UNCTAD National Workshop Jamaica

30 May – 1 June 2017, Kingston, Jamaica

"Climate Change Impacts and Adaptation for Coastal Transport Infrastructure in Caribbean SIDS"

Training

Gathering and applying climate information for decision-making

By

Cassandra Bhat

ICF, United States

Training

Gathering and applying climate information for decision-making

Climate Change Impacts on Coastal Transport Infrastructure in the Caribbean: Enhancing the Adaptive Capacity of SIDS

June 1, 2017

United Nations Conference on Trade and Development

National Workshop - Jamaica

Cassandra Bhat
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Objectives

- Learn the fundamentals about climate scenarios, models, and data
- Understand sources of climate data for the Caribbean

Source: ICF

Topic 1

Overview of Climate Scenarios, Models, and Information

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Key Concepts Help us Understand Climate Change Risks and Impacts

Connecting climate information with decisions requires a special vocabulary

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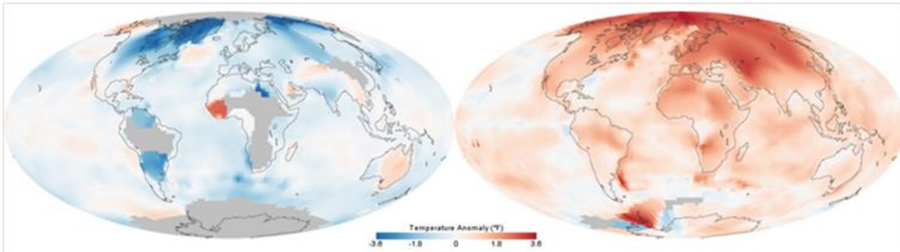
Climate

The average of weather over at least a 30-year period. Note that the climate taken over different periods of time (30 years, 1000 years) may be different. The old saying is climate is what we expect and weather is what we get.[1]



Definition: NOAA National Weather Service Climate Glossary | Figure: NASA

Extreme Events

Weather or climate conditions near the upper or lower ends of the range of observed values

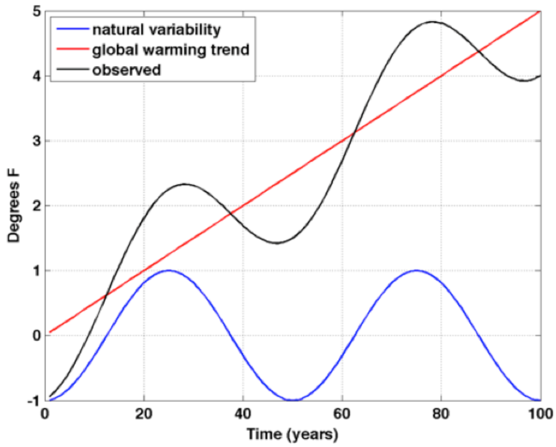
- Sometimes impacts on society and ecosystems become severe when climate conditions pass certain levels, called thresholds.

Extreme Temperatures

Extreme Rainfall and Flooding

Climate Change

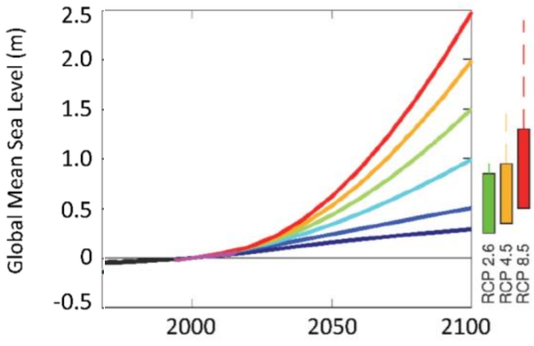
A non-random change in climate that is measured over several decades or longer.



