An Integrated Water Resources Management approach for building climate resilience in the Caribbean Water Sector

Module 3: Impacts of Climate Change on the Water Sector

Global Water Partnership Caribbean

Cap-Net UNDP

WMO/GWP Associated Programme on Flood Management

UNESCO-IHE Institute for Water Education

REDICA

CRHAMA

Credits and Acknowledgements

- Slides are adapted from Cap-Net 2009 Training Slides unless otherwise stated. See http://www.cap-net.org/training-material/iwrm-as-a-tool-for-adaptation-to-climate-change-english/)

- Unless otherwise stated, case studies and examples are provided from ***Cap-Net, WMO/APFM, UNESCO-IHE, REDICA and GWP-C. 2015. (Draft) IWRM as a Tool for Adaptation to Climate Change with Caribbean Case Studies. Training Manual and Facilitators Guide. Cap-Net.***

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- WACDEP is executed by GWP-C in Partnership with the Caribbean Community Climate Change Centre (CCCCC)

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Goals and objectives of session

By the end of the session participants will have a better understanding of

- The impact of CC/CV on the hydrological cycle
- The impact of CC/CV on water resources management

Climate Change /Climate Variability (CC/CV) and Water Basics: Higher rates of evaporation

- Higher temperatures due to CC leads to increased rates of evaporation across the globe
    - Less surface water
    - Less water in the soil

- Warm dry areas are likely to become drier e.g. Water scarcity likely in northern and southern Africa, Mediterranean and South West USA

- Some areas are likely to experience longer dry seasons e.g. Caribbean

- Increased incidence of droughts in some areas

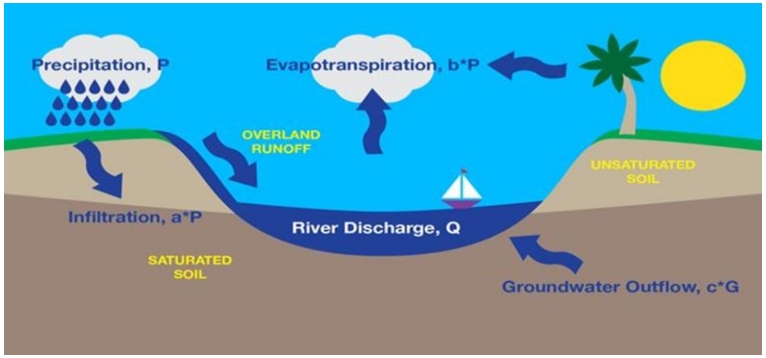

Image Source:
ttp://www.caribbean360.com/index.php/news/tandt_authorities_scrap_fee_for_use_of_river_water.html#axzz2kqIppKug

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CC/CV and Water Basics: increase in precipitation and increase in precipitation intensity

- Higher temperatures increase evaporation rates.
  - More water vapour in the atmosphere
  - Overall global increase in precipitation
- But varies from region to region
- Some areas more rainfall some less e.g. Mean annual precipitation to increase in Northern Europe and decrease further South
- When rain does fall events are likely to be intense due to the higher amounts of water vapour in the atmosphere

