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

Training

Gathering and applying climate information for decision-making

By

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Training

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

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Objectives

- Learn the fundamentals about climate scenarios, models, and data
- Understand sources of climate data for the Caribbean
Topic 1
Overview of Climate Scenarios, Models, and Information

Key Concepts Help us Understand Climate Change Risks and Impacts

Connecting climate information with decisions requires a special vocabulary
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


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
Dimensions of Climate Projections

- Emission scenarios
- Climate models
- Spatial resolution

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
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”
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

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=LatinAmerica&ThisCode=LCA
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


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


SERDP and ESTCP Webinar Series (#30)
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

Types of Climate Information and Sources

**Time Period**
- Past
- Present
- Future

**Sources of Information**
- Weather station
- Tide gauge
- Satellites
- River gauge
- Anecdotal info

**Statistical Model**

\[ \text{Precip} = f(\text{obs, GCM}) \]

**Global Climate Model**
Climate Data Sources for Saint Lucia – Historical Data

- Temperature, precipitation, and wind
  - Met Service

- Sea Level/Tides
  - Permanent Service for Mean Sea Level (closest tide gauge is FORT-DE-FRANCE II in Martinique, 1976-2016)

1976-1979: \[ y = 17.444x - 27640 \]
1983-1985: \[ y = -1.4908x + 9923.4 \]
2005-2014: \[ y = 8.1754x - 9432.8 \]
Overall Trendline (yellow): \[ y = 2.73x + 1517.5 \]
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- Hurricanes
  - Atlas of Probable Storm Effects in the Caribbean Sea (Caribbean Disaster Mitigation Project – Wind, wave and storm surge for the 10-, 25-, 50-, and 100-year return periods)
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  - NOAA National Hurricane Center Historical Hurricane Tracks

Climate Data Sources for Saint Lucia – Projected Data

- **Temperature, precipitation, and wind**
  - St. Lucia Second/Third National Communication on Climate Change

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.
Climate Data Sources for Saint Lucia – Projected Data

- Temperature, precipitation, and wind
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  - CARIBSAVE Climate Change Risk Atlas

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

<table>
<thead>
<tr>
<th>Month</th>
<th>Observed Mean (mm per month)</th>
<th>Observed Trend (mm per month)</th>
<th>Projected Changes for the 2020s</th>
<th>Projected Changes for the 2050s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jun</td>
<td>120</td>
<td>-4</td>
<td>-8</td>
<td>-16</td>
</tr>
<tr>
<td>Jul</td>
<td>135</td>
<td>-5</td>
<td>-10</td>
<td>-20</td>
</tr>
<tr>
<td>Aug</td>
<td>150</td>
<td>-6</td>
<td>-15</td>
<td>-30</td>
</tr>
<tr>
<td>Sep</td>
<td>165</td>
<td>-7</td>
<td>-20</td>
<td>-40</td>
</tr>
<tr>
<td>Oct</td>
<td>180</td>
<td>-8</td>
<td>-25</td>
<td>-50</td>
</tr>
<tr>
<td>Nov</td>
<td>195</td>
<td>-9</td>
<td>-30</td>
<td>-60</td>
</tr>
<tr>
<td>Dec</td>
<td>210</td>
<td>-10</td>
<td>-35</td>
<td>-70</td>
</tr>
</tbody>
</table>

Climate Change Results for Saint Lucia – Projected Data

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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, 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.
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.

Thank you! Questions?