ICF Definition: NOAA National Weather Service Climate Glossary | Figure: Climate Impacts Group - https://cig.uw.edu/learn/climate-variability/

Climate Change Effects

- Changes in the timing, amount, or intensity of precipitation
- Changes in heat waves, periods of freezing, maximum daily temperature



NOAA Global Mean Sea Level Scenarios for 2100

ICF Source: NOAA (2017). Global and Regional Sea Level Rise Scenarios for the United States. National Oceanic and Atmospheric Administration, National Ocean Service. Available at: https://tidesandcurrents.noaa.gov/publications/techrpt83_Global_and_Regional_SLR_Scenarios_for_the_US_final.pdf

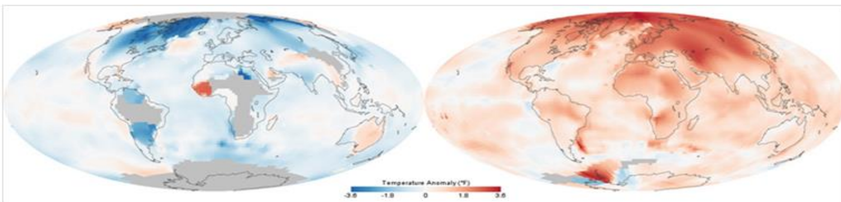
Characteristics of Climate Information

Stressor/Hazard:
- Temperature
- Precipitation
- Sea level rise
- Storm surge
- Drought
- Etc.

Variable:
- Tmax
- Tmin
- Tavg
- 24-hour rainfall
- Wind speed
- Humidity
- Etc.

Time period:
- Historical
- Forecast
- Projected

Temporal resolution:
- Daily
- Monthly
- Seasonal
- Annual
- Decadal



ICF Source: NASA

Dimensions of Climate Projections

- Emission scenarios
- Climate models
- Spatial resolution

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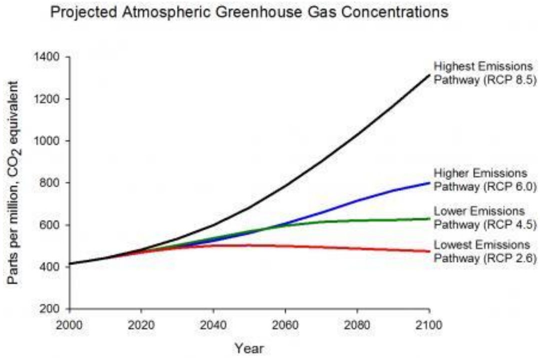
Emission Scenarios

Scenario = a possible future

Numerous alternatives of how the future can unfold

- Ranges from **high emission** to **low emission**



GHG concentrations → average temperature increase → SLR → other effects

Source: U.S. EPA

Representative Concentration Pathways (RCPs)

Scenario Name	Description	Concentrations (ppm CO_2 equiv.) by 2100	Change in CO_2 equiv emissions compared to 2010		Global Surface Temp. Change by 2100*
			2050	2100	
RCP 2.6	Emissions reduced substantially from current pathway.	430-480	-72 to -41%	-118 to -78%	0.5–3.0 °F (0.3–1.7 °C)
RCP 4.5	Emissions reduced sufficiently so that total radiative forcing is stabilized by 2100.	580-720	-38 to 24%	-134 to -21%	2.0–4.7 °F (1.1–2.6 °C)
RCP 6.0	Emissions reduced sufficiently so that total radiative forcing is stabilized by 2100.	720-1,000	18 to 54%	-7% to 72%	2.5–5.6 °F (1.4–3.1 °C)
RCP 8.5	High emissions continue through 2100. Most representative RCP of current emissions track.	>1,000	52 to 95%	74 to 178%	4.7–8.6 °F (2.6–4.8 °C)

Emission Scenarios

IPCC Fourth Assessment Report

Scenario Name	Description	Global Surface Temp. Change by 2100	Global Mean Sea Level Rise by 2100
B1	Low emissions.	0.54-1.62 °F (0.3-0.9 °C)	0.59-1.25 ft (0.18-0.38 m)
A1B	Medium-High emissions.	3.06-7.92 °F (1.7-4.4 °C)	0.69-1.57 ft (0.21-0.48 m)
A2	Medium-High emissions.	3.6-9.72 °F (2.0-5.4 °C)	0.75-1.67 ft (0.23-0.51 m)