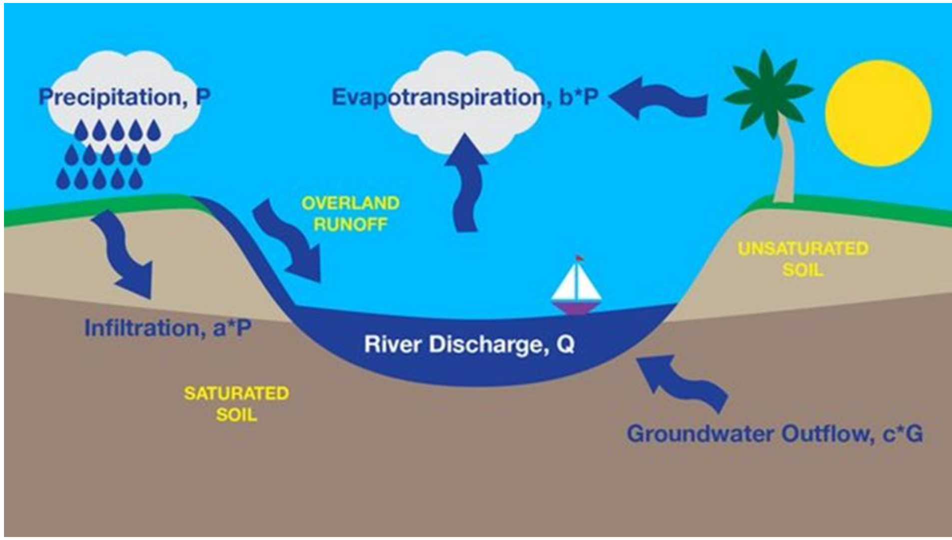

Image Source: ttp://www.caribbean360.com/index.php/news/tandt_authorities_scrap_fee_for_use_of_river_water.html#axzz2kqIppKug

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CC/CV and Water Basics: High intensity rain events

- Intense rain events lead to more surface runoff
- More surface runoff means less infiltration, less ground water and more flooding
- Compounded by site characteristics e.g. more surface runoff from paved surface

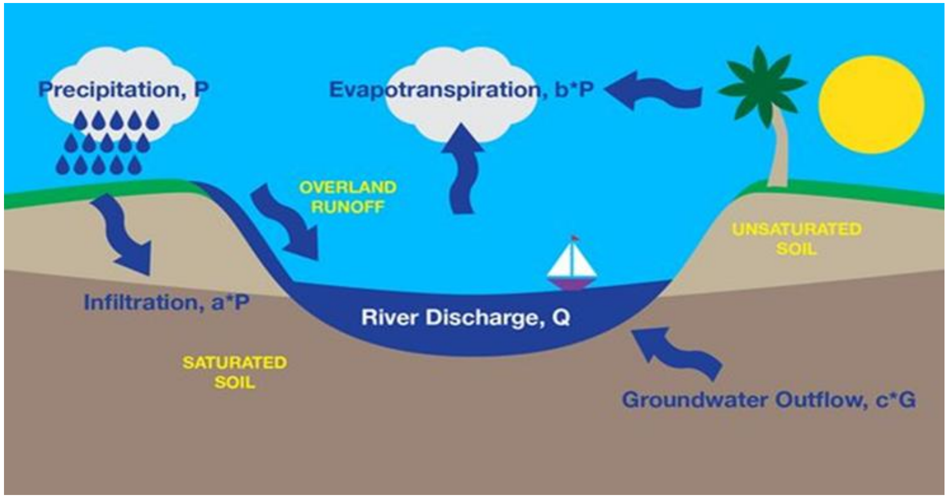

Image Source: ttp://www.caribbean360.com/index.php/news/tandt_authorities_scrap_fee_for_use_of_river_water.html#axzz2kqIppKug

Case Study : Recent Flash Flooding in the Caribbean Region

- Increasing occurrence of flash flooding: In April of 2003, the Caribbean Disaster Emergency Management Agency (CDEMA) initiated a Level 2 response to major flooding and subsequent landslide activity in Dominica. The Situation Report from CDEMA stated that the Pond Casse area experienced "… an extended period of moisture and instability" associated with a trough system. This system left behind severe damage to roads, bridges and other infrastructure in the area. The incident also left behind two fatalities (CDEMA 2013).
- The World Bank (2014) reported the December 2013 flash floods that affected the islands of Saint Vincent and the Grenadines, and St Lucia. Torrential rainfall and landslide activity left its trail on the damaged infrastructure, concentrated in the areas with the highest poverty levels. The incident also occurred during the peak of the tourist season and affected agriculture as well in both countries, leading to economic contractions.

