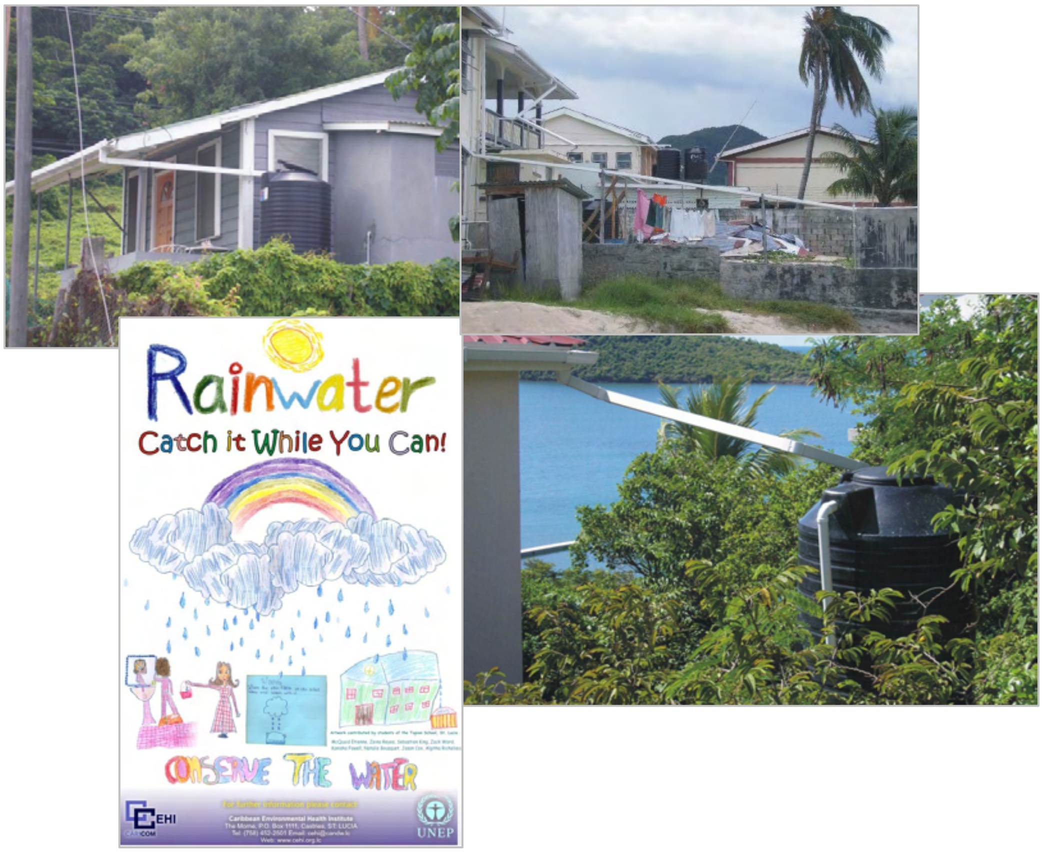
A Programme for Promoting
Rainwater Harvesting
in the Caribbean Region



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Executive Summary

The Caribbean Environmental Health Institute (CEHI) is the executing agency for the Caribbean component for a United National Environment Programme (UNEP)-funded global initiative on the promotion of the practice of Rainwater Harvesting (RWH). The tri-island State of mainland Grenada and its sister islands of Carriacou and Petit Martinique were chosen as a pilot for this initiative given their recent experience with the destruction brought on by Hurricanes Ivan and Emily in 2004 and 2005 respectively. These storms caused massive damage to the housing stock and commercial sectors, and disrupted water supplies in mainland Grenada for extended periods. Landslides and sedimentation from heavy rains caused problems to the distribution network, highlighting vulnerability of island communities to extreme water scarcity in a post-disaster environment. A national RWH programme was developed for Grenada, which emerged out of a national assessment of key public and private sector stakeholder institutions, and select communities, followed by national workshops held in mainland Grenada and Carriacou.

The Grenada national programme provided the basis for development of a Regional Programme which seeks to replicate the national actions proposed for Grenada, in addition to actions best implemented at the regional level to facilitate coordination and harmonization of approaches across the region.

The Programme is framed against the global vision of Integrated Water Resources Management (IWRM) with a broad objective stated as "*to contribute to the conservation of the water resources of the Caribbean through adoption of sustainable water management and conservation technologies*". More specifically, the Programme seeks to develop and strengthen capacity to facilitate the implementation of rainwater harvesting for household and commercial purpose and develop support policies and incentives, and mainstream them into national development strategies and policies within an IWRM framework.

The four major strategic areas constituting the elements of the Programme to be executed within the countries and across the Region are:

(1) Awareness-raising at the general public and policy maker levels;

(2) Capacity building at both the individual and institutional levels;

(3) Governance in terms of legislation and policy formulation;

(4) Infrastructural development.

The elements in the Programme that are outside the national scope will focus on strengthening regional partnership arrangements to facilitate coordination, resource mobilization, advocacy, information exchange and programme monitoring. Appropriate model RWH applications will be developed through the regional mechanism.

The regional Programme is proposed to run over a four-year period at an estimated cost of US$1,844,000. The lead regional agency to promote the programme will be defined in further consultation with regional partner agencies. It is proposed that the regional Programme forms the basis for a Caribbean Rainwater Harvesting Partnership initiative. Several RWH partnership networks exist in various regions of the world and these partnerships can be relied upon to assist in mobilizing the Caribbean Partnership and Programme.

Acronyms

CARDI	Caribbean Agricultural Research and Development Institute
CARICOM	Caribbean Community
CCCCC	CARICOM Caribbean Climate Change Centre
CEHI	Caribbean Environmental Health Institute
CWWA	Caribbean Water and Wastewater Association
FAO	Food and Agricultural Organization
gals	Imperial gallons
GoG	Government of Grenada
GPD	Gallons per day
GWP-C	Global Water Partnership Caribbean
IICA	Inter-American Institute for Cooperation on Agriculture
IWCAM	Integrating Watershed and Coastal Areas Management (project)
IWRM	Integrated Water Resource Management
km	kilometers
kph	kilometers per hour
m^3/d	cubic metres per day
MCM	million cubic metres
MGD	million gallons per day
MOH	Ministry of Health
mm	millimetres
Mm^3/day	million cubic metres per day
mph	miles per hour
NAWASA	National Water and Sewerage Authority
OAS	Organization of American States
OECS	Organization of Eastern Caribbean States
PSA	Public Service Announcement
RO	Reverse Osmosis
RWH	Rain Water Harvesting
SIDS	Small Island Developing States
SOPAC	South Pacific Applied Geoscience Commission
UNDP	United Nations Development Programme
UN-ECLAC	United Nations Economic Commission for Latin America and the Caribbean
UNEP	United Nations Environment Programme
US$	US dollar (equivalent to 2.70 East Caribbean dollars)
UWI	University of the West Indies

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The participants of the regional strategic planning workshop held in Tortola, British Virgin Islands (BVI) in March 2006 are thanked for providing their first-hand experiences in application of RWH systems and for their inputs in the conceptualization of this regional RWH programme for the Caribbean.

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1. Background and Scope

UNEP has embarked on a global initiative to promote Rainwater Harvesting (RWH) and to date has implemented projects in Asia, Africa and the Pacific Small Island Developing States (SIDS). UNEP is extending the initiative to the Caribbean using Grenada as a pilot, drawing on lessons learnt from other regions, particularly the Pacific SIDS. UNEP has also facilitated the formation of the Global Rainwater Partnership and CEHI will play a leadership role in its promotion in the Caribbean region.

The project funded by UNEP entitled "Promoting Rainwater Harvesting in Caribbean Small Island Developing States" has as a main objective ***to promote adoption of RWH practices and mainstreaming strategies that facilitate its adoption within wider water sector policies and to strengthen the institutional and human resources capacities of the Caribbean countries to use RWH***.

Grenada and its dependencies, Carriacou and Petit Martinique were selected for this pilot initiative given their recent experience with Hurricanes Ivan and Emily in 2004 and 2005 respectively. These storms wreaked great destruction on the tri-island State with the resulting negative impacts on water availability and quality, as well as on sanitation. The project leads to the articulation of a national RWH programme which seeks to build resilience in communities in terms of access to water in a post-disaster environment, and facilitate water supply augmentation during drought conditions. Grenada was well-suited since it has the attributes of a typical Caribbean SIDS, shares similar vulnerabilities and faces similar development challenges with respect to management and equitable access to water resources.

The Grenada national RWH Programme was used as the basis for upscaling to the regional level, incorporating regional level coordination and partnership activities. The Regional Programme presented in this document was defined from a series of consultations that assisted in the development of the Grenada programme, along with a major regional strategic planning workshop that was convened in Tortola in March 2006. The Regional Programme maintains the same four major strategic areas as in the Grenada national strategy and includes cross-cutting elements to be managed at the regional level. The four strategic areas are: (1) Awareness Raising, (2) Capacity Building, (3) Legislative and Policy Formulation and (4) Infrastructural Development. For each strategic area the objectives and key actions are detailed, along with key indicators and indicative costs.

In line with the Johannesburg Declaration of 2002, the countries of the Caribbean are in the initial stages of preparation of integrated water resource management plans (IWRMs). This will be a significant adjunct activity under the project Integration Watershed and Coastal Areas Management (IWCAM) that is presently being implemented in Caribbean SIDS over the next five years. This Regional Programme must be regarded as one of the elements in IWRM planning, particularly in the context of promoting water use efficiency and enhancing water security. In addition, the Programme should become an integral strategic element in the region's programme of adaptation to climate change and climate variability. It is also expected that the Programme will contribute to global knowledge-sharing in parallel with similar initiatives in the African and Pacific regions.

2. Introduction

2.1. Water and developmental issues – Global to Small Island Developing State perspectives

Water is life! It is undisputed that water is the most vital natural resource and all of life and life support processes are dependent on this liquid medium. Many scientific theories postulated that life itself originated in an aqueous medium and even though it evolved to survive under drier conditions, the role of water as a medium and conveyance of biochemical reactions that support survival and propagation of life remains a critical one. The finiteness of available water on this earth is very discernible when we consider that of the 1,400 million cubic kilometers of water on earth and circulating though the hydrological cycle, only one-hundredth of 1% of this amount is readily available for human use (FAO, 1995). It is believed that this quantity is sufficient to meet humanity's needs if it were evenly distributed; however, this available 9,000 cubic kilometer volume is very unevenly distributed across the planet. In areas where the indigenous water supplies average less than 1,000 cubic meters per person per year, these areas are categorized as water scarce (FAO, 1995).

