A SUMMARY OF INTEGRATED WATER RESOURCES MANAGEMENT (IWRM) AND ITS POTENTIAL IN THE CARIBBEAN

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Acronyms

CARICOM	Caribbean Community and Common Market
CARIWIN	Caribbean Water Initiative
CCCDF	Canadian Climate Change Development Fund
CIDA	Canadian International Development Agency
CIMH	Caribbean Institute for Meteorology and Hydrology
EAST	Environmental Audits for Sustainable Tourism
EMS	Environmental Management Systems
EU	European Union
EU WFD	European Union Water Framework Directive
GEO	Global Environment Outlook
GWP	Global Water Partnership
GWP-C	Global Water Partnership – Caribbean
HELP	Hydrology for the Environment, Life, and Policy
IWRM	Integrated Water Resources Management
JHTA	Jamaica Hotel and Tourist Association
LAC	Latin America and the Caribbean
LM	Luquillo Mountains
MDG	Millennium Development Goals
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
WB	World Bank
WMO	World Meteorological Organization
WRMG	Water Resources Management Group
WSSD	World Summit on Sustainable Development
WWC	World Water Council

Executive Summary

Integrated water resources management (IWRM) is a paradigm growing in popularity and applicability that sees water resources and uses as intertwined, and ultimately management should proceed in a similar manner. The need for IWRM is expressed globally, regionally in the Caribbean, as well as in reference to the Millennium Development Goals (MDG). The Global Water Partnership (GWP) established the IWRM ToolBox, which is endowed with the IWRM principles and provides good practices related to the implementation of IWRM. There are a multitude of organizations currently using IWRM in their mandates, including but not limited to the World Bank, the United Nations Environment Programme, as well as the World Water Council. IWRM has been applied outside of the Caribbean with some success, highlighted by examples from Costa Rica and Nicaragua. The Caribbean region itself, comprised mostly of small island nation states, has seen successful examples of implementation of IWRM in Jamaica and in Puerto Rico. Based on the tools presented in the GWP ToolBox, there are a number of ways in which IWRM could be potentially applied successfully in the Caribbean, but that is not without its challenges. Climate Change will also need to be a due consideration of Caribbean nations when implementing IWRM.

OVERVIEW OF IWRM

What is Integrated Water Resources Management?

Integrated Water Resources Management (IWRM) is a holistic manner in which to proceed with managing water resources. It is the integrating concept for various water uses such as hydropower, water supply and sanitation, irrigation and drainage, and environment. This type of perspective ensures that various dimensions such as social, economic, environmental, and technical, are taken into account in the development and management of water resources (World Bank 2007b). The groundwork of IWRM is found in the fact that the various uses of water are interdependent, and therefore the management of water resources must take this into consideration (with an overall goal of sustainable development being present). IWRM does not only acknowledge the idea that water resources are interdependent, but it also recognizes that the various water uses also have effects on each other (Cap-Net n.d.). Accompanying the concept of IWRM is endorsing the idea of the river basin "as the logical geographical unit for its practical realisation" (Cap-Net n.d.). What this implies is that management must occur on a river basin or watershed basis, and not stopping at a jurisdictional one. Due to the fact that river basins (as the functional units) do not necessarily respect jurisdictional units or boundaries, IWRM is a concept that requires much cooperation and dialogue between nations. This however will be less of a pressing issue in the Caribbean since most nations are separate island states and consequently do not share land-based borders with other nations and will not encounter this problem. Although the issue of international boundaries is generally not a pressing one in the Caribbean, there remains however the matter of jurisdictional boundaries within nations. In the case of the Caribbean Water Initiative (CARIWIN) partner countries of Jamaica, Grenada, and Guyana, they are separated into 14 and six parishes, and ten regions respectively (CIA 2007). Other Caribbean nations have various national jurisdictional boundaries (Table 3 – Appendix II).

