UNCTAD National Workshop Saint Lucia

24 – 26 May 2017, Rodney Bay, Saint Lucia

"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

May 26, 2017

United Nations Conference on Trade and Development

National Workshop - Saint Lucia

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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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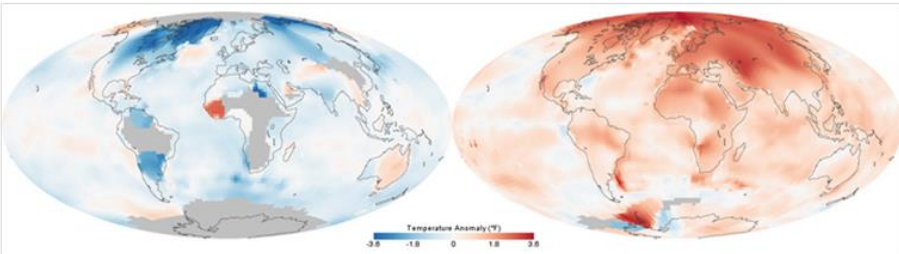
Climate

The characteristics of the atmosphere and water over a month or more, including the characteristics of extreme events



Source: NASA

Extreme Events

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

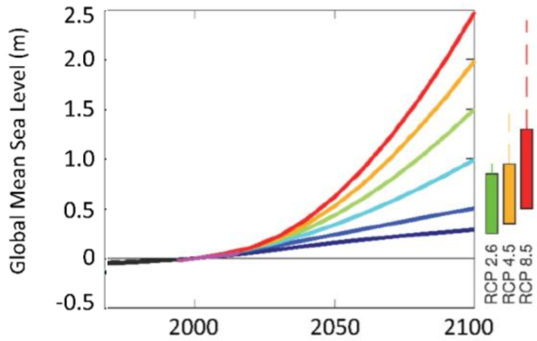
- Sometimes impacts on society and ecosystems become severe when climate conditions pass certain levels, called thresholds.

Extreme Temperatures

Extreme Rainfall and Flooding

Climate Change can have Many Different 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

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

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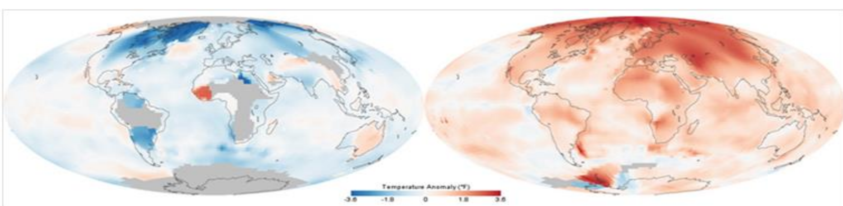
Characteristics of Climate Information

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



Source: NASA

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Dimensions of Climate Projections

- Emission scenarios
- Climate models
- Spatial resolution

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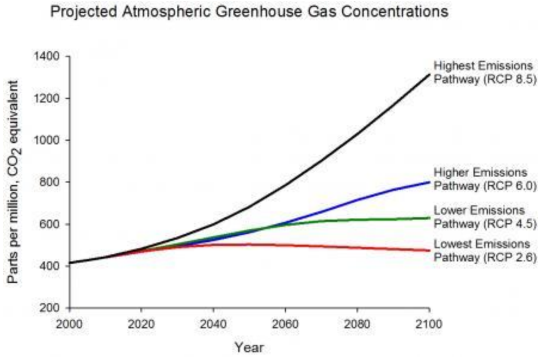
Emission Scenarios

Scenario = a possible future

Numerous alternatives of how the future can unfold

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



Source: U.S. EPA

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Uncertainties in Emission Scenarios

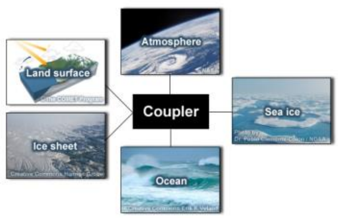
Uncertainties about the future

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

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

Climate Models

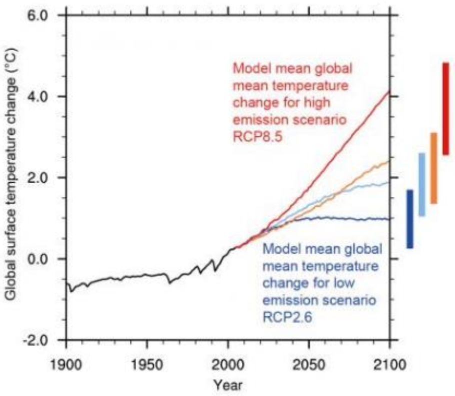
- Mathematical representations of climate system and interacting processes
- Can reproduce key features found in the climate of the past century
- Run emission scenarios and produce projections
- Can be done on different timescales and different geographic areas
- Global climate models referred to as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



