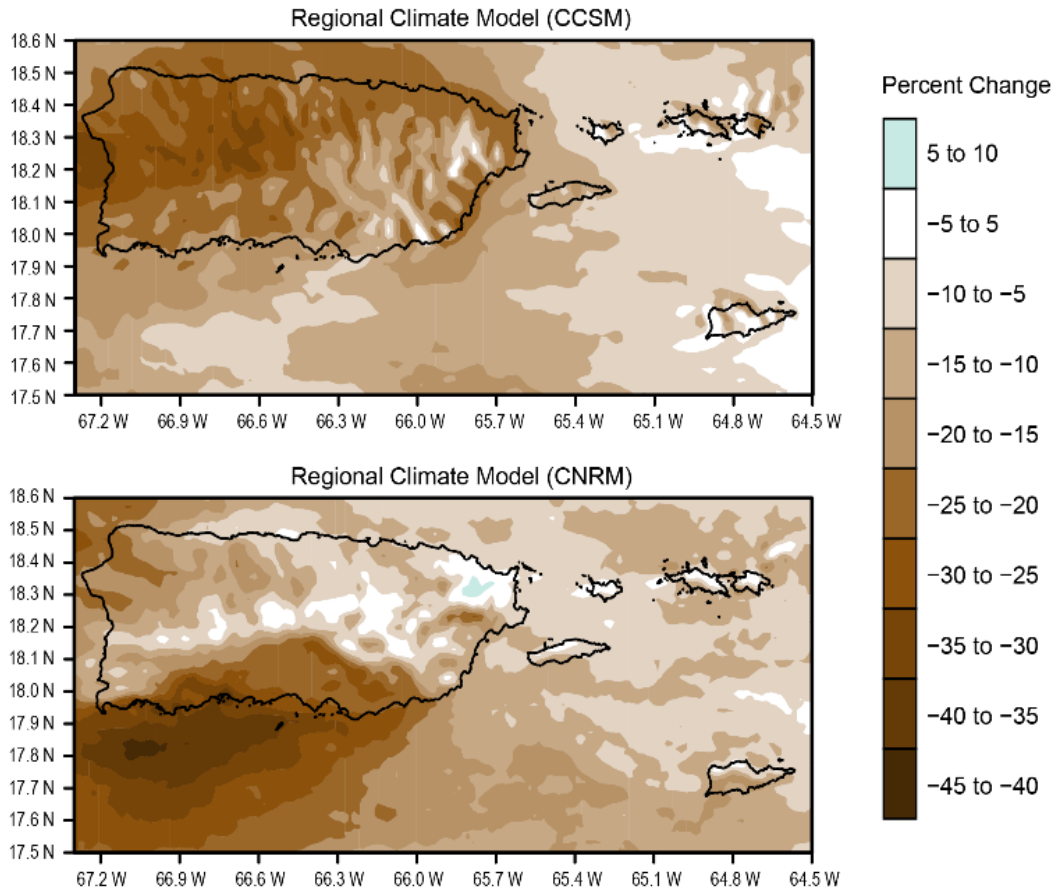
Coastal population: 2.3 million (61%) at 44 coastal municipalities

Territorial waters: 9 nm (A=5,078 mi²)

Coastline: 799 mi/1,225 beaches

Fig. 20.4: Projected Precipitation Change for Puerto Rico

This figure shows the projected percent change in annual precipitation over the U.S. Caribbean region for the period 2040–2060 compared to 1985–2005 based on the results of two regional climate model simulations.[29,30] These simulations downscale two global models for the higher scenario (RCP8.5)[26] and show that within-island changes are projected to exceed a 10% reduction in annual rainfall. Uncertainty remains as to the location of the largest reductions within the islands. Projections of precipitation change for the U.S. Virgin Islands are particularly uncertain because of model limitations related to resolving these smaller islands. *Source: Bowden et al. 2018.*[30]