It is also pertinent to mention that there have been four main conferences that have been especially significant in furthering the concept of IWRM (Mizanur Rahaman et al. 2004): the International Conference on Water and Environment Issues in the 21st century (Dublin, Ireland, January 1992), Second World Water Forum and Ministerial Conference (The Hague, Netherlands, March, 2000), International Conference on Fresh water (Bonn, Germany, 2001), and World Summit on Sustainable Development (Johannesburg, South Africa, 2002). The universal principles on water are the Dublin principles, which state that: (1) Fresh water is a

finite and vulnerable resource, essential to sustain life, development and the environment; (2) Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels; (3) Women play a central part in the provision, management and safeguarding of water; and (4) Water has an economic value in all its competing uses and should be recognized as an economic good (WMO n.d.).

Why is IWRM necessary?

Globally

The importance of water cannot be stressed enough. There is simply nothing else like it on Earth. Water is not only vital for the human population in terms of its consumptive use, but it is also directly and indirectly related to the livelihood of many in domains such as agriculture and various industries (as a production input), sewage and sanitation, and health. Water is also indispensable for the natural environment and various ecosystem functions, which also benefit the human population. Life would simply not exist without it, and that is why IWRM is a significant tool. This management system sees that all uses are met and balanced in the most sustainable manner possible, without compromising certain functions of water at the sake of others. IWRM is also necessary due the finite nature of (fresh) water, and the increasing pressure that the human population is placing on this irreplaceable resource. Globally we are in the midst of facing a water crisis that will escalate unless changes are made in the present. The following facts are a representation of the global situation in reference to water:

- Global water: 97% seawater, 3% freshwater; of the freshwater 87% is not accessible, 13% is accessible (0.4% of total);
- 263 river basins are shared by two or more nations;
- 2 million tonnes per day of human waste are deposited in water courses;
- Half the population of the developing world are exposed to polluted sources of water that increase disease incidence;
- 90% of natural disasters in the 1990s were water related;
- The increase in numbers of people from 6 billion to 9 billion will be the main driver of water resources management for the next 50 years (Cap-Net n.d.).
- 1.4 billion people lack clean water;
- 2.9 billion people lack sanitation disposal;

- 30,000 people die per day due to lack of water;
- Two-thirds of the global population is established around one-quarter of the world's freshwater supply;
- 70% of water withdrawal is for agricultural use;
- Two-thirds water use is in developing countries;
- Four-fifths irrigation use is also in developing countries (Bonnell 2006d);

Some of the facts presented are very dire – they represent how the situation stands globally. The worst numbers are exacerbated by the situation in Africa and the Middle East, where water scarcity is a pressing issue.

Caribbean

Although in the Caribbean the situation in respect to water does not seem to be at the same gravity as it is in other regions of the world, there are certain other conditions that are afflicting the Caribbean more so than other regions of the world, warranting the requirement of IWRM implementation. As a generalization, the economies of most of the Caribbean nations can be described as transitioning from agrarian to industrial (GWP-C n.d.). Firstly, since the countries within the region are at varying levels along this transition, IWRM is a useful tool due to its site-specific intent. Secondly, for the nations that are still more agriculturally-based, IWRM will be indispensable since more than likely most of the water use within these countries is agriculturally-driven and IWRM can help in addressing water for agricultural purposes. Since the region contains many small island states, two issues arise. Firstly, due to location, respective environments, and climatic conditions, the nations contain highly fragile ecosystems and are very susceptible to hurricanes and floods for multiple months of the year (GWP n.d.b). Furthermore, with a couple of exceptions, this idea of small island states produces the challenge of land availability since watershed areas are very intensively used for the various competing uses and that makes them very vulnerable (GWP-C n.d.). Small island states should be natural advocates of the concept of IWRM due to the idea that, "in small islands, there is no upstream or downstream. The short flow distances to the sea and the economic role that the sea plays in [our] lives both for recreation and for food makes it imperative that [we] adopt an approach which is holistic" (Forde 2007). Finally, the issue of tourism is a very important one since the Caribbean is the most tourism-dependent region (GWP 2007) and this huge influx of people places a heavy

demand on water supplies and infrastructure (GWP n.d.b). The following facts are a regional representation of Latin America and the Caribbean (LAC) of the situation relative to water:

