

Proceedings  
**National Symposium**  
on  
**Integrated Water Resources Management  
and Rainwater Harvesting**  
Antigua and Barbuda



**City View Hotel  
St. John's, ANTIGUA**

**30<sup>th</sup> and 31<sup>st</sup> January 2008**

A collaborative effort between the  
**Caribbean Environmental Health Institute (CEHI), the Antigua Public Utilities  
Authority (APUA), The Global Environment Facility-funded Integrating Watershed  
and Coastal Areas Management (GEF-IWCAM) Project and the United Nations  
Environment Programme (UNEP)**



## List of Acronyms

ABMS	Antigua and Barbuda Meteorological Services
APUA	Antigua Public Utilities Authority
CBH	Central Board of Health
CEHI	Caribbean Environmental Health Institute
GEF	Global Environment Facility
IWCAM	Integrating Watershed and Coastal Areas Management project
IWRM	Integrated Water Resources Management
RWH	Rainwater Harvesting
UNEP	United Nations Environment Programme
WHO	World Health Organization

# Preamble

This Symposium on Integrated Water Resources Management held over the 30<sup>th</sup> and 31<sup>st</sup> January 2008 was designed to raise awareness of the critical issues associated with water resource management in Antigua and Barbuda. The symposium familiarized participants with the principles of Integrated Water Resources Management (IWRM) with special focus on the importance of Rainwater Harvesting (RWH) in the context of augmenting water security against the backdrop of the anticipated negative consequences of climate change. Rainwater harvesting is regarded an important water augmentation strategy particularly in water-scarce countries and is well-placed within strategic water resources management planning considerations.

Under an IWRM platform the symposium brought together two project initiatives that are being implemented by the Caribbean Environmental Health Institute. They are the Global Environment Facility-funded Integrating Watershed and Coastal Areas Management (GEF-IWCAM) Project, and the Promotion of Rainwater Harvesting in Caribbean States Project. The GEF-IWCAM project, though an IWRM sub-project component, is providing support to participating Caribbean countries in the development of IWRM Plans, while the RWH Project is contributing to the development of demonstration models in Antigua and Barbuda on best practices in RWH.

The GEF-IWCAM Project is being co-implemented by the United Nations Environment Programme (UNEP) and the United Nations Development Programme (UNDP), and is being co-executed by the UNEP's Caribbean Regional Coordinating Unit (CAR-RCU) and the Caribbean Environmental Health Institute (CEHI). The RWH Project is a direct collaboration between UNEP Nairobi and CEHI.

For more information on the GEF-IWCAM Project please see the project website at [www.iwcam.org](http://www.iwcam.org). Information on the RWH collaboration between CEHI and UNEP is posted at the CEHI website at <http://cehi.org.lc/rainwaterharvest.htm>.

The local collaborators in the hosting of the symposium were the Antigua Public Utilities Authority (APUA as lead) and the Antigua Environment Division.

## Symposium Objectives

The major objectives of this Symposium were to:

- ❖ Raise awareness on the importance of planning for integrated water resources management within national development considerations;
- ❖ Familiarize participants with the requisite steps in the IWRM planning process and the nature of stakeholder engagement;
- ❖ Determine the next steps toward formulation of an IWRM Policy and Plan;

- ❖ Raise awareness of the importance of investment in RWH particularly in the context of potential increased water scarcity associated with the impacts of climate change, and how RWH fits within an IWRM planning context;
- ❖ Familiarize participants with the planned RWH demonstration initiative for Antigua and Barbuda.

## Participation

Participants were drawn from a wide range of interest groups across Antigua representing both public and private sectors. Technical resource persons came from the Caribbean Environmental Health Institute, the Antigua Public Utilities Authority, the Antigua and Barbuda Meteorological Services, the Central Board of Health, the Antigua and Barbuda Environment Division and the private sector.

The Workshop Agenda and List of Participants are contained in **Annexes 1 and 2**.

## Background

The following provides some background to the concept of IWRM Planning and RWH promotion and the efforts to date under the project interventions.

### Integrated Water Resources Management Planning

In 2002 the World Summit on Sustainable Development (WSSD) was held in Johannesburg, South Africa. Over 8,000 civil society participants representing NGOs, women, indigenous people, youth, farmers, trade unions, business leaders, the scientific and technological community and local authorities attended the Summit, to reaffirm the commitments made at the Rio Summit in 1992 and chart out a path for the future. Article 26 of the resultant Johannesburg Plan of Implementation (JPOI)<sup>1</sup> calls for all countries to: “*Develop integrated water resources management and water efficiency plans by 2005, with support to developing countries.*” This was deemed of utmost importance as an instrument to mainstream water in national economy and development and achieving the Millennium Development Goals (MDG’s) by 2015 specifically aimed at addressing the issues of poverty, hunger, health and environment. Those MDGs related to Water and Sanitation were:

- ❖ Halve, by the year 2015, the proportion of people without access to safe drinking water (reaffirmation of Millennium Development Goal).
- ❖ Halve, by the year 2015, the proportion of people who do not have access to basic sanitation.
- ❖ Develop integrated water resources management and water efficiency plans by 2005.

In the Caribbean region there has been steady progress towards the targets contained in bullets 1 and 2. However, no Caribbean states have developed the IWRM and water efficiency plans.

An Integrated Water Resource Management (IWRM) Plan is the guiding framework for sustainable management and development of water resources. The development process for such a plan requires consultation with all users of the water resource to ensure that their requirements are adequately met within the quantities of water that are naturally available, or within the capacity to generate in the case of desalination from the sea. The IWRM Plan also seeks to ensure that the water requirements to maintain health ecosystems (such as forests, mangroves, coral reefs) are also met. The IWRM Plan lays out how the

stakeholders in the country will coordinate management of its water resources to sustainably meet the water needs of society, the economy and the natural ecosystems in an equitable manner. The IWRM plan is a *national-level* plan.

To summarize, an IWRM Plan aims to:

- ❖ heighten awareness and understanding of the value and benefits of integrated water resources management;
- ❖ identify and implement actions to address specific causes of negative impacts and threats on human health and the environment;
- ❖ mobilize resources and partners, including the private sector, for implementation of specific projects to address the negative impacts and threats on human health and the environment.

The GEF-IWCAM Project is supporting CEHI in working with Caribbean countries in the formulation of national **IWRM Roadmaps**. IWRM Roadmaps are guidance documents that outline the specific steps that are required in the development of national IWRM Plans. The Roadmap will assist national stakeholders in the IWRM Plan development process in identifying and completing the required tasks that will be necessary in development of the Plan. These roadmaps are being formulated based on an Operational Guide prepared by the Global Water Partnership (GWP). The Operational Guide was derived from global country experiences and assembled by water resources experts and planners with extensive field experience. The regional and international partners involved in Caribbean efforts include the Global Water Partnership-Caribbean (GWP-C), the National Oceanic and Atmospheric Administration (NOAA) and the United Nations Environment Programme Collaborating Center on Water and Environment (UNEP-UCC).

## **Promotion of Rainwater Harvesting in the Caribbean**

The Caribbean Environmental Health Institute, with support from the United Nations Environment Programme (UNEP) is implementing a demonstration initiative in Antigua and Barbuda to promote the practice of Rainwater Harvesting (RWH) in the Caribbean. This support is follow-up to a first phase of a UNEP-assisted effort to raise the profile of the practice of RWH in the region. During that first phase Grenada was used as a pilot to develop a National Programme to promote RWH. The lessons learned and strategic directions that emerged from the national pilot were used to develop a Regional RWH Programme for the Caribbean. The project also funded the production of public awareness material that included posters, radio public service announcements, a feature-length video and a technical brochure.

In the second phase, the emphasis will be on the development of demonstration models that will showcase best practices in rainwater harvesting to the Caribbean. Antigua and Barbuda was selected as the candidate country given the fact that the practice is well established in the majority of households and business enterprises. Two candidate models will be selected; a typical household, and a small business enterprise (likely an agricultural enterprise). The project will finance required upgrade and/or retro-fitting of the existing RWH systems to bring them to recommended standard so that they represent best practice and serve as training resources for householders, contractors, business operators in Antigua and Barbuda, and the rest of the Caribbean. The project will support the hosting of a symposium, training activities, the development of a handbook on implementing RWH practices in Caribbean States including capacity-building for mapping RWH harvesting potentials across landscapes.

## **About CEHI**

The Caribbean Environmental Health Institute (CEHI), an agency under CARICOM, was established in 1989 with the broad mandate to provide technical assistance on matters of environmental management to Member States. The Institute is headquartered in St. Lucia. For more information on the Institute please visit [www.cehi.org.lc](http://www.cehi.org.lc).

# Day 1 Proceedings

## Opening Ceremony

The first day of the National Symposium commenced with an Opening Ceremony hosted under the auspices of the Prime Minister of Antigua and Barbuda, the Honourable Baldwin Spencer. Also present were the Minister of Health, the Hon. John Maginley, the Executive Director of CEHI Patricia Aquing and the Regional Project Coordinator of the Global Environment Facility-funded Integrating Watershed and Coastal Areas Management (GEF-IWCAM) Project, Vincent Sweeney. The Ceremony was chaired by Ivan Rodrigues, Operations and Maintenance Engineer of the Antigua Public.



*Head Table at Opening Ceremony (L to R): Vincent Sweeney, Regional Project Coordinator IWCAM; Hon Baldwin Spencer, Prime Minister of Antigua and Barbuda; Patricia Aquing, Executive Director, CEHI; Hon John Maginley, Minister of Health, Antigua and Barbuda; Ivan Rodrigues, Operations and Maintenance Engineer, APUA.*

Patricia Aquing, Executive Director of CEHI welcomed the Head Table and other participants to the symposium. She explained the mandate of CEHI and the value of the contribution of Antigua and Barbuda stakeholders to the work of the Institute. CEHI is committed to improved environmental management towards the social and economic well-being of the country. CEHI noted the interest of the Minister of Health in making environmental improvements in the McKinnon's area in particular and that there would be attention paid to it under upcoming demonstration project activities, being funded by the Global Environment Facility as part of the GEF-IWCAM Project. She also stated that CEHI would be seeking to mobilize additional technical resources to conduct relevant assessments in the McKinnon's and Runaway Bay coastal areas, in support of environmental and economic development in this area.

Mrs. Aquing also noted the role of Rainwater Harvesting (RWH) plays in IWRM and underscored the fact that enhancing water security requires a multi-sectoral, multi-disciplinary approach. Given that Antigua and Barbuda has long experience with various water augmentation strategies, it was appropriate that the country be chosen as the pilot for an important rainwater harvesting demonstration initiative. CEHI will be selecting a household and a small business enterprise to help with improvements in order to demonstrate best practice with the intention of replication

throughout the region. She ended her welcome address by thanking the Government, especially the APUA, the Ministry of Health, colleagues from the Environment Division, the private sector and all stakeholders represented.

Vincent Sweeney, the Regional Project Coordinator of the GEF-IWCAM Project, focused on the United Nations' concern over the looming crisis associated with water shortages and stated that it will be placed at the top of the global agenda this year and that urgent actions need to be taken to prevent conflicts over the scarce resource. The UN Secretary General reminded business and political leaders at the World Economic Forum that the conflict in the Darfur region of Sudan was touched off by drought — noting that shortages of water contribute to poverty and social hardship in many countries, including the Caribbean (notably Haiti). He welcomed the focus on water this year saying the (World Economic Forum) session should be named: "Water is running out." Mr. Sweeney noted that the U.N. Secretary General stated he will invite world leaders to "a critical high-level meeting" in September of 2008 to focus on meeting UN development goals, including cutting by half the number of people without access to safe drinking water by 2015. In this regard the symposium is timely as the Caribbean seeks to get a headstart on this important issue of IWRM planning.

The Honourable Minister of Health, John Maginley welcomed all participants. He also lauded the involvement of CEHI along with its partners in efforts to improve water management across the region, including Antigua and Barbuda. He noted that while the Ministry of Health is very concerned over the safety of water, this cannot be divorced from conservation of the resource clearly illustrating the need for a multi-sectoral, integrated approach to the management of water. He stated that water and sanitation are closely linked to health and that this symposium was indeed timely as 2008 has been designated the **Year of Sanitation** by the United Nations General Assembly.