The amount of water available to each person is falling considerably as growing human populations continue to place tremendous pressure on diminishing water resources. Water scarcity is exacerbated by pollution. According to the FAO (1995), 450 cubic kilometers of wastewater pollute the world's surface waters each year reducing utility of these waters for safe human consumption. This not only has implications for human populations but also for the natural environment, offsetting the delicate balance of ecological systems, and in severe cases unleashing irreversible consequences which may have direct adverse socio-economic consequences.

This situation is of particular concern for developing countries and Small Island Developing States (SIDS) where nearly one-third of the population has no access to safe drinking water. The Caribbean region has the least water available per capita as compared to other SIDS regions; just 13.3% of that available in the Indian Ocean SIDS and 1.7% of that available in the South Pacific SIDS on a per-capita basis. The island of Barbados for example, is ranked among the ten most arid countries in the world. The geomorphology of most Caribbean islands limits the physical availability of freshwater reserves on account of relatively small landmass areas and typical mountainous terrain. The impacts of relatively frequent natural disasters (typically hurricanes and floods) exacerbated by human activity, compromise water supply systems for extended periods, placing populations at risk under water scarce conditions. The potential impacts of climate change and climate variability on the water regime in SIDS cannot be underestimated and constitutes an additional threat to water security.

2.2. Rainwater Harvesting – a practical water augmentation measure

Available literature cites many variations on the definition of rainwater harvesting. A composite definition used in this document is:

Rainwater Harvesting is the method of capture of rainwater from man-made surfaces (typically rooftops and other constructed surfaces) and its storage for various applications which can include household, agricultural (irrigation and livestock watering) and commercial.

Rainwater harvesting (RWH) has been practiced by civilization for more than 4,000 years to satisfy daily water demands. This ancient technique continues to be an important source, in some cases the only source of fresh water to many communities, particularly those isolated from municipal water distribution infrastructure. In the context of the increasing pressures on limited conventional reserves and consequent supply constraints, the practice has tremendous potential for application in the Caribbean, from household to commercial purpose. The Caribbean region has a sub-tropical climate with relatively abundant rainfall during half of the year where wet-season rainfall accumulations vary from 1,500 mm to in excess of 3,000 mm.

The rudimentary practices of RWH have been improved with the introduction of simple technologies, and most water quality standards can be met by application of basic practices. RWH is a simple and low-cost water supply technology which is generally easy to install and maintain. In spite of these considerations, the practice has been declining in the Caribbean as communities have become better serviced by central municipal systems. Many countries have not included rainwater harvesting in integrated water resources management (IWRM) plans and/or water polices, as has been done for management of ground and surface waters. As a result, there has been relatively little commitment to investment in the practice in many islands. This can be further attributed to inadequate awareness, lack of requisite skills and knowledge among citizens and their governments.

The Thirteenth Session of the United Nations Commission on Sustainable Development (CSD 13) held between the 11th and 22nd April 2005, which focused on water policy, called for the use of rainwater harvesting to augment water demand and for the development of capacities in rainwater harvesting in accordance with the countries' needs involving all stakeholders, particularly women, youth and local communities.

Rainwater harvesting continues to be a main source of water supply in many of the drier islands of the Caribbean, notably the Grenadines, the Leeward and Virgin Islands, and the Bahamas. However, the emerging trend in some of these islands is to move away from traditional RWH methods in favour of alternative technologies such as desalination and deep-well abstraction. These alternative technologies come at a higher cost and sustainability of these alternatives depends on consumers' ability and willingness to pay for these services. Where investments in expensive water supply options are not viable, RWH remains an attractive option to meet shortfalls in supply particularly during the dry months.

It is important to note however, that rainwater harvesting is not intended to replace other conventional sources of water. Harvesting rainwater simply provides an additional measure of security to householders, farmers, hospitals, schools, hotel and business operators during times of water scarcity. The technology can be easily incorporated into existing plumbing systems and existing hard surfaces (kept clean) can be used to capture and channel harvested water.

An important consideration which warrants investment in RWH systems is the potential for enhancing water security following natural disasters (notably hurricanes), where distribution infrastructure may be damaged and remain out of commission for extended periods. Lack of water for drinking and sanitary purposes after natural disasters presents very serious health challenges in affected communities given the threat posed by diseases such as dysentery, typhoid and cholera.

Applications of rainwater harvesting are not only limited to household and domestic purpose but are also important to agriculture and the commercial sectors where rainwater can be used to offset heavy demands for non-potable water. The high volumes of potable water that are used in a variety of manufacturing, washing/cleaning, watering (crops and livestock) processes can be augmented by rainwater, which can benefit production costs and assist in conserving water supplies in general.

In several arid parts of the world rainwater is harvested to assist ground water aquifer recharge, given the high rates of exploitation. In the Caribbean however, this is not seen to be a leading objective driving the implementation of national RWH promotion programmes given the rainfall regimes in the region with respect to natural aquifer recharge and the abstraction rates. There is some application in the Caribbean; in Barbados for example, runoff from the drainage systems of paved road surfaces is used to recharge local aquifers.

Investment in RWH at the community level should be framed against the following considerations (UNEP/OAS, 1997):

- Is there a real need for an improved water supply in terms of reliability and quality?
- Are present water supplies either distant and not easily accessible or contaminated, or both?
- Are suitable roofs and/or other catchment surfaces available for capture of rainwater?
- Does the average annual rainfall exceed 400 mm? (this consideration is a benchmark applied in arid countries and is not generally applicable in the Caribbean where rainfall exceeds that amount)
- Does an improved water supply feature prominently in the community's list of development priorities?

If the answers to the above questions are 'yes', it is a clear indication that rainwater harvesting might be a feasible water supply augmentation measure.

As with all technologies and processes there are advantages and inherent disadvantages. UNEP/OAS's Source Book of Alternative Technologies for Freshwater Augmentation in Latin America and the Caribbean (1997) lists of advantages and disadvantages typically associated with implementing RWH systems.

Advantages:

- Rainwater harvesting provides a source of water at the point where it is needed. It is owner-operated and managed;
- It provides an essential reserve in times of emergency and/or breakdown of public water supply systems, particularly during natural disasters;
- The construction of a rooftop rainwater catchment system is simple, and local people can easily be trained to build one, minimizing its cost;
- The technology is flexible. The systems can be built to meet almost any requirements. Poor households can start with a single small tank and add more when they can afford them;
- It can improve the engineering of building foundations when cisterns are built as part of the substructure of the buildings, as in the case of mandatory cisterns;
- The physical and chemical properties of rainwater may be superior to those of groundwater or surface waters that may have been subjected to pollution, sometimes from unknown sources;
- Running costs are low and construction, operation, and maintenance are not labour-intensive;

Disadvantages:

- The success of rainfall harvesting depends upon the frequency and amount of rainfall; therefore, it is not a dependable water source in times of dry weather or prolonged drought;
- Low storage capacities will limit rainwater harvesting so that the system may not be able to provide water in a low rainfall period. Increased storage capacities add to construction and operating costs and may make the technology economically unfeasible, unless it is subsidized by government;
- Leakage from cisterns can cause the deterioration of load bearing slopes;
- Cisterns and storage tanks can be unsafe for small children if proper access protection is not provided;
- Possible contamination of water may result from animal wastes and vegetable matter;
- Where treatment of the water prior to potable use is infrequent, due to a lack of adequate resources or knowledge, health risks may result; further, cisterns can be breeding grounds for mosquitoes;
- Rainfall harvesting systems increase construction costs and may have an adverse effect on home ownership. RWH systems may add between 30% and 40% to the cost of a building;
- Rainfall harvesting systems may reduce revenues to public utilities;
- Rainwater is mineral-free; generally has a flat taste and may contribute nutrition deficiencies in people who are already on mineral-deficient diets.

3. Situational Analysis of the Caribbean

3.1. Geography

The Caribbean is an archipelago of small island states stretching from the Gulf of Mexico and the southern United Sates to the northern coast of South America, with the Caribbean Sea to

Figure 1: The Caribbean region *(on-line map source: University of Texas at Austin)*

the west and the North Atlantic Ocean to the east. Also included in the Caribbean Community (CARICOM) of nations are three continental countries, namely Belize, Guyana and Suriname. Countries outside the CARICOM group include Cuba, the Dominican Republic, the French overseas departments of Martinique and Guadeloupe, Puerto Rico, the United States Virgin Islands and the Netherlands Antilles.

The Caribbean islands are varied in their size and topography. The region is divided into two island groups, the Greater Antilles and the Lesser Antilles (Figure 1). The former are comprised of the large islands of Cuba, Jamaica, Hispaniola (which is shared by the countries of Haiti and the Dominican Republic) and Puerto Rico. The Lesser Antilles include all the small islands in the archipelago that extend east of Puerto Rico southward to Trinidad. The Bahamas and Turks and Caicos lie to the north of the Greater Antilles. The islands of the Greater Antilles are significantly larger than those in the Lesser Antilles and with the exception of Cuba are characterized by elevated terrain. The geology of these islands is varied and include sedimentary and volcanics, and freshwater is supplied from surface runoff and ground aquifers. In Jamaica for example, a significant area of the island is characterized by limestone formations possessing significant ground water reserves. Water scarcity tends to be critical generally in areas along the coastal fringe or in heavily populated areas where demand exceeds supply capacity.

The Lesser Antilles are volcanic islands that include some of the Virgin Islands, St. Kitts and Montserrat in the north southward to Grenada, and the coralline islands that include Antigua, Barbuda and Barbados. The volcanic islands lie at the edge of the South American Plate subduction zone and are dominated by elevated terrain and orographic lifting yields relatively high moisture regimes. Most of the freshwater resources on these islands are derived from surface sources, as ground water tends to be relatively inaccessible. The coralline islands are characterized by low elevation and total rainfall accumulations tend to be low resulting in arid conditions. On these islands water is generally extracted from ground sources and augmented by rainwater harvesting. The Bahamas and the Turks and Caicos possess similar geomorphology.

The islands in the Caribbean are characterized by a tropical maritime climate. Mean annual rainfall in the Greater Antilles ranges between 1,300 mm and 2,000 mm, although accumulations in the highest mountain ranges of Jamaica can exceed 5,000 mm. The low coralline islands of the Lesser Antilles tend to be most arid where mean annual rainfall ranges between 1,275 mm and 1,875 mm. In the Bahamas rainfall varies over the island group, ranging from 600 mm in the dry south-eastern islands to more than 1,600 mm in the north-western islands. The volcanic islands tend to have a higher rainfall regime on account of their elevated terrain and consequent orographic rainfall. Mean annual rainfall ranges between 1,000 mm and 3,000 mm with higher accumulations in the interior.