- The region has 30.8% of the available global water supply but 8.6% of the world's population (although very unequal distribution in the region);
- 60% of the population is concentrated in the 20% of the land area that has only 5% of the renewable water resources;
- This population is growing at a rate of 2.17%, with high projected increases by the year 2025;
- Central America and the Caribbean have endowed 6, 890 cubic metres of water per capita per year;
- 80% of the urban population and 53% of the rural population have reliable access to supplies of drinking water;
- 74% of the urban population and 30% of the rural population have access to sanitation (but this figure varies across nations);
- Agricultural withdrawals represented 63.6% of the total water withdrawals in 1990 (Ringler, Rosegrant, and Paisner 2000).

The situation in relation to water resources is more promising in the Caribbean region than it is globally.

Necessity due to Millennium Development Goals

The alarming nature of some of the previous figures demonstrates the growing need for IWRM; however, these figures do not tell the whole story of why IWRM is necessary. The proper management of water resources is necessary due to the role of water (and its adequate supply) and the importance it plays in other facets of life. Addressing water scarcity and improving water management through IWRM can aide in such matters as the fulfilment of the eight Millennium Development Goals that were proposed during the UN Millennium Summit in September 2000 in New York (UNDP 2006), such as eradicating extreme poverty and hunger; ensuring environmental sustainability; promoting gender equality and empowering women; reducing child mortality; improving maternal health; and combating HIV/AIDS, malaria, and other diseases. (Table 1) (UN-Water 2006b).

IWRM IN MORE DETAIL

IWRM and the GWP IWRM ToolBox

IWRM Principles

For water governance to be effective, there are certain principles that need to be fulfilled. The following is a summary of good governance principles from the GWP IWRM Toolbox. Institutions involved need to proceed in such a way that is both transparent and open. The progress of developing IWRM and the actual policies need to be inclusive and communicative. With greater and improved participation in all levels, there will be a greater likelihood that the end result, as well as whatever institution created the policies obtained, will harbour greater confidence from the population. Policies and actions taken must be coherent and integrative by being equitable and ethical. The opportunity to maintain or ameliorate well-being should be accessible to all men and women. Throughout the process of policy development and implementation, there needs to be a careful monitoring of the level of equity among the various interest groups, stakeholders, and consumer-voters. When referring to performance and operation, the requirement out of processes and operations are accountability, efficiency, and responsiveness and sustainability. In terms of accountability, there must be clarity within the roles in the legislative and executive processes and the institutions involved must explain and take responsibility for the actions they take. Efficiency must not only be with regards to economics, but as well as to politics, social, and environmental. In order to be responsive and sustainable, there must be an evaluation of future impacts (and if possible of past experiences) and the objectives must be clear (GWP 2003).

Toolbox

The GWP Toolbox is a consolidation of good practices related to the principles of IWRM. There are roughly 50 tools presented in the Toolbox (Table 2) in a hierarchal, organized fashion (GWP n.d.c). With the characteristics accompanying each one of the tools, the user can make an informed decision about a suitable mix and sequence of tools that could be used in their own local context. When choosing tools, there are sometimes constraints that need to be addressed in order to proceed. For example, there might be unchangeable political or ethical constraints, trade agreements, etc. There are also four cases where multiple changes might be required in order for the use of the tool to occur: (i) there are preconditions for its use (another

tool might need to be implemented first; (ii) the tool needs to be accompanied by other measures to make it effective; (iii) the tool creates losers who may need to be compensated to buy acceptance of the reform; and (iv) the tool may generate unintended and undesirable consequences (GWP 2003).

International Agencies which are using IWRM

Global Water Partnership

The Global Water Partnership (GWP) was created in 1996 by the World Bank, the United Nations Development Programme, and the Swedish International Development Agency. The Partnership was formed after the Dublin Conference on Water and the Environment in 1992 and the subsequent UN Conference on Environment and Development in Rio de Janeiro in 1992, when it was made evident that a more holistic approach to water resource management was required. The GWP is a working partnership among all of the stakeholders involved in water management, from governments to private companies, and others committed to the Dublin-Rio principles. The GWP works to identify global, regional, and national level knowledge needs, aid in the designing of programs for meeting these needs, and be a mechanism for building alliances and exchanging information on IWRM. The overall goal of the GWP is to help nations in ensuring the sustainable management of their water resources (GWP n.d.a).