The Honourable Baldwin Spencer, Prime Minister of Antigua and Barbuda delivered the Feature Address. He noted that Integrated Water Resources Management (IWRM) is "an essential approach that needs to be adopted by our water-stressed country in order to sustain our enviable development". He noted that Antigua and Barbuda look forward to advancing the development of IWRM Plans underscoring the recognition that the principles of IWRM are important and relevant to national development. He highlighted the need for greater involvement of all stakeholders, both in the planning for and conservation of water resources. He noted that civil society participation is essential in grappling with these important



*The Honourable Baldwin Spencer, Prime Minister of Antigua and Barbuda delivering the Feature Address.*

water management issues and that citizens must no longer believe that water management is the sole responsibility of the state and that management of water is everyone's responsibility.

Prime Minister Spencer, in applauding the organisers of the symposium, looked forward to ongoing dialogue and collaboration in order to advance the process of improving water resources management in Antigua and Barbuda. He was optimistic that progress would be made and expressed appreciation for the support being received by Antigua and Barbuda, along with the rest of the Caribbean, from the Global Environment Facility (GEF) and specifically the project on Integrating Watershed & Coastal Area Management (IWCAM). In this regard he thanked UNEP, the Caribbean Environmental Health Institute and others for their efforts.

## **Presentations**

### **Presentation: IWRM Principles**

**Presenter: *Christopher Cox, Caribbean Environmental Health Institute***

The first presentation was made by Dr. Christopher Cox, Programme Director (Acting) of CEHI. Dr. Cox presented the principles of IWRM. He described an IWRM Plan as a strategic statement that details a country's actions toward to sustainable management of its water resources. He provided background on the global effort at committing to the sustainable management of water resources, noting that it was rooted initially in the 1992 International Conference of Water and Environment and was subsequently elucidated at the Johannesburg Summit on Sustainable Development that took place a decade later. Out of this summit, countries committed to the development of IWRM and water Use Efficiency Plans by the year 2005. Furthermore, IWRM planning needs to be firmly rooted in the country's commitments to meeting the Millennium Development Goals. He also provided insights as to how an IWRM fits within existing policy frameworks that guide national development agendas.

Dr. Cox then provided suggestions on what an IWRM Plan will typically address in terms of content and emphasized that IWRM Planning does not stop with the formulation of the final plan. The process is cyclical that broadly starts with process initiation, following through to policy-setting to strategy selection, implementation and evaluation to determine whether the planning and implementation process meets the stated intentions. The concept of IWRM Roadmapping was introduced. This is definition of the various steps that countries will generally need to undertake in the formulation of their IWRM Plans.

The full presentation is contained in **Annex 4.1**.

## Discussion

Participants expressed interest in determining the next steps following IWRM roadmapping in the planning process. Dr. Cox noted that this would be the actual development of the IWRM Plan. This plan would address the entire range of water resources development needs including infrastructural development whether in rainwater harvesting systems or desalination plants. He noted that financial support is very important in developing institutional capacities to develop and implement an IWRM Plan. He further explained that an IWRM Plan considers all areas of water resources management including conservation and environmental aspects. The APUA noted that an IWRM plan would assist in the formulation for water supply planning not only for potable water but also for non-potable purposes notably farming. The IWRM Plan could also cause focus on delivery of such services to the rapidly expanding tourism sector.

## **Water resource management issues in Antigua and Barbuda**

**Presenter: John Bradshaw, Antigua Public Utilities Authority Water Division**

This presentation was made by John Bradshaw, Water Manager of the APUA. Mr. Bradshaw informed participants that Antigua's water supply is being drawn from a variety of sources including surface and ground sources and from the sea (desalination). He noted some of the major water issues facing the country include:

- ❖ No National Water Policy to guide developments in the water industry;
- ❖ The water demand currently exceeds the water supply by 1MGPD and there is a need for excess water production during the dry season;
- ❖ Age of the infrastructure network and associated problems of encrustment within pipes, leakages and high-unaccounted for water due to corrosion;
- ❖ Inadequate storage to keep pace with demands;
- ❖ Inadequate operation system given the decentralization of various sources that feed into the distribution and transmission system;
- ❖ Faulty water meters that give rise to erroneous and inconsistent meter readings that impacts billing;
- ❖ Inadequate water rate given the type of water that APUA distributes;
- ❖ Threatened watersheds and water resources due to intensive and in some cases unregulated land use.



*Cross-section of participants at the symposium.*

Some of the recommendations for water resources management in Antigua and Barbuda include:

- ❖ Development of adequate water policies supported by appropriate legislation;
- ❖ Development of an Integrated Water Resources Management Agency;
- ❖ Incremental annual expansion for source and supply development to meet needs;
- ❖ Replacement of pipeline system;
- ❖ Ensure improved financial viability of APUA's Water Division.

The full presentation is contained in **Annex 4.2**.

## Discussion

There was concern over the extent and intensity of land development and the degree to which surface and ground water supplies are being affected by household runoff and sewage contamination. Mr. Bradshaw noted that buffer zones and water protection areas need to be established in conjunction with the Development Control Authority. This will help curb encroachment of housing in water gathering grounds and vulnerable aquifers where well heads and other abstraction points are situated. The introduction of a centralised sewerage system will also assist in addressing encroachment issues as well as improving water quality. He noted that all major stakeholders need to become involved to ensure that Antigua's aquifers are not polluted.

Development of a national water policy is of high priority and the APUA is seeking assistance to develop one. A policy should address water allocation issues such as the use of water from the southern part of the island to augment the drier areas of the north. The APUA has been experiencing serious financial constraints since the 1980s and as a result the Authority has not been able to increase its storage capacity to meet rising demands. The Government of Venezuela is presently negotiating with the Government of Antigua and Barbuda in provision of assistance in this area.

## **Antigua and Barbuda GEF-IWCAM Demonstration Project update**

**Presenter: *Melesha Banham, Environment Division***

Melesha Banham, Senior Environmental Technician of the Environment Division delivered an update of activities at the GEF-IWCAM demonstration project. Ms. Banham explained that the McKinnons Pond area was selected due to a variety of reasons that included:

- ❖ direct discharge of untreated effluent into the open drainage system that empties into the Pond;

- ❖ septic tanks not pumped frequently enough and of inadequate capacity, thereby increasing pollution risk;
- ❖ contamination by septic tank waste that is being disposed of at the municipal landfill;
- ❖ rising number of houses in the area with increasing number of septic tank systems.

The demonstration project components are:

- ❖ Development and implementation of a public awareness campaign;
- ❖ Development of a sewage management strategy to identify the most appropriate means of handling sewage discharge within the demonstration area;
- ❖ Identification and design of sewage treatment option (including options related to a Wetland Filtration System) that will meet the environmental and economic needs of St. John's and the rest of the country;
- ❖ Development of a medium-sized project proposal for the construction of a wetland filtration system for submission to the GEF;
- ❖ Implementation of a programme of collection of environmental indicators;
- ❖ Development of a full proposal with technical, financial and institutional arrangements for the management of wastewater in St. John's for submission to The Cabinet for approval;
- ❖ Conduct a review of legislation as it applies to sewage handling, treatment and discharge and to protection of groundwater and coastal waters;
- ❖ Development of recommendations for policy reforms and supportive legislation and regulations in support of a new sewage treatment options;
- ❖ Identification of funding mechanisms to recover costs of monitoring (compliance and water quality data) and enforcement.

The full presentation is contained in **Annex 4.3**.

## Discussion

Ms. Banham explained that effluent from the many households in the area is directed to the McKinnons Pond. The Environment Division is currently examining data in order to make a determination as to what would be the best treatment system for the pond. This included consideration of a wetland filtration system option. The area around the pond is quite swampy and there are drainage problems. A number of households also have soakaway systems despite the high water table in the area.

## Roadmapping towards IWRM

**Presenter:** *Christopher Cox, Caribbean Environmental Health Institute*

The final presentation of the day was done by Christopher Cox of CEHI. He explained that an IWRM Roadmap is a description of the steps required in the development of a national integrated water resources management plan. The nine steps for the roadmapping process are:

1. Process initiation
2. Steering committee establishment
3. Process management team establishment
4. Stakeholder involvement plan development and implementation
5. Communications plan development and implementation
6. Situational Analysis and IWRM Plan Framework
7. Vision Statement and Goals Articulation
8. Evaluate IWRM Plan options
9. IWRM Plan promotion, adoption and implementation

The full presentation is contained in **Annex 4.4**.

## **Plenary Discussion: Next steps for IWRM Policy and Planning in Antigua and Barbuda**

It was proposed that a dedicated water resources agency be established to manage water resources in Antigua and Barbuda. Such an entity will be able to drive the IWRM planning and development process. Jamaica was cited as has a good model in such a process that could be adopted. Grenada is in the process of developing a water policy that takes supply provision and water resources management into account. It was agreed that the APUA will lead the process in Antigua and Barbuda until such time as a separate water resources agency is formed. The GEF-IWCAM project can assist with the development of the water policy. The policy should aim to foster an adequate planning and investment climate that places emphasis on water capture in the surplus areas in the south of mainland Antigua with distribution to the more water-stressed areas in the north. Special focus should be afforded to the agricultural community to ensure that water requirements are met.

Currently the APUA is responsible only for the monitoring their own production output, the data supplied to the Ministry of Health. However, private businesses that provide their own water (through desalination) are monitored directly by the Ministry of Health. It was agreed that improvements could be made to harmonize the monitoring regime.

The capacity of the human resources and laboratory capacity with respect to water quality monitoring were also discussed. There was agreement amongst the participants that operators in the water services sector should be certified. It was noted that the GEF-IWCAM Project will lend capacity building support to laboratory strengthening in the Caribbean including Antigua and Barbuda. Under this effort CEHI will be undertaking assessments of regional laboratories and then determine what is needed to strengthen their capacities.

# Day 2 Proceedings

## **A Programme to promote Rainwater Harvesting (RWH) in the Caribbean**

**Presenter: *Camille Roopnarine, Caribbean Environmental Health Institute***

The presentation introduced a historical perspective to rainwater harvesting both at the global level and in the Caribbean region, noting some typical examples of the practice in the more water-scarce islands. The positive benefits of investing in RWH were highlighted with particular emphasis on the possible changing rainfall patterns associated with climate change. Water security in the context of RWH in post-disaster situations was also highlighted.

The collaboration between CEHI and UNEP Nairobi on a first-phase initiative to promote RWH in the Caribbean region was presented. In this phase Grenada was used as a pilot to develop a National Programme to promote RWH, along with promotional material that included posters, brochures, radio public service announcements and a television feature. The National Programme laid the basis for formulation of a Regional Programme that can be replicated in each country.

The second phase of the programme will focus on Antigua and Barbuda in which two demonstration models to showcase best practices in RWH will be developed. This will involve the retro-fitting/installation of RWH system components to a household and a small business enterprise (likely an agri-business). Capacity-building seminars for professionals in the construction sector, farmers, homeowners, will be conducted, along with the production of technical materials. Water availability mapping for Antigua will also be undertaken.

The full presentation is contained in **Annex 4.5**.

## Discussion

The problem of animals (birds, rats) entering the guttering and contaminating the water on its way to the tank or cistern is a safety risk. It was suggested that RWH systems be configured to exclude animal entry. The demonstration project will seek best solutions to minimize direct contamination. It was noted that householders in the US Virgin Islands are able to purchase special devices that are fitted on to guttering that excludes birds, leaves and other contaminants from entering the storage system. These devices do not appear to be readily available in other parts of the Caribbean.

It was noted that it is important to realize that not all the water that comes off the roofing should be captured. Excess runoff should be diverted for landscaping and crop production. Excess runoff should not be labelled "waste" water. The project

will not only emphasize storage of water for household use but the use of rainwater for other purposes that include agriculture.

An appropriate legislative framework is needed that will encourage investment in RWH and ensure that home and business owners comply with DCA requirements to install water storage capacity. Enforcement of these requirements should be strengthened. The DCA stipulates that storage capacity is mandatory in all approved developments; some policing is carried out, however capacity is limited. It was suggested that the legislative and regulatory framework also include provisions for financial incentives to offset the cost of special equipment and materials for RWH.

In Barbuda, building below-ground cisterns is a challenge due to the limestone bedrock that dominates the island; this has significant cost implications for construction. It was suggested that the Public Works Department assist homeowners by providing subsidized services for cistern construction.

In Barbuda the main secondary school has a 270 m<sup>3</sup> (60,000-gallon) cistern that has been in operation for two years; the school does not rely on the public service. The cistern provides water for all the school's needs, from drinking to cleaning and sanitary purposes. The school generally uses no more than one-third of the cistern capacity. It was noted that the school does not have a routine water quality testing regimen; however, the water is regularly treated with bleach as chlorine tablets are difficult to obtain in Barbuda. It was recommended that the Barbuda school experience should be captured for sharing with other countries in the Caribbean.