https://nca2018.globalchange.gov/chapter/20/

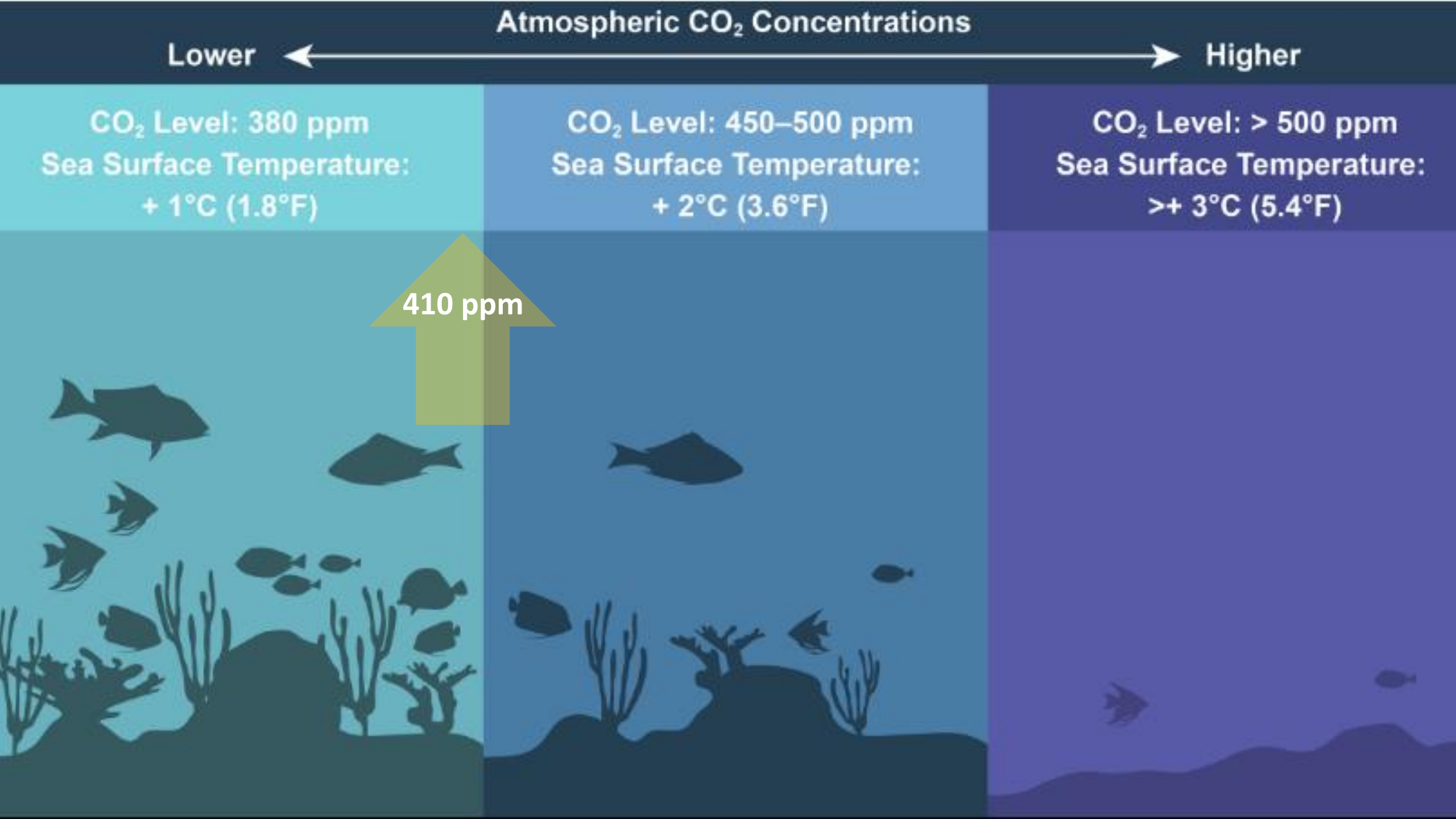

Atmospheric CO_2 Concentrations
Lower
Higher
CO_2 Level: 380 ppm
Sea Surface Temperature:
+ 1°C (1.8°F)
CO_2 Level: 450–500 ppm
Sea Surface Temperature:
+ 2°C (3.6°F)
CO_2 Level: > 500 ppm
Sea Surface Temperature:
>+ 3°C (5.4°F)
410 ppm

Fig. 20.5: Ocean Chemistry and Temperature

This figure represents an annual time series from 1993 to 2016 of atmospheric carbon dioxide (CO_2; black line), sea surface temperature (red line), and seawater pH (blue line) for the Caribbean region. The Caribbean ocean is subject to changes in surface pH and temperature due to the increase in atmospheric CO_2 concentrations. The oceans have the capacity to not only absorb heat from the air (leading to ocean warming) but also to absorb some of the CO_2 in the atmosphere, causing more acidic (lower pH) oceans. Continued ocean acidification and warming have potentially detrimental consequences for marine life and dependent coastal communities in the Caribbean islands. *Source: University of Puerto Rico.*