Global Water Partnership-Caribbean

The Global Water Partnership-Caribbean (GWP-C) is the regional representative for the GWP. Formally launched in 2004 in Tobago, the GWP-C is a working partnership including all stakeholders in water management within the region (GWP-C 2007).

The mission of the GWP-C is to "foster the coordinated development and management of water and related resources in the region" (GWP-C n.d.). Through distributing information to senior officials and the ministers responsible for water, the agency has been able to support the construction of natural IWRM plans and strategies. There exist also plans by the partnership to create a database on all of the IWRM plans and strategies present in the Caribbean that will be available to all stakeholders (GWP-C n.d.).

World Bank

As the World Bank came to the understanding of all the difficulties that came with trying to develop mechanisms that deal with water in a holistic manner that would serve to fulfill "good basin management principles", they established in March of 2000 the Water Resources Management Group (WRMG) within the Bank. This formal group is based on "good basin management principles" and thusly the members of the group come from various groups (such as specialists from water and sanitation, hydropower, irrigation, and environment; the lead water resource specialists from each region, various other water leaders, etc) (World Bank 2007a). Furthermore, the mandate of the group includes such features as "human resource actions with respect to water resources management, working collaboratively with various sector boards; outreach and corporate positions on water resource issues; and knowledge management on water resources" (World Bank 2007a).

The goal of their Water Resources Management website is to "serve as a central organizing point for water as a cross-cutting issue throughout the World Bank. It addresses water as a resource in its many dimensions, serves to assess and disseminate emerging lessons and shared experiences, to publicize policies and guidelines, facilitate cooperation on water issues and to address issues of knowledge generation, management, and enhancing skill" (World Bank 2007b).

UN-Water

Endorsed in 2003, UN-Water became the new official UN mechanism that supports Member States in their efforts to achieve water and sanitation goals and targets in the wake of the water-related decisions reached at the 2002 World Summit on Sustainable Development (WSSD) and the Millennium Development Goals (UN-Water 2006a). Furthermore, the work undertaken by UN-Water looks at both freshwater resources and sanitation, and the interaction between the two.

IWRM is the overarching framework under which UN-Water organizes its various projects and work related to water issues. IWRM is the organization's framework for action at three levels: local, national, and regional. UN-Water makes reference to the WSSD in Johannesburg in 2002, where the Implementation Plan from that conference for IWRM calls for

such action as “measures to improve the efficiency of water use, to reduce losses and to increase recycling of water in a way that gives priority to the satisfaction of basic human needs while preserving or restoring ecosystems and their functions, and diffusion of technologies and capacity building for non-conventional water resources and conservation technologies to developing countries and regions facing water scarcity conditions” (UN-Water 2006b).

United Nations Environmental Programme

The United Nations Environmental Programme (UNEP) was established in 1972 with the objective of being the voice for the environment within the UN network. UNEP’s roles include catalyst, advocate, educator and facilitator of the promotion of the wise use and sustainable development of the global environment while working with many partners (UNEP n.d.).

As part of the Global Environment Outlook (GEO), UNEP acknowledges the significance of IWRM in is use to as an approach attaining sustainable freshwater resource use and decreasing human vulnerability to water-related environmental change (UNEP 2003).

World Water Council

Due to increasing global concern about world water issues, the World Water Council (WWC) was formed in 1996 in response to this growing concern. The mission of the WWC is to “promote awareness, build political commitment and trigger action on critical water issues at all levels, including the highest decision-making level, to facilitate the efficient management and use of water in all its dimensions and on an environmentally sustainable basis” (WWC 2007b).

IWRM is a tool that considers the linkages between various water-related uses and the need to encourage more efficient water use. The WWC recognizes this point, and they believe that they can play a key role in the process of global learning – countries and communities can draw on the experiences of others for their own implementation of IWRM (WWC 2007a).

