# Temperature, rainfall, and extreme events

IX



### **REUNIÓN CUMBRE**

### **DEL CCCPR**

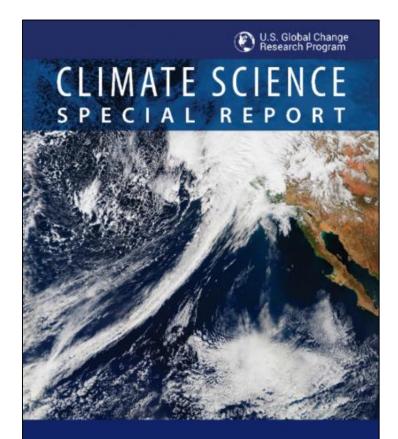


William Gould, USDA FS International Institute of Tropical Forestry, Río Piedras, Puerto Rico, wgould@fs.fed.us 8 de junio de 2018



### NCA<sub>4</sub> Vol. I: Climate Science Special Report

- NCA4 is being developed in two volumes
- NCA4 Vol. I was released Nov 3, 2017, after clearance through the same process being used for NCA4 Vol. II
- Key advances:
  - Detection and attribution
  - Extreme events (tropical cyclones, tornadoes, atmospheric rivers)
  - Downscaled information
  - Sea-level rise
  - Potential surprises
- Summarized in Our Changing Climate chapter of NCA4 Vol. II



Fourth National Climate Assessment | Volume I

### Read and download the report at science2017.globalchange.gov





### NCA<sub>4</sub> Vol. II chapters

- I. Overview
- II. Our Changing Climate
- III. National Topics
  - Water
  - Energy Supply, Delivery, and Demand
  - Land Cover and Land Use Change
  - Forests
  - Ecosystems, Ecosystem
     Services, and Biodiversity
  - Coastal Effects
  - Oceans and Marine
     Resources
  - Agriculture and Rural Communities
  - Built Environment, Urban Systems, and Cities

- Transportation
- Air Quality
- Human Health
- Tribes and Indigenous Peoples
- Climate Effects on U.S. International Interests
- Sector Interactions, Multiple Stressors, and Complex Systems
- **IV. Regional Chapters** 
  - Northeast
  - Southeast
  - U.S. Caribbean
  - Midwest
  - Northern Great Plains
  - Southern Great Plains
  - Northwest

- Southwest
- Alaska
- Hawai`i and U.S. Affiliated Pacific Islands
- V. Response
  - Near-term Adaptation Needs and Increased Resiliency
  - Reducing Risks through Emissions Mitigation
- VI. Appendices
  - Process
  - Information Quality Act
  - Data Tools and Scenarios
  - International
  - Frequently Asked Questions





### Team effort

NCA4 4OD: DO NOT CITE, QUOTE, OR DISTRIBUTE

Chapter 20

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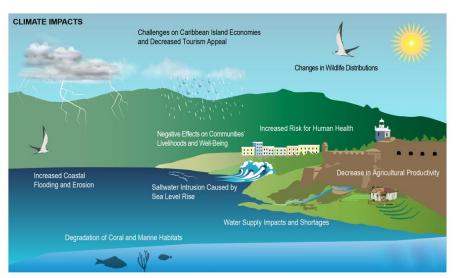
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## 6 technical contributors 1 review editor 3 USGCRP contributors



### Contents





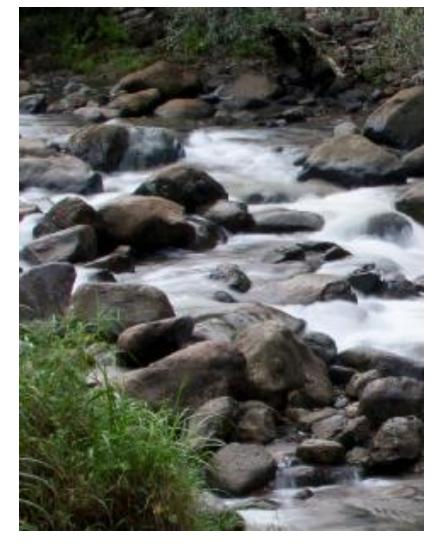
#### Executive summary Background Observed and Projected Climate Change