UN IPCC Working Group I: The Scientific Basis (http://www.ipcc.ch/ipccreports/tar/wg1/029.htm)

IPCC Fifth Assessment Report

Scenario Name	Description	CO_2 equiv. ppm by 2100	Global Surface Temp. Change by 2100	Global Mean Sea Level Rise by 2100
RCP2.6	Substantial and sustained emissions reductions	475	0.5-3.0 °F (0.3-1.7 °C)	0.85-1.8 ft (0.26-0.55m)
RCP4.5	Stabilization	630	2.0-4.7 °F (1.1-2.6 °C)	1.0-2.1 ft (0.32-0.63m)
RCP6.0	Stabilization	800	2.5-5.6 °F (1.4-3.1 °C)	1.1-2.1 ft (0.33-0.63m)
RCP8.5	High emissions continue	1313	4.7-8.6 °F (2.6-4.8 °C)	1.5-2.7 ft (0.45-0.82m)

Source: UN IPCC, Climate Change 2013: The Physical Science Basis (https://www.ipcc.ch/report/ar5/wg1/)

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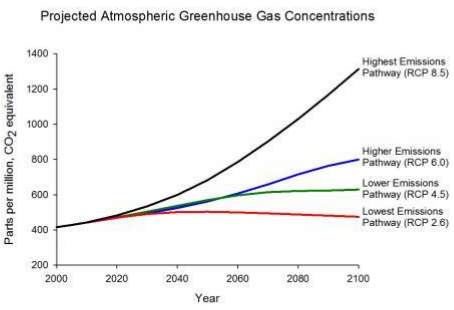
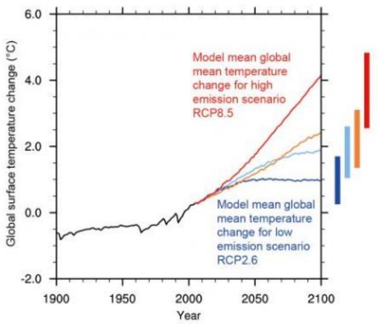
RCPs





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Uncertainties in Emission Scenarios

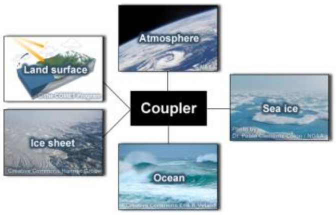
Uncertainties about the future

- Socio-economic development
- Technology
- Energy use
- Policies for GHG mitigation

These uncertainties increase as they are projected further out in the future

Climate Models

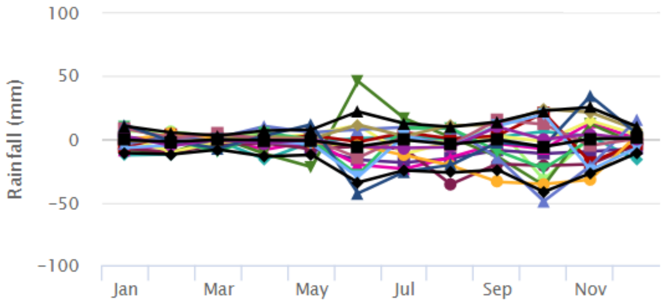
- Mathematical representations of climate system and interacting processes
- Can reproduce key features found in the climate of the past century
- Run emission scenarios and produce projections
- Can be done on different timescales and different geographic areas
- Global climate models referred to as "GCMs"



Model components (UCAR)

