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

Module 4: Adaptation Strategies

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Cap-Net UNDP

WMO/GWP Associated Programme on Flood Management

UNESCO-IHE Institute for Water Education

REDICA

RHAMA

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.***

- This training package is produced by Global Water Partnership - Caribbean and CAPNET/Caribbean WaterNet with Funding from the GWP-C Water Climate and Development Programme (WACDEP)

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

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Goal and Objectives of the session

At the end of this session, participants will be able to:

- Explain the difference between adaptation and mitigation
- Understand what is meant by climate resilience
- Become familiar with technological, infrastructure options for adaptation to climate change in the water sector
- Distinguish various approaches to climate resilience/climate adaptation

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Adaptation, Mitigation, Resilience

- Mitigation is a human intervention to reduce the sources or enhanced sinks of greenhouse gases (IPCC 2014)

- Adaptation is the process of adjustment to actual or expected climate and it's effects (IPCC 2014)

- Resilience: The ability of system to resist, absorb, accommodate and recover from the effects of a (climate) hazard in a timely and efficient manner while retaining the same basic structure and ways of functioning (GWP-C and CCCCC 2014).

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Adaptation, Mitigation, Resilience

Mitigation

Adaptation

Resilience

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Some examples of mitigation in the water sector

Some strategies being used in the California by water utility companies includes:

- Water supplies- Coordinating pumping to minimize electrical demand during peak hours- it was found that electricity provided during peak hours is generally the most costly and GHG intensive
- Water distribution- Improving pump efficiency; store water to avoid pumping at times of peak energy cost
- End user- Improving efficiency (especially hot water systems) including onsite supply, treatment and reuse where appropriate

Source: Climate Protection Campaign 2008; EPA 2013

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Some examples of mitigation in the water sector

- Wastewater treatment- Improving plant efficiency, generate more biogas etc.
- Energy- purchase electricity with lower GHG content (wind, solar, biogas); improving energy efficiency throughout water distribution pumping and wastewater treatment systems by replacing older less efficient motors before burnout whenever cost effective rather than waiting for scheduled maintenance; implement cogeneration and other onsite renewable power options (solar panels, wind turbines, low-head hydro)
- GHG offsets- invest in GHG reductions elsewhere in the local economy
- Overheads- reduce GHG in buildings, vehicles, employee commute etc.

Source: Climate Protection Campaign 2008; EPA 2013

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The Caribbean sector needs to mitigate, adapt and be resilient

- This training focuses less on mitigation and more on adaptation (Module 4)
- Climate resilience through an IWRM approach is the focus of Module 5

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Adaptation

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Adaptation is nothing new

- Both organisms and ecosystems, including the human species, have adapted to changes and variability in climate.
- In the water sector we are already adapting e.g. water rationing
- Adaptation- for the Caribbean water sector- doing more of what we are already doing to cope with competing demands, expanding populations etc. Climate change/Climate variability is just an additional factor and brings a greater urgency

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The basic premise . . .

Climate change is a global phenomenon, but the problems will be very local and we will have to adapt and plan locally.

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What does the Caribbean water sector need adapt to?

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

References: Cashman et al (2010), Trotman (2012) (CapNet 2015)

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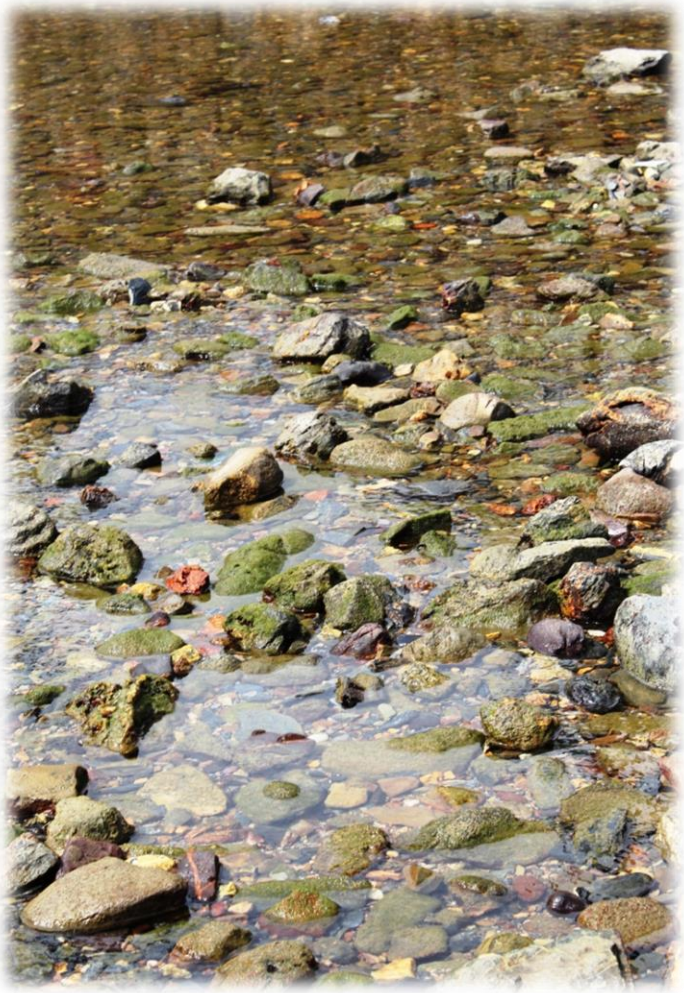
What does the Caribbean water sector need to adapt to?