- Temperature
- Precipitation
- Seas surface temperature and ocean acidification
- Sea level rise

#### Key messages

- Links between climate change and regional risks
- Future climate change relevant to regional risks
- Challenges, opportunities, and success stories for reducing risk
- Emerging issues Traceable accounts References





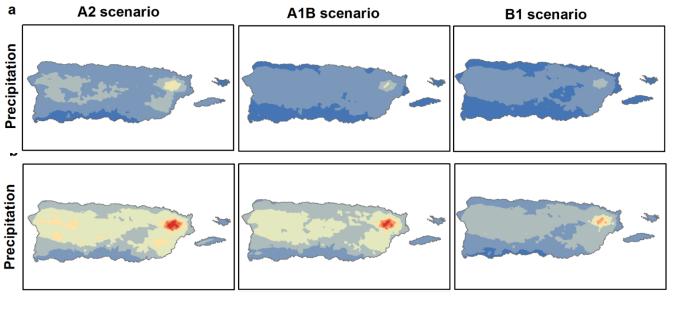
#### Key Message 1:

- Critical to life.
- Projected reduction in average rainfall by the end of the century.
- Extreme rainfall events expected to increase in intensity.
- 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 alter the distribution of ecological life zones and exacerbate existing problems in water management, planning, and infrastructure capacity.



#### Statistically downscaled projections

**Regional climate** models project between 18 to > 50% decline in mean annual precipitation through the end of the century, with increasing variability being marked by a general drying trend and more frequent and profound drought events (Hayhoe, 2013; Karmalkar et al. 2013; Khalyani et al., 2016).



### Precipitation decline (mm) < 300 1,500.1 - 1,800 300.1 - 600 1,800.1 - 2,100 600.1 - 900 2,100.1 - 2,490 900.1 - 1,200 1,200.1 - 1,500</pre>

Uppe	er. All model
Ense	mble:
A2:	29.80
A1B:	20.69
B1:	18.24

Lowe	r. Bimodal	
Ensemble:		
A2:	53.81	
A1B:	49.49	
B1:	36.39	

#### Projected percent change in annual precipitation over the U.S. Caribbean for the period 2040–2060 compared to 1985–2005 Regional Climate Model (CCSM)

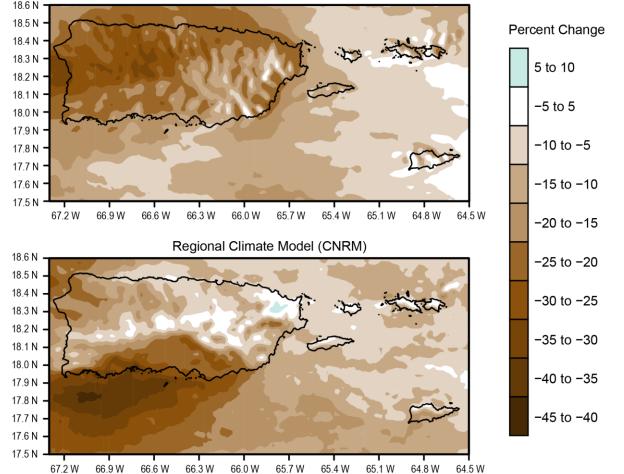
Based on the results of two regional climate model simulations (Wootten et al 2016; Bowden et al. 2018 forthcoming).