Climate Models

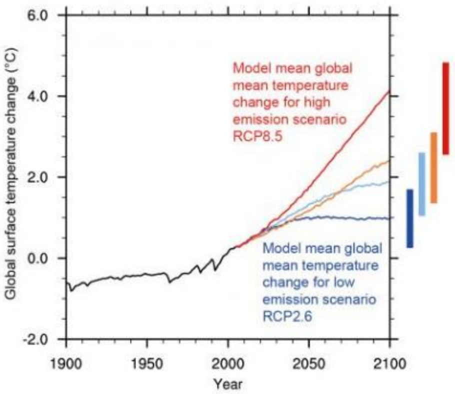
- Many models exist
- Different models produce different results
- Model agreement is not necessarily an indication of likelihood



Source: CCKP, http://sdwebx.worldbank.org/climateportal/index.cfm?page=country_future_climate&ThisRegion=Latin%20America&ThisCcode=JAM

Climate Projections

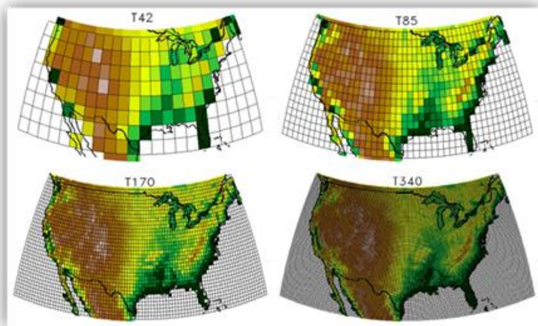
- Simulation of possible climate future in terms of temperature, precipitation, and other climate variables
- Each projection = combination of model, scenario, and initial condition



Source: IPCC, 2013

Downscaling

- Global climate models (GCM) spatial resolution ranges from about 50 to 300 km
- Resolution may be too coarse for regional decision-making
- Downscaling = take information known at large scales to make predictions at local scales



Source: https://www.pacificclimatefutures.net/en/help/climate-projections/introduction-climate-change-projections/

Types of Downscaling

- **Statistical –** applies the statistical relationship between local weather variables (e.g., surface rainfall) and larger-scale climate variables (e.g., atmospheric pressure) to adjust GCM outputs to the local scale
- **Dynamical –** uses GCM outputs to feed a higher-resolution regional climate model (RCM)

Dynamically downscaled data available for the Caribbean at 25 km and 50 km resolution

Uncertainties in Models

"All models are wrong, but some are useful."

- **Sources of uncertainty:**
  - **Natural** uncertainty – climate variability resulting from natural processes in the climate system
  - **Human** uncertainty – Future emissions of greenhouse gases resulting from human activity (this becomes a larger component of uncertainty on time scales of 50 years or more)
  - **Scientific** uncertainty - an incomplete understanding of and ability for computer systems to model Earth's complex processes (clouds, particles, ice, natural variability, etc.)

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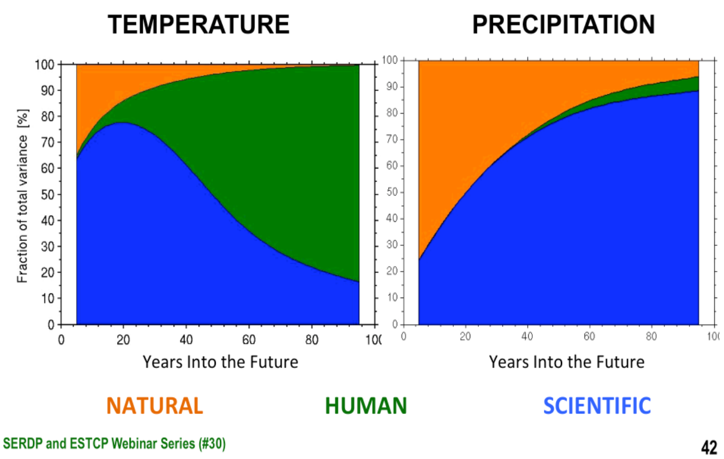
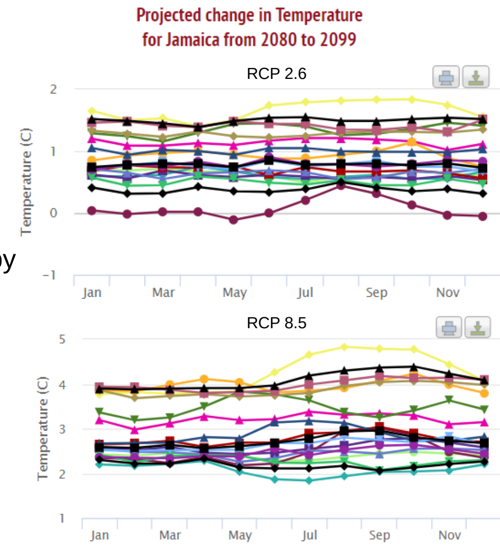
Uncertainty Varies over Time and by Stressor