Rainfall over the region is seasonally distributed with approximately 80% of the annual rainfall occurring between May and December (Enfield & Alfaro, 1999) on account of cyclonic activity associated with the hurricane season. The dry season during the first half of the year is characterized by significant moisture stress and in many islands water availability is exacerbated by human-induced factors that adversely affect the natural environment. Lowered dry-season stream flows and pollution of surface ground water are major manifestations of unsustainable land use that are now having serious implications for long-term socio-economic development. The looming threat from climate change and the possibility for altered rainfall patterns warrants concern for the Caribbean whose available water resources are already highly vulnerable. In a circumstance of reduced rainfall, this will mean less recharge and more severe water scarcity; in a scenario of increased rainfall and more extreme weather the possibility exists for accelerated land and water degradation from already degraded watershed areas.

3.2. Socio-economic factors and water-related environmental considerations

The population of the Caribbean numbers approximately 40.6 million (excluding Martinique and Guadeloupe) (UN-ECLAC, 2004). Of this some 15.8 million are from Caribbean Community (CARICOM) member and associate member states. By 2015 the population is projected to reach 44.6 million (not considering Martinique and Guadeloupe) of which 18.0 million will be from CARICOM member states (UN-ECLAC, 2004).

At the Johannesburg World Summit on Sustainable Development in 2002, participating member states agreed to commit to halve, by the year 2015, the proportion of people without access to safe drinking water *(reaffirmation of Millennium Development Goal)* and halve, by the year 2015, the proportion of people who do not have access to basic sanitation (UNDESA, 2002). The **Caribbean Water Vision**, which was complementary to the World Water Council's Long-term Vision on Water, Life and Environment in the 21st Century (**Vision 21**) stated that: *" All people in the Caribbean within the next 25 years (should) have safe, adequate, reliable, affordable water and sanitation facilities as a Basic Human Right; in an equitable manner through partnerships, appropriate technology, low cost solutions, gender sensitive approaches to development, which will ensure the enhancement of the environment and an improved quality of life".* (Sweeney & Vermeiren, 2002).

Access to safe water supplies varies between the Caribbean States. In most of the islands, municipal water distribution network services the majority of households. In Barbados as many as 99% of all households are serviced with pipe-borne water supply. By contrast, only 35% of households in Port-au-Prince, Haiti, are serviced by the unreliable municipal water supply; water distribution to the remainder of the country is sporadic, contributing to serious health and sanitation problems (USACE, 1999). Of all the countries, only Dominica and Guyana are relatively water abundant, although concern is being expressed in Dominica over apparent declining baseflows. In many countries antiquated and inefficient water distribution networks severely compromise delivery of services to some communities which often go for extended periods without reliable water supplies. Effective water resource management is hindered by lack of adequate governance mechanisms, human and financial resources and little exists in the way of effective market-based incentives to encourage investment in conservation.

The pressures of access to water is expected to become more severe given increasing populations and the rapidly growing demands for water from other economic sectors, notably the hospitality sector, which has seen dramatic growth in most Caribbean states. This creates special challenges as peak demand (corresponding to peak visitor arrivals) in that sector coincides with the driest period of the year where demands can range from between five and ten times the amount required by the residential sector (Sweeney & Vermeiren, 2002). Water availability is also negatively impacted by improper land use management practices within watershed areas resulting from unsustainable agriculture, poorly planned commercial and urban development, solid and liquid waste pollution. Countries that rely on ground water abstraction such as Barbados and the Bahamas are vulnerable to saline intrusion resulting from over-exploitation of groundwater aquifers.

Other compounding problems to the water availability situation in many Caribbean SIDS include inadequate legal and institutional frameworks, weak policy and planning guidance for water management, limited financial and human resources and consequent low level of investment in infrastructure and environmental monitoring, public apathy, low level of awareness and the realities of poverty in many of the affected communities.

Many Caribbean countries are increasingly faced with the prospect of exploiting alternative resources to ease the demands placed on conventional water reserves. In the Bahamas, the Cayman Islands, the Virgin Islands and Turks and Caicos, desalination is becoming increasingly important in spite of the production cost. The Point Lisas Industrial Complex in Trinidad now relies primarily on desalinated water on account of supply difficulties from the municipal supplies (UNESCO, 2006). Investment in desalination is viable in countries with higher per-capita income where consumers have a greater ability to pay. In most of the other countries where investment in desalination is not economically viable, traditional sources will continue to be exploited; affordable water augmentation measures and enhancement of use-efficiency will need to dominate water development agendas in these countries.

3.3. Impacts of extreme events on water resources in small islands

Although the Caribbean has been impacted by destructive hurricanes such as Gilbert (1988), Hugo (1989), Luis (1995), Georges (1998) in recent decades, the Atlantic hurricane season has been particularly active in 2004 and 2005. The islands of the Caribbean have seen a succession of destructive hurricanes that included Ivan, Emily, Jeanne, Frances, that have carved paths of death and destruction, wreaking great losses to economies and infrastructure. In 2004 damages across the Caribbean was in excess of US$5.7 billion. The increase in hurricane activity is forecast to continue over the next decade in a return to more conducive atmospheric and oceanic conditions to spawn formation of storms. There is a great deal of speculation that the spike in the occurrence of major hurricanes is attributable to warming sea surface temperatures as a result of global warming. Whether there is in fact a real linkage between climate change and the increase in hurricane activity, the fact remains that Caribbean populations are becoming increasingly vulnerable to the effects of extreme weather phenomenon as communities continue to grow in high-risk areas.

In post-disaster conditions, water scarcity is among the most dangerous outcomes with increases in outbreaks of infectious water-borne diseases such as dysentery, typhoid and cholera. The impacts of destructive cyclones on watershed systems of small islands are particularly evident where the watersheds have been highly degraded on account of unsustainable land management practices attributable to agriculture, housing or other infrastructural development. The high rainfall accumulations associated with these storms tend to cause massive erosion in steep upland areas where the soils have been rendered exposed, with consequent siltation of river channels and deposition of enormous sediment loads in offshore marine ecosystems. In many Caribbean islands a large percentage of the potable water supply is sourced from rivers and streams typically in upland areas that may be already compromised by human activities in the watershed. Silt and debris-laden high storm flows frequently choke the water intake infrastructure, while landslides often cause breakages in water distribution lines, forcing supply interruptions to many communities for weeks, in some cases, months. Water supply deficiencies over extended periods can have serious adverse public health and sanitary implications.

The need to secure adequate potable water supplies to assist with the post-disaster restoration and recovery efforts cannot be understated. Following Hurricanes Ivan (2004) and Emily (2005) which both struck the tri-island state of Grenada, the availability of potable water to Carriacou residents as compared to those on mainland Grenada was not seriously compromised due to the dominance of RWH systems on that island. Whereas blockage of intake dams and damages to the distribution network disrupted the water supply on mainland Grenada, the individual household and communal cisterns of Carriacou and Petit Martinique provided a ready potable water supply during the immediate recovery period.

In short, the extent of destruction caused by recent hurricanes has elucidated the heightened need for reducing human-induced influences in terms of vulnerability to natural disasters. Greater emphasis needs to be placed on coordinated and integrated land use planning, regularization of unplanned settlements, watershed resource conservation and rehabilitation, and integration of hurricane safety provisions in the rebuilding process.

While the climate change scenario is expected to have a magnifying effect on the occurrence and magnitude of hurricanes in the Caribbean region, it is anticipated that sea-level rise (SLR) and higher temperatures in general will have further negative effects on fresh water resource availability due to (Sweeney and Vermeiren, 2002):

- Salt water intrusion of coastal aquifers;
- Reduced rainfall producing less ground water recharge and surface water in streams and rivers;
- Higher temperatures increasing the rate of evaporation from surface water sources thereby reducing the amount of water available in reservoirs;
- Greater overall demand from resource users to combat higher temperatures.

3.4. Water governance and rainwater harvesting in the Caribbean – Select country reviews

This section presents a brief synopsis of the water sector, challenges and the status of rainwater harvesting in **select** countries of the Caribbean.

Antigua and Barbuda

Antigua and Barbuda have very limited water availability on account of the low rainfall regime. The country is almost devoid of perennial streams and consequently the country's water supply is sustained by ground water extraction, man-made pond structures and desalination. Antigua's water demands ranges between 22,500 and 27,000 m^3/day (5 to 6 MGD) during non-drought periods and as much as 40,000 m^3/day (9 MGD) in drought periods. The drought periods coincide with the high arrival rate of tourists to the country thus the increase in demand in the drought periods.

Antigua's aquifers are subjected to some level of contamination from land-based activities, most notably farming. Irrigation back-wash contaminated with agro-chemicals often flushes into these aquifers compromising water quality. Farmers are encouraged to engage in good agricultural practices to reduce excessive chemical use and conserve water in irrigation application.

A major 9,100 m^3/day (2 MGD) Multi-Stage Flash Distillation (MSFD) desalination plant operated by the Antigua Public Utilities Authority (APUA) is installed at Crabbs and supplies water to 90% of Antigua. A number of reverse-osmosis (RO) plants operated by the APUA augment water from the main facility. The APUA has also installed a RO plant in the sister island of Barbuda. This plant was commissioned in March 2005 and has a capacity of 120 m^3/day (27,000 IGPD). Since its commissioning, the plant had to be taken out of service for operational reasons (CEHI, 2006). A number of privately operated RO plants exist in Antigua as well, including at St. James' Club, Carlisle Bay Hotel, Rex Halcyon Resort and Jumby Bay resort (CEHI, 2006).

To address water resource constraints, rainwater harvesting has been built into infrastructure and development policy. The Town and Country Planning Act requires that all dwellings must be built with facilities to store at least 3 to 4 days water requirements based on the house size; this approximates 18 m^3 (4,000 gallons) storage for every bedroom. In general for each gallon of storage, US$1.10 (EC$3.00) needs to be invested in cistern construction. Cisterns generally cost about 6% of the house construction cost. There has been public request for the Government to consider providing incentives to offset some of the cost of cistern installation. (Source: APUA, 2006)

Bahamas

The Bahamas are among the Caribbean's most water-scarce countries. These islands do not have surface rivers and have traditionally relied on ground water and rainwater harvesting. The groundwater reserves in the Bahamian islands lie at very shallow depths below the rock surface and are inherently vulnerable to surface-based contamination sources. Additionally, the over-pumping of boreholes has led to intrusion of saline water compromising the utility of the water. This is particularly the case for New Providence (BWSC, on-line source). Bahamas Water & Sewerage Corporation (BWSC) has invested in reverse osmosis as a principle strategy to process brackish and seawater to augment the country's tremendous water demand. The Corporation has a Marine Operations outfit which is responsible for the barging of some 19,300 m^3/day (4.25 MGD) of potable water per day (year 2000 figures) from the Andros Island well fields (BWSC, on-line source). Some 88% of the population has access to pipe borne water. It is estimated that there are over 200 RO plants currently operational in the Bahamas producing more than 4.5 m^3/day (1,000 GPD) each. Future plans anticipate termination of the system of barging water and the commissioning of new plants with near total dependence on desalination for main supply (CEHI, 2006).