CLIMATE

CHANGE COUNCIL

Simulations downscale two global models for the higher scenario, RCP8.5 (USGCRP 2017)

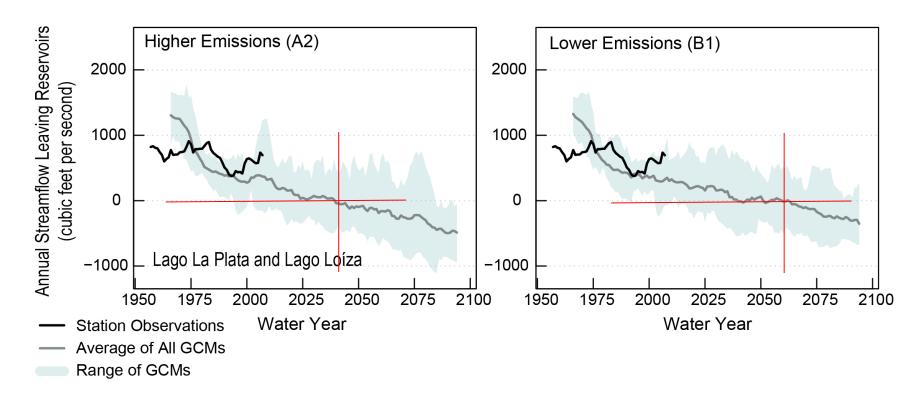
Within-island changes are projected to exceed a 10% reduction in annual rainfall. Uncertainty remains as to the location of the largest reductions within the islands.



Source: Bowden et al. 2018 forthcoming



#### Projected changes in annual streamflow



Ten year moving averages of annual streamflow leaving Lago La Plata and Lago Loiza. Projections were developed using an estimation of water supply entering the reservoir and an estimation of withdrawals (Van Beusekpm 2016).

### At Risk - Tropical montane cloud forests in the Luquillo Mountains of Puerto Rico

Characterized by frequent clouds, reduced tree height, a high number of endemic and endangered species, and high water content of the soil due reduced solar radiation.

Cloud forests around the world are vulnerable to warming and drying conditions expected with climate change.

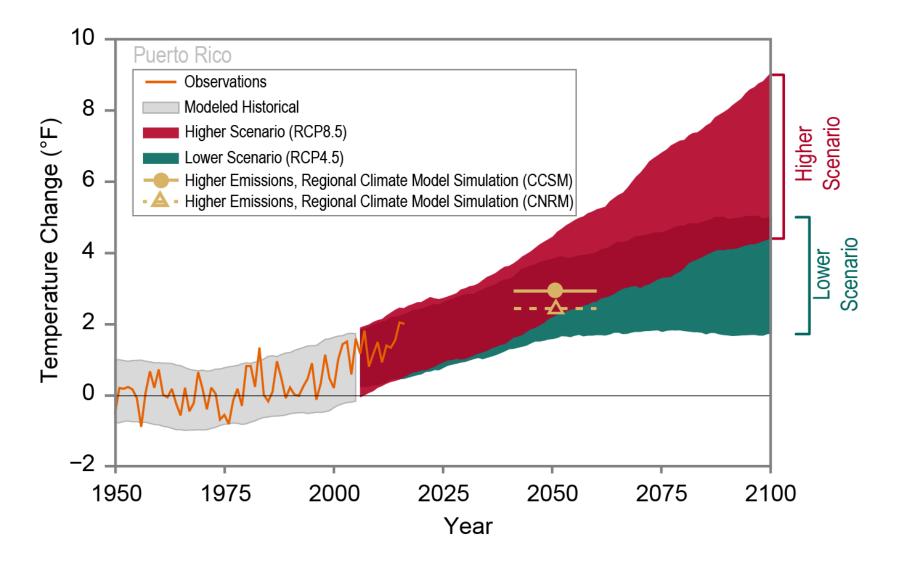
Cloud forests on low mountains are especially vulnerable.

Drying and warming conditions can increase the elevation at which clouds form, thereby reducing or possibly eliminating the cloud cover shrouding the mountain peaks.