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CC/CV and Water Basics: Storms/Hurricanes

- Warmer temperatures (sea surface temperatures) lead to increases in the intensity, wind speed, and precipitation during storm events
- Intense storm events
    - Damage to water infrastructure (landslides, /wind damage)
    - Surface runoff
    - Flooding

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CC/CV and Water Basics

- Overall Climate change intensifies the hydrological cycle

- Specific impacts vary from region to region based on pre existing climatic, hydrological and geographic characteristics and on global circulation patterns

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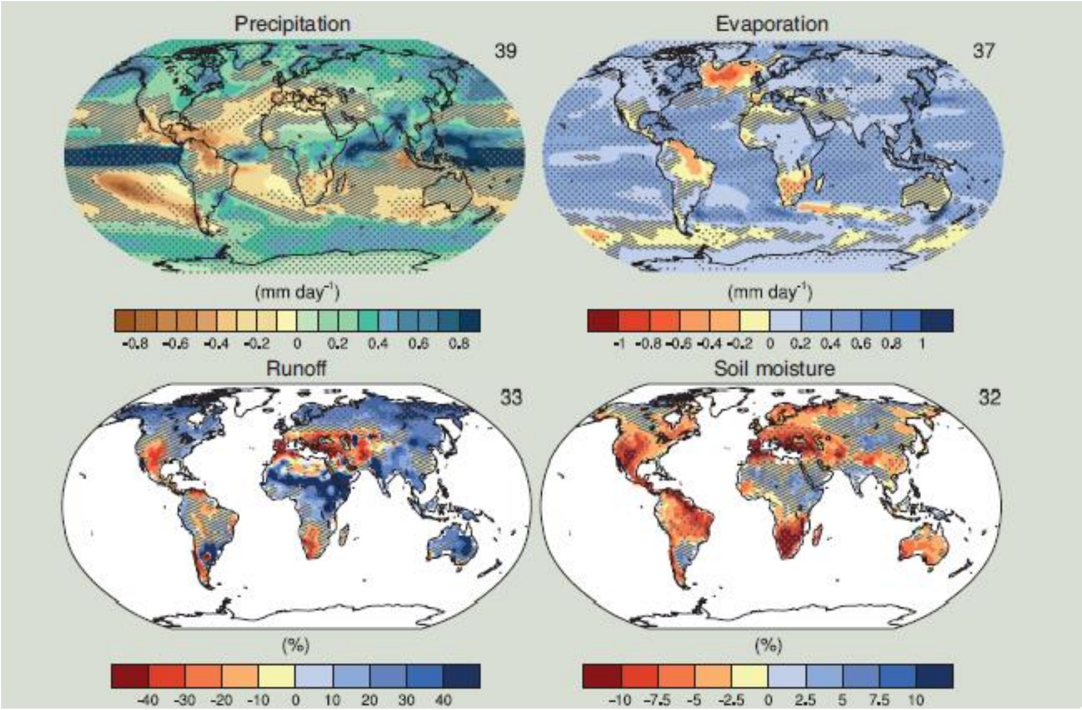
CC/CV and Water- Global Models

- Based on 15 Global Circulation Models (GCMs)
- Four variables:
  - precipitation
  - evaporation
  - soil moisture
  - runoff
- Annual mean changes for 2081–2100 relative to 1986–2005
- Regions where models agree on the sign of change are stippled.



Annual mean changes in (a) precipitation (percent); (b) evaporation (percent); (c) run-off (percent) and (d soil moisture (percent). Changes are annual means: scenario A1B, period 2081–2100 relative to 1986–2005. The number of Coupled Model Intercomparison Project Phase 5 (CMIP5) models to calculate the multi-model mean is indicated in the upper right corner of each panel