ICF Source: https://www.serdp-estcp.org/Tools-and-Training/Webinar-Series/04-07-2016

Working with Uncertainty

- Despite uncertainties, model information can be useful to decision making
- Use an ensemble of model simulations produced from a range of climate models driven by different future scenarios and timescales
- Consider the spread of the models within an ensemble (10th percentile, median, 90th percentile)



Source: CCKP

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Topic 2

Caribbean climate data sources

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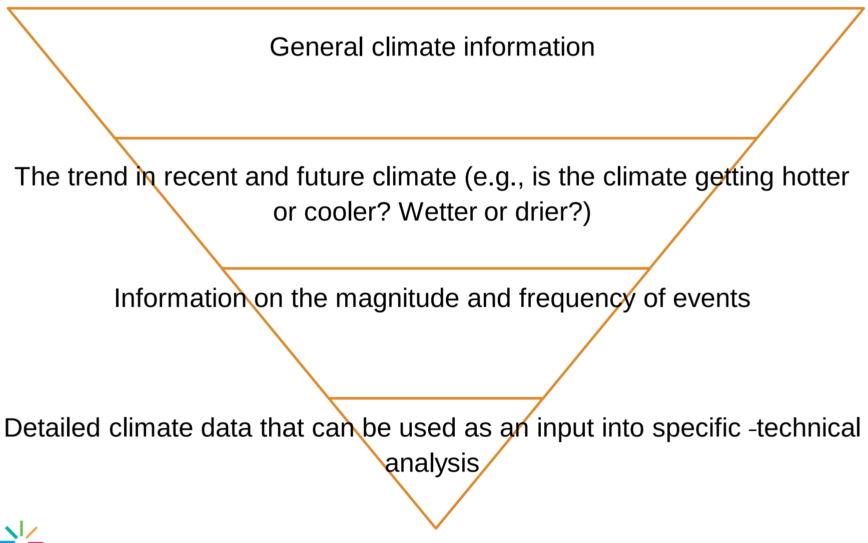
Levels of Climate Information



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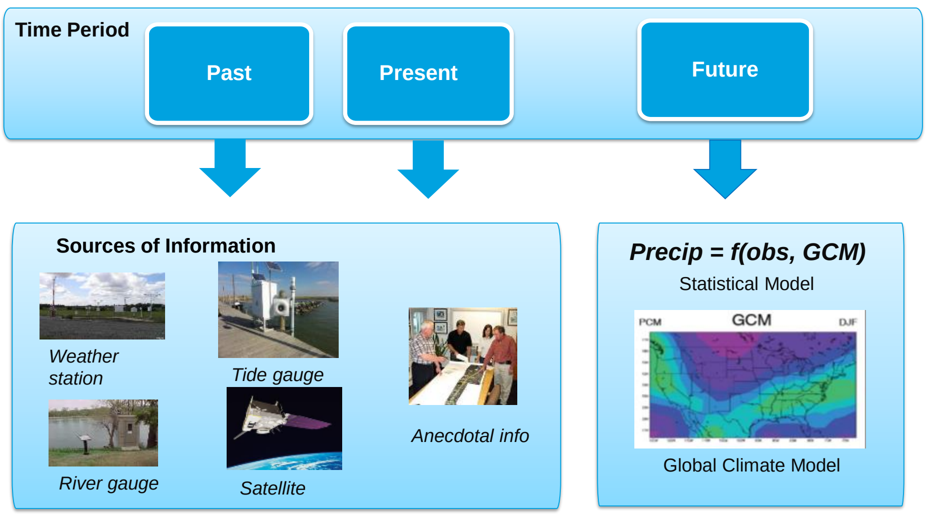
Types of Climate Information and Sources