### **Rising temperatures**



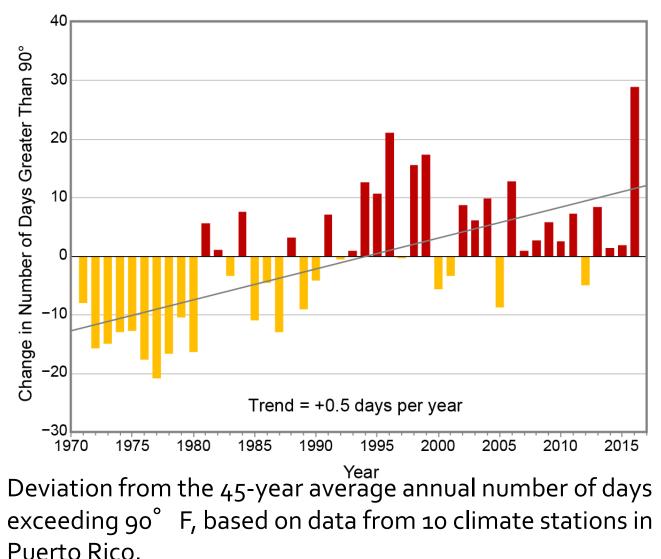


### **Rising temperatures**

Changes to average and extreme temperatures have direct and indirect effects on organisms and strong interactions with hydrological cycles, resulting in a variety of impacts.

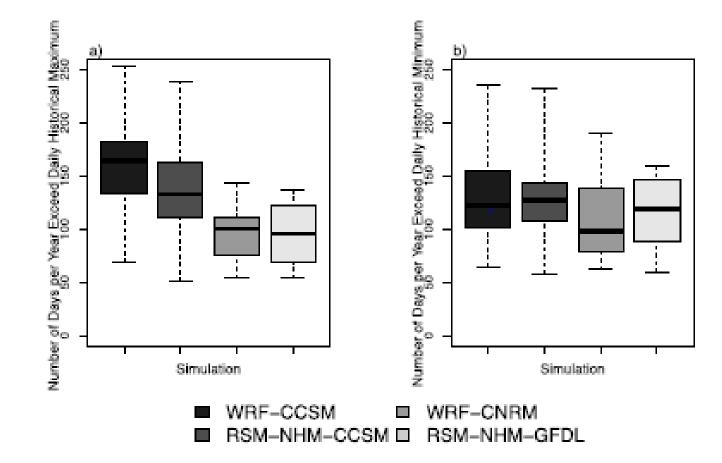
Increases in average temperatures will likely lead to decreases in agricultural productivity, changes in habitats and wildlife distributions, and risks to human health, especially in vulnerable populations.

As maximum and minimum temperatures increase, there are likely to be fewer cool nights and more frequent hot days, which will affect the quality of life in the U.S. Caribbean.





### **Rising temperatures**



Minimum of 1 day a week with record breaking heat compared to historical climate. Some years could experience high frequency (~4 days per week).

Source: Bowden et al. 2018 forthcoming

#### Disaster risk response to extreme events

Increasing frequency or intensity of extreme events threatens life, property, and economy in the Caribbean.

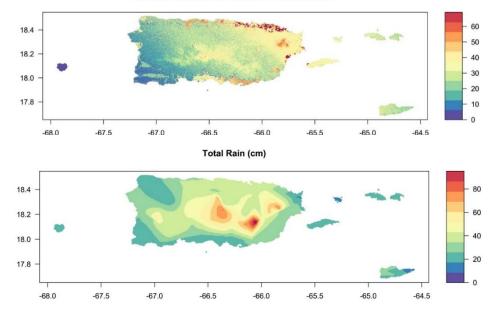
Extreme events such as flooding and droughts are projected to increase in frequency and intensity.

Increasing hurricane intensity and rainfall rates will affect human health and well-being, economic development, conservation, and agricultural productivity.

Increased resilience will depend on collaboration and integrated planning, preparation, and responses across the region.