Source: IPCC, 2013

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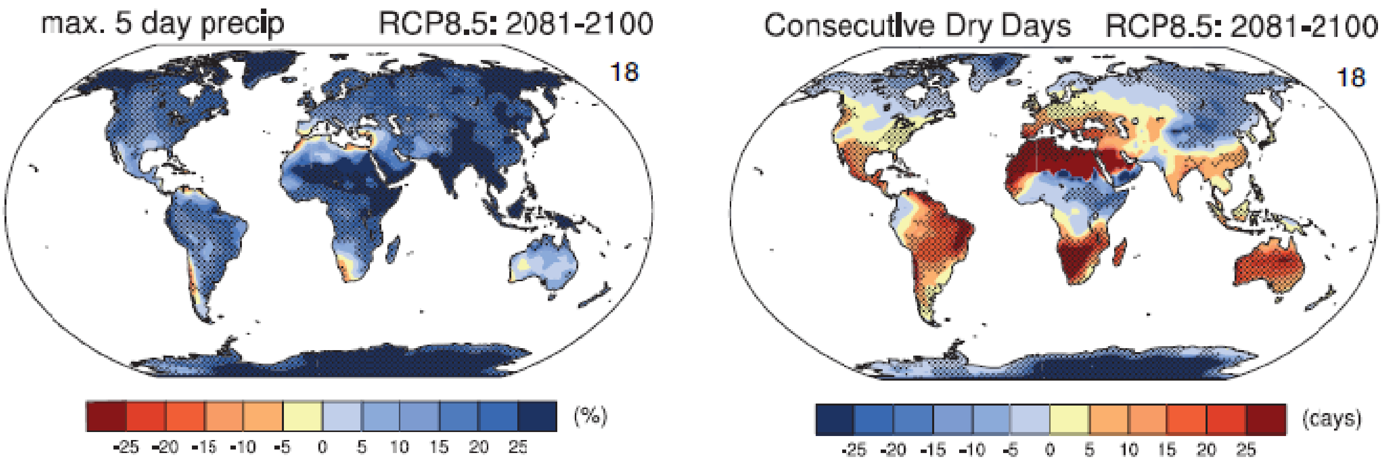
CC/CV: Global models of projected change spatial patterns of precipitation intensity and dry days



Source: Updated from Sillmann et al. (2013), excluding the FGOALS-s2 model

- Based on 9 GCMs
- Changes in spatial pattern of
  - precipitation intensity
  - dry days
- Annual mean changes for 2081–2100 relative to 1986–2005
- Stippling: at least 5 out of 9 models concur denoting that change is significant

Projected changes by region: Europe and Latin America

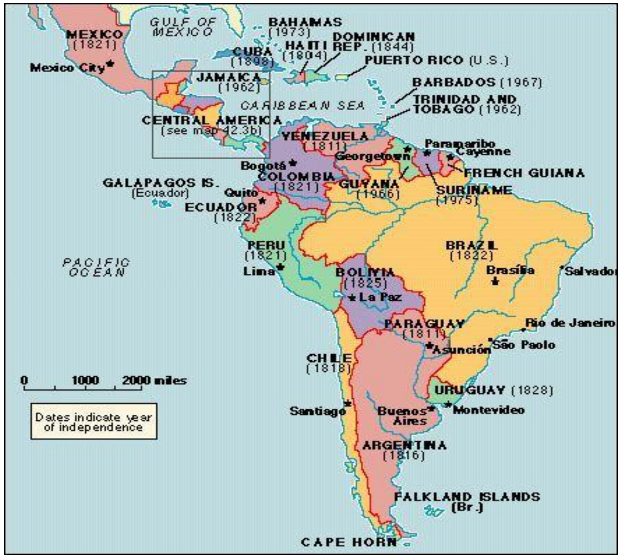
Europe:

- Mean annual precipitation to increase in Northern Europe and decrease further south
- Mediterranean and some parts of central and Eastern Europe to be more prone to droughts

Latin America:

- Number of wet days expected to increase over parts of south-eastern South America and central Amazonia
- Extreme dry seasons to become more frequent in Central America

Source: mapoftheworldmapz.blogspot.com



Source: www.wwnorton.com

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Projected changes by region: Africa and North America

Africa:

- Water scarcity in northern and southern Africa
- More precipitation in Eastern and western Africa

North America:

- Climate change to constrain already over-allocated water resources, especially in the semi-arid western USA (ex. California crisis)
- Water levels to drop in the Great Lakes

Source: mapdata@2015

Source: mapoftheworldmaz.blogspot.com

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CC/CV and Water Basics: Sea level rise

- Higher sea levels lead to salt water intrusion in wells/aquifers near the coastline
  - Reduction in the supply of ground water