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Climate Data Sources for Jamaica – Historical Data

- **Temperature, precipitation, and wind**
  - Met Service
  - State of Jamaican Climate Report
  - Climatic Research Unit

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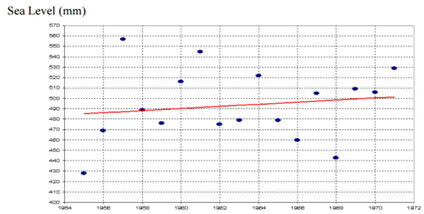

Figure 4.7.1: Mean annual sea levels at Port Royal measured between 1955 and 1971. Redrawn from Horsfield (1973). Linear trend inserted.

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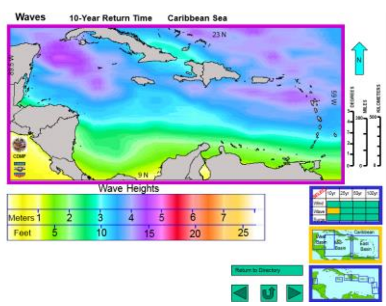

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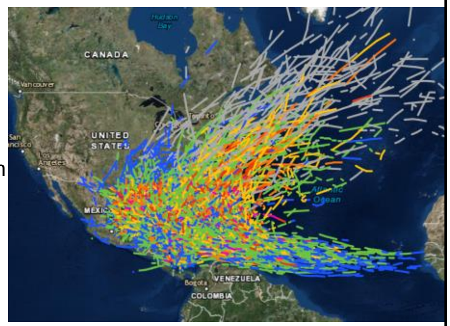

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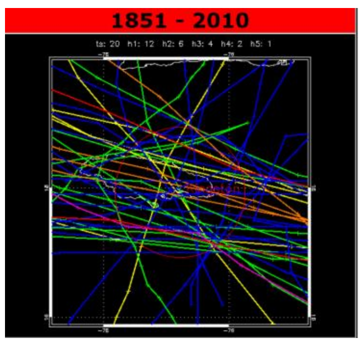
  - Caribbean Hurricane Network



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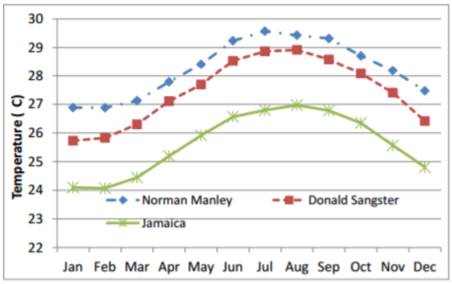

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Table 3.3.1: Observed and GCM Projected Changes in Precipitation for Saint Lucia.