A personal insight was offered by one participant on RWH in Antigua. During the time he was resident in Antigua his family practiced RWH with great discipline that included recycling of dish-washing water. This was in contrast to the seemingly emerging notion in some islands (such as Barbados) that RWH belongs in the past. RWH provides additional water security which in turns redounds to maintenance of health and sanitation.

## **Climate Change and Rainfall in Antigua**

**Presenters: Keithley Meade, Director (Ag) and Dale Destin Climatologist (Ag), Antigua and Barbuda Meteorological Services**

A joint presentation was delivered by the Antigua and Barbuda Meteorological Services (ABMS) on climatic trends in Antigua and Barbados in the context of climate change and water security. The first part of the presentation was delivered by Keithley Meade, while the second part was delivered by Dale Destin.

### **Part 1**

Antigua has historically experienced episodes of drought with particularly severe episodes during the 1960s. These droughts had significant consequences for the population of Antigua due to the heavy reliance on rainwater in many parts of the

island. However, with the installation of desalination plants the effects of drought and water shortages has not been as severe as in the past.

The following is a summary of the general trends in rainfall patterns that have been observed in recent decades:

- ❖ The appears to be a decline in June precipitation;
- ❖ There has been a shift in the driest month from February to March;
- ❖ There has been a flattening of the rainfall peak in September;
- ❖ There continues to be a consistent but minor peak in rainfall in May.

It must be noted that it is not definitive that there has been an overall change in total rainfall but there is a clear spatial variability over the island.

## **Part 2**

Statistical data presented suggested that there has not been significant departure from the long-term rainfall averages to suggest that climate change as a result of global warming is having a noticeable impact on Antigua's rainfall regime (i.e. the moving average has remained relatively flat).

The annual average rainfall for Antigua is 1,172.46 mm (46.16"); the annual average rainfall for Barbuda (at SpringView) is 1,125.47 mm (44.13"). November is statistically the wettest month in Antigua and Barbuda. These figures for November were contributed to by the passage of Hurricane Lenny in 1999.

It is observed that precipitation extremes tend to be skewed to the higher rainfall range (rather than low-end observations). There tends to be significant drought once every three years with minor drought episodes in between. The Antigua and Barbuda Meteorological Services are examining rainfall over 3-month periods to assist forecasting of these episodes as part of an early warning capability for drought management.

The full presentation is contained in **Annex 4.6**.

## **Discussion**

Question: What roles does carbon dioxide play with respect to the trends we are seeing?

Response: CO<sub>2</sub> interferes with the balance of energy inputs and energy losses which is what contributes to global warming. In some places over the globe this causes changes in rainfall accumulation. Small islands in ocean environments may not be affected in the same way as other locations (particularly continental) over the globe and the change in precipitation may not occur at the same rate as in continental locations.

Question: What causes the rainfall peak in May?

Response: This is attributed to the 'change-over' in the occurrence in the types of weather systems that affect Antigua and Barbuda at that time of year, from non-

tropical systems (e.g. fronts) to tropical cyclonic systems. During this time both types of systems may occur and interact, giving rise to increased rainfall.

The Caribbean Community Climate Change Centre (CCCCC) has suggested that in the Caribbean there will likely be changes in rainfall toward a general drying trend, and re-distribution of precipitation more evenly over the year. This will have implications in terms of water security particularly as it relates to the potential scenario of less annual rainfall accumulation.

In Antigua many old rainfall stations are now disused and represents losses to the country's data record. In many cases these rainfall stations were on private lands and over time they have simply fallen into abandon. There is also concern by ABMS over the accuracy of some of the historic records due to equipment malfunction and observer error. The ABMS is moving to enhanced monitoring capacity with the establishment of remote stations.

## **Rainwater Harvesting**

**Presenter: Lionel Michael, Chief Health Inspector, Central Board of Health**

There is no national systematic monitoring programme for water quality associated with RWH. The Central Board of Health (CHB) primarily focuses on monitoring the safety of the APUA-produced water. The Department examines the physical infrastructure of private homes from time to time. In many cases the CHB is called in to private dwellings to investigate the causes of foul odours emanating from cistern water. In some cases the cause has been attributed to cross-contamination from septic systems through below-ground seepage. Further, many RWH storage systems are not designed for easy maintenance.

In Antigua and Barbuda many homes use harvested rainwater for toilet flushing and garden irrigation. The general practice is that stored rainwater is usually disinfected before drinking using either bleach or filters. It is a general observation that the filters installed as part of the RWH system are either not adequate for the purpose or not properly maintained.

Antiguans have a decided preference for consuming rainwater based on the taste, but there is concern by CHB over adherence to best practices with respect to maintaining safe drinking water quality standards. The CHB provides advice to householders on how to treat their water. RWH is 'soft water' and is particularly preferred for laundry purposes.

The CBH notes that in some instances householders inadvertently cross-connect piping from their RWH systems with the piping that delivers potable water from APUA. It was stressed that this practice exposes the APUA water distribution system to potential contamination that may extend beyond the offending home to adjacent homes in the network.

CBH does limited chemical tests on rainwater stored in cisterns; chemical oxygen demand is checked at times. No other chemical tests are done in light of the limited local capacity to routinely carry out such analyses. There has been concern expressed over the types of sealants that are applied in cisterns and whether they have the potential to leach harmful compounds into the stored water. The Department has no evidence to suggest that compounds currently used pose a significant health risk. There is need for expanded chemical testing capability and laboratory strengthening in this regard.

The full presentation is contained in **Annex 4.7**.

## Discussion

Question: How does the APUA detect and manage the presence of harmful contaminants in the distribution system?

Response: Limited capacity exists to quickly test for chemicals (notably heavy metals). The APUA tests routinely for bacterial vectors. The company tests all drinking water sources and where necessary uses an Arkansas lab facility for more extensive analyses.

Any chemical substances that find their way into cistern water likely originate from the roofing materials, including the paints and sealants. It was noted that the country imports much of its roofing material from the US where suppliers may not consider RWH applications, giving rise to some risk of exposure.

In the past the APUA used lead pipes and lead-based joint sealants but when the risk from lead poisoning became known the practice was discontinued.

Question: Are there test kits homeowners can use for testing their own water supply?

Response: There are test kits that can be easily obtained; of use are those that allow for testing for residual chlorine.

With the proliferation in the use of PVC piping for plumbing on account of its ease of installation, persons who are not qualified or experienced plumbers sometimes make poor and unsafe installations in households. In some cases the CBH finds that there are cross-connections between RWH piping and plumbing that services toilet tanks. This leads to 'blue-water' getting into the household water supply as a result of toilet cleanser getting back-washed into the system under a pressure differential. Some type of professional certification is needed to minimize such problems.

It was noted that filters on RWH systems need to be replaced as required to avoid problems associated with accumulation of sediment and organic matter that will foul the water. The filter system selected must be appropriate for the configuration of the RWH system.

There needs to be special attention paid to commercial enterprises, farms, funeral homes and industries that use RWH systems to ensure that there are appropriate back-flow control mechanisms to eliminate cross-contamination of the APUA potable supply.

The same concern extends to potential contamination of the potable supply from irrigation ponds and watering holes for animals. In this case there is potential contamination from faecal waste and agro-chemicals. Food safety from farm to table is of high concern in Antigua.

Question: How does the CBH see their role in continual monitoring of private water supply systems?

Response: The CBH regards this type of monitoring the responsibility of home owners as the agency has limited capacity and therefore cannot carry out intensive monitoring of all households. The agency therefore has more of an advisory role. Individuals should undertake their own basic testing; if more elaborate work is required then CBH can assist in laboratory consultation.

## **Water harvesting and irrigation on an Antigua farm and Rainwater harvesting in a small agro-processing enterprise**

**Presenters: Alvin Christian, Farmer and Rosemarie McMaster, Susie's Hotsauce**

Mr. Christian provided an illustrated overview of his experiences with irrigation use in agriculture at his farm holding situated at Bendals, and the challenges associated with flood control.

See **Annex 4.8** for select photos of the installation of irrigation works and the flood management issues after heavy rainfall.

Mrs. McMaster provided a brief overview on the use of rainwater at Susie's Hot Sauce, a local agro-processing enterprise.

All production is done at home and RWH is heavily used. Rainwater lends itself well to food preparation and yields better-looking and higher-quality preparations. The public water supply is 'hard' water and considered less desirable for use by the company. Strongly advocates that agro-food processing should be entirely serviced by rainwater due to its good qualities.



*Rosemarie McMaster, Managing Director of Susie's Hot Sauce (private sector representative) in support of widened advocacy for RWH in Antigua.*

It was noted that rainwater use should be actively promoted in schools and that concerted efforts should be made to educate school children on the value of water as a precious commodity.

## Discussion

In the 1970s Halcrow (a UK-based engineering consulting firm) was contracted by the Antigua and Barbuda government to evaluate the feasibility of installation of a large capacity dam in the Big Creek area. However, much of the land was already under private ownership and being developed for agriculture and housing. Given the associated costs of dislocation and potential social issues, the government decided to shelve the project. It was noted that many economic variables are at play in balancing the implementation of large reservoir projects.

Question: What types of control measures are in place to reduce the likelihood of entry of household septic waste and other pollutants into Mr. Christian's irrigation reservoir?

Response: The reservoir was designed large enough to allow for dilution. The drip irrigation system that is being used for the crops is also designed to minimize delivery of pollutants. Further, crops (vegetables in particular) are carefully washed with potable water from the APUA system (not the irrigation water). Finally, the physical characteristics of the soils that surround the irrigation reservoir render overland pollutant delivery unlikely.

It was noted that Mr. Christian should be complemented and his efforts be used as an example to others not only in Antigua and Barbuda, but elsewhere in the Caribbean.

Question: Is the Halcrow study still valid in the context of Antigua's current water needs?

Response: It is a possibility but there will need to be careful consideration of all land development options in terms of the extent to which compromises and conflicts can be rationalized.

Question: Can Antigua and Barbuda draw on lessons in water resource development in China? Response: Given the vast size of China and the obvious emphasis on large-scale reservoir projects to meet the massive needs of its population, direct application to Antigua may be challenging.

## **Plenary Discussion: Next steps for the Antigua RWH Demonstration Project**

Participants were again reminded of the components of the demonstration initiative and asked for final inputs regarding the next steps toward implementation. The following suggestions were made:

- ❖ The candidate demos should be selected from within low-income areas that have limited or no access to the APUA water supply;
- ❖ The selection criteria should be designed to favour 'typical' lower-income households with opportunity for easy replication;
- ❖ There should be opportunities built in the project for technical exchanges between countries.

## Field Trip

The purpose of the field trip was to engage participants in on-site discussions in the concepts of IWRM and water conservation (including RWH) as it relates to (1) land use and development and how it impacts the water resource and (2) development and management of water supply and distribution infrastructure and how water augmentation measures have evolved in Antigua. Two sites were selected by the APUA and the Environment Division as providing good case examples for the purpose. The field trip marked the closure of the workshop.

### Site 1: Wallings Reservoir



*Wallings Reservoir; LEFT: access and high water spillway; ABOVE: reservoir (note old pumphouse in ruin at extreme left)*

The Wallings Reservoir was constructed in 1890 to service the water demands of English Harbour in the island's south coast and has a capacity of approximately 59,100 m<sup>3</sup> (13 million gallons). The water treatment facility at the reservoir was decommissioned in the early 1990s due to a range of operational difficulties. The reservoir catchment area was too small given the impoundment capacity; as a result adjacent watershed areas were utilized to supply the reservoir through the use of connector conveyance drains. Over time the drains gradually fell into disrepair as

alternative water supply options were developed to service the needs of the surrounding communities. The water quality at this site has always been of good

quality. At one time the APUA evaluated the possibility of re-commissioning the facility but concluded that it would not have been economically viable.

The site is now among the main eco-touristic locations on the island and has positive development potential in providing spin-off benefits to the surrounding areas. A sustainable management regime for the site is regarded a high-priority need.

The key environmental concern at the site is the encroachment of invasive lemon grass within the surrounding hillsides. Lemon grass is particularly prone to fire during the dry season with the risk of triggering accelerated soil erosion within the watershed.