Model components (UCAR)

Climate 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

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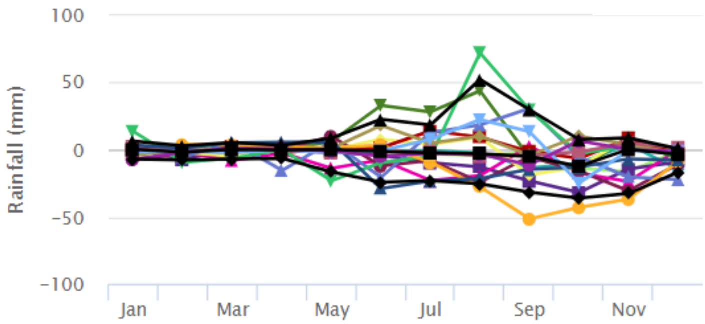
Climate Models

- 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=LCA

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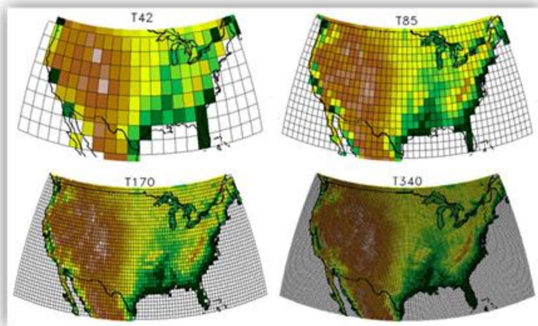
Downscaling

- 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)

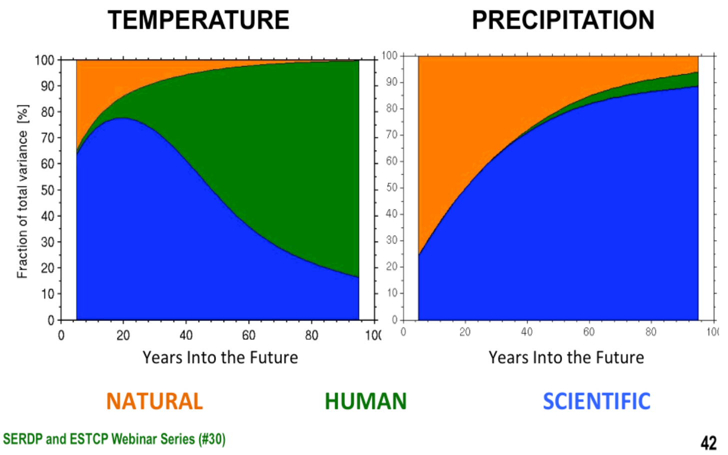
Dynamically downscaled data available for the Caribbean at 25 km and 50 km resolution

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.)

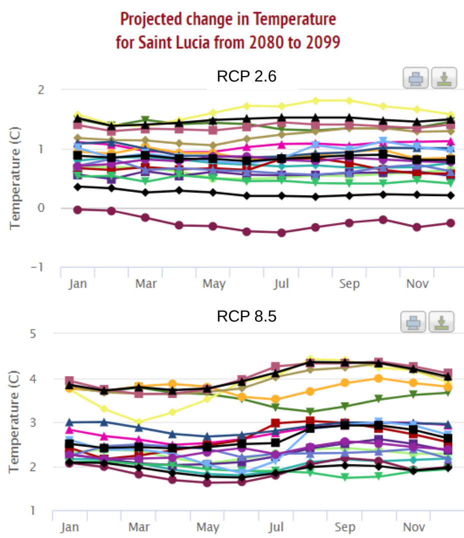
Uncertainty Varies over Time and by Stressor



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

Topic 2

Caribbean climate data sources

Levels of Climate Information

General climate information

The trend in recent and future climate (e.g., is the climate getting hotter or cooler? Wetter or drier?)

Information on the magnitude and frequency of events

Detailed climate data that can be used as an input into specific -technical analysis

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Types of Climate Information and Sources

Time Period

Past | **Present** | **Future**

Sources of Information

Weather station

Tide gauge

River gauge

Satellite

Anecdotal info

Precip = f(obs, GCM)

Statistical Model

Global Climate Model

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Climate Data Sources for Saint Lucia – Historical Data

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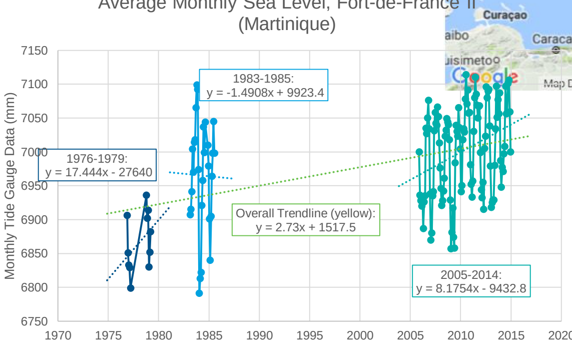