Rainwater harvesting is a significant source of water for individual households on many islands of Bahamas especially in the off-shore Abaco cays, Cat Island, and sections of Long Island, although desalination plants and piped distribution is forcing less reliance on RWH. Large artificial catchments were operational in former US naval bases in Eleuthera and Mayaguana, and on Moores Island, Grand Cay, Mayaguana, and Green Turtle Cay community catchments were built however many have become defunct. Public institutions with rooftop systems are relied on in some of the islands to serve communities. The island of Whale Cay has a piped distribution system that is supplied by rainwater. Industries, hotels and restaurants rely heavily on RWH exclusively or as a back-up source (UNEP/OAS, 1997).

Barbados

Barbados is a critically water-stressed country given its relatively small land area (430 km^2 or 166 sq.mi.) and large population (estimated at 272,000 at 2005; UN-ECLAC, 2004), and the high level of commercial development. The country's main water supply is from groundwater aquifer reserves (79% of the total fresh water resources), and 2005 estimates of production stand at 159,909 m^3/day (35 MGD). There are presently two desalination plants in operation; one, a seawater reverse osmosis desalination plant, is privately owned and used for irrigation of a golf course. The second one is a brackish water reverse osmosis plant contracted to supply up to 40,000 m^3/day (6 MGD) to the BWA under a 15-year Build Own Operate (BOO) arrangement. Desalinated water is supplied to sections of the west and southern coasts. The Barbados Water Authority (BWA) has 99% coverage to all potable needs and 90% of consumers receive water on a continuous basis (J. Mwansa, pers. comm. 2006). Irrigation at both small and large scale is the next largest consumer of potable water (following domestic use) accounting for 13.27 million m^3 per year (2,920 million gallons per year) (BWA, 2004).

Rainwater harvesting was traditionally practiced on Barbados but has been on the decline. However, an amendment to the Town and Country Planning Development (Amendment) (No. 2, Order of 1995) requires all new residences in Barbados to make provision for rainwater storage. The following regulations are therefore applicable for new constructions (not applicable to buildings that pre-date the amendment):

- Every house with a gross floor area of between 139.4 (1,500 sq.ft.) and 278.7 m^2 (3,000 sq.ft.) must have a rainwater storage tank of at least 13,638 litres (3,000 gallons) capacity;
- Every house with a gross floor area of more than 278.7 m^2 (3,000 sq.ft.) must have a rainwater storage tank of at least 27,276 litres (6,000 gallons) capacity;
- Every building other than a house that has a gross floor area of 92.9 m^2 (1,000 sq.ft.) or greater, must have a rainwater storage tank whose capacity is calculated at a rate of 195 litres per square meter (43 gallons) of gross floor area.

A tax rebate incentive is applicable to the minimum requirements. Tax rebates may be claimed for older buildings, but on a voluntary basis. These regulations are enforced by the Town and Country Planning Office (TCPO), which require that the rainwater storage provisions be included in development plans submitted to them for permission to build. The TCPO inspectors also certify that such storage exists before the rebate is given. Administration of the regime has been weak with regard to ensuring that the storage provided is used for the intended purpose. There is a need to review the legislation and attendant regulations to allow for flexibility in implementation (J. Mwansa. pers. comm. 2006).

In Barbados, there is also a growing demand for water due to the development of golf courses. It is estimated that, given current plans, the demand for irrigation water for golf courses will increase to five (5) times the present demand UNEP/CEHI (2001).

British Virgin Islands (BVI)

The British Virgin Islands (BVI) comprises over forty (40) small islands, which total approximately 153 km^2 (59 square miles) in area. Of these, about sixteen (16) are inhabited by a total population of about 25,802 according to the Development Planning Unit estimate for 2005. The BVI also has an annual visitor population of approximately 495,000. Tortola, Virgin Gorda, Jost Van Dyke and Anegada are the main islands in terms of population and development.

Prior to 1989 when desalinated water was introduced in the public water supply, rainwater harvesting by rooftop catchments and groundwater were the principal sources of potable water in the BVI. As in most Caribbean islands, rainwater has been, and continues to be the preferred source of water. To encourage rainwater harvesting the government of the British Virgin Islands, at one point, issued loans and subsidies to construct cisterns and, more recently, distributed plastic tanks to farmers. According to the Land Development Control Guidelines 1972, each building intended for human habitation must be constructed with a rainwater catchment or cistern having a capacity of 4.5 m^3 (1,000 gallons) per 9.3 m^2 (100 sq.ft.) of roof catchment area. Additionally, in the 1960's and 70's the government constructed public rainwater catchments in Long Trench, Solider Hill, Fahie Hill and Doty on the island of Tortola for domestic and agricultural purposes.

The average annual rainfall of about 1,143 mm (45 inches) has, in the past, been capable of satisfying residential needs; however, rapid development and changing standards of living have significantly increased potable water demand. This increased demand, especially during periods of low rainfall has resulted in severe shortages of water over the years. These shortages eventually forced the introduction of desalinated water in the BVI's public water supply in 1989.

Presently, of the eight desalination plants serving the BVI's public water supply system, there are five plants on Tortola, two on Virgin Gorda and one on Jost Van Dyke. Seven of these are owned and operated by private companies in accordance with terms agreed to with the Government. The other is owned and operated by the BVI Electricity Corporation. These plants supply approximately 11,365 m^3 (2.5 million imperial gallons) of desalinated water per day for distribution. This accounts for approximately 60 % of the demand. The remaining 40% comes from groundwater, private cisterns and catchments, and private desalination plants (owned by hotels).

The public water supply system generally serves areas located below the 90-metre contour through a distribution network having about 10,000 water connections. Presently, approximately 727 m^3 (160,000 imperial gallons) of groundwater is used daily in the public water supply distribution system. This water mainly feeds customers in the Lower Estate and Huntum's Ghut areas, and part of Road Town. This groundwater is extracted from three wells to supply a desalination plant located at the BVI High School campus. This supply makes up roughly 6% of the public water supply on Tortola.

Dominica

Relative to the other countries of the Caribbean, Dominica ranks among the most water abundant. The island is very rugged and has remained predominantly under forest cover. The combination makes for a very humid environment in the interior where mean rainfall accumulation is double that recorded in neighbouring St. Lucia and Grenada. Natural surface water is more than adequate to sustain demand, given the relatively low population and level of development. Water is abstracted by the Dominica Water and Sewerage Company (DOWASCO) from 43 stream and spring sources at an estimated rate of 45,500 m^3/day (10 MGD) (USACE, 2004). The company services 90% of the population with 16,000 customer connections (USACE, 2004). There is growing concern however over changes in land use in some interior areas that may be contributing to the observed lowered base flows in some rivers.

Rainwater harvesting is not significant on Dominica, although it is assumed that it is practiced by some households in remote areas that are not connected to the distribution network.

Grenada

Mainland Grenada's water supply is drawn almost exclusively from surface stream sources located at relatively high elevations so that the distribution network is primarily gravity-fed. The estimated water production ranges between 27,300 m^3/day (6 MGD) and 31,800 m^3/day (7 MGD) during the dry and wet seasons respectively. The National Water and Sewerage Corporation (NAWASA) claims up to 90% coverage of their distribution network with reliability in service provision that ranges between 85 and 90%. Communities in the extreme south and north of the island tend to be more water-stressed given their relative location at the distal ends of the distribution networks, a problem that can be particularly acute during the dry season. Demands from tourism and other commercial sectors and urbanization are placing pressures on the existing production points. In 1998 the Government of Grenada (GoG) procured a 1,818 m^3/day (400,000 US GPD) desalination plant to assist in augmentation of water supply to the southern communities, however, inadequate supply from production wells delayed the completion of project. NAWASA is also considering deep-well abstraction for supply augmentation for mainland Grenada (A. Neptune pers. comm. 2006)

On the sister islands of Carriacou and Petit Martinique water is drawn almost exclusively from individual or communal RWH systems as these islands are very arid and have virtually no perennial streams. There is 1 borehole from which groundwater is abstracted to serve the small downtown core of Hillsborough in Carriacou. Rainwater also finds uses in other sectors such as agriculture, construction and tourism. In 1998 the Government of Grenada invested in desalination plants for both Carriacou (100,000 US GPD output capacity) and Petit Martinique (30,000 GPD output capacity). The former is plagued with regular mechanical failures, while the latter, since the passage of hurricane Ivan has been non-functional. A few hotels and resorts (e.g. in Culligen) have small desalination plants to augment their water supplies (CEHI, 2006).

RWH is practiced to a small degree on mainland Grenada but more so by households in communities particularly in the south of the island where there are serious supply problems. In general, the practice has become less common as NAWASA's distribution has expanded to service almost all communities on the island. By contrast, RWH is of paramount importance in Carriacou and Petit Martinique where communal and private systems supply almost 100% of demand. There are no specific policies or legislative provisions to support RWH in Grenada.

Jamaica

Jamaica exploits over 400 ground and surface water sources where the estimated daily production is 913 MCM (million cubic metres) per day. More than 70% of the country's water comes from ground water sources (NWC, 2003). The public water supply system operated by the National Water Commission presently services 72% of the population. While Jamaica has sufficient water to meet all demands, the resources are unevenly distributed in both time and location. The present shortfall is estimated at 400 MCM/yr (GoJ, 1999). Roughly 30% of water abstracted goes to domestic purpose while 70% goes into non-domestic purpose which includes agriculture.

The large landmass combined with the topography, hydrologic and economic considerations present challenges to realization of 100% coverage, and isolated communities need to rely on small water supply systems whether from catchment tanks, truck deliveries or surface sources. In some rural areas, small scale rural water development companies (registered as Benevolent Societies) have been established to operate water production systems. Development planning is closely linked to availability or access to water. Water demand for developments in rural areas is calculated at 150 litres/person/day and the per capita urban water demand is 172 litres /person/day.