http://fiusm.com/2014/11/24/what-sea-level-rise-means-to-south-florida/

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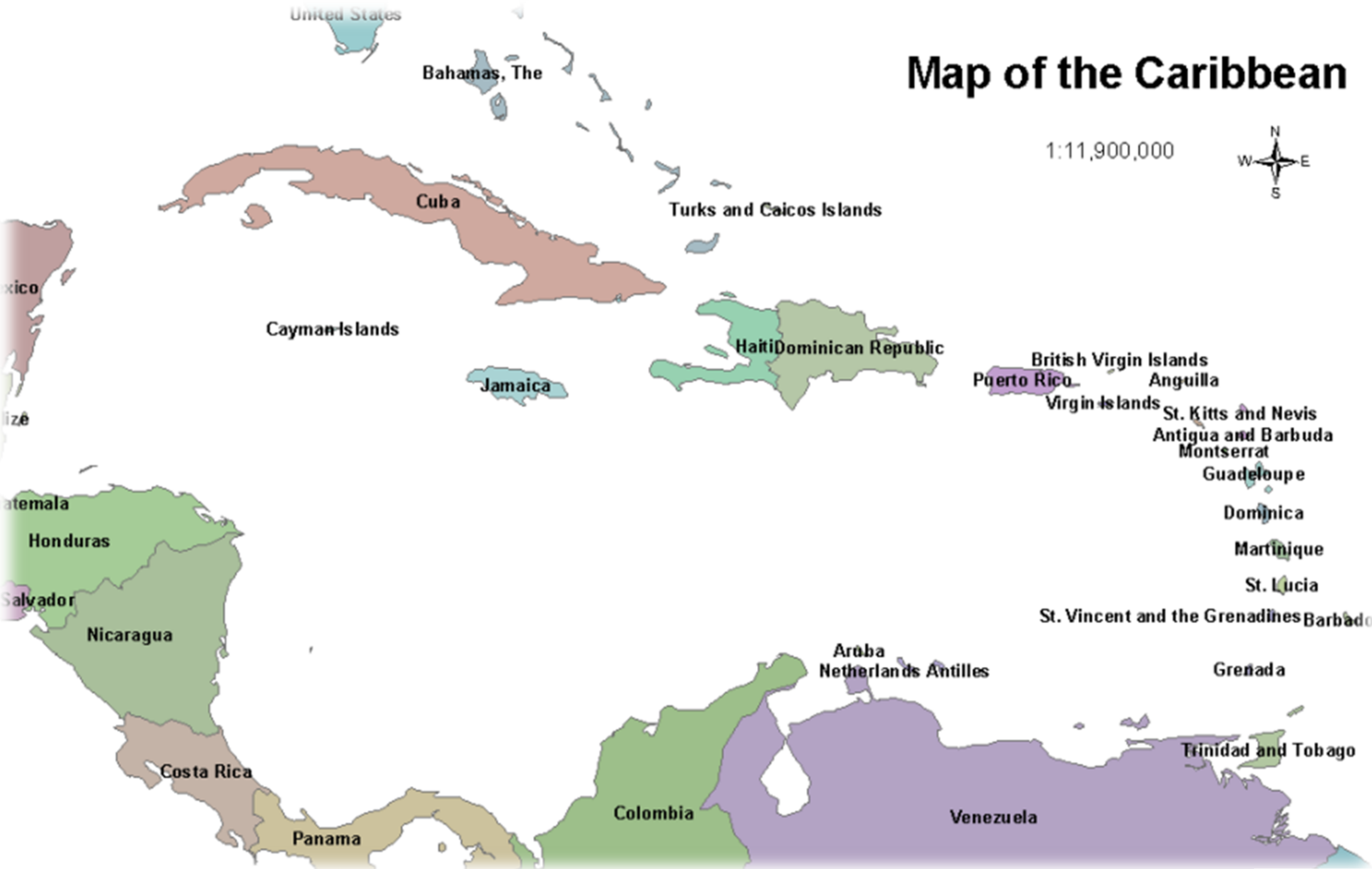
Water and Climate: Caribbean Scenario



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Changes in precipitation frequency and intensity: Caribbean Scenario

- Main Caribbean basin- Drier
- Possible wetter conditions Northern Caribbean
- Drier & longer dry season
- Caribbean region primary rainy season (May- Nov) significantly drier.
- Expected overall decrease in annual precipitation of about 12% for Caribbean region
- When rain does fall- heavy downpours
- More intense hurricanes

References: Cashman et al (2010), Trotman (2012), Cap-Net (2015)