### Irma and Maria combined Calculated Wind and Rain

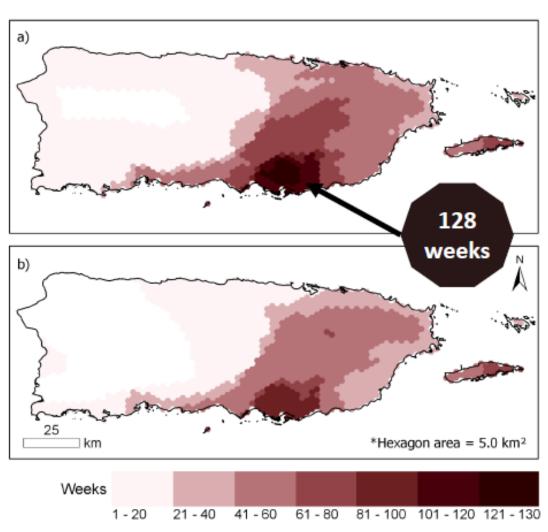
Irma and Maria Gale Wind Kinetic Energy MJ/m^3



Van Beusekom et al. in preparation



#### Disaster risk response to extreme events



#### 2000-2010

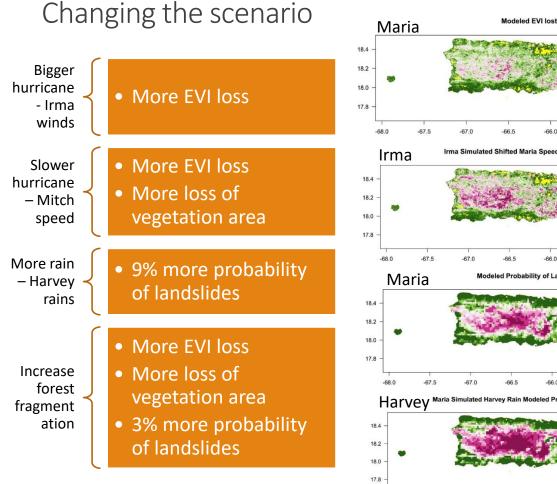
- 92.01% of Puerto Rico experienced periods of drought conditions.
- eastern Puerto Rico experienced more than 41 weeks of nonconsecutive droughts
- the southeastern region: 128 nonconsecutive weeks

#### 2014-2016

- 80 consecutive weeks of moderate drought, 48 of severe drought and 33 of extreme drought conditions in different regions of Puerto Rico
- severe drought in the southeast (42 weeks of Salinas and Vieques 40).
   extreme drought conditions within the southeast region, with 31 weeks of consecutive drought.



#### Disaster risk response to extreme events



-68.0

CLIMATE CHANGE

COUNCIL UERTO RICO

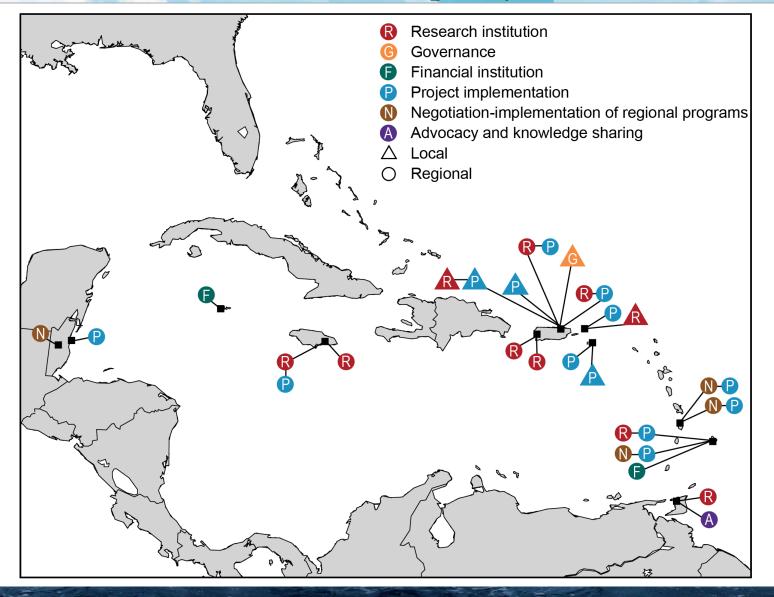
- 0.4 0.3 0.2 0.1 -66.5 -66.0 65.5 -65.0 -64.5 Irma Simulated Shifted Maria Speed Modeled EVI lost 0.2 0.1 66.5 -65.5 65.0 Modeled Probability of Landslides 0.8 0.6 04 0.2 -65.5 -65.0 64 5 -66 5 -66.0 Harvey Maria Simulated Harvey Rain Modeled Probability of Landslides 0.6 0.4 0.2 -67.5 -67 0 65 5
- Hurricane Maria (and Irma) caused 31% of the vegetation to be lost and Maria caused 34% of the area to have a landslide density of at least one in 1 km2.
  - A storm with slower that average forward speed or more precipitation would have caused significantly more damage.
  - The largest factor in the amount of damage was the the initial EVI for vegetation damage and slope for landslide damage.
  - The second largest factor was the amount of energy doing the damage.
  - This study does find evidence that increased fragmentation will increase damage.