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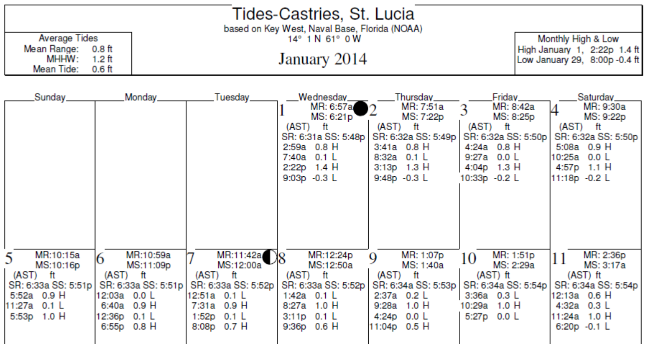

Tides-Castries, St. Lucia
based on Key West, Naval Base, Florida (NOAA)
14° 1 N 61° 0 W

January 2014

Average Tides
Mean Range: 0.8 ft
MHHW: 1.2 ft
Mean Tide: 0.6 ft

Monthly High & Low
High January 1, 2:22p 1.4 ft
Low January 29, 8:00p -0.4 ft

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
			1 MR: 6:57a MS: 6:21p (AST) ft SR: 6:31a SS: 5:48p 2:59a 0.8 H 7:40a 0.1 L 2:22p 1.4 H 9:03p -0.3 L	2 MR: 7:51a MS: 7:22p (AST) ft SR: 6:32a SS: 5:49p 3:41a 0.8 H 8:32a 0.1 L 3:13p 1.3 H 9:48p -0.3 L	3 MR: 8:42a MS: 8:25p (AST) ft SR: 6:32a SS: 5:50p 4:24a 0.8 H 9:27a 0.0 L 4:04p 1.3 H 10:33p -0.2 L	4 MR: 9:30a MS: 9:22p (AST) ft SR: 6:32a SS: 5:50p 5:08a 0.9 H 10:25a 0.0 L 4:57p 1.1 H 11:18p -0.2 L
5 MR:10:15a MS:10:16p (AST) ft SR: 6:33a SS: 5:51p 5:52a 0.9 H 11:27a 0.1 L 5:53p 1.0 H	6 MR:10:59a MS:11:09p (AST) ft SR: 6:33a SS: 5:51p 12:03a 0.0 L 6:40a 0.9 H 12:36p 0.1 L 6:55p 0.8 H	7 MR:11:42a MS:12:00a (AST) ft SR: 6:33a SS: 5:52p 12:51a 0.1 L 7:31a 0.9 H 1:52p 0.1 L 8:08p 0.7 H	8 MR:12:24p MS:12:50a (AST) ft SR: 6:33a SS: 5:52p 1:42a 0.1 L 8:27a 1.0 H 3:11p 0.1 L 9:36p 0.6 H	9 MR: 1:07p MS: 1:40a (AST) ft SR: 6:34a SS: 5:53p 2:37a 0.2 L 9:28a 1.0 H 4:24p 0.0 L 11:04p 0.5 H	10 MR: 1:51p MS: 2:29a (AST) ft SR: 6:34a SS: 5:54p 3:36a 0.3 L 10:29a 1.0 H 5:27p 0.0 L	11 MR: 2:36p MS: 3:17a (AST) ft SR: 6:34a SS: 5:54p 12:13a 0.6 H 4:32a 0.3 L 11:24a 1.0 H 6:20p -0.1 L

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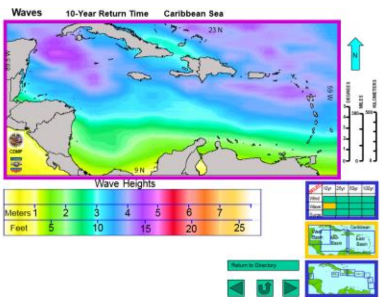

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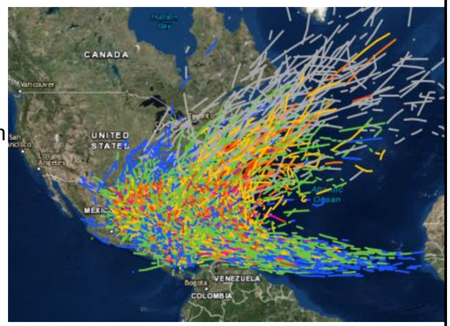
  - NOAA National Hurricane Center Historical Hurricane Tracks