RWH systems are common in areas where there is no reliable public water supply and in areas lacking access to river, spring or well water sources. It is estimated that more than 100,000 Jamaicans depend on RWH as the primary source of water (UNEP/OAS, 1997). In some of the new housing areas established on reclaimed lands from abandoned bauxite operations such as in Claremont, St. Ann; RWH systems are the primary sources of potable water. In the aftermath of Hurricane Ivan in 2004, RWH was extensively employed by various public institutions that were affected by supply interruptions. In communities where RWH is practiced, the Environmental Health Department (EHD) educates persons in system management and sanitation, and routine water quality monitoring is carried out. In addition, the EHD regulates the design and materials for use in RWH systems.

The Water Resources Authority (WRA), the agency responsible for the management, protection, and controlled allocation and use of Jamaica's water resources advocates the use of rainwater harvesting techniques in areas lacking access to river, springs or groundwater resources and also to augment the public water supply system during period of water scarcity.

St. Kitts and Nevis

Most of St. Kitts' water demands is met by ground water although prior to 1970, surface water was the dominant source. The coastal aquifers are divided into seven major ground water basins with an estimated total safe yield of 50,000 m^3/day (11 MGD) of which about 27,300 m^3/day (6 MGD) has been developed to meet current demands.

There are some twenty-five (25) ground water wells while the average demand from these wells is about 18,200 m^3/day (4 MGD). In addition there are six surface water intakes that yield about 9,000 m^3/day (2 MGD). There are about five independent distribution systems with inter-linkages for redundancies.

In Nevis ground water accounts for 80% of the public pipe-borne supply, and surface water accounts for the remaining 20% (UNACE, 2004). The St. Kitts Water Services Department estimates 98% coverage to users in St. Kitts and 90% for Nevis. There are two privately-owned desalination plants in St. Kitts with capacities of 3,600 and 5,500 m^3/day (0.8 and 1.2 MGD). There are no desalination plants on Nevis.

There is growing concern over protection of the aquifers from impacts related to sea level rise and saline intrusion given the relative scarcity of freshwater resources. Abstraction rates must be carefully controlled along with judicious management of land resources to control potential pollution risk (USACE, 2004).

Rainwater harvesting is more common in Nevis where it is estimated between 80 to 90% of residents and businesses have capacity to capture rainwater. In St. Kitts it is estimated that 5% of the population practices RWH.

St. Lucia

Virtually all St. Lucia's potable water is abstracted from surface sources; a total of 30 surface water sources according to the Water and Sewerage Company (WASCO). Current water production is estimated at 45,500 m^3/day (10 MGD) although this fluctuates between 43,200 and 47,700 m^3/day (9.5 and 10.5 MGD) and 33,600 m^3/day (7.4 MGD) during the dry and wet seasons respectively. This increase in demand in the dry seasons is due to the high arrival rate of tourists to the country at that time.

Demand outstrips supply during the dry months where several communities particularly in the south of the island suffer severe water stress due to supply distribution problems (on account of the aged infrastructure) and limited available water at source locations relative to the populations they serve. The percentage coverage provided by the municipal distribution network is estimated at 75% while the remainder of the population has access to water through standpipes. Water supply is further compromised by poor land management practices stemming from unsustainable agriculture and poorly planned urban, commercial and industrial development within watershed areas. Rapid urbanization and touristic developments are placing extreme stress on the limited water resources. Reverse-osmosis desalination plants are used by at least two resorts in St. Lucia with approval for another currently pending.

As with many other Caribbean countries, RWH was the dominant supply source before expansion of the pipe-borne supply system. At the distal ends of the distribution network, particularly at the northern extreme of the island where the most affluent neighbourhoods on the island are located, RWH systems have been installed in the majority of the houses as built-in cisterns. RWH is practiced in scattered pockets in rural areas over the rest of the island, and is used to augment stored water from the municipal system. It is common practice to store pipe-borne water from WASCO in polyethylene plastic tanks (typical capacity of between 1,600 and 2,700 litres). There are no legal instruments that mandate installation of RWH systems except for larger developments which are subject to agency reviews in which case WASCO may advise on supply constraints and the need to make provisions for RWH.

St. Vincent and the Grenadines

Like the other islands in the Windward island group, mainland St. Vincent relies solely on surface water sources to meet demands. Compared to St. Lucia and Grenada, St. Vincent has more available water relative to demand. Current estimated production stands at 26,000 m^3/day (5.72 MGD). Some 95% of the population has access to the public water supply and 92% of the consumers are metered. There are concerns over poor land management practices that has caused degradation in watershed areas with consequent implications for water quality. Hydro-electric power is being generated from the South Rivers, Richmond and Cumberland rivers.

On the inhabited Grenadine islands that include Bequia, Mustique, Canouan and Union Island, RWH is the principle means of water supply. Most are private systems with some community catchment systems on Bequia, Canouan and Union Island. Desalination technologies are used by hotel operators in Canouan, Bequia, Union Island and Palm Island.

RWH is practiced in some locations on mainland St. Vincent where topographic constraints limit access to the public distribution system. There are no provisions in current national legislation or policies to facilitate the adoption of RWH.

Trinidad and Tobago

Trinidad and Tobago is not a water scarce country, with the average annual rainfall ranging from 1,200 to 3,800 mm per year. The available surface water in Trinidad is estimated to be 3,600 million cubic metres (MCM) per year, which is more than ten times the water demand. For Tobago the available surface water is estimated to be 140 MCM per year and the demand is estimated to be about seven percent of the supply. The water availability per capita for Trinidad and Tobago is approximately 2,500 m^3/year, which exceeds the international standard of less than 1,000 m^3/year per person for water scarcity. However, surface water availability which is the major source of water is strongly influenced by seasonal and spatial variations.

Trinidad and Tobago exploits surface and groundwater at the rate of 65 % and 25% of total volume respectively. A ten percent of the water produced is from desalination. The Water and Sewerage Authority (WASA) assets that relate directly to drinking water include 23 surface water treatment facilities, 53 groundwater treatment facilities, 48 rural intakes and spring sources, 120 pumping stations (booster stations), approximately 6,000 kilometers of water pipeline, 4 raw water impounding reservoirs (total storage of 68 million megalitres or 15 billion gallons) and 436 wells. The estimated daily production stands at 950,000 m^3/day (210 MGD). In Tobago water production stands at approximately 40,000 m^3/day (9 MGD) to be soon increased to 545,000 m^3/day (12 MGD) by the drilling of new water wells. In the late 1990's the Government of Trinidad and Tobago (GoTT) through WASA, established a contract for the supply of desalinated water from the Desalination Company of Trinidad and Tobago (DESALCOTT). This involved the construction of 100,000 m^3/day (24 MGD) capacity desalination plant to service the Point Lisas Industrial Estate on the west coast of Trinidad which houses the heavy petrochemical plants. Water from this plant accounts for 10% of the total water production in the country.

The Water and Sewerage Authority (WASA) presently serves 92% of the population, however only 18% of the population has a 24/7 level of service. The country faces water deficit during extended dry periods with several communities most notably those in Southern Trinidad including Penal, Debe, La Brea, Point Fortin, Siparia, Mayaro, Union and Bristol Village experiencing significant supply interruptions. As with most countries in the Caribbean, Trinidad and Tobago faces similar challenges with respect to management of its watershed areas and the issues associated with poor land management and its impacts on the water quality and quantity. Provision of adequate water for agricultural irrigation and industry is a major consideration.

Rainwater harvesting is not new to Trinidad and Tobago. During the 1960's and 1970's nearly all remote estates in Trinidad and Tobago and most households in rural areas constructed and maintained cisterns made of concrete, steel and other types of materials to collect water from the rooftops. This system has been discontinued in areas where WASA has a reliable water supply, however some households in the rural areas still maintain a rainwater system to augment the pipe borne supply especially for farming. Rural areas, notably Plum Mitan, Biche, Matelot, Blanchisseuse, Moruga, Morne Diablo, Cedros, Princes Town, Tableland, Rio

Claro, La Brea, Charlotteville, including hillside areas within the Northern Range, households depend heavily on rainwater harvesting.

Other non-CARICOM states

The **Turks and Caicos** Islands rely almost exclusively on rainwater harvesting and all developments must include storage capacity at a ratio of 400 l/m^2 of roof area. In addition there are a number of government-built, public rainfall catchment systems. It is also a legal requirement in the **US Virgin Islands** that all buildings must have RWH systems installed with 400 l of storage for each m^2 of roof area. Cistern construction is further regulated by the Virgin Islands Building Code to insure the structural integrity of these cisterns, which usually form an integral part of building foundations (UNEP/OAS, 1997).

4. Strategic Directions for a Regional Rainwater Harvesting Programme

4.1. Objectives

At the overall objective level the proposed Rainwater Harvesting Programme for the Caribbean attempts to: ***Contribute to the conservation of the water resources of Small Island Caribbean States through adoption of sustainable water management and conservation technologies***. The anticipated outcome of the programme is: ***Capacity for implementation of rainwater harvesting for household and commercial purposes strengthened and support policies and incentives developed and mainstreamed into national development strategies and policies***.

The Programme will focus on promotion of investment in RWH across the Caribbean, with emphasis on countries possessing communities that are significantly water-stressed, where investment in alternative water augmentation measures are not practical for widespread adoption in the short to medium-term. Water-stressed countries that already have deeply-rooted RWH traditions will also be targeted, but with emphasis on adoption of best practices.

4.2. Approach

The Regional Programme is conceptualized as a slate of actions to be implemented at (1) the national level, replicating the country programme developed for Grenada within a common harmonized framework and (2) at the regional level to ensure overall coordination of the programme in alliance with regional partners in the water resources management sector.

National elements of the Programme are as follows; (1) Awareness raising, (2) Capacity building, (3) Legislative and policy formulation and (4) Infrastructural development. A fifth element is Programme Administration, Monitoring and Evaluation. This additional element, is being built into the programme given the typical human and financial constraints in many of the lead national agencies that are envisaged to carry out the monitoring and evaluation requirements of the Programme. This element will also be reflected at the regional level.

The suite of interventions within each component is anticipated to lead to the creation of an enabling environment that fosters greater investment in RWH as a viable water supply augmentation measure. The extent to which national governments, and by extension society, re-adopts what is an old traditional practice will depend greatly on how much support is provided at the institutional level. It is proposed that national agency focal points with lead responsibility for water will be charged with the responsibility of championing the national elements of the Programme.

For each strategic component the objectives are defined, along with the key actions, verifiable indicators that need to be monitored, and the anticipated result. Indicative costs for each activity are also provided.