Saint Lucia: Country Scale Changes in Precipitation												
	Observed Mean 1970-99	Observed Trend 1960-2006		Projected changes by the 2020s			Projected changes by the 2050s			Projected changes by the 2080s		
				Min	Median	Max	Min	Median	Max	Min	Median	Max
	(mm per month)	(change in mm per decade)		Change in mm per month			Change in mm per month			Change in mm per month		
			A2	-15	-2	4	-19	-4	4	-37	-16	6
Annual	179.2	0.1	A1B	-10	-2	9	-18	-6	6	-29	-8	5
			B1	-11	-3	13	-18	-2	3	-21	-4	7
			A2	-3	0	11	-8	-1	1	-10	-4	3
DJF	125.6	1.9	A1B	-6	0	4	-8	-1	6	-12	-3	3
			B1	-7	-1	14	-9	-1	7	-8	0	6
			A2	-15	0	8	-20	0	17	-27	-1	9
MAM	105.3	-0.9	A1B	-8	1	8	-20	-1	8	-26	0	8
			B1	-10	0	10	-16	0	2	-17	0	5
			A2	-32	-7	10	-36	-18	12	-72	-27	14
JJA	219.3	-6.7	A1B	-25	-7	6	-34	-19	14	-45	-19	4
			B1	-26	-10	31	-36	-12	5	-40	-15	21
			A2	-29	-4	17	-40	-4	8	-57	-12	8
SON	265.4	5.7	A1B	-30	-2	23	-35	-7	21	-59	-11	15
			B1	-24	-2	12	-39	-1	16	-45	-6	9

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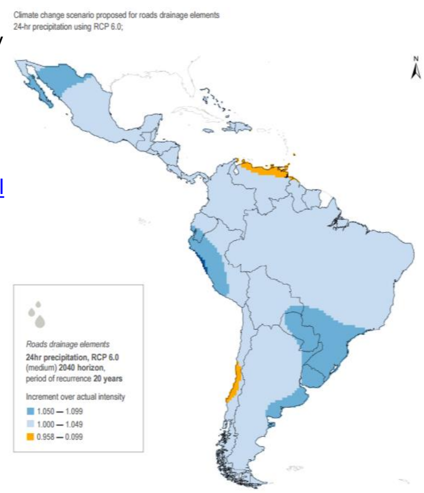

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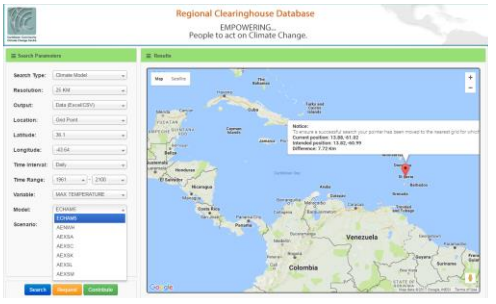

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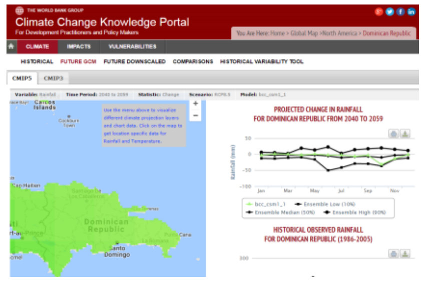
  - World Bank Climate Change Knowledge Portal (CCKP)



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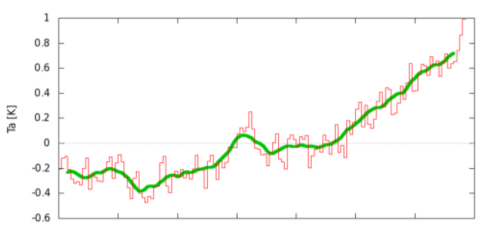

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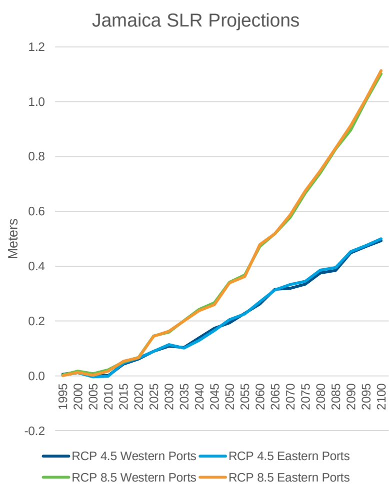

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  - HadGEM2-ES modeling (localized scenario modeling)
  - NOAA 2017, Technical Report on Global and Regional Sea Level Rise Scenarios for the United States (scenarios)

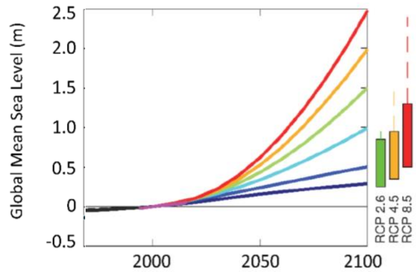

Table 4. Probability of exceeding GMSL (median value) scenarios in 2100 based upon Kopp et al. (2014).