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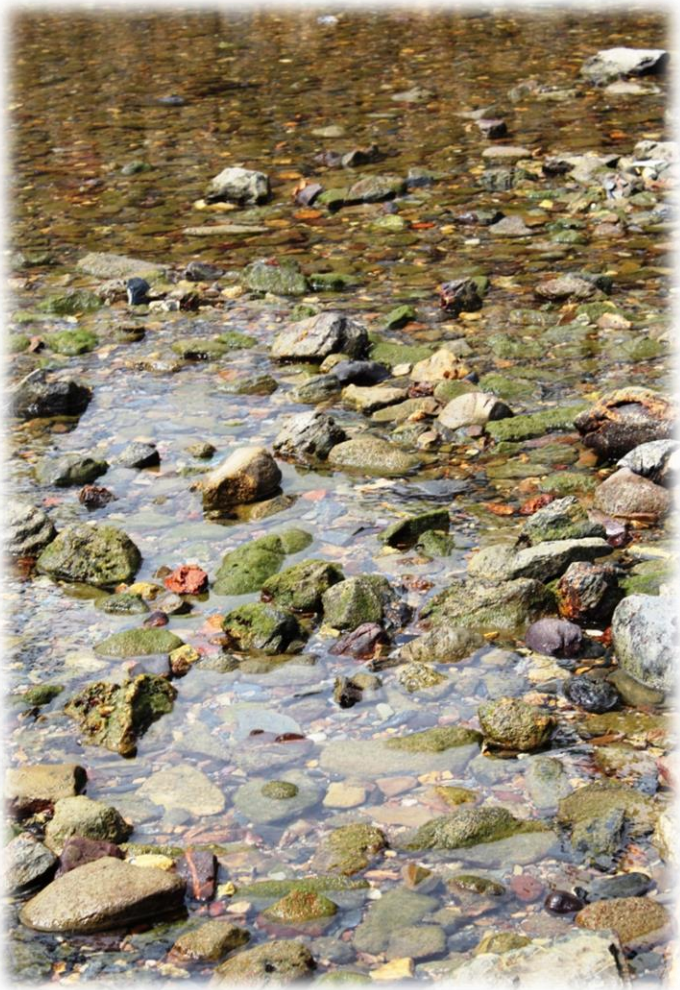
CC/CV consequences for Water Resources Management

- Increasing temperatures, higher evaporation rates, increased surface runoff, more intense storms, salt water intrusion into aquifers, droughts, floods has consequences for:
- Water availability
- Water quality
- Water use
- Water infrastructure and water treatment processes
- Fresh water ecosystem functioning



CC/CV consequences for Water Resources Management: Water availability/supply

- Less water available for domestic; industrial, agricultural use due to
  - Less rainfall
  - Lower volumes of water in reservoirs and rivers
  - Alterations in the timing of rainfall
  - Intense rainfall, more surface runoff and less infiltration

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Water availability for hydropower in the Caribbean

- Renewable energy resources on small islands have only recently been considered within the context of long-term energy security (Praene *et al.,* 2012; Chen *et al.,* 2007). In the Caribbean, the reasons for the slow uptake of alternative energy technology include a lack of resources and the appropriate regulatory framework. In 1998, the Caribbean Renewable Energy Development Programme (CREDP) was founded by 16 Caribbean countries in order to remove the barriers to the use of renewable energy and to foster its development and commercialisation. Currently, 13 countries are participating in the programme, exploring primarily wind and hydropower energy options.

- Hydropower production decreases with decreased flows as has been the experience of some Caribbean countries that depend on hydroelectricity for their energy needs. During a period of drought, hydropower contribution to total electrical energy in St. Vincent and the Grenadines fell from 28 percent in 2009 to 8.1 percent 2010 (Farrell et al 2010). The Jamaica Observer newspaper reported that the recent 2014 drought resulted in a 15 percent reduction in the country’s hydropower production.