IWRM OUTSIDE THE CARIBBEAN

In trying to study examples of IWRM used outside the Caribbean, it only seemed reasonable to compare with Central American nations due to their proximity and subsequent similar climatic and geographical conditions, as well as their size. There isn’t as much of a point in comparing Caribbean nations with examples of IWRM from very big, non-coastal, or rich

countries that have a capacity that greatly outranks that of the small island developing states of the Caribbean.

Costa Rica

The following summary of the application of IWRM in Costa Rica is based exclusively on the case report (#1) produced by Sarah Cordero (n.d.).

This report presented a case where the introduction of an environmental charge on water users was implemented with the purpose of protecting forest covers and ultimately water resources. This case may possibly the only example of a country that recognizes "the importance of its forests in providing environmental services, including water catchment protection and recovery of the water resources".

Until 1995-1996 in Costa Rica, water was considered a public good, allocating the status of free and unlimited. After a study was conducted in 1995, the Costa Rican government searched for an improvement in the economic valuation of natural resources. In 1997, the program of payments for environmental services officially began. Towards the end of that year, the Central Volcanic Mountains Foundation and the National Fund for Forestry Financing, along with a private hydroelectric company, signed an agreement stating "that the company would pay for the protection and conservation of the forests in the watershed that supplies the hydroelectric project. The agreement, although small in magnitude, sets a precedent for voluntary accords with private companies for payment of environmental services". The funding for the environmental services payments came from dual sources, a fuel tax and from selling emission reduction credits. This made way for the introduction of an environmental charge. On top of the water fee, consumers were charged extra for the idea of environmental services received. After considerable debate the amount approved for this environmental component was ¢1.90 /m3 (US$0.00543 /$m^3$). As it stands now, the price that consumers pay for water services include "the mean cost that the water undertaking pays to gather, make potable, transport, and distribute the water. It also includes a fixed service charge, a variable charge based on consumption, and a sometimes variable charge for sewage treatment". The project was a success in the fact that people no longer viewed water as a free commodity – they developed a much more sustainable view towards it. However, the project did not do enough in terms providing environmental protection, or more specifically protection of water resources. The emphasis of protection and

conservation of this project was the forest resources, so therefore along with strong water pricing, there should have been a coupling of a reliable land use plan, and a solid environmental policy that also deals with water pollution and source protection.

Nicaragua

The following summary of the attempted application of IWRM in Nicaragua is based exclusively on the report (#12) produced by David K. Milton (n.d.).

This case explores the reasons behind why a 'text book' planning exercise in Nicaragua has so far not succeeded in having any real impact.

Although Nicaragua has an abundant amount of water resources, uneven spatial and temporal distribution, as well as population pressure, and surface water and groundwater degradation due to industry and agriculture have led to periods of water scarcity. Water resource management has typically been fragmented in Nicaragua; the number of government bodies have unclear and overlapping mandates. There was also no established water law, so the government had to depend on sectorally-based legal instruments that were not comprehensive enough for implementation of IWRM. The most significant action taken by the government was the Environmental Action Plan of 1994, which was centered around the formulation of a policy and associated strategies for the "rational development and management of water resources. The project was based on IWRM principles as was evident by the numerous tools used, including preparation of a national water resources policy, training to build capacity in water professionals, water resource assessment, and pollution and environmental charges. At the time of this project, the political and institutional environment was unstable, and the Environment Law was being conceived in the meanwhile with general and overlapping aspects of water resource management. The project however did not see very much success. Not all of the objectives were fulfilled, stemming from a shortage of political will due to the lack of concept of local "ownership" of the project. There was little or no implementation of Action Plan recommendations. Although the project was not a complete failure since there was active participation of local staff from state institutions and local personnel produced various documents, it was doomed to fail from the beginning since the project objectives were too ambitious given the political state of the nation, too-short of a time frame, and the lack of a

suitably string project anchor. The lessons learned from this case should be exemplary in what nations like Nicaragua should not aim to repeat.