## **Site 2: Carlisle Bay**

Of interest at this site was issue of improper solid waste disposal within an area of the watershed that drains into Carlisle Bay on Antigua's south coast. Of particular concern was the disposal of articles containing potentially harmful chemical compounds that could be transported in overland flow or in the sub-surface flow to the adjacent coastal waters.

Representatives of the agencies present noted that discussions have been ongoing between the hotel developers, the Environment Division and the Antigua Solid Waste Management Authority to reach an amicable solution. The problems of inappropriate land management and indiscriminate solid waste disposal are key issues that need to be addressed in IWRM in Antigua and Barbuda.



*Participants observing environmental pollution that threatens nearby Carlisle Bay.*



*Symposium participants*

# Annexes

- 1** Participant List
  - 2** Workshop Agenda
  - 3** Workshop Evaluation
- 

## **4** Presentations

- 1.** IWRM Principles: Christopher Cox, Caribbean Environmental Health Institute
- 2.** Water resource management issues in Antigua and Barbuda: John Bradshaw, Antigua Public Utilities Authority, Water Division
- 3.** Antigua and Barbuda GEF-IWCAM Demo Project update: Melesha Banham, Environment Division
- 4.** Roadmapping towards IWRM: Christopher Cox, Caribbean Environmental Health Institute
- 5.** A Programme to promote Rainwater Harvesting (RWH) in the Caribbean: Camille Roopnarine, Caribbean Environmental Health Institute
- 6.** Rainwater Harvesting: Lionel Michael, Central Board of Health
- 7.** Climate change and Rainfall in Antigua: Keithley Meade, Dale Destin, Antigua and Barbuda Meteorological Services
- 8.** Water harvesting and irrigation on an Antigua farm: Alvin Christian, private sector

## ANNEX 1 Participant List

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## ANNEX 2 Agenda

### Agenda

## National Symposium on INTEGRATED WATER RESOURCES MANAGEMENT (IWRM)

City View Hotel, St. John's, Antigua & Barbuda, January 30<sup>th</sup> - 31<sup>st</sup>, 2008

### Day 1

8:00 – 9:00	Registration of Participants	
9:00 – 9:45	Opening Ceremony Chairperson: Ivan Rodrigues, Antigua Public Utilities Authority	<ul style="list-style-type: none"> <li>• Patricia Aquing – Executive Director, Caribbean Environmental Health Institute (CEHI)</li> <li>• Vincent Sweeney – Regional Project Coordinator, GEF-IWCAM</li> <li>• Hon. Minister John Maginley – Minister of Health</li> <li>• Hon. Baldwin Spencer – Prime Minister</li> </ul>
9:45 – 10:00	Break	
	Introduction of Participants	
Presentations: 10:00 – 10:30	IWRM Principles	Christopher Cox, Caribbean Environmental Health Institute
10:30– 11:00	Water resource management issues in Antigua and Barbuda	John Bradshaw, Antigua Public Utilities Authority
11:00 – 11:30	GEF-IWCAM Project	GEF-IWCAM
11:30 – 12:00	Roadmapping towards IWRM	Christopher Cox, Caribbean Environmental Health Institute
12:00 – 1:00	Plenary discussion on way forward in IWRM planning process	Facilitated by CEHI and APUA
1:00 – 2:00	Lunch	

### Day 2:

Presentations: 9:00 – 9:30	A Programme to promote Rainwater Harvesting (RWH) in the Caribbean	Camille Roopnarine, Caribbean Environmental Health Institute
9:30 – 10:00	Health and sanitation issues associated with RWH	Lionel Michael, Central Board of Health
10:00 – 10:15	Break	
10:15 – 11:15	Climate change and water security	Keithley Meade, Antigua and Barbuda Meteorological Services
11:15 – 11:45	Best practices in RWH in Antigua and Barbuda	Alvin Christian & Rosemarie McMaster, Private sector representative
11:45 – 12:30	Plenary discussion on way forward	Facilitated by CEHI and APUA
12:30 – 1:30	Lunch	
1:30 – 4:00	Field trip – IWRM field concepts	Antigua Public Utilities Authority / GEF-IWCAM

## Annex 3 Workshop Evaluation

The following is a synopsis of the Workshop Evaluation Forms that were completed and returned by participants.

Thirteen (13) evaluation forms were completed and returned.

### Content and Format:

Responses to the relevance to the sector of attendees and the sequence of activities were rated as either excellent or good. The pace of the proceedings was generally described as either excellent or good.

### Presenters:

All agreed that the preparation, knowledge, provision of answers to questions and organisation of presenters was either good or excellent.

### Logistics:

Most indicated that the logistical arrangements were either good or excellent. 1 respondent described them as fair.

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Participants were asked a few open ended questions which were intended to guide the development and effectiveness of future related activities.

### How do you think the region can benefit from this and similar workshops?

- (a) Ensuring the health and safety of future generations;
- (b) Through right knowledge and discipline
- (c) Learning from all the islands
- (d) Raise the awareness of the responsibility of everyone to secure and conserve rainwater
- (e) Rainwater harvesting is vital and more people need to be made aware of it
- (f) Rainwater harvesting provides a very viable and relatively inexpensive way of getting water for water-challenged islands
- (g) Need to provide more information on financing rainwater harvesting initiatives
- (h) Practical help is needed for people who already use rainwater harvesting

### What did you like about the programme?

- (a) Very timely
- (b) The use of practical language to explain the subject matter
- (c) Presenters were very informative and insightful
- (d) Presenters were very interactive with the participants and sparked interest with their knowledge and presentations
- (e) The organisation and presenters were adequate

What could be improved?

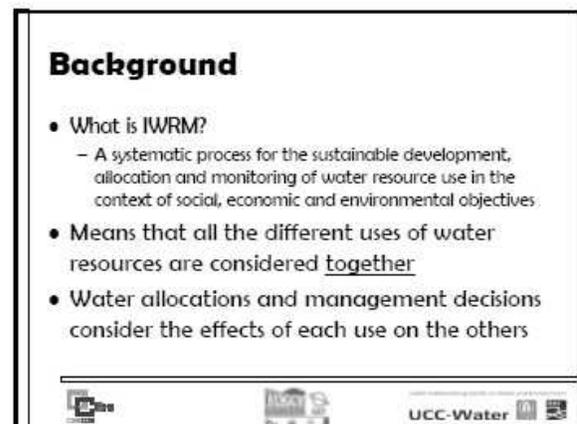
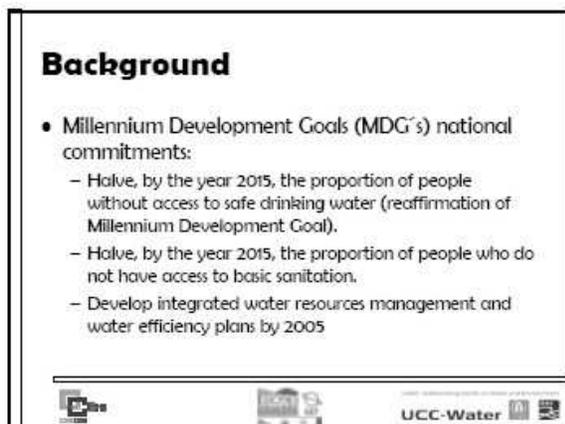
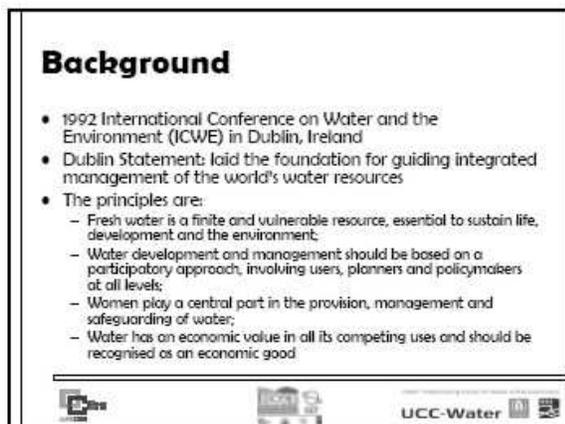
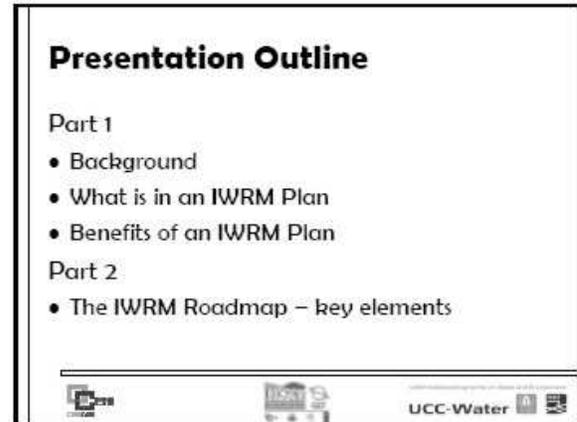
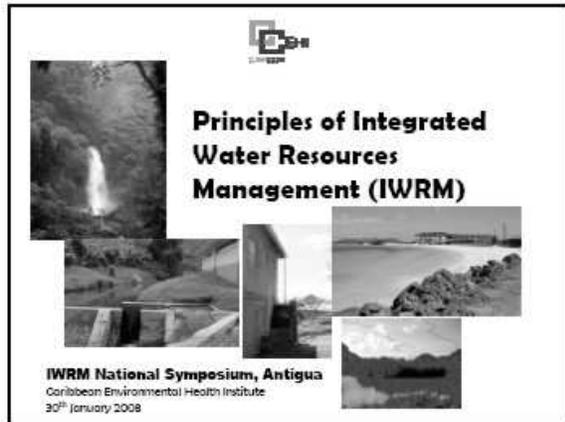
- (a) Policy makers should have been directly involved in the discourse
- (b) More stakeholders should have been present including students and the general public
- (c) The GIS topic should have been elaborated on

Comments and recommendations for this programme:

- (a) More programmes like these are needed in Antigua and Barbuda
- (b) This programme should be introduced into schools, tourism etc. Posters should be distributed and slogans should be used to spread the message of RWH

## Annex 4 Presentations

### 4.1 Christopher Cox: Caribbean Environmental Health Institute



## What is an IWRM plan?

- A strategic statement that details a country's actions toward to sustainable management of its water resources
  - Scope - Fresh and coastal waters
  - Defines the issues and the strategic responses by all actors
  - Lays out the indicative cost outlay required for action over short to medium-term; basis for sourcing funding internally or externally

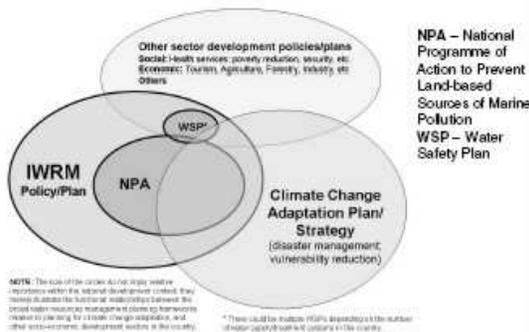


## Context for IWRM Plan

- Link to other strategies and plans
  - NEMS and other existing national plans/strategies
  - National MDG strategies
  - National poverty reduction strategy papers (PRSPs)
  - National 5-year plans
  - National sustainable development strategies
  - National Biodiversity Strategy and Action Plans



## Where does an IWRM Plan fit?



UCC-Water

## What does an IWRM Plan look like?

- Description of the existing water management approach. Where it came from, how long has it been in place, what legal instruments (policies, laws and institutions) support it, and the constraints of the current approach to water management.
- A description of the current water resources situation in the country (a water resource assessment)



## What does an IWRM Plan look like?

- A description of the scope of the plan. (Goals, aims and objectives we wish to attain)
- A description of how we plan to achieve the vision, goals, aims and objectives.
- Links the IWRM plan to other national processes and/or plans (e.g. How relevant is the IWRM Plan for a Poverty Reduction Plan or an Integrated Development Plan).
- Resource requirements to implement the plan
  - Integration within the Public Sector Investment Programme



## An IWRM Plan should:

- Heighten awareness and understanding of the value and benefits of integrated water resources management and vulnerability of human health and the environment from poor Water resources management;
- Identify and implement actions to address specific causes of negative impacts and threats on human health and the environment from poor water resources management practices;
- Assist mobilize resources and partners, including the private sector, for implementation of specific projects to address the negative impacts and threats on human health and the environment from poor water resources management practices.