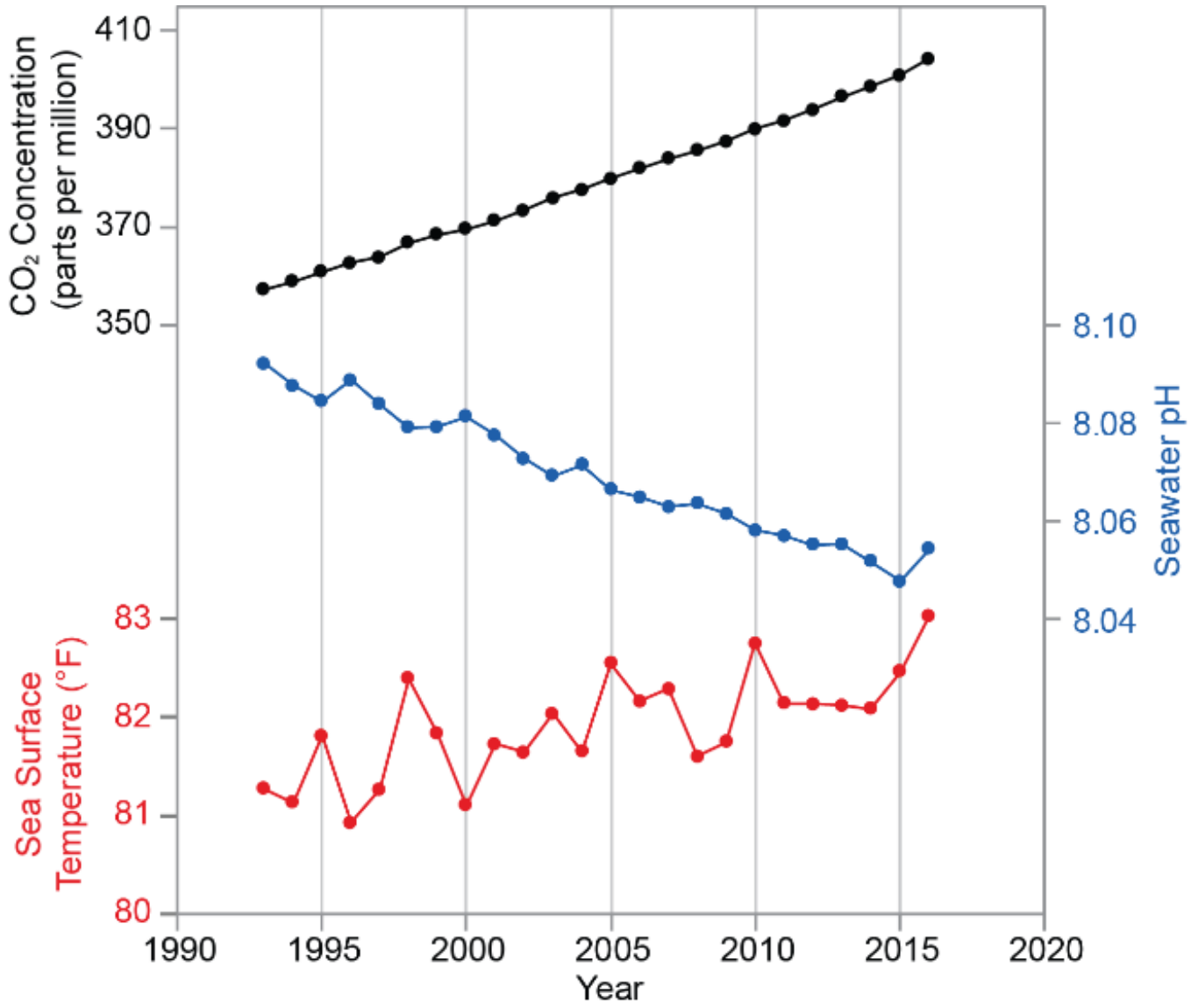


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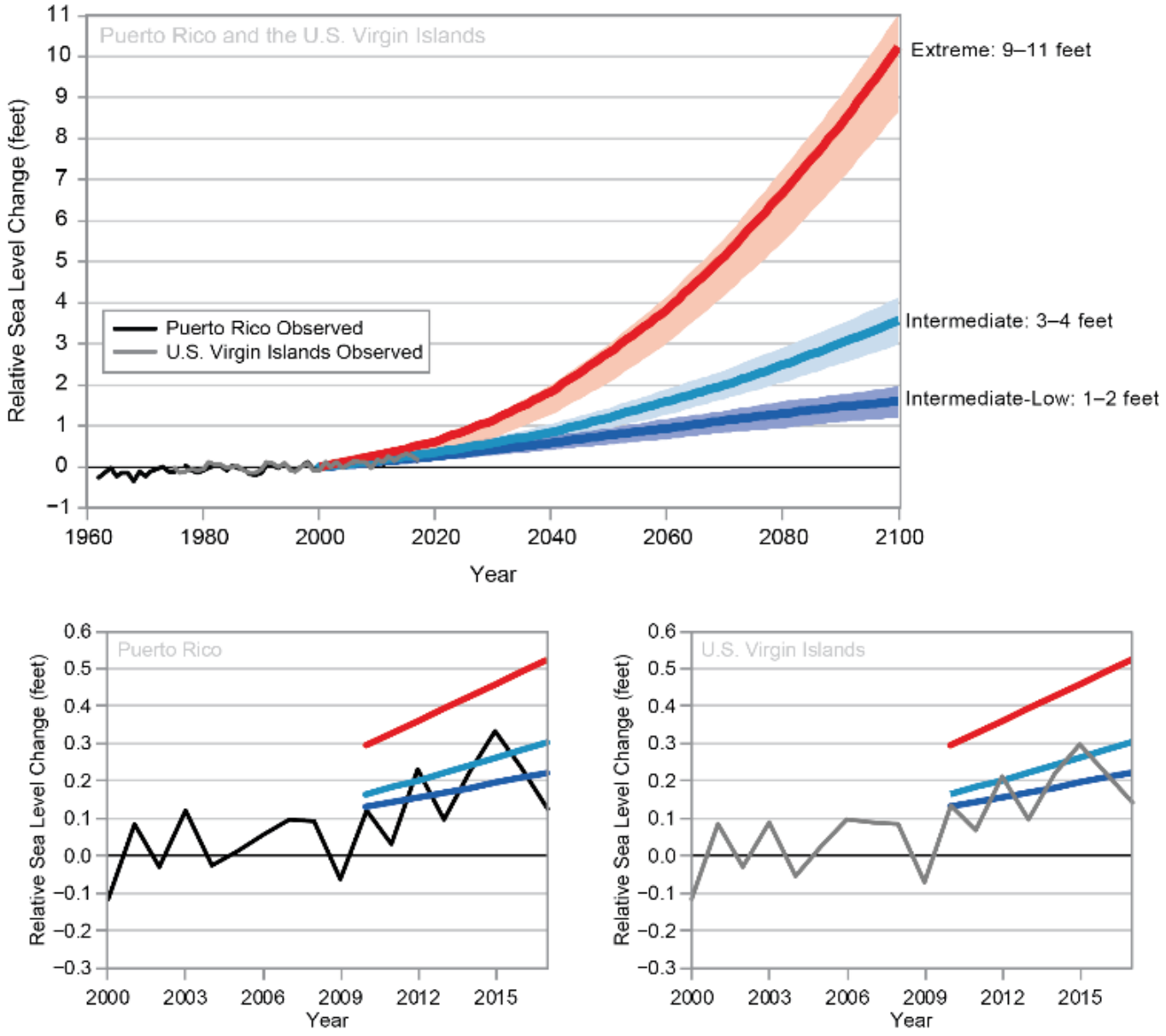
Fig. 20.6: Observed and Projected Sea Level Rise

(top) Observed sea level rise trends in Puerto Rico and the U.S. Virgin Islands reflect an increase in sea level of about 0.08 inches (2.0 mm) per year for the period 1962–2017 for Puerto Rico and for 1975–2017 for the U.S. Virgin Islands. The bottom panels show a closer look at more recent trends from 2000 to 2017 that measure a rise in sea level of about 0.24 inches (6.0 mm) per year. Projections of sea level rise are shown under three different scenarios of Intermediate-Low (1–2 feet), Intermediate (3–4 feet), and Extreme (9–11 feet) sea level rise. The scenarios depict the range of future sea level rise based on factors such as global greenhouse gas emissions and the loss of glaciers and ice sheets. *Sources: NOAA NCEI and CICS-NC.*