CC/CV consequences for Water Resources Management: Water quality

- Pollutants in water courses include fertilizers, pesticides, municipal wastewater
- Higher evaporation rates, less water- pollutants become more concentrated
  - implications for water abstraction/recreational use
- Heavy rainfall events – pollutants become diluted
- Depends however on the level of pollution in the water body, vs. Level of Pollution in the watershed
  - Heavy surface runoff can increase pollutant levels in

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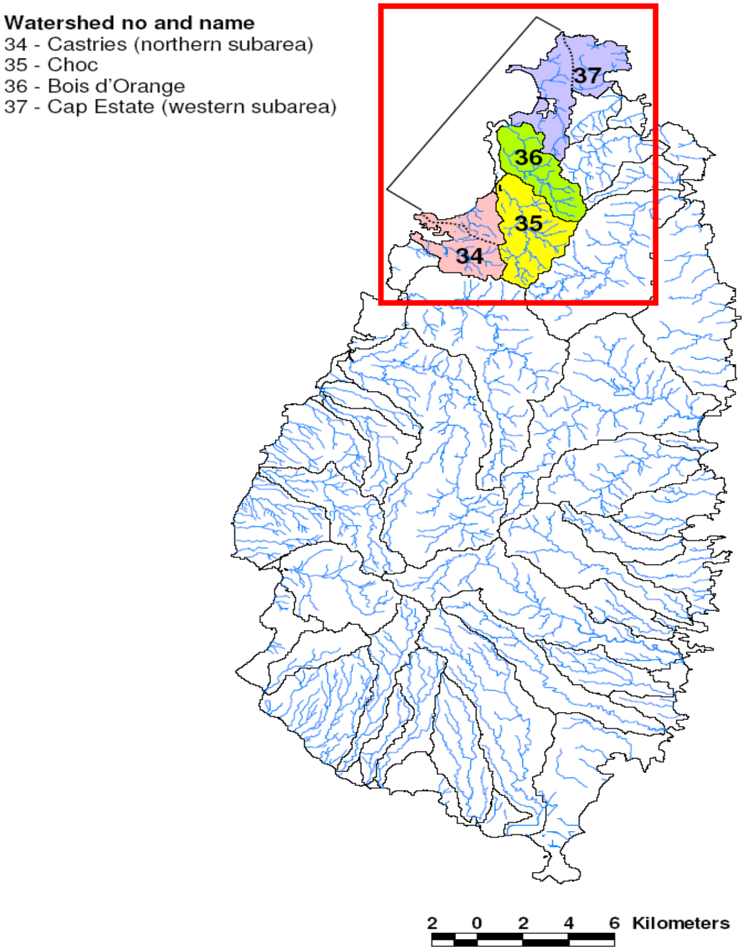
Dilution Effects: Case Study St. Lucia

Implementation and demonstration of best practices for pollutant discharge reductior into water courses.

Project highlights the need to reduce stressors that exacerbate climate change impacts



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CC/CV consequences for Water Resources Management: Water use

- Higher temperatures
  - Increased consumption of water for drinking, cooling, bathing
  - Demand for water increases

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CC/CV consequences for Water Resources Management: Water infrastructure and treatment processes

- Low water levels in reservoirs
- High turbidity levels due to intense rainfall events and surface runoff
- Pipes may be impaired by high temperatures, floods
- Reservoir infrastructure?
- More overflows in sewerage systems with increased precipitation
- urban drainage

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Water infrastructure

In 2010, Hurricane Tomas affected several islands in the Caribbean. The island of St. Lucia was particularly hard-hit by the heavy rains that accompanied the cyclone: up to 635 mm of rain within a 24 hour period. This unusually heavy rainfall event resulted in landslides that damaged the infrastructure of the John Compton Dam, which provides water to over half of the island's population (GWP-C 2010). Within a relatively short period of time, the dam was again compromised in December 2013 by a trough that brought heavy rainfall resulting in siltation. Events such as these highlight the need to adapt to extreme inter-annual climate variability as well as longer term projected impacts of climate change.

CC/CV consequences for Water Resources Management: Ecosystem Functioning

- Low flow due to Higher evaporation rates
  - less habitat availability
  - Less food
  - Anaerobic conditions
- High flow due to intense rainfall
- Organisms may be washed away

http://www.agweek.com/news/nation-and-world/3798474-usda-declares-parts-puerto-rico-disaster-areas-due-drought

CC/CV Impacts on water affects different sectors e.g. Agriculture

- Food Security/Agriculture
  - Water availability
  - More subtle issues- heavy rains followed by high temperatures promotes bacterial and fungal growth http://www.ipsnews.net/2013/09/trinidads-farmers-outpaced-by-climate-change/

CC/CV Impacts on water affects different sectors e.g. Tourism

Tourism

- Rainfall patterns
- Water Availability for Swimming Pools, Golf Courses etc.