## Processes in IWRM



UCC-Water

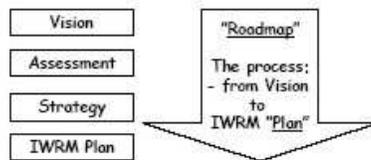
## IWRM Roadmapping

- What is an IWRM Roadmap?
  - A description of the steps required in the development of a national integrated water resources management plan
- GEF-IWCAM Project and partners
  - Assist Caribbean countries initiate the process toward development of IWRM Plans
  - First stages – awareness-raising: defining the Roadmap
    - Partners: GEF-IWCAM Project; United Nations Collaborating Centre for Water and the Environment (UCC); Global Water Partnership – Caribbean (GWP-C).



UCC-Water

## IWRM Roadmap: Plan for the process



UCC-Water

## 4.2 John Bradshaw: Antigua Public Utilities Authority

### NATIONAL SYMPOSIUM ON INTEGRATED WATER RESOURCES MANAGEMENT – ANTIGUA & BARBUDA

### WATER RESOURCE MANAGEMENT ISSUES

Prepared by: APUA  
WATER DIVISION

### WATER SOURCES

- SURFACE WATER
- GROUND WATER
- DESALINATION WATER

### SURFACE WATER SOURCES

1. POTWORKS DAM  
BETHESDA DAM
2. HAMILTON  
BRECKNOCKS #1  
BRECKNOCKS #2  
FISHER  
BIG CREEK  
BENDALS POOL  
BODY POND
3. DUNNINGS

### SURFACE WATER TREATMENT PLANTS



### GROUNDWATER

#### WELL FIELDS

- BRISOL/COLLINS
- FOLLIES
- CLAREMONT
- BENDALS
- CADES BAY
- VALLEY/ROSES



### Desalination Plants 1&2

Combined Cycle Co-Generation Plant Electricity and  
Water



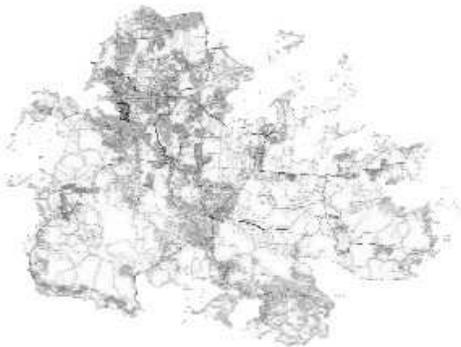
**TYPES OF DESALINATION PLANTS IN ANTIGUA**



• ENERSERV  
• CAMP BLIZZARD

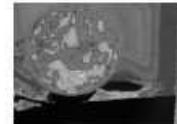


**WATER DISTRIBUTION SYSTEM**



**STATUS DISTRIBUTION SYSTEM**

❖ The Deterioration Of Metal Mains In The Distribution System



Increase In Brown Water

❖ Increase In Main Replacement

❖ Increase In The Use Of More Chemicals To Manage Corrosion

❖ Redesign Of the Distribution Pumping Stations  
(Impellers were changed to stainless steel)

**STORAGE TANKS**



**WATER RESOURCES MANAGEMENT ISSUES**

1. No National Water Policy to guide developments in the water industry.
2. The water demand exceed the water supply by 1MGPD for the year 2008 and there is a need for excess water (dry season)
2. Inadequate water distribution and transmission systems because of the aging pipelines, metal pipes, and growth within the distribution system
3. Inadequate water tank facilities because of growth of the distribution system
4. Inadequate operation system given the decentralization of various sources that feed into the distribution and transmission system
5. Inaccurate water meters because of their age
6. High unaccounted for water given the aging distribution system, inaccurate water meters, inconsistent meter readings, and "bill system"
7. Inadequate water rate given the type of water that APWA distributes (Antigua and Barbuda)
8. High non cash revenues water given to the Central Government.
9. A low motivated workforce
10. The purchasing procedure for minor capital items is too lengthy given the Tender's Board regulations.
11. APWA in recent time is unable to pay its suppliers in a timely manner and as a result it affects the delivery of goods and services and it also affects our overall ability of service delivery.
12. Land Use - (Growing population in the watersheds)
13. Brackish water situation in Barbuda
14. Standby Abuse.

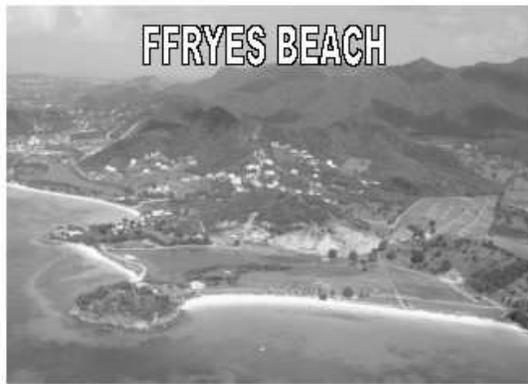
### Recommendations

- Develop adequate water policies followed by appropriate legislations
- Develop an Integrated Water Resources Management Agency
- The recommendations for source/supply development would use the techniques leading the demand with incremental expansion annually.
- The recommendations for construction of storage tanks are based on the standard of demand and supply on how much storage will be required to provide a sustainable water system over a period of time.
- The recommendation to replace pipeline system is based on the aging distribution and transmission pipes (water meter also)
- Other recommendations would be based on positioning the Water Division to survive to the year 2011.

### EXPANSION OF SOURCES

1. Construction of a RO plant at Fryes Beach of 600KGPD by 2008
2. Increase the capacity at Crabbs site by 400KGPD by 2008
3. Increase the groundwater capacity by 200KGPD by 2009
4. Construction of a Brackish RO Plant at Follies of 300KGPD by 2009
5. Install 400KGPD RO Plant at Crabbs by 2009.
6. Increase capacity by 600KGPD in 2010.

### FFRYES BEACH



### Groundwater Development



### ARTESIAN WELL AT FOLLIES



### Construction of Water Tanks

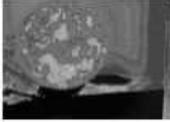
In the year 2008 Water Division is recommending the construction of a water tank in the Wallings and Buckleys Areas and the rehabilitation of the lower reservoir at Grays Hill.

In the year 2009 the Water Division is recommending the construction of storage tanks in St. Phillips and Liberta by 2009.

In the year 2010 the Water Division is recommending the construction of tanks at Halycon Heights or New Winthropes Hill/land and Five Islands.

### Replacement of Mains

Water Division recognizes that the replacement of main is an on-going project in order to improve the water quality and reliability and therefore recommends that 500 feet per day of pipes be replaced for the next five years. In other words, approximately 10 miles of pipes should be replaced per annum for the next five years.



### Replacement of Water Meters

Water Division recognizes the importance of accurate water meters that affects the overall revenue of the Department and is hereby recommending the following:

2008	-	2,500 meters be replaced
2009	-	2,500 meters be replaced
2010	-	1,500 meters be replaced
2011	-	1,500 meters be replaced
2012	-	1,000 meters be replaced

The Water Division would also install water meters at Delaps and Bendals Water Treatment Plants in order to capture the water produce by various sources.

### OTHER OPTIONS

The Water Division is also recommending the following:  
Prepaid Meter System to be introduced by the year 2009 to capture all apartments and high risk consumers.

The recapturing of the Hotel market by the year 2009 in order to increase revenue.  
Construction of a Central Sewage System for St. John's by the year 2010.  
Development of an Irrigation Department by the year 2010 to meet the farmers demand for water.

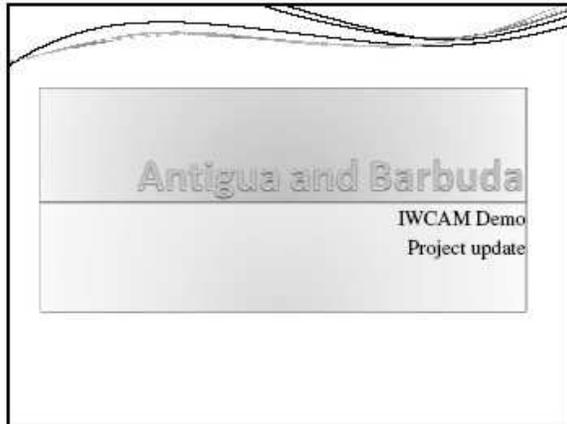
### WATER DIVISION WATER AUTHORITY

Water Division is also recommending the separation of the Water Division from the Telephone and Electricity Division to create a new entity that would adequately managed the national water, wastewater and irrigation services. This organization will be known as National Water and Sewerage Authority (NWASA) by 2011.

*Thank You*

❖ Questions ?

## 4.3 Melesha Banham: Environment Division

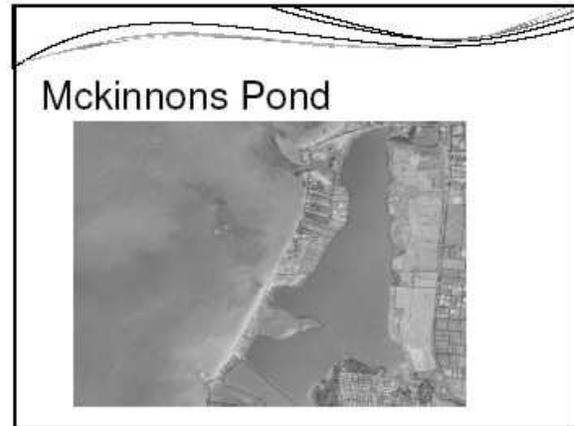


### Background

- Antigua and Barbuda has experienced a number of problems with coastal water quality particularly in the parish of St. John and as such this issue was given priority when the opportunity to focus on a solution came to the forefront.
- A Global International Water Assessment (GIWA) -based Hotspot Selection exercise was undertaken
- St. John's and McKinnons were nominated and adopted by the Steering Committee as a Hotspot. This site has since been changed to McKinnons which was another hotspot.
- The selection mechanism identified St. John's harbour and the north west coast as primary pollution Hotspot Areas within the country, with particular concerns related to microbiological pollution and eutrophication resulting from inadequate sewage and general wastewater treatment

### IWCAM Demonstration Project

- Initially, St. John's was chosen as the demonstration site for the IWCAM project due to the activities which occur within the town, the potential pollution to the harbor among other issues.
- Due to the recent work carried out in St. John's and the requirements that would have to be implemented St. John's was seen as no longer appropriate for the work to be completed and as such the next hot spot on the list was selected – McKinnons Pond
- The choice was easy to make as the major problems within St. John's city are experienced in and around the areas surrounding McKinnons.



### IWCAM Demonstration Project

#### CAUSES

- direct discharges of untreated effluent directly into the open drainage system
- septic tanks not pumped frequently enough and of inadequate capacity
- septic tank waste disposed of at municipal landfill poses a threat
- increasing number of septic tanks

### IWCAM Demonstration Project

#### Threats

- increased coastal pollution
- threats to public health in St. John and adjacent recreational beaches
- loss of ground water quality from sewage effluent intrusion
- threats to tourism industry (particularly Cruise tourism and tourists interests on the North West Coast)

## IWCAM Demonstration Project

Main barriers for better control and management of sewage handling, treatment and discharges:

- Lack of adequate handling and holding facilities within the St. Johns Parish
- Lack of treatment facilities prior to discharge
- Inappropriate waste disposal mechanisms for septic tank sludge
- Inadequate legislative control and lack of capacity for enforcement
- Poor incentives/disincentives for construction and use of effective septic tanks
- Inadequate monitoring of water quality to guide policy-makers and legislators

## IWCAM Demonstration Project

### PROJECT COMPONENTS

- A public awareness campaign
- Sewage management strategy to identify the most appropriate means of handling sewage discharge in the demonstration area
- The implementation of a programme of collection of environmental indicators;

## IWCAM Demonstration Project

### PROJECT COMPONENTS – cont.

- Identification and design of sewage treatment option (including options related to a Wetland Filtration System) that will meet the environmental and economic needs of A. The parish of St. John and B. the rest of the country
- Development of full proposal with technical, financial and institutional arrangements for management of wastewater and sewage treatment in St. Johns' for submission to The Cabinet for approval
- Development of a proposal for a medium size project for the development of a wetland filtration system for submission to the GEF

## IWCAM Demonstration Project

### PROJECT COMPONENTS – cont.

- A review of legislation as it applies to sewage handling, treatment and discharges and to pollution of groundwater and coastal waters
- Recommendations for policy reforms and supportive regulations and legislation in support of a new sewage treatment option.
- Identification of funding mechanisms to cover costs of monitoring (compliance and water quality data) and enforcement

## IWCAM Demonstration Project

### END OF PROJECT LANDSCAPE

- Show a model system for retroactive fitting of sewage handling systems within the parish of St. John.
- The model will have been demonstrated on-the-ground and proved to be effective
- A detailed report will have been produced and submitted to Cabinet;

## PMU

- The PMU is currently made up of the Project Coordinator, Senior Technical Assistant, Administrative Assistant
- The technical advisory committee has been established to offer advise in various activities as the project progresses.