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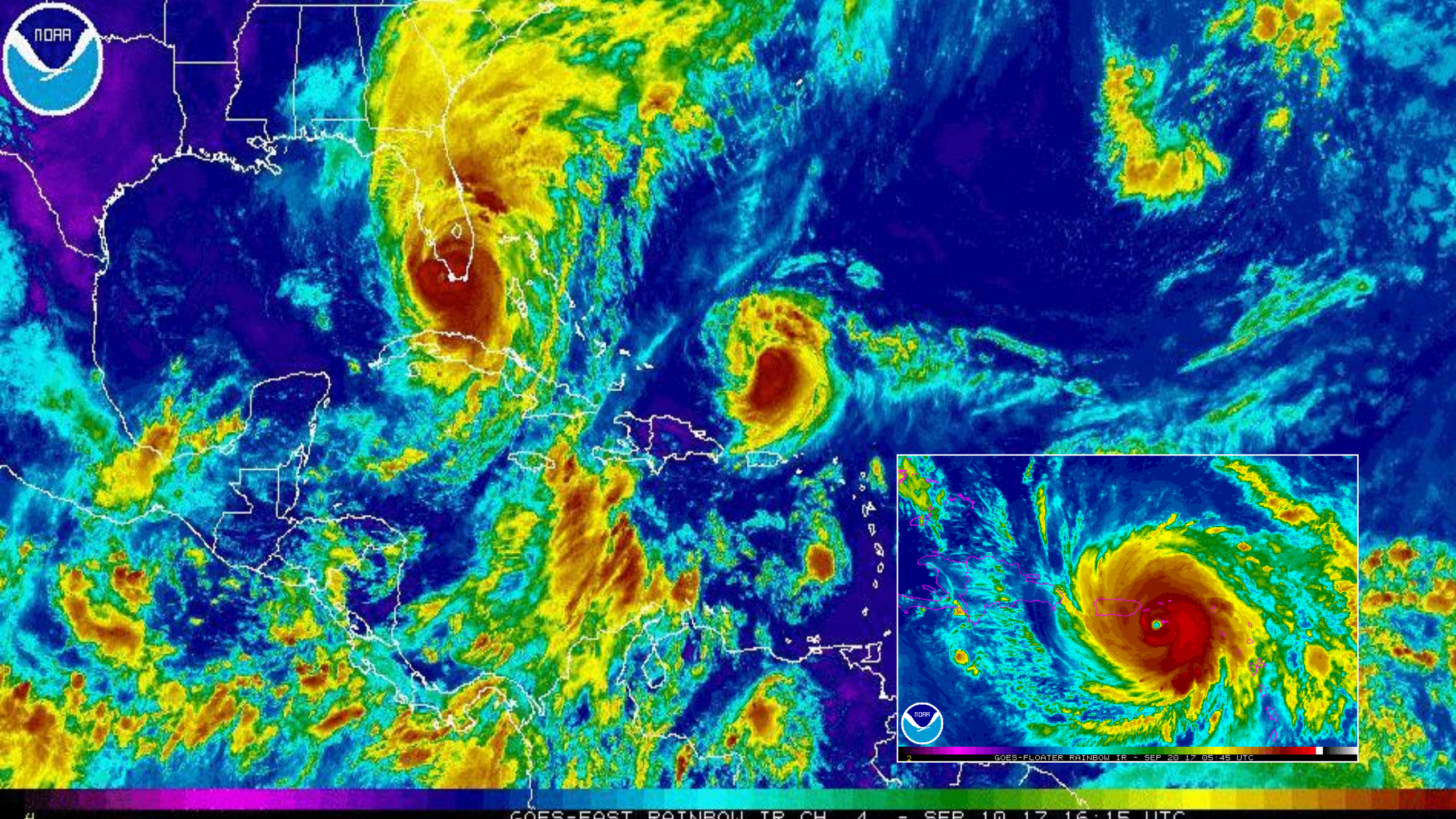
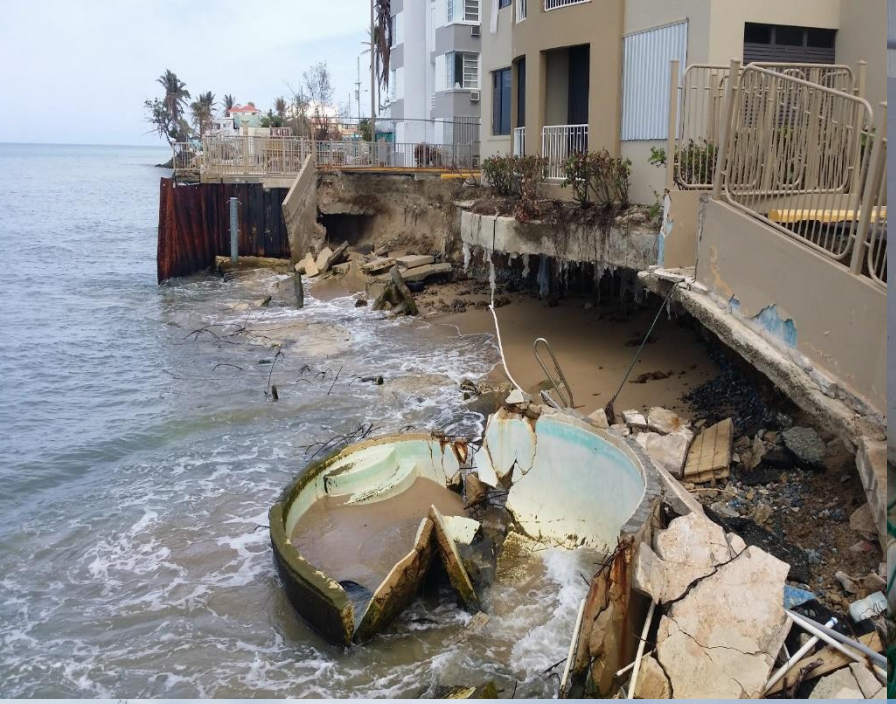
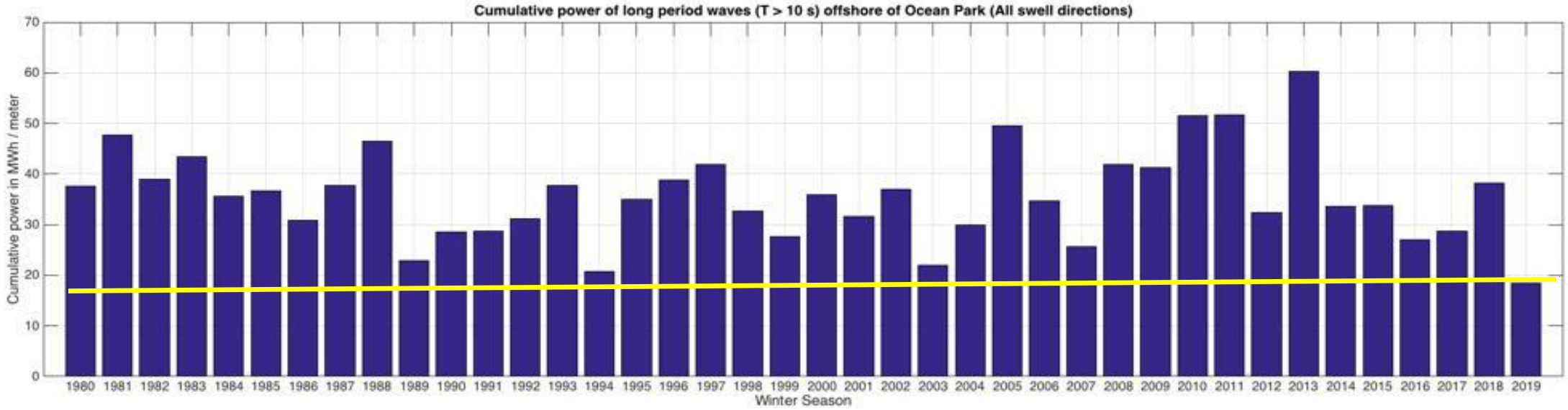