- Increased surface runoff
- Salt water intrusion into aquifers
- Droughts
- Floods
- Changes in
  - Water availability
  - Water quality
  - Water use
  - Fresh water ecosystem functioning



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Adaptation

What are we adapting to?	What do we need to put in place?	How do we get there?
Increased surface runoff, Floods	Integrated Flood Management Climate resilient agricultural water systems	➢ Intensification of processes/systems ➢ Changes in processes/systems ➢ New processes and systems ➢ Modification to existing infrastructure ➢ New infrastructure ➢ New technologies ➢ Revisiting and improving old technologies ➢ Use of natural systems/green infrastructure ➢ Use/Improve/Better disseminate existing data and models
Salt water intrusion into aquifers	Efficient water consumption	
Droughts	Drought resilient water supplies, Climate resilience agricultural water systems	
Changes in water availability	Efficient water consumption, Water Augmentation	
Water quality	Resilient and healthy water resource systems	
Water use	Efficient water consumption Climate resilient agricultural water systems	
Freshwater ecosystems functioning	Resilient and healthy water resource systems	
Heavy rainfall/intense hurricanes	Climate resilient water infrastructure	
Variability in rainfall patterns	Real time weather forecasting and early warning systems	

Efficient water consumption

- Demand management at the household, utility, business and farm level through technological processes;
- behavioural change is required to support the overall efficiency of water management and use across the region.

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For efficient water consumption we need to consider:

- Household demand management
- Water user efficiency for large scale water consumers
- Leakage and Unaccounted for water (Non-Revenue) Water reduction in water utilities

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Efficient water consumption: Household water demand

- Rationing
- Incentives for efficient water fixtures
- Low water use technology
- Rates and Tariffs

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Waterless toilets in Jamaica

In 2011, several of these toilets were installed in various locations of St. Catherine, Jamaica

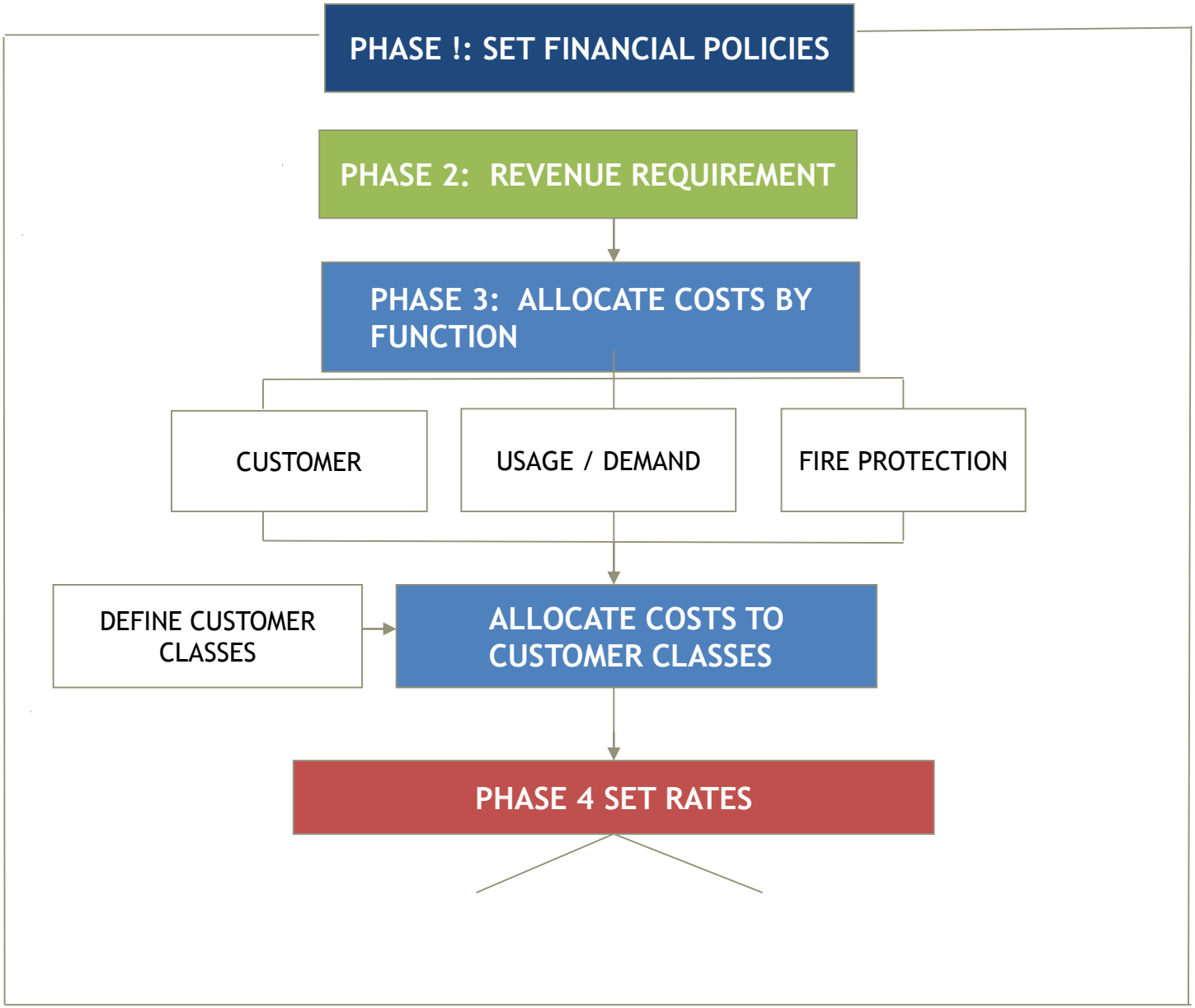
The toilets work by separating liquid and solid waste as it enters the bowl.