It is proposed with the endorsement of the constituent countries, that the Caribbean Environmental Health Institute (CEHI) will be the regional focal point to coordinate the execution of the Regional Programme under the aegis of the Caribbean Rainwater Partnership (an extension of the Global Rainwater Partnership under UNEP). Through the framework of IWRM, CEHI will seek placement within the high-level political agenda at CARICOM through the Council for Human and Social Development (COHSOD) and Council of Trade and Economic Development (COTED) to ensure commitment and translation to national development agendas.

This initiative is framed against the backdrop of fostering adaptation measures and building resilience in communities in the context of water security, in consideration of the potential effects of climate change and climate variability as evidenced by the impacts of several destructive hurricanes in the Caribbean in recent years.

4.3. Strategic elements – National actions

4.3.1. Component 1: Awareness Raising

4.3.1.1. Objectives

To enhance positive public awareness on the practice of RWH

RWH was at one time universally practiced in the Caribbean before the introduction of potable supply distribution networks. Traditional RWH systems were rudimentary when households had no internal plumbing. As communities became more affluent and houses were built with internal plumbing supplied by the municipal network, the perceived need for RWH declined and generally fell out of favour. The majority of households in many islands do not practice water supply augmentation using rainwater, although many households are equipped with back-up storage that is supplied by potable water (excepting the water-scarce islands such as the Grenadines, the Virgin Islands, some of the Bahamas and Turks and Caicos) It is noted however that up-scale housing developments in many countries are all outfitted with RWH systems, particularly in cases where they are situated in remote locations, or at the distal ends of the potable distribution network.

The Programme therefore focuses on crafting a new image for RWH on the premise of building resilience in an environment where there is increasing pressure on scarce water resources. This will be framed against the backdrop of ensuring some measure of security of supply in a post-disaster circumstance and during prolonged drought conditions when demand surpasses supply. The recent experience with destructive hurricanes in Grenada, Jamaica and the Bahamas will no doubt help galvanize favorable public perception. The threats posed by climate change are of concern and will be an issue that will need to be confronted over the coming decades. Adaptive strategies elaborated in the UNFCCC national communications all have water resource security at their core and the strategy proposed here will build on adaptive measures proposed by Caribbean states.

To increase investment in RWH

Investing in RWH systems has been constrained to some degree by the cost associated with construction of storage systems within households, which may add between 10 and 20% to the cost of construction. For most potential homeowners this added cost is typically not factored into new homes, and existing home owners are typically unwilling to invest in retro-fitting their homes with appropriate measures to capture rainwater, on account of cost. The public education strategy must focus on consideration of the long-term advantages of RWH. While the initial investment cost may be relatively high, particularly for lower-income households, the cost of foregoing investment can outweigh the investment in the long-term.

The Programme will focus on the hospitality and other commercial sectors which consume large volumes of water for a variety of purposes. In many instances they utilize the potable supply for non-drinking purpose; in other words, using relatively expensive water for 'low-end' uses. These low-end uses can be serviced by rainwater to some extent, whereby operators can realize significant cost savings, while contributing to water conservation particularly when the supply is under stress at peak demand during the dry season. Investment in RWH not only translates to direct cost saving to the user but contributes to continued service provision which is of direct economic interest to service providers.

To promote RWH as a viable augmentation measure for conventional potable networks in water-stressed areas, and promote water conservation In countries that are predominantly supplied by surface water the municipal water utility will typically ration water supplies to particular communities during the dry season with resultant interruptions for portions of the day, and in extreme cases, for several days. The situation is worse for communities that are situated at the most distal ends of the water distribution network. Residents and business operators in these areas familiar with the difficulties associated with water shortages tend to be those most readily accepting of implementing RWH systems.

The Programme will use such water-stressed areas as prime demonstrations, drawing on the added dimension that some of the areas lie within key touristic development zones, a sector that is becoming increasingly important as a source of foreign exchange and investment in most Caribbean countries. Emphasis will be placed on general water conservation as part of on-going education with all partners in the water sector.

To foster best practices with respect to health and sanitation

The issue of sanitation needs to be addressed in two areas: (1) proper management of community RWH systems through regulated regimes and (2) encouragement of good practices at the individual household level.

In some islands where communal RWH systems are employed such as Carriacou and Petit Martinique, there is a lack of a coordinated framework for administration of community catchment systems. It is the common perception that the systems are the responsibility of the State and that the State should take full responsibility for their operation and maintenance. Lack of State resources and low level of involvement of communities in management invariably leads to a situation of poor maintenance with potentially serious health consequences.

Private householders with homes equipped with RWH systems at times do not take the necessary measures to safeguard their water as it passes through the various components of the RWH system. Roofs and conveyance systems are sometimes not made of the appropriate materials thereby introducing possible contaminants, and the cisterns or tanks may not be of the correct type or configuration that may cause either the introduction of contaminants, or affect ability to service the cistern. In some cases simple techniques to treat the water to ensure reduction in bacterial counts is not carried out.

The awareness strategy will therefore need to address all aspects of management and maintenance of RWH systems whether large-scale communal or individual systems. In the case of the communal systems (for example on Carriacou and Petit Martinique), creating clear understanding on the roles of the various stakeholders in provision of quality water from communal systems will be required. Policy makers will need to be sensitized so as to recognize the social and economic dimensions associated with management of common-property resources as is the case with operation and management of communal systems.

4.3.1.2. Key actions

- **Public and policy-makers workshops and seminars –** A series of workshops and seminars targeting community members, the private and commercial sectors, and policy makers will assist in promotion of the programme and create the environment necessary to foster investment in the practice. These seminars and workshops will need to be tailored to ensure maximum receptivity depending on the audience. It is anticipated that educational materials developed under the CEHI/UNEP project will form core resources for facilitators.

- **Media productions –** Public service announcements (PSAs), TV documentaries, features, radio/TV panel discussions, print articles in newspapers and magazines should be used to promote messages related to water conservation and RWH. They should be designed to coincide with significant commemoration days (World Water Day, March 22^{nd}, World Environment Day, June 5^{th}, World Day to Combat Desertification, June 17^{th} and World Food Day October 16^{th}) and should be featured in advance of the annual dry season when the public is most acutely aware of impending water scarcity. Under the CEHI/UNEP RWH pilot project, radio PSAs and a 15-minute video documentary has been produced. Additional feature films and radio productions are envisaged to deliver more targeted country-specific messages.

- **Dissemination of technical material –** In addition to the media productions, a reserve of technical material should be made available to the general public for consultation where specific information on the design and construction of RWH systems is being sought. A Handbook and technical brochures has been developed under the CEHI/UNEP RWH pilot project which was designed to furnish users with appropriate information for various types of applications. The Handbook is regarded a work in progress; as new lessons are learnt and new technologies introduced, it will be updated. The Handbook and brochures are being made available in limited copies but will be available in Adobe portable document format (pdf) on CEHI's website at no cost.

- **School competitions –** Competitive essay and art competitions to promote the message of water conservation and RWH should be organized. These programmes can be tied into significant commemorative events such as World Water Day (March 22^{nd}), World Environment Day (June 5th), World Day to Combat Desertification (June 17th) and World Food Day (October 16th).

- **Creation of a RWH website –** A RWH resources website with focus on application to the Caribbean region should be developed. It is proposed that this site be hosted on CEHI's server and linked to UNEP's website that features other global RWH initiatives. Other links to regional partners in the water resources sector such as the Caribbean Water and Wastewater Association (CWWA) and the Global Water Partnership-Caribbean (GWP-C) will be carried on the website. Other Caribbean web resources include the CARICOM Caribbean Climate Change Centre (CCCCC), the Caribbean Agricultural Research and Development Institute (CARDI) and the Inter-American Institute for Cooperation on Agriculture (IICA).

- **Public/stakeholder assessments on level of awareness pre- and post-programme –** Essential to any public outreach campaign is the systematic assessment of impact. Targeted communities should be polled periodically to determine the extent to which they may have adopted RWH practices as a result of the public education initiatives. The ministries responsible for health, environment and water along with water utility companies could partner in this regard.

4.3.1.3. Key indicators

- Percentage participation (in relation to number invited) in awareness seminars;
- Number of development applications to the Planning (Town and Country) Ministries (households, commercial enterprises) that include provisions for RWH systems;
- Number of times television, radio features and PSAs are broadcast via local media;
- Number of handbooks and brochures disseminated; both in print and downloads of electronic versions;
- Number of schools and students participating in RWH (water conservation) awareness programmes;
- Existence of a dedicated RWH resources website (number of hits on the web-site, number question and answer submissions and traffic on discussion board may be considered as other indicators);
- Survey results (reflective of heightened awareness).

4.3.1.4. Key results

Public and policy makers' awareness raised on RWH concepts, practices, water quality and sanitation issues

4.3.1.5. Indicative costs

Activity expenditure items	Estimated cost US$
Workshops and seminars for public and policy makers	150,000
Radio public service announcement productions (excluding broadcast cost)	15,000
Video feature productions (excluding broadcast cost)	20,000
Printed material production	15,000
Website development and management	25,00
School awareness programme (primary and tertiary levels)	60,000
Public and commercial house surveys surveys (annually and at end of programme)	60,000
Total	**320,000**

4.3.2. Component 2: Capacity Building

4.3.2.1. Objectives

To develop and improve national competency in developing (design and construction) and operating RWH systems
In Caribbean countries where RWH is not a common practice there is generally low capacity in the area of proper design and construction of RWH systems. This finding emerged out of a national assessment carried out in mainland Grenada and is reflected in many countries. By comparison, architects and building contractors in islands with long histories of using rainwater are familiar with cistern construction. Examples are known from Grenada where poor cistern design leads to a range of problems, and in extreme cases compromising the integrity of building foundations (A. Daniel pers. comm., 2006).

Capacity needs to be developed in application of RWH technologies for non-household uses particularly in the commercial and agricultural sectors, with emphasis on enhancing efficiencies in water utilization. RWH application can also be extended to municipal uses. In the case of firefighting, paved roads, parking lot surfaces, and roofs of large buildings can be used to harvest rainwater for storage at strategic locations as water reserves. This is of value particularly in clustered hillside housing developments where access to water for firefighting is often a problem.

This Programme proposes to train private sector specialists in the area of design and planning of RWH systems, drawn from the local pool of contractors, engineers and architects. Training will also be necessary for public service professionals in Town/Country Planning departments and other technical sections of relevant ministries (Health, Agriculture) to equip them with the necessary advisory and technical support tools for transfer to clients. It is anticipated that associations of professional engineers in the various countries will be a key partners in support of coordinated capacity development.