NOAA
GOES-FLOATER RAINBOW IR - SEP 20 17 05:45 UTC
GOES-EAST RAINBOW IR CH 4 - SEP 10 17 16:15 UTC



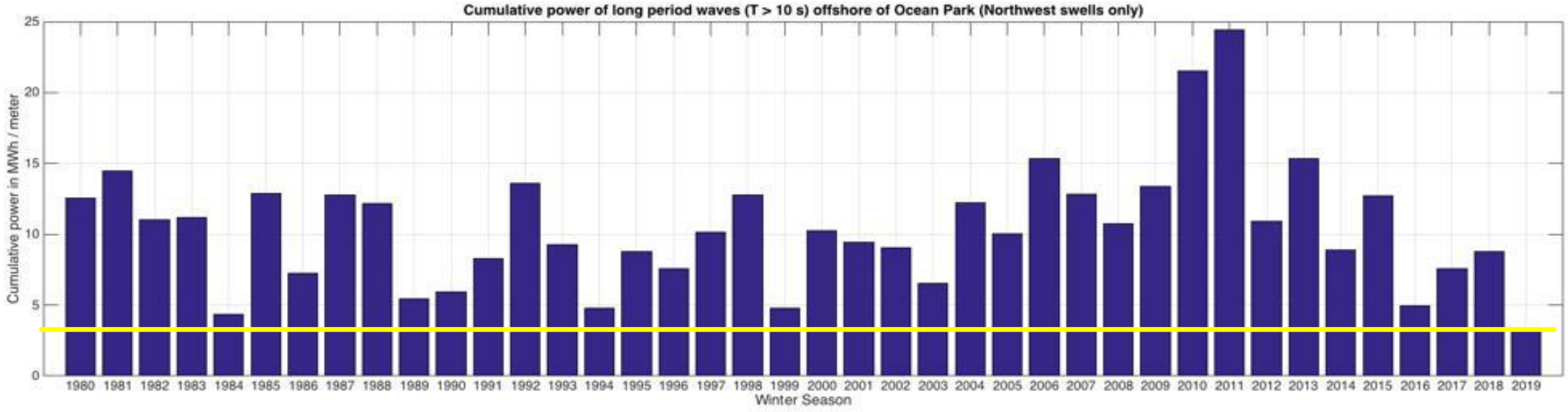



Situation analysis: Ocean Park 2018-2019

Ocean Park: 2018-2019 (Acute Erosion)



What? When? How? Who? B-C Analysis? Who pays?



Dr. Miguel Canals-Silander, In progress

San Juan Metro coral reef barrier

Map of Puerto Rico highlighting the metropolitan area of San Juan.