Both are exposed to a continuous flow of air that dehydrates the solid waste and causes the liquid to evaporate quickly.

A wind-driven extractor directs odour into the atmosphere

http://www.ticotimes.net/2013/12/19/central-america-is-prime-target-for-massive-florida-based-christian-charity

Lets talk a little more about Rates and Tariffs


PHASE !: SET FINANCIAL POLICIES
PHASE 2: REVENUE REQUIREMENT
PHASE 3: ALLOCATE COSTS BY FUNCTION
CUSTOMER
USAGE / DEMAND
FIRE PROTECTION
DEFINE CUSTOMER CLASSES
ALLOCATE COSTS TO CUSTOMER CLASSES
PHASE 4 SET RATES

Efficient water consumption: Leakage and Non Revenue water

- Modification/ upgrade of existing infrastructure

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Efficient water consumption: Large Scale Water Consumers

- Tourism sector
  - Water loss reduction devices
  - Low volume water use fixtures
  - Conservation practices

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Water Augmentation

- Ground water
  - Access ground water supplies
  - Modelling and assessment needed in many countries
- Springs/Wells
  - Water quality issues?
  - Supply
- Desalination
  - Energy intensive
  - Brine
- Waste re-use
- Rainwater Harvesting
  - Low cost but requires maintenance