## Project Update

- The project is currently in the later stage of the first phase.
- Terms of reference have been created and consultants are being recruited for the various research aspects of the project. A consultant to conduct the legislative review and statistical data collection has been sourced, we are in the process of securing a consultant for the sewage management policy creation
- Actually, we have started Data collection for the statistical needs of the project. GPS reference points have been created that will be used to monitor changes in various environmental media through out the project

## Project Update Continued

- Indicators have been developed for the project as well through our accepted work plan.
- The next phase is the sourcing of consultants and the issuing of contracts for the actual demonstration works. This will be initiated once the sewage management strategy has been completed as this is necessary to choose the final site for the demo
- The project is scheduled for completion at the end of November 2008

## 4.4 Christopher Cox: Caribbean Environmental Health Institute



**The Roadmap towards Integrated Water Resources Management (IWRM) Planning**

**IWRM National Symposium, Antigua**  
Caribbean Environmental Health Institute  
30<sup>th</sup> January 2008

### The Roadmap

- What is an IWRM Roadmap?
  - A description of the steps required in the development of a national integrated water resources management plan

### Major steps in IWRM Roadmap

1. Process initiation
2. Steering committee establishment
3. Process management team establishment
4. Stakeholder involvement plan development and implementation
5. Communications plan development and implementation
6. Situational Analysis and IWRM Plan Framework
7. Vision Statement and Goals Articulation
8. Evaluate IWRM Plan options
9. IWRM Plan promotion, adoption and implementation



### 1. Process initiation



- Determine who should initiate the process
- Assess political support for developing and implementing an IWRM plan
- Identify available resources to undertake process
- Examine successful processes that have been applied in neighbouring countries

### 2. Steering committee establishment

- Ideally, use existing inter-sectoral coordinating mechanism
- Terms of reference for SC
  - Provide the Process Management Team (PMT) with general guidance and support;
  - Review the proposals and reports prepared by the management team;
  - Regularly review progress in implementation;
  - Assist the PMT in securing primary data and information;
  - Be responsible for coordinating and monitoring the implementation of relevant activities within their respective agency, organisation or community;
  - Decide on the composition of the PMT and appoint its members.

### 3. Process management team establishment

- Terms of reference for the PMT:
  - Organize and coordinate the overall strategy process;
  - Planning specific activities and meetings;
  - Procuring expertise and resources (human and financial);
  - Support working groups and other committees;
  - Act as a focal point for communication

#### 4. Stakeholder involvement plan development and implementation

- First steps: identification of stakeholders, assessment of their interests, their potential contributions to the IWRM process and their relative influence and importance
- Grenada and Union – stakeholder assessment conducted and categorized:
  - HH – High Priority/High Influence: These stakeholders are the bases for an effective coalition of support for the project
  - HL – High Priority/Low Influence: These stakeholders will require special initiative if their interest are to be protected
  - LH – Low Priority/High Influence: These stakeholders can influence the outcomes the project but their priorities are not those of the project. They may be a risk or obstacle to the project
  - LL – Low Priority/Low Influence: These stakeholders are of least important to the project
- Need to ensure buy-in from key stakeholders



#### Stakeholder management plan

(A) Stakeholder Name: *Prime (govt) stakeholders*

(B) Group: *Government* Priority: *High* Interest: *High* Influence: *High*

(C) Potential roles of stakeholders in the IWRM Plan development (for roles below):

(D) Level of participation in the IWRM Plan development (check one or more):

(E) Consultative schedule and anticipated implementation by region (use 3-month periods):

Activities (check for IWRM Plan development activities)	Year 1			Year 2			Expected contributions
	Q1	Q2	Q3	Q1	Q2	Q3	
Stakeholder meetings							Policy guidance
Focus group meetings							Feedback, discussion amongst decision stakeholders
Expert study on coastal water management							Guidance on preparation of terms of reference for coastal zone study
Expert study on coastal water management							Participation in review of established expert contributions on concepts, review materials

*Note: Use as many additional rows for activities as needed*

#### 5. Communications plan development and implementation

- This will set out the process for dissemination of core messages to stakeholders on the importance of IWRM and the need for an IWRM Plan.
  - Define the target audiences
  - Determine key messages
  - Determine appropriate modes of dissemination



#### 6. Situational Analysis and IWRM Plan Framework

- Examine the existing water resources management system in terms of the IWRM principles and the goals of sustainable management and development.
- Identify the pertinent parameters of the hydrological cycle, and evaluate the water requirement of different development alternatives.
- Impacts on terrestrial (forests) and aquatic ecosystems as a result of water use, and waste water disposal/management should also be considered.
- Socio-economic aspects need to be assessed in terms of impacts of present water management system.
  - The analysis should pinpoint potential conflicts, their severity and social implications, as well as risks and hazards posed by flood and drought occurrence



#### 7. Vision Statement and Goals Articulation

- The vision statement for IWRM is an expression of society's aspirations in how they may benefit from good water resources management
- Establish **goals** in context of three main pillars
  1. Enabling Environment *e.g. Making provision for cost recovery, charges, incentives and financing arrangements to assist sustainability of water resources management initiatives*
  2. Institutional Roles *e.g. Separation of water resources management functions from service delivery functions*
  3. Management Instruments *e.g. Establish a water allocation mechanism*
- Establish **targets**: assist in focusing resources and guiding the selection of options for action



#### 8. Evaluate IWRM Plan options

- Look at IWRM Plan to determine if practical meets the national needs
- Some key considerations; does the Plan contribute to:
  - Reducing Poverty
  - Addressing Water Scarcity and Competition for Water
  - Improving the Situation of Women
  - Protecting Ecosystems
  - Maintaining Human Health
  - Sustaining Economic Development



## 9. IWRM Plan promotion, adoption and implementation

- Political and stakeholder participation from the onset of the process is of utmost importance to gain Plan acceptance
- Conditions of acceptance of the IWRM Plan would be clear at process inception.
- During the entire process, implementation of the Communications Plan is critical to keep stakeholders engaged and informed.
- Endorsement of the final draft of the Plan should be via national-level stakeholders forum; followed by ratification by the Cabinet of Ministers on behalf of Government



## Example workplan for IWRM Plan development (Union Island, SVG)

Key activities by Action area	Lead Responsibility	Quarters by year								
		Year 1				Year 2				
		1	2	3	4	5	6	7	8	
<b>Action 1: Process initiation</b>										
1.1	Topic national stakeholder consultation	DO, MGA								
1.2	Conduct national level stakeholder consultation	DO								
1.3	Preparation of briefing for plan development	DO, EU								
<b>Action 2: Steering Committee (SC) establishment</b>										
2.1	Draft TOR for Steering Committee	SC								
<b>Action 3: Process management team (PMT) establishment</b>										
3.1	Draft TOR for Project Management Team	SC								
3.2	Identify/assign members of PMT	SC								
<b>Action 4: Stakeholder involvement plan development and implementation</b>										
4.1	Focus group meetings	SC, PMT								
4.2	Consultation of Budget	PMT								
4.3	Stakeholder review	PMT								

SC - Steering Committee  
 PMT - Project Management Committee  
 DO - Department of Environment, Ministry of Health and Environment  
 DG - Director General of Health  
 MGA - Ministry of Governance and  
 GI - Government Information Service

## Example workplan for IWRM Plan development

Key activities by Action area	Lead Responsibility	Quarters by year								
		Year 1				Year 2				
		1	2	3	4	5	6	7	8	
<b>Action 1: Cross-sectional plan development and implementation</b>										
1.1	Development of strategy	SC								
1.2	Recruit communication specialist	SC, PMT								
1.3	Recruitment of professional services (communication material)	PMT								
1.4	Stakeholder review	PMT								
1.5	Identify partners (specifically through MGA)	SC, PMT, EU								
1.6	Production of material	PMT								
1.7	Distribution of awareness material	SC, PMT, GI								
<b>Action 2: Situational Analysis and IWRM Plan Framework</b>										
2.1	Preparation of TOR for expert studies	SC, PMT, EU								
2.2	Recruit specialist for expert studies	SC, PMT								
2.3	Conduct studies	PMT								
2.4	Consultation of findings	PMT								
2.5	Presentations to stakeholders	SC, PMT								

## Example workplan for IWRM Plan development

Key activities by Action area	Lead Responsibility	Quarters by year								
		Year 1				Year 2				
		1	2	3	4	5	6	7	8	
<b>Action 3: Vision Statement and Goals Articulation</b>										
3.1	Recruitment of consultant to review TOR for Plan	SC, PMT								
3.2	Stakeholder consultation - vision and goal setting	SC								
3.3	Focus group meetings - specific information requests	SC, PMT								
3.4	Consultation of findings	PMT								
3.5	Stakeholder review consultation - draft Plan review	SC, PMT								
<b>Action 4: Evaluate IWRM Plan options</b>										
4.1	Stakeholder review consultation - draft Plan review	SC								
<b>Action 5: IWRM Plan promotion, adoption and implementation</b>										
5.1	Presentation to national level - include stakeholder group	SC, EU, DO, MGA								
5.2	Presentation and consultation at Cabinet level	SC, EU, DO, MGA								
5.3	Government endorsement of implementation									

## Outcomes at end of Roadmapping process

- IWRM Road map document
  - Costed proposal for procuring \$\$ for full plan development (next stage)
- Sensitized public and lead actors
- High-level government endorsement for commitment to IWRM Planning process



## Next steps for Antigua & Barbuda

- Key considerations:
  - Why might IWRM be necessary for Antigua & Barbuda?
  - Who will lead process?
  - How to solicit high-level buy-in; what will be the 'hook'?
  - Roadmap map formulation; how?
    - Situational analysis
      - Governance structures, gaps, challenges, state of readiness for IWRM planning process
    - Main actions (9 steps)



## Partners in IWRM Planning in Caribbean



UNEP Collaborating Centre on Water and Environment  
**UCC-Water**



**Global Water Partnership**



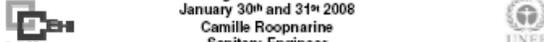
## 4.5 Camille Roopnarine: Caribbean Environmental Health Institute

### Programme to promote Rainwater Harvesting in the Caribbean



Pilot Project funded by  
**The United Nations Environment Programme**  
 Executed by  
**The Caribbean Environmental Health Institute**

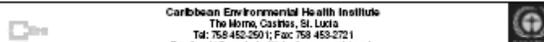
IWRM National Symposium  
 Antigua and Barbuda  
 January 30<sup>th</sup> and 31<sup>st</sup> 2008  
 Camille Roopnarine  
 Sanitary Engineer



### Presentation outline

- Background
- Regional RWH Programme
- Antigua and Barbuda National RWH Programme

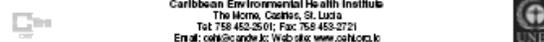
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 The Mirre, Castles, St. Lucia  
 Tel: 758 452 2501; Fax: 758 453 2721  
 Email: [cehi@carde.lc](mailto:cehi@carde.lc); Web site: [www.cehlog.lc](http://www.cehlog.lc)



### RWH in the Caribbean

- The Caribbean region has less available water per capita compared to other SIDS regions
  - Caribbean SIDS have only 13.3 % of the Indian Ocean island group's existing resources and 1.7 % of the South Pacific island group's existing resources (UNEP 1999)
- Main source of water for three centuries
- An estimated 500,000 people across the region depend on RWH to varying degrees
- Virgin islands, Turks and Caicos, and the Grenadines are heavily reliant on RWH systems
  - Islands characterized by small land area, no perennial streams and little significant ground water reserve

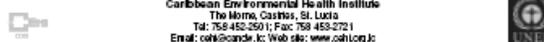
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### Why invest in RWH?