Cangrejo Arriba

© 2018 Google

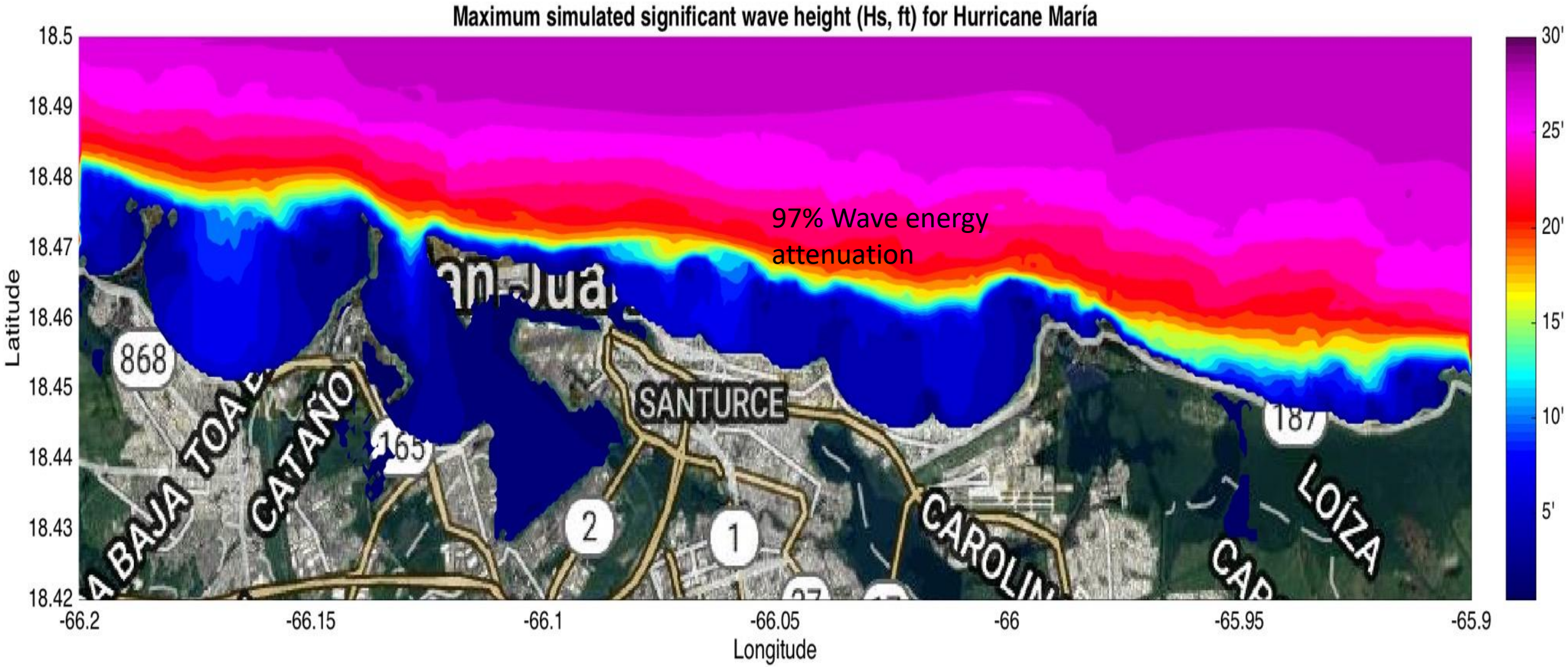
Image © 2018 DigitalGlobe

Google Earth

1994

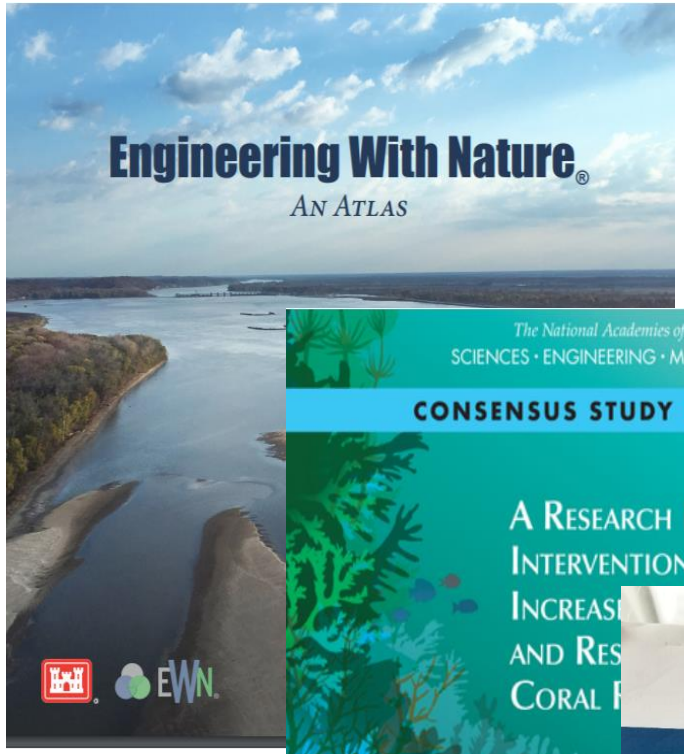
18°28'03.27" N 66°04'09.90" W elev 0 ft eye alt 30454 ft