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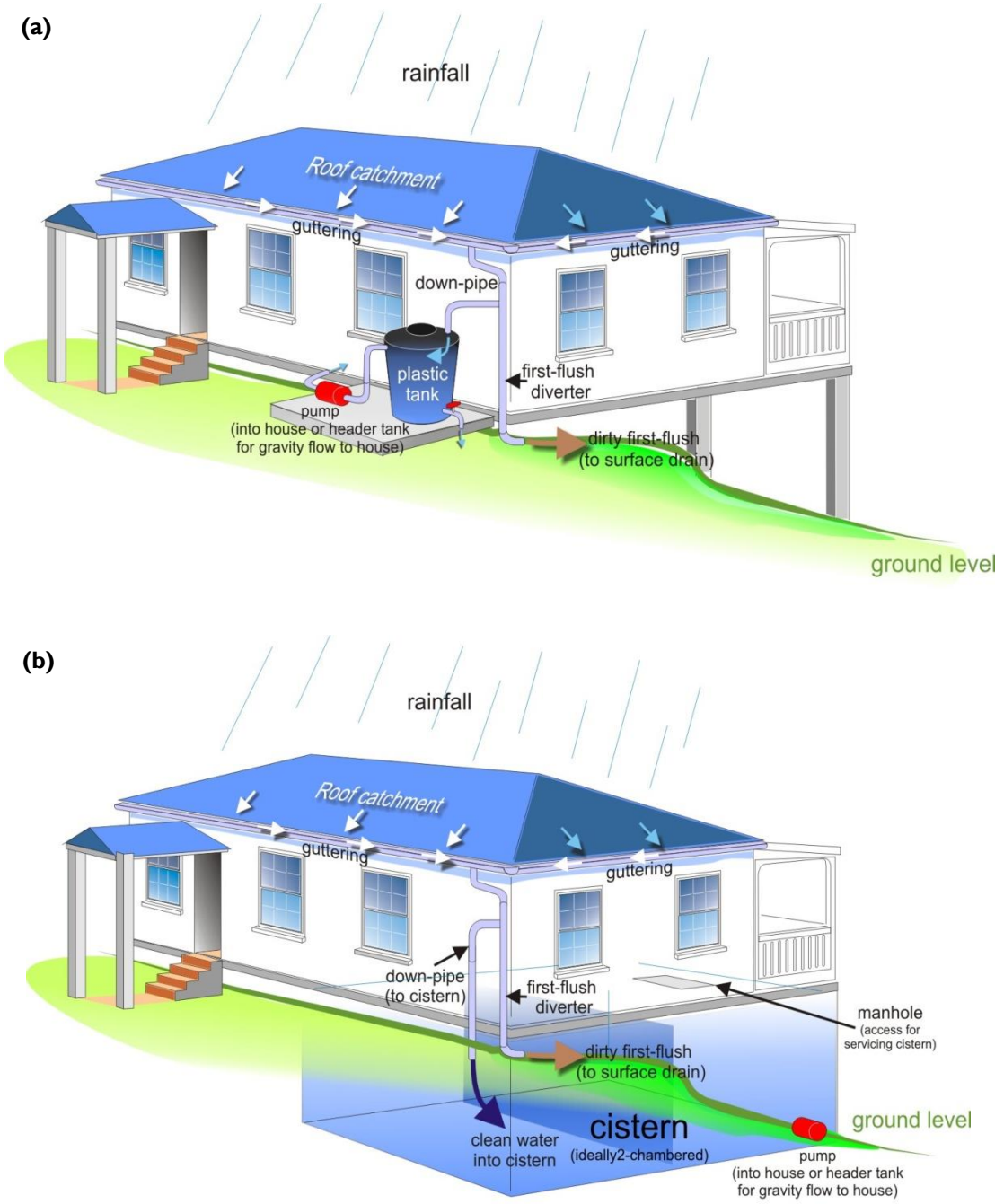
Water Augmentation via Domestic Rainwater harvesting (RWH)

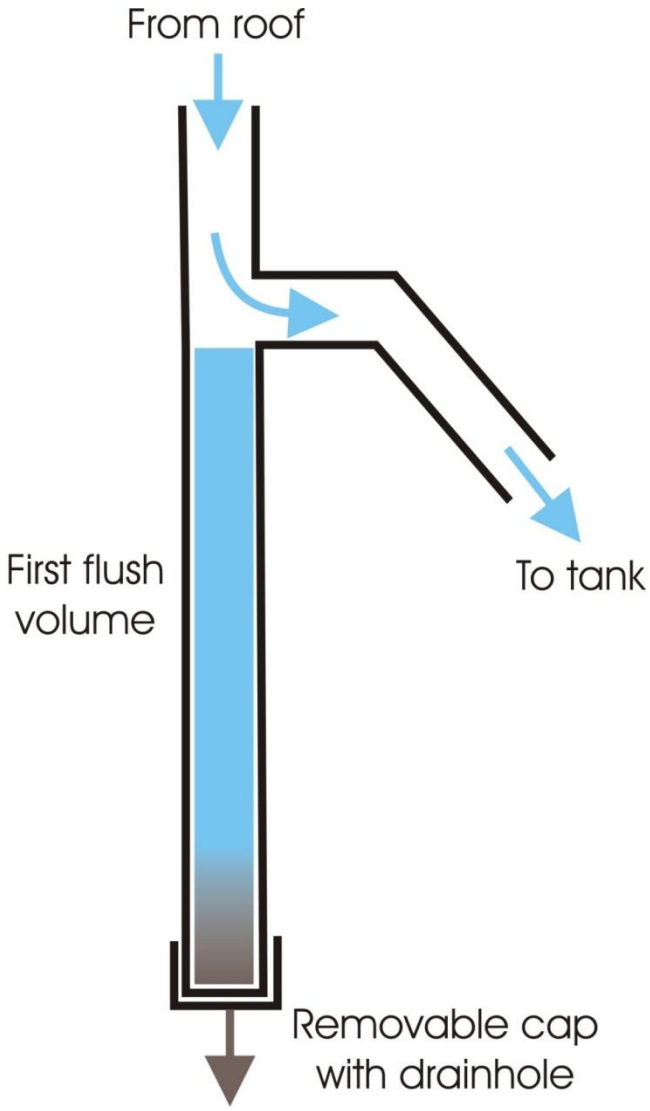


Source CEHI 2009

Safe RWH

If harvesting water to drink consider the following to ensure the safety of your water supply for consumption

- Maintenance/cleaning of gutters and tanks
- First flush systems
- Chlorination
- UV disinfection
- Filters



First flush Diverter

Safe RWH

Source of Picture above
CEHI 2009

Prevention of mosquito breeding

- •Chikungunya
- •Dengue

Use:

- Meshing/netting screens across openings
- Tanks are sealed

Drought resilient water supplies

- Include water efficiency and water augmentation measures already outlined
- Review/development of Drought Management Plans
- Drought modelling

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Integrated Flood Management (IFM)

- The Caribbean still focuses on “flood control” instead of the more realistic and modern integrated flood management (IFM).