To train communities in operation and management of community RWH systems

In Grenada the poor management and operation of the communal RWH systems in Carriacou and Petit Martinique is of serious concern. Lack of collective responsibility on the part of the Carriacou and Petit Martinique residents who use these systems has contributed to deterioration of the communal systems to a point where livestock are permitted to stray on the catchment surfaces and vegetation is allowed to grow on the catchment surfaces causing serous damage and affecting the quality of the water. The community does not pay for water obtained from these communal systems, which fosters an attitude of non-responsibility.

The strategy will call for awareness-building as noted in 4.1 above, and strengthen capacity within beneficiary communities to play a collaborative role along with support agencies in management and maintenance of communal water supplies.

To train professional in water governance

Training of professionals in water governance is a recurring need in all facets of water resource management including RWH and must always be kept in the forefront of development planning for the water sector. Training professionals in water governance lends significant value to the crafting of appropriate policy and incentives and creating the enabling environment to facilitate investment in water management and conservation programmes by the private sector and civil society.

The Programme will call for a series of technical exchanges between local public and private sectors professionals, with other professionals and consultants from the Caribbean and outside the region. Some of these exchanges may take the form of in-country technical seminars and workshops while others may involve travel to neighbouring Caribbean countries and where necessary, outside the region, to gain first-hand insights on best practices that are relevant to specific countries' needs. Given the cost involved in this undertaking, donor assistance will need to be sought through partners such as the Food and Agricultural Organization (FAO), the Caribbean Water and Wastewater Association (CWWA) and the Global Water Partnership (GWP). The Integrating Watershed and Coastal Areas Management project (IWCAM) which is a Caribbean-wide initiative executed by CEHI and UNEP/RCU will contribute resources to facilitate some of the envisaged activities.

4.3.2.2. Key actions

- **Technical seminars –** Special seminar series for home owners, contractors, hotel plant managers, industry, agricultural extension officers, farmers, irrigation service providers, and senior policy makers should be organized to sensitize them on practical issues related to implementation (operation, maintenance and quality testing/monitoring) of RWH systems. These seminars can be organized and tailored depending on the target sector. A training-of-trainers programme should be considered. Local professional engineer associations should be regarded as playing key roles, particularly in reaching out to the private sector. The Rainwater Harvesting Handbook developed under the CEHI/UNEP pilot project should be used as a key tool in this effort.

- **Training workshops for communities on best practices for communal RWH systems –** Training workshops for targeted community members should be conducted in the areas of cistern and distribution network construction and maintenance, water quality testing and treatment. It is proposed that this be carried out under technical supervision of the relevant ministries responsible for water, health and sanitation. The technical handbook developed by the CEHI/UNEP pilot project should be used as a major reference.

- **Technical exchange programme –** A series of exchanges should be organized to send professionals to respective countries and have reciprocal visits to regional and extra-regional countries to exchange experiences in rainwater harvesting applications. In several Caribbean countries the water sectors have been, or are in the process of being reformed to meet the challenges imposed by the increasing complexity of water user allocations, and requirements from the agri-food and health sectors which have direct trade implications, all in the face of declining water availability. Other water-scarce SIDS, notably those in the South Pacific have made tremendous strides in RWH in all areas, from technical advancements to policy and governance. These countries have similar geography and face similar development challenges making them ideal for partnering in exchange programmes. The Global Rainwater Partnership could provide a useful medium for piggy-backing initiatives and technical exchanges of this nature.

4.3.2.3. Key indicators

- Number of technical seminar sessions organized, and attendance level;
- Number of downloads of RWH Handbook from source websites; number of hard copies disseminated by various agencies;
- Number of technical professional exchanges undertaken.

4.3.2.4. Key results

Capacity strengthened amongst professionals (technical, advisory services) and other stakeholders, for the implementation and management of RWH systems

4.3.2.5. Indicative costs

Activity expenditure items	**Estimated cost US$**
Technical training seminars.	75,000
Training workshops on operation and maintenance of RWH systems (communal RWH systems).	9,000
Technical exchanges.	150,000
Total	**234,000**

4.3.3. Component 3: Legislative and Policy Formulation

4.3.3.1. Objectives

To promote integration of RWH within national IWRM plans through policy and legislative reform

Success in sustained implementation of a national RWH programme is contingent on existence of an integrated water resources management (IWRM) plan. Few countries in the Caribbean region have developed IWRM plans, which are at the core as to why management of water resources has been a fragmented, poorly coordinated process. RWH falls within the realm of water conservation and is recognized as a key strategic element of any water resource management plan.

Legislative and policy reform should realize a process of harmonization of water resources management which includes RWH considerations across sectors within the context of an IWRM plan. The IWRM plan should speak to all elements of management instruments in terms of optimizing supply and managing demand and creating the enabling environment and institutional frameworks (GWP, 2001; USAID, 2005). The national IWRM development process must be championed by the relevant government agencies with mandates for water resources management and environmental management. The ministries with responsibility for health and sanitation, and the water utilities should play key technical support roles. As noted previously the IWCAM project will lend technical support to the IWRM development process across the Caribbean region.

To create an enabling environment to foster investment in RWH

The degree of investment in RWH in a country depends on the water scarcity situation and availability of water augmentation options. In critically water stressed islands (Bahamas, Leeward and Virgin Islands), legislative instruments have been passed that mandate all households and business enterprises to construct with adequate storage capacity. However the emerging trend that is being driven primarily by development of the hospitality sector is increased investment in desalination technologies. The need for reliable water supplies to service the tourism sector makes sole reliance on rainwater and traditional groundwater reserves unfeasible. With the increase in service supply using desalinated water not only to the commercial sector but to households, investment in RWH in water-scarce countries such as the Bahamas is falling, mirroring similar trends as in most of the Caribbean.

RWH still has a very valid role to play in the Caribbean water management realm. Regardless of water supply source, as water utilities expand their service coverage the impact among the communities and business they serve is to increase reliance on the potable supply, relegating RWH to secondary importance. The risk is that policy-making within state regulatory nodes or and water utilities may loose sight of the benefit RWH has in the context of building water security during adverse circumstances. Disruption to electricity generation after storms directly affects water distribution and catastrophic land movements triggered by rainfall or seismic activity can severely damage infrastructure for extended periods. Furthermore rainwater can ease the demand on potable supplies for non-potable uses of water, particularly in the case of relatively more expensive water. A further complication in promotion of RWH is the cost to include capacity for required storage and ancillary works. The national assessment carried out in Grenada was instructive in highlighting that most persons interviewed stated that they would invest in RWH infrastructure if some level of financial support was provided.

The programme therefore calls for an incentives regime to be developed that is tied into packages of concessions that may be available to investment in water conservation devices and related products. The regime may have to be operationalized via sector-specific incentive regimes that may exist in support of tourism, agriculture and manufacturing/processing investments. Popularly applied instruments in other development facets that may be utilized include direct rebates, government subsidies, and corporate and personal tax exemptions. Research towards development of the most appropriate incentive package based on country circumstance will need to be undertaken.

4.3.3.2. Key actions

- **Review existing legal and policy instruments to propose an effective legal (regulatory) and policy framework for promotion of RWH –** A comprehensive review of existing legislative and policy frameworks in the various countries will need to be undertaken to determine the extent to which existing legal and regulatory instruments meet the requirements for promotion of RWH within a structured programme in the context of IWRM. As is typically the case, many of the instruments exist; however, amendments will be required to ensure proper synergistic relationships are established to facilitate promotion of RWH. This must be framed against the backdrop of significant national environmental and water sector policies and commitments under international conventions, notably the UNFCCC in the context of adaptation strategies in the water sector.

- **Design appropriate incentive regime to promote supply augmentation and water conservation measures –** Appropriate suites of incentive measures need to be developed to encourage water conservation from the individual household level to the large-scale commercial development level. While concessions may be available to developers (tourism, agriculture, manufacturing), these are generally not specifically targeted in the context of water management and conservation. Should the incentive regime invariably reside within separate economic sectors, the policy/regulatory instruments should be harmonized across sectors both in terms of administration and intended effect. In a harmonized incentive regime, investors should be able to obtain concessions for supplies and materials that are used specifically to harvest and conserve water (guttering, tanks, pumps); however creative ways may need to be sought to include generic (general-purpose materials, e.g. cement, steel) material used in RWH system construction.

  Given the varying water resource availability and socio-economic settings within countries across the region, a blanket regime may not be applicable to all countries. An approach to designing the incentive regimes may be to group countries according to similarities in terms of needs and modes of implementation. This activity will need to be done in conjunction with ministries of finance which are the focal points for fiscal policy.

- **Consultation/workshops with stakeholders –** In support of the above activities consultations with all key stakeholders will be necessary.

4.3.3.3. Key indicators

- Legislation revised/amended and passed by Parliament into law;
- Number of consultations / stakeholder workshops held and record of attendance;
- Harmonized incentive regime developed and effected.

4.3.3.4. Key results

Existing legal and policy instruments reviewed to develop and effect an effective legal (regulatory) and policy framework for promotion of RWH

4.3.3.5. Indicative costs

Expenditure items	**Estimated cost US$**
Legislative and policy reviews	80,000
Design incentive regime for RWH	75,000
Stakeholder workshops	20,000
Total	**175,000**

4.3.4. Component 4: Infrastructural Development

4.3.4.1. Objectives

To optimize RWH systems to increase the quantity and improve quality of water
The poll conducted by CEHI in November 2005 on mainland Grenada revealed that approximately 20% of respondents practiced RWH and that there is a willingness to invest in RWH, a position that is shared in other Caribbean states that have not have a strong tradition of RWH. Given the rapid expansion in urban development and the hospitality sector in particular, the demands placed on municipal water supply systems during the dry months in some cases far outstrips supply. Many new households and properties in water-stressed areas are configured for near sole reliance on rainwater during the dry months. Without significant upgrades in water utilities' infrastructure to meet supply shortfalls it can be expected that investments in RWH for new developments will likely increase.

The Programme therefore calls for technical support to homeowners, investors in various sectors and the public sector (schools, hospitals and other public buildings) to make investments in RWH. In the case of the private sector this will likely be dependent on the effectiveness of the emerging incentive regime to support investment, with emphasis on areas of the country that are frequently impacted by poor water supply. In the case of state properties, investment in RWH should be mandatory in water-stressed areas, however, it is recommended that policy dictate that all new government properties be configured to harvest rainwater. For the communal systems on Carriacou and Petit Martinique, and possibly on other islands, urgent investment must be made in upgrading the infrastructure to adequately meet demands.