MAX WAVE HEIGHT @ SJ / CAROLINA– HURRICAANE MARÍA (SEP 20.2017)



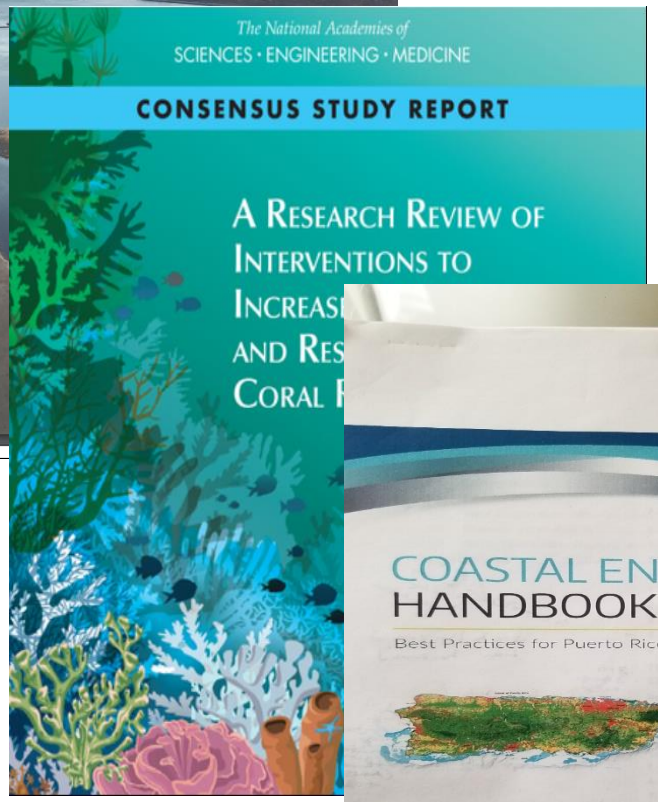
CARICOOS

CAOSE

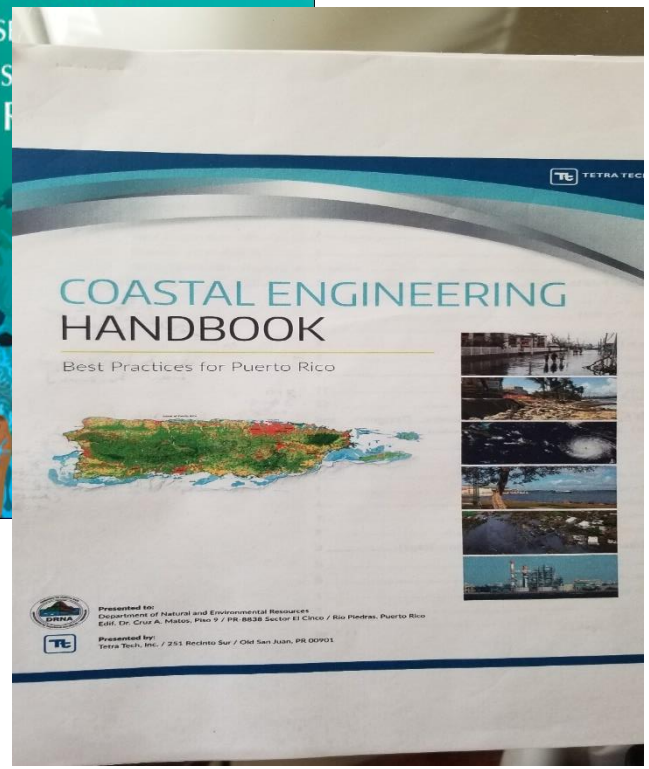


Swiss Re

FEMA



WORLD BANK



NOAA

DRNA

The National Academies of | SCIENCES ENGINEERING MEDICINE

Building Coastal Resilience

Planning and design:

- Land Use plans, zoning regs, building codes
- Dynamic Setback/Coastal Construction Line
- Increase Freeboard requirements (best BFE)
- Adaptive design
- Information, outreach and education

New generation of infrastructure:

- Hybrid and Nature-based alternatives
- Coral reefs interventions
- Wetlands restoration/interventions
- Beach nourishment/Energy attenuation
- Taller dunes – Restoration and Creation

B-C Analysis:

- Lower or similar cost
- Rapid return on investment
- Lower O&M (Operations and Maintenance)
- Longer design life
- Aesthetically attractive
- Tourism and recreation benefits

Sustainable Development Report Dashboards 2019

Transformations to Achieve the Sustainable Development Goals

SUSTAINABLE DEVELOPMENT SOLUTIONS NETWORK
A GLOBAL INITIATIVE FOR THE UNITED NATIONS

BertelsmannStiftung

Faced with uncertainty, decision makers must consider plausible outcomes. Ignoring uncertainty undermines effective risk management.