- IFM “integrates land and water resources development in a river basin, within the context of Integrated Water Resources Management (IWRM), with a view to maximizing the efficient use of floodplains and to minimizing loss of life and property”.

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Integrated Flood Management (IFM)

IFM entails:

- Adopting a basin/watershed approach and Integrating land and water and coastal management
- Protecting ecosystems
- Flood management plans
- Promoting “living with floods” e.g. flood proofing homes and critical infrastructure
- Reducing and managing risk, uncertainty and vulnerability e.g. through flood forecasting/warning systems
- Adopting a best mix of strategies including structural and non structural solutions: Using retention ponds, permeable areas, infiltration trenches, porous pavements, green roofs, and natural systems

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Climate Resilient Agricultural Water Systems

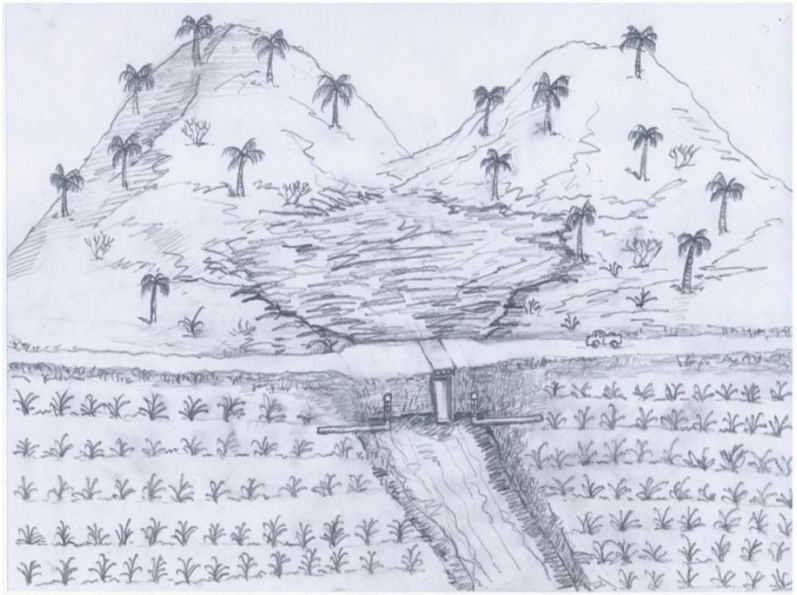
- Separate adaptation topic because of the critical need for food security
- Global population increase 2b in next 35-50 years
- What is the prediction for Curacao

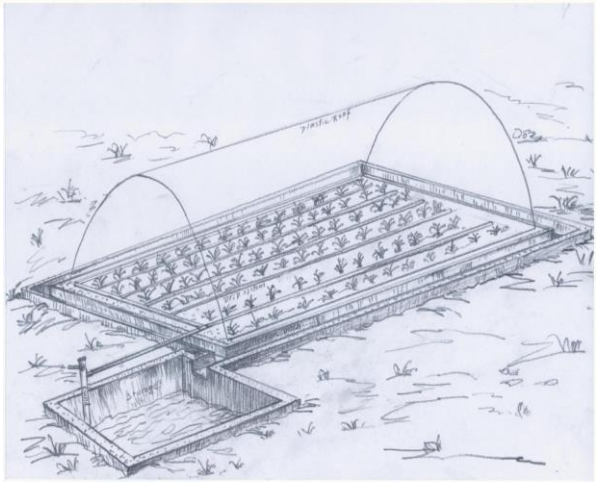
Climate Resilient Agricultural Water Systems

- Water efficiency
  - Crop water modelling
  - Water conservation oriented irrigation systems
- Best Agricultural practices
  - E.g. mulching

Climate Resilient Agricultural Water Systems

- Water Augmentation
  - Rain-fed Ground water Recharge
  - Rain-fed Mini dams
  - Rainwater Harvesting off Sheds
  - Rainwater Harvesting off Greenhouses





Diagrams
FAO 2008

Adaptation to drought impacts on Caribbean Agriculture

- The severe to extreme 2009-2010 drought that was experienced throughout most the Caribbean impacted harshly on the region's farming community, particularly since the majority of the countries relies on rain-fed agriculture (Farrell et al 2011). Banana production in Dominica was approximately 43 percent lower in 2010 than 2009; St. Vincent and the Grenadines experienced a 20 percent overall reduction in agricultural production (Farrell et al. 2011).