GMSL rise Scenario	RCP2.6	RCP4.5	RCP8.5
Low (0.3 m)	94%	98%	100%
Intermediate-Low (0.5 m)	49%	73%	96%
Intermediate (1.0 m)	2%	3%	17%
Intermediate-High (1.5 m)	0.4%	0.5%	1.3%
High (2.0 m)	0.1%	0.1%	0.3%
Extreme (2.5 m)	0.05%	0.05%	0.1%

What if the information you need is unavailable?

Data gaps can be filled by:

- Interpolation of station data
- Reanalysis, satellite data
- Indigenous knowledge
- Non-traditional data sources, such as ship or aircraft data
- Combining data from different sources
- Investing in additional observation stations
- Fostering collaboration between information providers and users

Build relationships and trust with information providers

- Build relationships with partner(s) who are well-equipped to collect and analyze climate data
  - Universities, 5Cs, Met Office, consulting firms
- Work together to identify and overcome data gaps, refine data needs
- As you become familiar with the climate information it becomes more useful, and your needs more apparent. This may involve some capacity building and active partnerships.

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Summary: Best practices in identifying information

- Consider how climate has impacted the system in the past, recognizing that it is not a direct parallel
- Account for climate variability, both natural and human-caused, and potential climate extremes.
- Recognize uncertainty in future outcomes and consider a full range of climate scenarios.
- Ask for help from partners and experts if you cannot find or understand the information you need.

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More Details in Report

Name	URL	Variables	Time Period	Temporal Resolution	Models	Scenario(s)	Spatial Resolution
Caribbean Community Climate Change Centre (CCCCC) Regional Clearinghouse – RCM	http://clearinghouse.caribbeanclimate.bz/?db_type=Climate%20Model&country=&collection=V501&s=&sector=&topic=	Available soil moisture content in root zone, convective rainfall rate, evaporation rate from canopy, large scale rainfall rate, max temperature, minimum temperature, humidity, etc.	1961-2100	Daily	ECHAM5	A1B	25 km
CCCCC Regional Clearinghouse – GCM	http://clearinghouse.caribbeanclimate.bz/?db_type=Climate%20Model&country=&collection=V501&s=&sector=&topic=	Change in annual mean temperature, Change in total precipitation rate (mm/day), Change in mean surface temperature, Change in relative humidity, Change in wind speed at 10 m (m/s)	1990-2100 (ECHAM), 2010-2069 (Had)	Daily	ECHAM4, HadAM3P	A2, B2	50 km
CARIBSAVE Climate Change Risk Atlas	http://www.caribbeanclimate.bz/closed-projects/2009-2011-the-caribsave-climate-change-risk-atlas-cccra.html	Mean temperature, total precipitation, wind speed, relative humidity, sunshine hours, sea surface temperatures, frequency of hot days, frequency of hot nights, frequency of cold days, frequency of cold nights, per centage of rainfall falling in heavy events, maximum 1-day rainfall, maximum 5-day rainfall	2020s, 2050s, 2080s (rel. to 1970-1999)	Seasonal and Annual	Ensemble of 15 General Circulation Models (GCMs) and PRECIS Regional Climate Model (RCM) driven by ECHAM4 and HadCM3	GCMs: A2, A1B, B1 RCM: A2	GCMs: 2.5 degrees RCM: unknown

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Thank you! Questions?

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