#### Van Beusekom et al. in preparation



#### Regional collaboration increases adaptive

#### capacity





#### Communicating best adaptive practices

#### **OUTREACH**



#### agricultura y cambio climático



Series of four educational videos that highlight best adaptive practices

VIDEOS

2-page summary of climate change effects & adaptive practices per sector

**FACTSHEETS** 

Response to our stakeholder's requests and needs

Climate Resilient Trainings: Workshops & Webinars (2017)

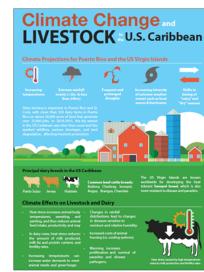
TRAININGS

#### 1. Cattle & Dairy Farming

- 2. Plantains & Vegetables
- 3. Permaculture, water & soil conservation
- 4. Coffee & forestry

YouTube Channel 100 subscribers 8,600 views FB Page 730 followers 1 video = 4,000 views WEBSITE





USDA CARIBBEAN CLIMATE HUB | 2016 Request for Services Climate Resilient Agriculture Training in Puerto Rico & the US Virgin Islands

> Closing Date for Submission: Friday, August 26, 2016 esponses must be submitted to: <u>caribbeanclimatehub@gmail.co</u>

#### BACKGROUND INFORMATION

The UDA Carbboa Climate hids is located in San Juan, Puetra Rice, and is one of ten Climate Hubs automoties there instino is to define science based involveding and practical information to farmers, ranchers, and forest landowners to help them adapt to climate ruleing and weather variability. The work of the Carbboan Hub Societon on developing and delivering climate services for better planning and implementation of adaptation and mitigation actions in hereits face and the U.S. Ying building (DVI).



resilence in apriculture and ferently through funding for the divergence of uncivalised and on furn trainings for fummers. Notest landowners, luind managers, approximative, and agricultural absisters that still emphasize pere to serve it learning opportunities. One approximation on individual lasked and uncivity in it hereits false and during the USGA Carlobean Climate Hub to develop and document uncivitapos that all provide



apacity-building support to the working lands community over a period of twelve month

#### EXPECTED OUTCOMES and OUTPUTS

Workshops and on-lam training will combine local expertise and experience with memoriphy technologies to be immersial advancements that because what set of anxietics works beef for them in dealing with drought, butters scatched, high temperatures, fooding, burricense, sold exacts, and dates of their interfaced balances, and scatched advances, and exacts are scatched by advances to the <u>SCAN building Birstoire trainer</u> balances and be readed as the temperature of the scatched balances being benchmark to the <u>SCAN building Birstoire trainer</u> balance balance balance balances in Partic Rice and build readires are in the climate balance balanc

 Providing workshops on climate resilient agricultural practices that simultaneously work to reduce greenhouse gas (GHG) emissions and increase farm resilience and profitability



### **¡MUCHAS GRACIAS!**

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