- In an attempt to cope with droughts, some farmers in Jamaica have turned to more short-term crops as an adaptation option. This action has resulted in an overall reduction of crop production and of seasonal earnings (Gamble et al., 2010).

Climate resilient infrastructure

- Protecting infrastructure e.g. reservoirs, pipes, water treatment plants from flooding, landslides caused by hurricanes, high sediment loads in water
- Higher flood levees

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Resilient and Healthy Water Resource Systems

- Management of water sources/Source water protection to maintain volume and quality of water available for consumption and ecosystem functioning
  - Watershed management
  - Integrated land water and coastal areas management
  - Wastewater management
  - Water Safety Planning

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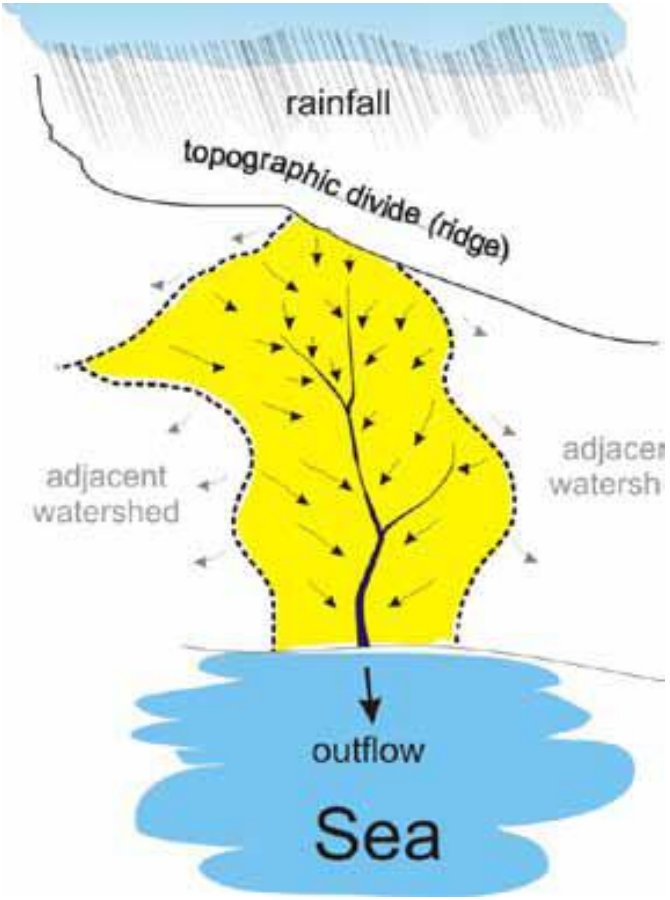
IWRM: Watershed Management/River Basin Planning



Integrated Watershed and Coastal Areas Management

Small Island Developing States of the Caribbean (SIDS)

- Small, narrow, steep watersheds
- Encourages surface runoff
- Short distance to the coastal areas
- Watershed activities impact on coastal resources
  - Heavy dependence on coastal resources
  - Tourism, Fishing
  - Land based sources of marine pollution

Integrated Watershed and Coastal Areas Management

In tandem management of freshwater and coastal resources

- Land based sources of Marine Pollution -
  - •Sewage, Solid waste, Sediment
  - •Nitrates, Phosphates
  - •Oils/Grease

- Caribbean- Cartagena Convention –
  Protocol concerning land based sources of Marine Pollution (LBS)
  http://www.cep.unep.org/cartagena-convention/lbs-protocol
  - Regional Activity Centre in Trinidad- Institute of Marine Affairs
  - Some National water policies speak to the LBS protocol

- Internationally GPA http://www.gpa.unep.org/

For managing freshwater quality and quantity and Coastal water quality- where do you focus your attention within a watershed?

Ideally- holistic management- entire watershed:

- Develop a watershed plan
- Stakeholder consultation
- Ecosystem concerns
- Future needs

Not so ideal world: Focus on Steep Slopes, Hotspots and Riparian zones

Critical areas in a Watershed: Steep slopes

- Need to maintain vegetation, reduce surface runoff
- Slopes less than 5 degrees (without conservation measures) is intensive agriculture
- 20 - 30 degrees should be reserved for agro-forestry
- >30 degrees should remain under forest.