- RWH increasingly attractive as water availability declines due to competing uses
- Conservation of water from existing surface sources is of top priority – reduce sole reliance on these sources
- Stakeholders to benefit include:
  - Households – ease stress due to short-fall (increasing population, lifestyle changes) during dry months
  - Industry – enable maintenance of production capacity
  - Agriculture – enable irrigation of arable lands in arid areas (extend growing season); livestock watering
  - Hospitality sector – enable hotel plant expansion without need for costly alternative technologies (e.g. desalination)
    - Potential for use in pools, washing, sanitation and irrigation
  - Institutions (schools, hospitals) – ease stress due to short-fall
    - washing, sanitation

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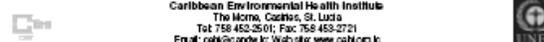


### RWH in the Caribbean

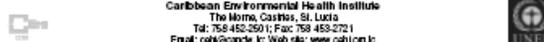
- Bahamas: Whale Cay has a piped distribution system based on rooftop-collected water
- Turks and Caicos: Government regulations make it mandatory for all homes to have storage capacity of (at least) 400 litres per m<sup>2</sup> roof area
- Grenadines: Carriacou and Petit Martinique are mostly reliant on RWH, 33 communal catchments and 78 public storage systems
- ANU: All new concrete homes are required by national standards to have a cistern or alternating water storage system.



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## Why invest in RWH?

### Main selling points

- Supply security
  - Reduce reliance on intermittent potable water network
  - Reduce vulnerability after natural disaster
    - Augmented supply after natural disasters (notably hurricanes) when potable water infrastructure is disabled
- Quality
  - The physical and chemical properties of rain water are often better than ground or surface water
- Cost
  - RWH is a simple and low cost method. No additional distribution systems necessary



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## CEHI's Previous Collaboration with UNEP

- UNEP has worked with CEHI in 2005 in Grenada to develop a National Rainwater Harvesting Strategy
- A Regional RWH Programme was developed for the Caribbean
- A Draft RWH Handbook was developed



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## Regional RWH Programme National-level actions

### ■ Component 1: Awareness Raising

- **Objectives**
- To enhance positive public awareness on the practice of RWH
- To increase investment in RWH
- To promote RWH as a viable augmentation measure for conventional potable networks in water-stressed areas, and promote water conservation
- To foster best practices with respect to health and sanitation

### ■ Component 2: Capacity Building

- **Objectives**
- To develop and improve national competency in developing (design and construction) and operating RWH systems
- To train communities in operation and management of community RWH systems
- To train professionals in water governance



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## Regional RWH Programme National-level actions

### ■ Component 3: Legislative and Policy Formulation

- **Objectives**
- To promote integration of RWH within national IWRM plans through policy and legislative reform
- To create an enabling environment to foster investment in RWH

### ■ Component 4: Infrastructural Development

- **Objectives**
- To optimize RWH systems to increase the quantity and improve quality of water
- To enhance capacity to manage and maintain communal RWH systems



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## Regional RWH Programme Regional-level actions

- Lead regional agency – to be determined
- Partnerships – strengthen advocacy efforts, resource mobilization
- Website – dissemination of best practices in RWH
- Toolkit and handbooks – educational resources
- Integration with other regional programmes (e.g. FAO School Feeding and School Gardening programmes)
- Public awareness promotion:
- Monitoring of national RWH initiatives;
- Training and certification of resource persons (e.g. via CBWMP)
- Building capacity within agencies and develop skills bank
- Develop model RWH applications



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## Public awareness

- Posters
- Technical brochure
- Feature video



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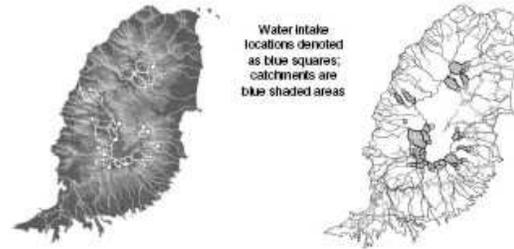
## Water Availability Mapping

- Objective: map areas on mainland Grenada subjected to moisture deficit
- Based on simplified water balance
  - Determine the depth of runoff from water catchment areas (areas upstream of NAWASA intakes)
- Three analytical steps
  1. Determine spatial variability in monthly rainfall
  2. Determine spatial variability in evapotranspiration (ET)
  3. Determine spatial variability in water deficit
- Catchments with low yield/runoff (during dry months) – downstream communities expected to experience shortfalls – **PROMOTE RWH!**

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Most catchments located at high elevations; high rainfall  
Water yield is function of catchment area and effective rainfall (balance after ET)

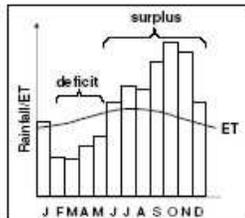


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## Water Availability Mapping

- Estimating water deficit
  - Simply the difference between rainfall input and ET losses
  - Also referred to as effective rainfall
    - Water available for abstraction – potable (domestic) water; irrigation, livestock watering



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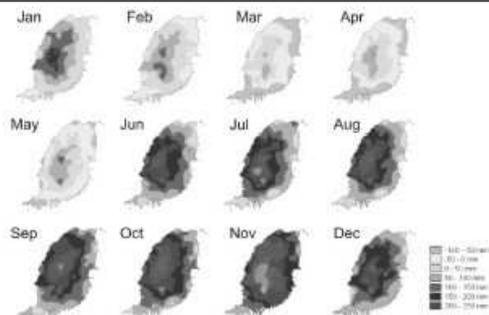
## Water Availability Mapping

- Water balance – partitioning of components of the hydrological cycle
- $P = R + ET + S$  (simplified)
  - $P$  = rainfall
  - $ET$  = evapotranspiration (FAO Penman-Monteith combination equation)
  - $S$  = storage
- In small island environments the storage component is negligible (relative to other components)
- Hence, after estimating losses to ET; remainder from precipitation input is runoff; available for use

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## Water Availability Mapping



## Water Availability Mapping



By extension, communities exclusively dependent on these sources will be relatively vulnerable to water stress during dry months. Water supply augmentation strategies highly recommended. (NOTE: there may be other abstraction sources not analyzed at this time; verification needed)

March rainfall deficit

## Objectives of the ANU Project

- To raise awareness at the public and policy makers level
- Capacity building at both individual and institutional levels
- Development of infrastructure
- Development of GIS Maps to reflect the impact of climate change on water resources under various climate change scenarios



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## ANU RWH Pilot

### ■ Antigua and Barbuda selected:

- Opportunity to share experiences already in place in Antigua and Barbuda for the benefit of other Caribbean countries
- Opportunity to raise the awareness of best practices already in place in ANU for other proponents



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## Rainwater Harvesting Initiative 2008

- National Symposium
- Training Seminars (2) for RWH practitioners
- Selection of two (2) demonstration models – low income household and small business
  - These models would be provided with assistance in order to improve their RWH systems. The process (technical specifications and costs) would be documented
- Showcase seminar
- RWH Handbook
- Water Availability Mapping



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## Partners

- Antigua Public Utilities Authority
- Central Board of Health
- Ministry of Communications and Works
- UNEP
- Environmental Division



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## National Symposium

- Open to a broad cross section of the public and private sector
- Kickstarts the IWRM process in Antigua and Barbuda
- Designed to raise awareness of the importance of investment in RWH particularly in the context of increased water scarcity associated with the impacts of climate change



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## Capacity Building

- Two one-day seminars will be conducted for practitioners
- Seminars will be practical
- Training on configuration, installation/retro fitting appropriate RWH systems on building structures, paved and ground surfaces



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## Capacity Building

- Existing RWH practitioners will be recruited as resource persons
- Targeted for small contractors, planners, small businesses, farmers etc



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## Demonstration Models

- |  |  |
|--|--|
| <b>Low Income Household</b>  | <b>Small Business</b>  |
| ▪ Must have a RWH system in place                                      | ▪ Preferably agro processing   |
| ▪ Project will provide funds for the improvement of the infrastructure | ▪ Must use RWH in the production process                               |
|  | ▪ Project will provide funds for the improvement of the infrastructure |



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## Mapping

- Develop GIS maps indicating climate change impact on water resources for different climate change scenarios
- Involve modelling projected changes in rainfall inputs and temperature regimes
- Used to estimate changes in the overall budget for the island



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## Way Forward

- A RWH technical handbook will be produced (will reflect the work done in Antigua and Barbuda)
- These handbooks will be distributed to other countries in the Region



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## Thank You!



<http://cehi.org.lc/rainwaterharvest.htm>

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## 4.6 Lionel Michael: Central Board of Health

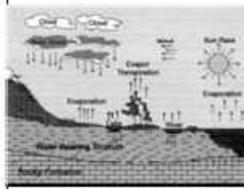


### Rainwater Harvesting

Lionel Michael  
Chief Health Inspector



### 21<sup>st</sup> century potential problems



- rising sea levels
- more costly energy supplies
- adequate useable water supply

### DETAIL ISSUES

- partnership between CEHI and CBH on the selection of potential 'candidate demonstration sites.
- education program
- disinfecting chemicals in the rainwater storage facilities
- water-holding vessels - mosquito breeding containers

### Microbiological characteristics

- total coliform - 'indicator'
- fecal coliform - 'presence of animal waste'

***harvested water not be used for potable purposes***  
***there be absolutely no physical connection between a harvested-water system and the APUA system.***

### Physical & chemical characteristics

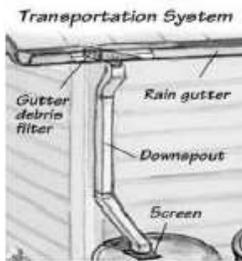
- "Maximum contaminant level," (MCL)
  - ◆ inorganics ranging from barium to sulfate
  - ◆ organics, pesticides and herbicides,
  - ◆ disinfectant and disinfectant byproducts
  - ◆ lead and copper

### Physical & chemical characteristics

- Iron content
  - ◆ aesthetic concern - stain fittings such as sinks and toilet bowls.
- zinc



## harvested rainwater



- 'soft' water
- 'dirt' of various kinds, leaves and twigs
- color, taste, and odor

## Questions



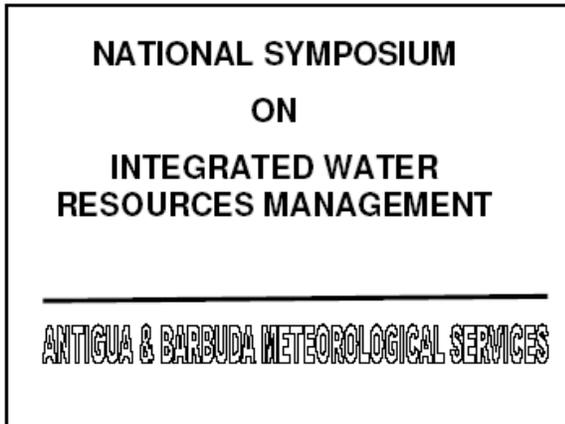
- leakage loss through the national water distribution system
- reduced-flush toilets mandated
- 'secondary' water sources such as wastewater treatment plant effluents

## Questions

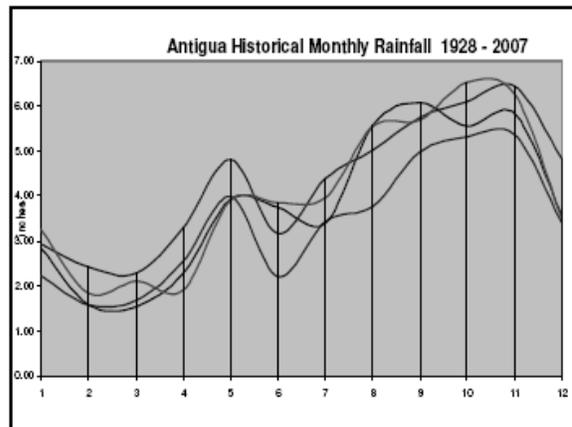
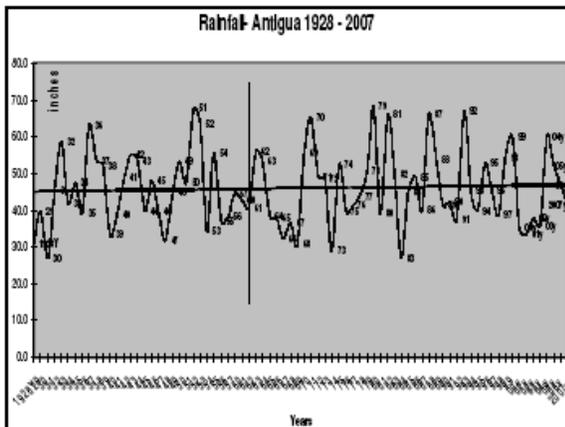
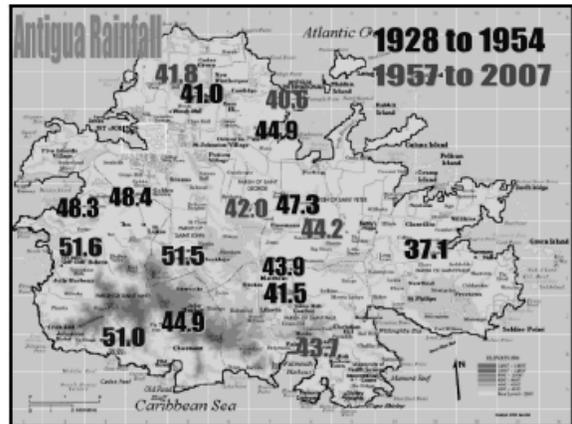