A pool of technical resources needs to be made available to render assistance in design and project management, and assist in financial procurements for investment.

To enhance capacity to manage and maintain communal RWH systems

The sustainable management of communal rainwater systems presents special challenges given the fact that they service multiple households. Unlike a single-dwelling RWH systems where the owner has sole responsibility for that system, community systems are 'owned and managed' either under public sector (state or local municipal) or cooperative arrangements. In a low-investment environment these RWH systems may not be adequately maintained or operated. The communal systems on Carriacou have fallen into states of disrepair on account of loose institutional arrangements, non-adherence to best practices and lack of systems that ensure the value of water is paid for and is returned to management of the system. In the case of Carriacou, responsibility for upkeep of the systems has been left entirely to the National Water and Sewerage Authority as community members are not empowered to manage the existing systems.

The Programme therefore proposes to address the situation with respect to management of the communal RWH systems such as those on Carriacou and Petit Martinique, by building capacity amongst key members in the community actively who will actively contribute to management in collaboration with the other institutional stakeholders (refer to Section 4.2.2 for details). Emphasis will also be paid to the formulation of adequate cost recovery mechanisms and their management.

4.3.4.2. Key actions

- **Conduct stakeholder discussions –** Dialogue must be pursued to determine precise needs and identify concepts for project elaboration. In the case of public sector investments broad-based consultations may be required; depending on the nature of the application.

- **Technical and feasibility studies for RWH applications –** RWH has traditionally been associated with water supply augmentation for household use however, the range of applications can extend well beyond that. In the hospitality and agricultural sectors use of rainwater can be a viable substitute for potable supplies for non-drinking purpose, which is particularly important during the dry season. Use of rainwater allows for investments to be made in geographic locations that are not serviced by the national water distribution network, or where water supplies are irregular.

Technical studies must be undertaken in development of project in order to match appropriate RWH technology to suit demand requirements depending on application. A Standard Code of practice must be developed to ensure appropriate procedures are adopted by contractors, plumbers and other service providers to minimize problems associated with interconnection between RWH systems and the municipal supply networks.

Technical institutes such as the South Pacific Applied Geoscience Commission (SOPAC), the FAO, UWI, University of Trinidad and Tobago (UTT), College of Science, Technology and Applied Arts of Trinidad and Tobago (COSTAATT) should be solicited to provide resources through either provision of personnel, financing, technical materials, or a combination thereof, through partnership arrangements.

- **Project development and funding procurement –** Following development of project concepts, full project proposals across the broad development needs spectrum (agriculture, hospitality, manufacturing applications, municipal uses [irrigation, fire-fighting]) should be developed. The relevant technical and advisory agencies and ministries should play lead roles in conceptualization along with potential beneficiaries, supported by ministries of finance.

- **Technical/training workshops in operation and management of new investments –** Once investments are made there must be requisite capacity built for operations and maintenance (O&M). Section 2 details some of the key requirements and the general approach to be pursued with respect to capacity development.

4.3.4.3. Key indicators

- Number of study/feasibility reports commissioned and completed;
- Number of developed proposals with committed funding;
- Number of executed projects.

4.3.4.4. Key results

Effective and efficient RWH Systems established

4.3.4.5. Indicative costs

Expenditure items	**Estimated cost US$**
Stakeholder consultations	45,000
Technical studies	180,000
Project development & funding procurement	75,000
Training workshops - O&M for new investments	80,000
Total	**380,000**

4.3.5. Programme Administration, Monitoring and Evaluation (national level)

The Regional Programme assumes that Grenada will continue as the pilot country with respect to follow-on activities identified in the National Rainwater Harvesting Programme for Grenada (CEHI/UNEP, 2006). In the national pilot programme it was proposed that programme administration capacity be built into the Grenada Ministry of Health and Environment as the lead agency responsible for execution of the programme. This was considered necessary given the human and financial resource constraints in that agency. For Grenada it was proposed that a Programme Management Unit be staffed by two personnel; one at a senor level with public education/outreach and project management skills, and the other at an administrative assistant level with skill in financial management. The basic terms of reference for the Unit included all services and supplies procurements, general administration of the Programme to include reporting, financial management and monitoring. Similar arrangements as described above may be applied to other countries that lack dedicated resources to perform this role.

4.3.5.1. Indicative costs

Activity expenditure items	**Estimated cost US$**
Salaries and allowances (in-country coordinators and office support)	150,000
Officer equipment and supplies	30,000
Communications and utilities	20,000
Technical backstopping	150,000
Programme evaluation	75,000
Total (over a four year period)	**425,000**

4.4. Regional level actions

The Regional Programme will need to be coordinated within the framework of the Global Rainwater Harvesting Partnership. A lead institutional node within the Caribbean to drive the programme is to be identified in consultation with national and regional agencies. Proposed regional partners will include inter-alia, the Caribbean Community Centre for Climate Change (CCCCC), the Global Water Partnership-Caribbean (GWP-C) and the Caribbean Water and Wastewater Association (CWWA). Resources will need to be sourced to strengthen capacity of the lead and partner agencies to assist in execution of the regional elements.

Out of a regional strategic planning workshop held in Tortola in March 2006 a series of key actions that will need to be pursued at the regional level were identified. These are as follows:

- Formal ratification and endorsement of a lead regional agency for the promotion of the regional RWH strategy. This will need to be done in consultation with stakeholder agencies. The agency will have as primary responsibility, provision of technical support and act as an information hub.
- Establish partnership arrangements with relevant Caribbean agencies to strengthen outreach and advocacy efforts and assist with resource mobilization in execution of various components of the regional strategy;
- Development of a website for the capture and dissemination of best practices in RWH as an important tool. This will be linked to national and international nodes concerned with water resources management. Maintenance of a dedicated website could be facilitated through contributions by manufacturers of supplies and equipment used for RWH systems;
- Development of a toolkit by the GWP to be included as an additional educational resource. This toolkit, in addition to the Handbook developed under the UNEP/CEHI RWH pilot project may be used as guidance in the design of RWH systems. The Handbook is a Caribbean version of the UNEP/OAS (1997) Water Augmentation Handbook;
- Promotion of the RWH initiative through integration with the irrigation support components of the regional FAO School Feeding and School Gardening programmes;
- Collaboration and coordination with the Government Information Services of the respective territories to assist with the national broadcast of the public awareness programmes developed under the CEHI/UNEP RWH pilot project;
- Coordination of monitoring of the level of success of national RWH programmes;
- Negotiate with the Caribbean Basin Water Management Programme (CBWMP) to include RWH as a component of their certification programme;
- Build capacity within relevant Caribbean agencies and develop a skills bank to provide technical assistance in RWH to territories;
- Development of model RWH applications for the Caribbean based on research and development.

It is proposed that independent evaluations of the Programme be conducted periodically to assess success of the programme and contribute to recommendations in an adaptive learning process. A pre-programme evaluation should establish the baseline (in conjunction with the assessment conducted under the CEHI/UNEP RWH pilot project) to be followed by a mid-term and post-programme evaluation. The agency with lead responsibility for the programme should be responsible for management of the evaluation process.

4.4.1. Indicative costs

Expenditure items	Estimated cost US$
Human resource – programme coordination, technical back-stopping	200,000
Communications and networking	50,000
Programme evaluation	60,000
Total	**310,000**

5. Conclusion

A Regional Programme for the promotion of RWH in Caribbean States is proposed. The effort is part of a global initiative led by the United Nations Environment Programme in the promotion of RWH as a viable water supply augmentation measure. The selection of Grenada as a pilot country in the Caribbean was made in the context of securing water supply in a post-disaster environment given the nation's recent experiences with Hurricanes Ivan and Emily in 2004 and 2005 respectively. Water supply problems associated with heavy demand that peaks in the dry months is typical to many of the Caribbean islands, and with the impending impacts of climate change on rainfall patterns, many countries including Grenada need to consider appropriate options in securing water supply.

The broad objective of the proposed programme is to contribute to the conservation of the water resources of the Caribbean through adoption of sustainable water management and conservation technologies. More specifically the programme seeks to develop and strengthen capacity to facilitate the implementation of rainwater harvesting for household and commercial purpose and develop support policies and incentives and mainstream them into national development strategies and policies. The various consultations under the UNEP/CEHI Project have pointed to four major strategic areas to be implemented locally within the programme:

(1) Awareness building for public and policy makers;

(2) Capacity building at both the individual and institutional levels;

(3) Legislation and policy formulation to enhance water resource governance;

(4) Infrastructure development.

Also included in the programme is support to administration and monitoring of the programme.

The four key outcomes or result areas are as follows:

1. *Public and policy makers' awareness raised on RWH concepts, practices, water quality and sanitation issues;*

2. *Capacity strengthened amongst professionals (technical, advisory services) and other stakeholders, for the implementation and management of RWH systems;*

3. *Existing legal and policy instruments reviewed to develop and effect an effective legal (regulatory) and policy framework for promotion of RWH;*
4. *Effective and efficient RWH systems established.*

The regional programme is proposed to run over a four-year period although this may need to be modified depending on rate of implementation and procurement of financing for core elements such as the public awareness and governance components. The proposed programme costs are indicative and intended to serve as a guide to procurement of financing for the overall programme. The overall cost of the programme is estimated at US$1,844,000.

It is envisaged that the programme will be implemented at two levels; (1) national actions will be coordinated along the four main strategic elements and (2) regional actions that seek to harmonize approaches and gain synergies with partner agency initiatives along the lines of technical support and information exchange.

The main agencies to be charged with the responsibility for execution of the national elements should be the ministries with responsibility for water, health and environment with close support collaboration from the water utilities. The range of applications for RWH is potentially very broad and as such continued discussion with all stakeholders in the public and private sectors needs to be pursued.

It is recommended that a Caribbean Rainwater Partnership be established as a mechanism to share knowledge and experiences on the practice. This partnership may be promoted as a network of community groups and users that share common interests in water security, supported by key community development agencies, water utility companies, the private sector (particularly those that are already engaged in the practice) and technical agencies in the region. It is suggested that UNEP continue to remain engaged to continue to provide necessary technical support and support in raising funds for projects in the region. To facilitate this process a regional coordination node for the programme needs to be agreed upon by the stakeholder agencies in the Caribbean region.

Finally, RWH must be promoted with the understanding that it is a supply augmentation measure and that it is **not intended to replace reliance on conventional potable supplies**. It is envisaged that by the end of the programme significant investments will be made in RWH in new housing developments, commercial and public sector investments. An evaluation of the programme during and after the programme must be undertaken against some of the proposed indicators.

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