Soil conservation techniques

Image Source http://derek.broox.com/photos/our-honeymoon/2723/

What happens where there is limited land space, or no enforcement of zoning regulations

[where they do exist]

Critical areas in a Watershed: Hotspots

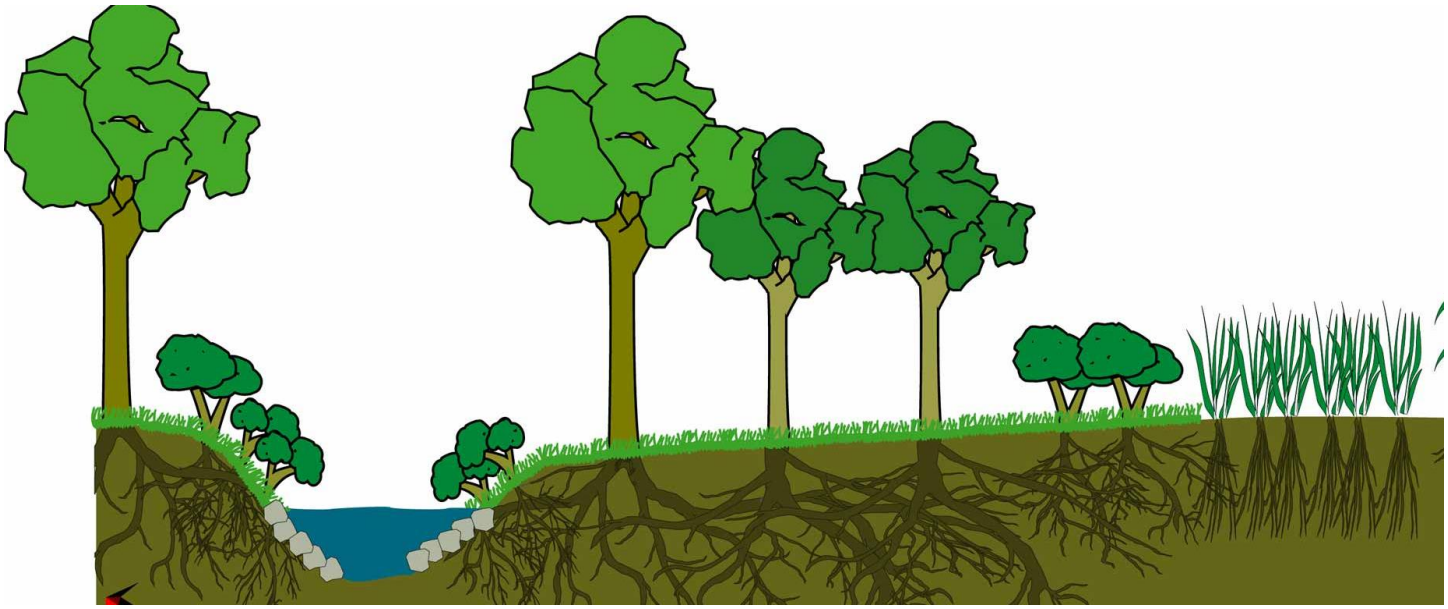
Hot-Spot is a specific location within a watershed or coastal area associated with discharge of pollutants

High priority pollutant sources

Critical areas in a Watershed: Riverbanks/Riparian zones

Riparian zones: Introduction

- Transitional areas between terrestrial and freshwater systems
- Riverbanks and shores of ponds and lakes.
- Along riverbanks riparian zones extend from the water's edge to the areas landward that either experience flooding or have elevated soil water levels.



Riparian Zones: Ecological Importance

- High plant productivity
- High nutrient, temperature and moisture levels
- High plant and animal biodiversity
- Habitats and corridors for wildlife

Riparian Zones: Anthropogenic benefits

Riparian plants

- trap sediment and pollutants and take up nutrients from surface and groundwater filtering into the stream.

Riparian plant buffers are often created or maintained for water quality protection especially at and upstream of sites used for recreation and water abstraction

Forecasting and early warning systems

- Linking water authority operational practices with real time weather hazard forecasting and warning systems such as those developed by CIMH (building on CIMH flood forecasting work)
- Flood early warning systems