CC/CV Impacts on water affects different sectors e.g. Health

- Human Health
  - Is there enough water to sustain life?
  - Is there enough water for sanitation purposes?
  - Is the water of an adequate quality?
- Emergency situations: Climate related droughts, floods hurricanes

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Case study: St. Lucia 2010: The perfect storm

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Case study: St. Lucia 2010-Hurricane Tomas

- Category 1 Hurricane which stayed over the island dumping between 533mm-635mm (21-25 inches)of rain over a 24hr period,
- Yearly average is 1500-3800mm
- 8 people died (NHC, 2011) Total cost of damage and losses was US$336.2 million (ECLAC, 2011).
- Landslides exacerbated by soil conditions brought on by the drought earlier in the year

Photo source https://www.globalgiving.org/photo/PIC29661/landslide-in-soufriere-st-lucia-in-2010-devastating-hur/

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St. Lucia 2010- Water crisis in the aftermath of Hurricane Tomas

- Landslide damage to the pumping and distribution infrastructure from the John Compton Dam.

- This dam provides water to the NW urban corridor, approximately 55% of the island's population

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St. Lucia 2010- Water crisis in the aftermath of Hurricane Tomas

- Stored tank water ran out
- Relief bottled water supplies were not reaching everyone
- People resorted to pulling water out of polluted rivers/drains
- Rainwater harvesting
- Country at a standstill

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Potential Environmental Health
Public Health Crisis

- Ministry of Health/Caribbean Environmental Health Institute/
- International relief agencies
- Purification packs
- Water filtration systems

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Water Augmentation/Alternate Water sources during the water crisis

- Rivers & Springs
  - Water quality issues
- Rainwater harvesting (RWH)
  - Rudimentary
  - Remnant old time cisterns
  - Systems in health care systems
- In tandem intense public awareness campaigns on safe rainwater harvesting

Rainwater Harvesting in the Caribbean

RWH Technical Fact Sheet: Chlorination guidelines and making your water safe

Chlorine disinfection procedure

- Estimate the amount of water in your tank.
- **Add ½ cup (125 ml) of plain household-grade unscented and uncoloured bleach to every 200 gallons** (1,000 litres) of water in the tank. Use the table to the right as a guide for various volumes.
- Wait 24 hours after putting in the chlorine to allow enough time to disinfect the water before drinking
- Any chlorine smell and taste in the water will go away after a short time. If you find the taste of chlorine unacceptable, an option is to boil the water for at least 5 minutes before drinking it.

For large quantities (water tank):

Volume of water in tank			Amount of bleach to add
Imp. gallons	US gallons	Litres	(cups)
200	240	909	½
400	480	1,818	1
600	720	2,727	1½
800	960	3,637	2
1,000	1,200	4,546	2½
2,500	3,000	11,365	5½
5,000	6,000	22,730	11½
10,000	12,000	45,461	22½
20,000	24,000	90,922	45½

For smaller quantities (bucket, pail, drum):
Add **8 to 10 drops OR ⅛th of a teaspoon** of ordinary household-grade unscented and uncoloured bleach **per gallon** of water (same for either Imperial or US gallon)

NOTE:
1 Imperial gallon = 4½ litres
1 US gallon = 3¾ litres

In times of emergency:

Store 1 gallon per person per day!

In the home – managing your stored water

- Place storage containers out of reach of small children and animals
- Ensure containers are clean and keep them covered or sealed.
- Draw water from containers in a hygienic manner; pour, do not dip other vessels
- **NOTE: Boil water if contamination is suspected.**

For more information contact:
The Bureau of Health Education, C/O Ministry of Health, Waterfront,
Tel# 468 5349 or one of the following Environmental Health Offices:
Castries - Tel# 468 3700; Vieux Fort - Tel# 454 6329; Soufriere - Tel# 459 7329

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How do we manage these climate challenges?

- We mitigate
- We adapt
- We build resilience
- We will discuss more in Module 4

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Thank You

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