THE CARIBBEAN REGION

The Caribbean region is composed of mainly small island nation states, with only a few nations sharing land-based geographical borders with other nations. The nations included within the Caribbean region are found in Box 1, and basic population, land area, and water data are included as well (Table 3 – Appendix II).

Map 1 - The Caribbean Region

Source: (World Atlas.Com n.d.)

IWRM IN THE CARIBBEAN

Although growing in attention and importance, from the lack of literature on the subject, it seems that there is quite a bit of difficulty in successfully implementing IWRM principles and completing IWRM projects in Caribbean nations. There are some cases where literature has been made available that relates to the potential applicability of IWRM in some of the Caribbean countries (for example Trinidad and Tobago and Belize), but applying IWRM has been problematic. However, there are some instances where IWRM is being applied in nations

through various projects. A fully-completed case report was found for Jamaica and Puerto Rico, as IWRM has successfully begun.

Due to the fact that IWRM is not being extensively utilized in the Caribbean (or that its uptake is proceeding at a very slow process), it is implied that it should be used much more than it is currently used. Although its limited use is problematic, it is also encouraging to know that since there is minimal application there is much potential for IWRM in the Caribbean.

Box 1
Antigua and Barbuda
Anguilla
Aruba
The Bahamas
Barbados
Belize
Bermuda
British Virgin Islands
Cayman Islands
Cuba
Dominica
Dominican Republic
Grenada
Guyana
Haiti
Jamaica
Montserrat
Netherlands Antilles
Puerto Rico
St. Kitts and Nevis
St. Lucia
Saint Vincent & the Grenadines
Suriname

Jamaica

The following summary of the application of IWRM in Jamaica is based exclusively on the case report (#153) produced by Bill Meade (n.d.).

The overall goal of this case study was to demonstrate how to establish environmental responsibility into the private sector, to help people involved with the hotel industry recognize the cost savings of water (and energy) conservation, and to build capacity within local businesses and institutions to become more efficient in their water use and protect both coastal and freshwater resources.

Jamaica, like the rest of the Caribbean, is very dependent on tourism. Although this industry is vital for the economy and job creation, it can take its toll on infrastructure and the environment (which the tourism industry normally requires for its self-preservation). For that reason, in 1997 USAID launched a new partnership with the Jamaica Hotel and Tourist Association (JHTA) to fund the inception of environmental management and best practices in small hotels (<100 rooms). An environmental management system (EMS) was defined in this report as a "systematic framework for integrating environmental management into an organization's activities, products, and services". An EMS requires continuous improvement (evolving as conditions change) and the use of "best practices". An organization was hired to implement the EAST (Environmental Audits for Sustainable Tourism) Project. The Project consisted of: "developing greater awareness and understanding of the benefits of environmental management systems and audits among hoteliers, restaurateurs, and allied tourism businesses; upgrading the technical skills of Jamaicans who are expected to conduct audits and advise on

environmental management systems; assisting tourism-related establishments in carrying out environmental audits; and systematic application of best environmental management practices among tourism and hospitality organizations". The best practices were implemented on a hotel-wide scale and were water conservation measures including but not limited to low-flow showerheads, installing drip irrigation and low pressure sprinkler systems in landscaped areas, and initiating voluntary towel reuse programs in guest rooms. The tools used for the project included: improved efficiency of use (of water), information and transparency for raising awareness, training to build capacity in water professionals, and communication with stakeholders.

Although the hoteliers were sceptical at first about their EMS, their scepticism began to waiver as they started seeing monetary returns. The project was successful, and much of it was due to the support of senior level management and the leadership abilities of the Environmental Officer (the individual that was allocated access to the financial, time, and training resources that are required to implement an effective EMS. The project contributed to water savings of over 41.4 million imperial gallons among the participating hotels as well as reduced energy and chemical use. After the implementation of this project, hotels saw a savings of US$913 per room and came to the realization therefore that water conservation is both cost effective and ecologically beneficial. With the hotels becoming less water and energy intensive, more resources were available to the surrounding community. This meant that service to all Jamaicans was improved, creating social justice along the way. The overall impact of the tourism industry on Jamaica's environment has been reduced, and the country is now a leader in sustainable tourism.