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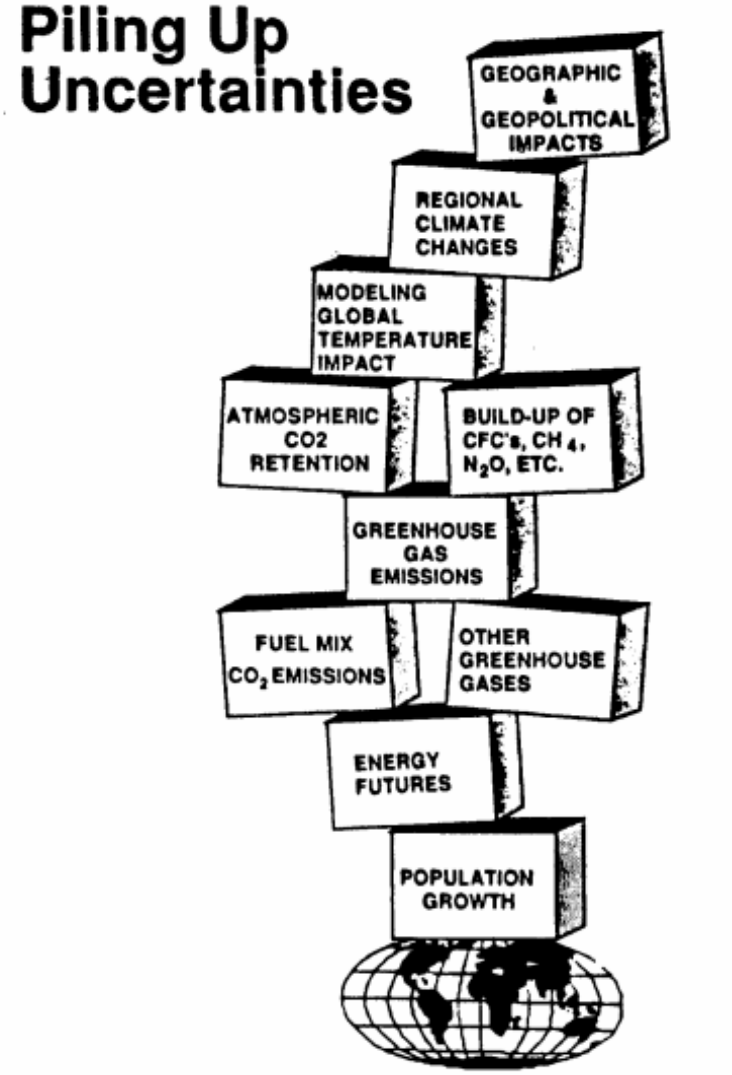
Emergency Response Plans

- Dealing with water crises
  - Flood
  - Drought
  - Wastewater spills
  - Chlorine leaks

What else?

Plan- Prepare - Practice

Adaptation has to take into account uncertainty



Weather forecasting and climate models improving but still some uncertainty

- e.g. rainfall magnitude, timing, spatial distribution

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Uncertainty and Risk

1. When will the rain fall?
2. Will I get rain next week?
3. How long is this drought going to last?
4. Should I plant this tree now?
5. If I build another dam- will I be wasting money?
6. How many hurricanes will we have this year?

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Risks sharing and spreading

- **Insurance**
  - Primary insurers
  - Re-insurance
  - Micro-insurance
- **Finance**
  - Development banks
  - Private/micro-lenders
  - Solidarity funds
- **Community solidarity**
- **Livelihood diversification.**

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Caribbean Catastrophe Risk Insurance Facility

With regards to financial mechanisms available for relief and development after natural disasters, the Caribbean Catastrophe Risk Insurance Facility (CCRIF) can provide immediate financial liquidity to Caribbean governments for post-disaster relief and recovery needs (World Bank, 2007).

The 2004 hurricane season (in particular hurricanes Charley, Frances, Ivan, and Jeanne) prompted the collaborative efforts of CARICOM Heads of Government, the World Bank, key donor partners, and other regional governments (World Bank, 2007) to form CCRIF in 2007 as the first multi-country risk pool in the world (CCRIF, 2014). CCRIF helps to relieve the short-term financial difficulties usually encountered by small developing economies in the aftermath of a natural disaster (CCRIF, 2014). \

Currently, 16 governments are members of CCRIF: Anguilla, Antigua and Barbuda, the Bahamas, Barbados, Belize, Bermuda, the Cayman Islands, Dominica, Grenada, Haiti, Jamaica, St. Kitts and Nevis, Saint Lucia, St. Vincent and the Grenadines, Trinidad and Tobago, and Turks and Caicos (CCRIF, 2014). Since the establishment of CCRIF in 2007, there have been eight pay-outs to seven member governments totalling some USD$32M

Adaptation caveats

- Pluses and minuses to adaptation measures
- Need to assess what works best for your situation and manage the challenges in each adaptation measure
- Need to combine adaptation measures, be flexible

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So some of the adaptation measures we have looked at are

Integrated Flood Management	Flood management plans	Encouraging infiltration	Watershed management
Water Efficiency	Household Water Demand: Rationing Incentives, Rates and Tariffs	Large scale consumers: conservation practices, low water usage devices	Leakage and unaccounted for water: upgrades to infrastructure
Water Augmentation	Groundwater	Wastewater reuse	Rainwater harvesting
Drought Management	Drought plans	Drought modelling	Water Augmentation
Climate Resilient Agricultural Water Systems	Crop modelling	Water use efficiency	Water Augmentation e.g. RWH
Climate Resilient Infrastructure	Reservoirs	Levees	Sewerage systems
Forecasting/ Early Warning	Tighter coupling of operational practices with forecasting		Early warning systems
Healthy and Resilient Systems	Watershed management	Wastewater management	Water Safety Planning

Thank you!

E-mail: info@gwp-caribbean.org
Website: www.gwp-caribbean.org

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