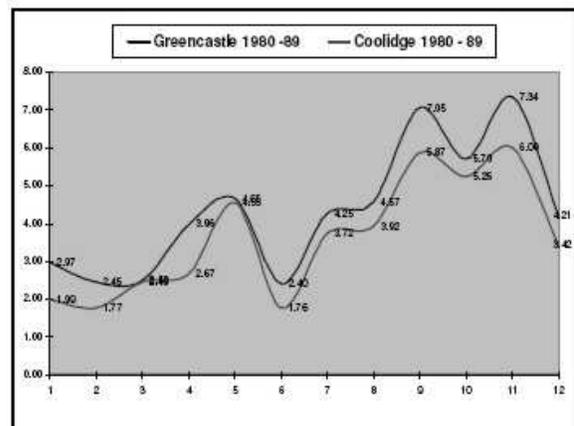
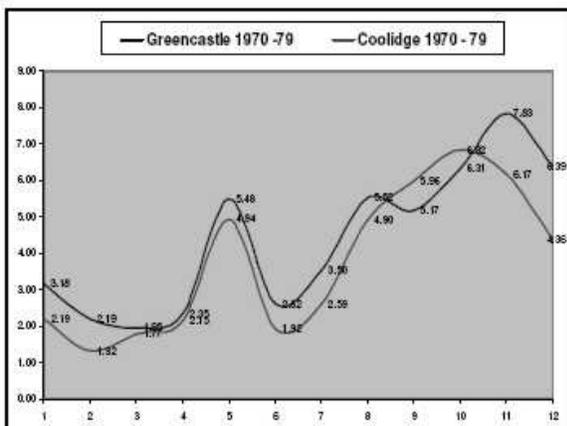
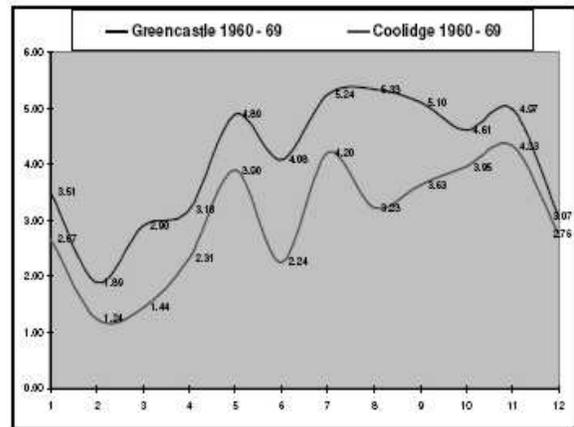
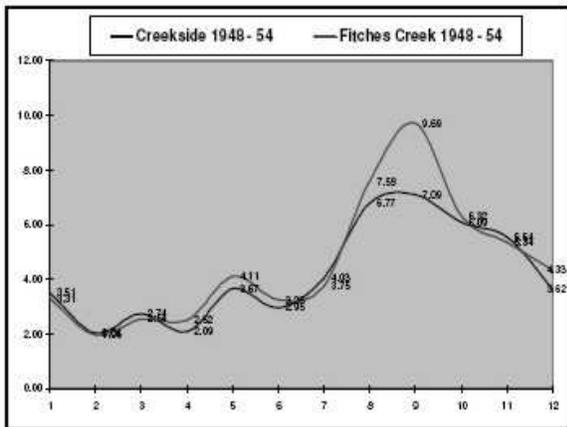
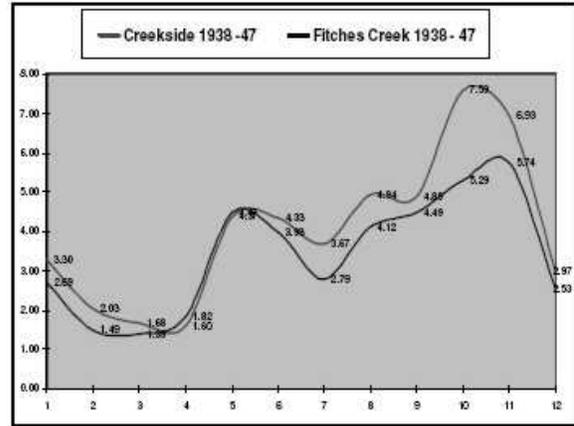
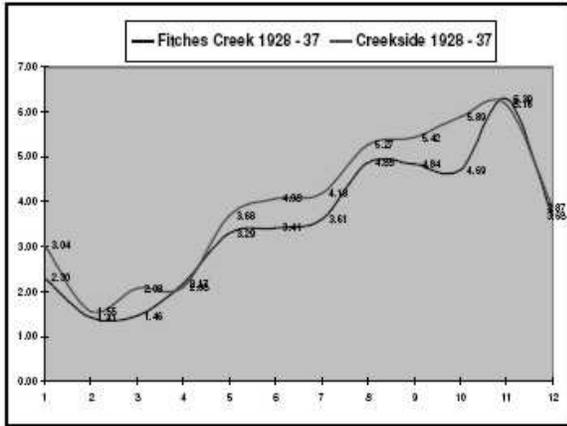
- reforestation and improved diversion of runoff
- surficial soil amendments created from the organic fraction of the waste stream

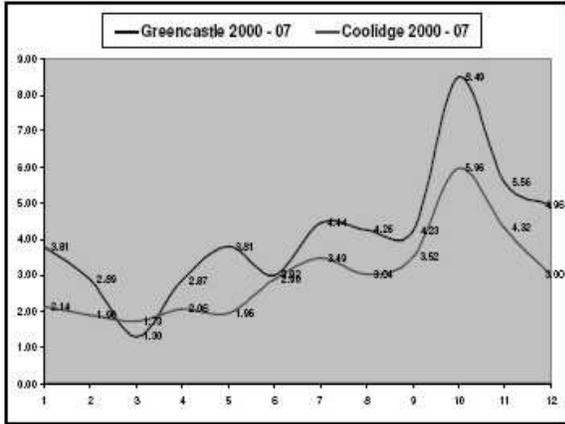
## 4.7 Keithley Meade and Dale Destin: Antigua and Barbuda Meteorological Services



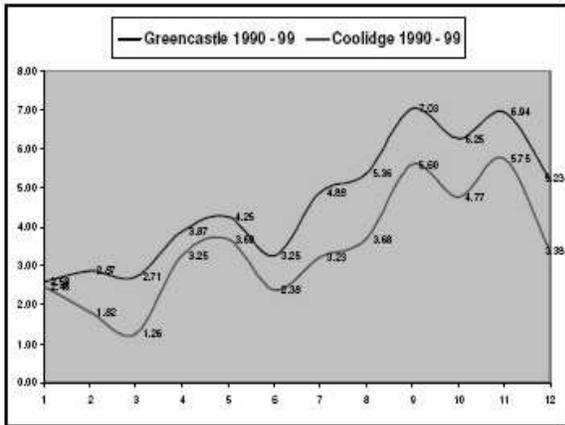
- Rainfall producing weather systems that affect Antigua and Barbuda annually are typically:
- High pressure ridges
  - Tropical waves
  - Troughs
  - Fronts (mostly cold fronts)
  - Storms/hurricanes.







- THE EFFECTS OF CLIMATE CHANGE ON OUR RAINFALL
- RAINFALL DISTRIBUTIONS
- DROUGHTS

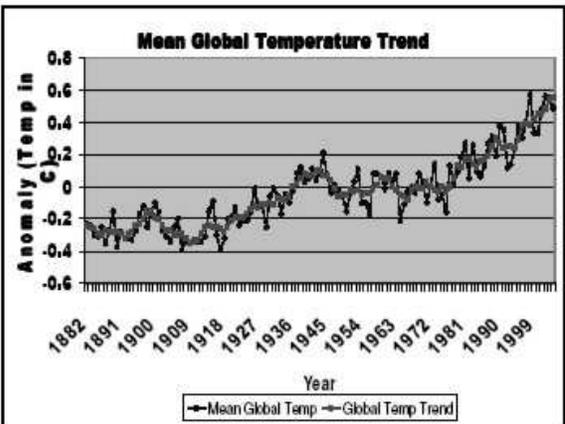


Climate

**The average weather conditions at a particular place over a period of time, generally not less than 30 years.**

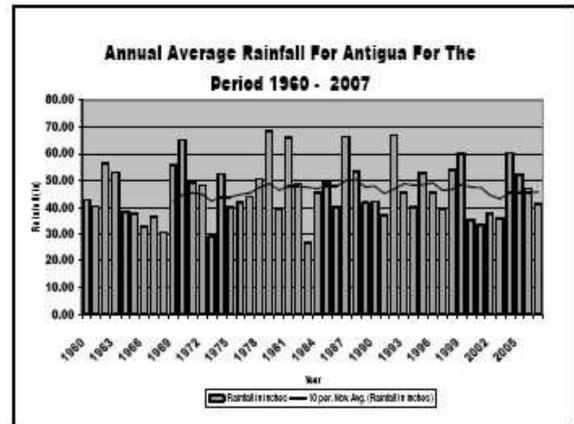
Climate Change

**The change in climate attributed directly or indirectly to human activity which, in addition to natural climate variability, is observed over comparable time periods.**



Rainfall before departure from mean:  
45.68" or 1160.27 mm

Rainfall after departure from mean:  
46.82" or 1189.23 mm

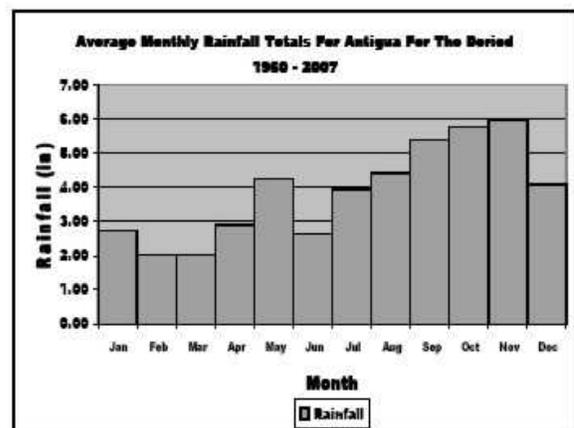


### Antigua

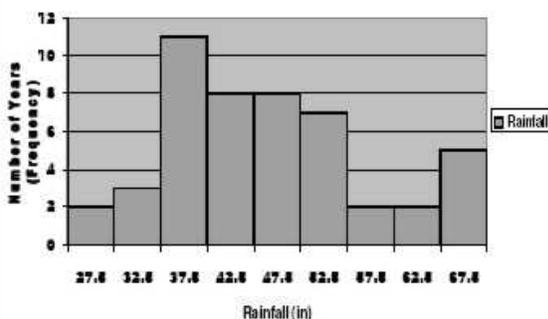
The normal annual avg. rainfall:  
46.16" or 1172.46 mm

### Barbuda

Spring View: 44.31" or 1125.47 mm



Average Annual Rainfall Frequency Distribution For Antigua For 1960 - 2007



### Drought

A drought is a prolonged, abnormally dry period when there is not enough water for users' normal needs. Drought is not simply low rainfall. Because people use water in so many different ways, there is no universal definition of drought.

### Drought Episodes In Antigua

At the Meteorological Office, we also measure drought and wet episodes in seasons; a season being any three month period.

Example: DJF JFM FMA.

### Drought Episodes In Antigua Continues

A drought episode is a continuous set of three seasons or more whose rainfall totals fall in the first tercile of the historical rainfall data.

A wet episode is a continuous set of four seasons or more whose rainfall totals fall in the third tercile of the historical rainfall data.

### Drought Episodes In Antigua Continues

By this measure, we experience, on average, a drought episode every 18 months and a wet episode every 34 months.

THE END...  
???

**4.8 Alvin Christian: Private sector representative (selected slides of water harvesting/irrigation initiative at Bendals, Antigua.**