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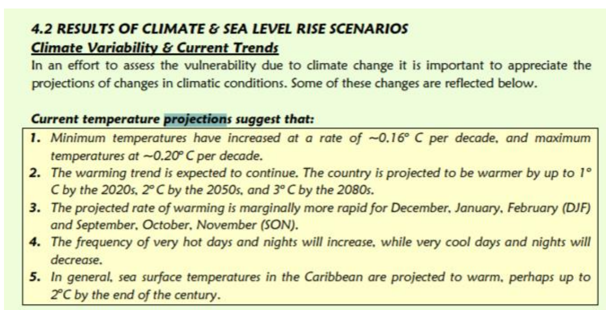

4.2 RESULTS OF CLIMATE & SEA LEVEL RISE SCENARIOS

Climate Variability & Current Trends

In an effort to assess the vulnerability due to climate change it is important to appreciate the projections of changes in climatic conditions. Some of these changes are reflected below.

Current temperature projections suggest that:

1. *Minimum temperatures have increased at a rate of ~0.16° C per decade, and maximum temperatures at ~0.20° C per decade.*
2. *The warming trend is expected to continue. The country is projected to be warmer by up to 1° C by the 2020s, 2° C by the 2050s, and 3° C by the 2080s.*
3. *The projected rate of warming is marginally more rapid for December, January, February (DJF) and September, October, November (SON).*
4. *The frequency of very hot days and nights will increase, while very cool days and nights will decrease.*
5. *In general, sea surface temperatures in the Caribbean are projected to warm, perhaps up to 2°C by the end of the century.*

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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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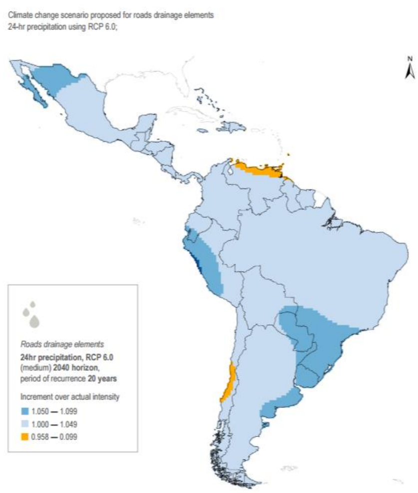

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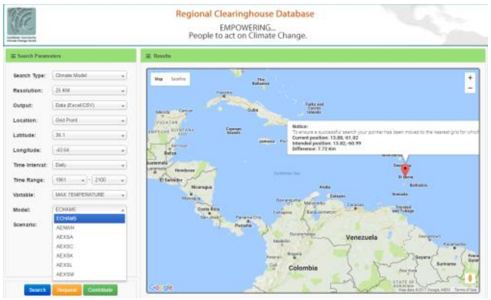

31

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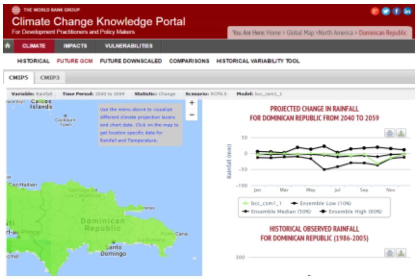

32

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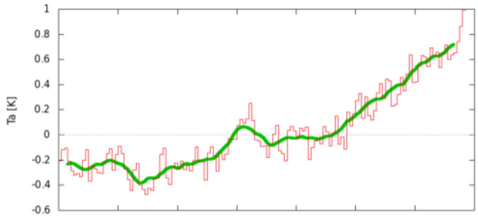

33

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34

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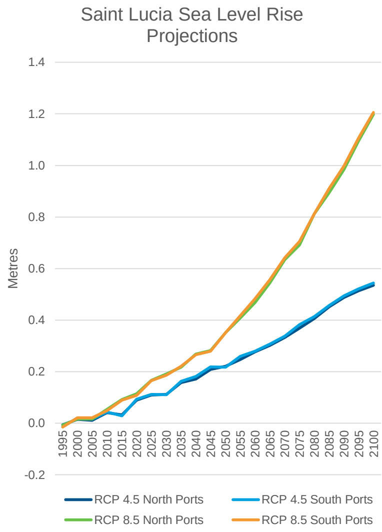

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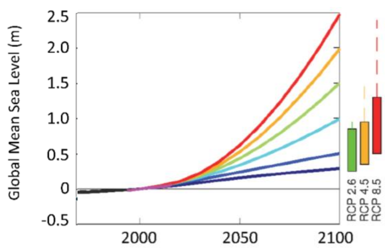

- NOAA 2017, Technical Repot on Global and Regional Sea Level Rise Scenarios for the United States (scenarios)

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

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Build relationships and trust with information providers

- Build relationships with partner(s) who are well-equipped to collect and analyze climate data
  - Universities, CCCCC, Met Service, 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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Thank you! Questions?

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