Puerto Rico – the Luquillo Mountains

The following summary of the application of IWRM in Puerto Rico is based exclusively on the study *IWRM in the Luquillo Mountains, Puerto Rico: An Evolving Process* (Ortiz-Zayas et al. 2004).

IWRM in Puerto Rico is a continuing and evolving process, made possible by the Hydrology for the Environment, Life, and Policy (HELP) programme. This programme is promoting the application of IWRM principles by sponsoring case studies around the world. The

HELP programme is highlighted in the Caribbean by the case study of a group of small river basins draining the Luquillo Mountains (LM) in Eastern Puerto Rico.

Puerto Rico is physically a large nation (relative to the Caribbean), and densely populated. Like many of the other Caribbean nations, Puerto Rico and the LM have experienced rapid population growth in recent decades. The relatively abundant and high quality nature of the water yield from the LM leads to its intensive use in both consumptive and non-consumptive purposes. In addition to its high use, the distribution of water is poor in the sense that published data revealed that approximately 42% of the total water deliveries in Puerto Rico are unaccounted for due to leaking in the water distribution system and illegal connections. The future efforts of the application of IWRM in the LM are framed within the four universal principles presented in Dublin in 1992, therefore addressing the concepts of water as a finite and vulnerable resource, the participatory approach, the important role of women, and water as an economic good.

To date, there are some unique examples of effective collaboration in water resource management that illustrate evolving the IWRM processes in the LM. Engineers and aquatic ecologists have worked in combination to implement original solutions to increase water supplies while protecting the ecological integrity of fresh water ecosystems; one of these original solutions has been to make adjustments in water extraction schedules to favour the life cycles of sensitive aquatic ecologists, in tandem with effective dissemination of the research findings. Also underway is the development of a wastewater reuse project in a large resort in Rio Grande.

One of the major goals of the LM HELP project is to develop “a network of ‘problem-solving’ watershed groups with both a local and regional approach to water resources management in the LM. These groups should have adequate representations of water managers, stakeholders, policy-makers and water scientists”.

HOW IWRM CAN BE IMPLEMENTED IN THE CARIBBEAN

Challenges

The problems and challenges facing water resources in Latin America and the Caribbean can be grouped within the following challenges: social, economic, financial, environmental, and institutional. It is argued by San Martin that these challenges are rooted in: (1) a lack of

understanding of the uniqueness or integral character of the water resource and its low degree of substitution; (2) heterogeneity in terms of quantity, quality, and availability of the resource; (3) insufficient consideration of the economic value of the response, and, aggravating this situation; (4) the low levels of awareness about water resource problems among the general public, which in turn results in a lack of political commitment among decision makers to take action on these matters (2002).

The difficulty of adopting IWRM-fulfilling policies (and laws) can be seen even in the European Union (EU). The Water Framework Directive (WFD) was presented and then adopted in 2000 by the EU Commission as a means of addressing the increasing demand by the people for cleaner water. The discovery of seven mismatches between the EU WFD and IWRM by Mizanur Rahaman et al. (2004) demonstrates the difficulty in implementing IWRM, even by nations with very high institutional capacities, many educated and trained professionals, increased financial capacity, etc. The difficulties in implementation will be even greater in the Caribbean, where the institutional and financial capacities are not as strong and building a human resource base is a work in progress.

Possibilities

With tourism being the dominant sector of the economy, there is a lot of potential for IWRM and sustainable tourism, as was the case with Jamaica. The amount of water savings from only sustainable tourism could be unprecedented. Since millions of imperial gallons were conserved in only Jamaica, if such policies were further implemented in the region in popular tourist destinations such as Dominican Republic, Bahamas, Bermuda, Haiti, etc. the region could become a leader in water conservation. Sustainable tourism is slowly spreading across the region, as is seen at a number of hotels in Barbados. The Asta Hotel was given the Green Globe certification for measures such as low-flow faucets and toilets, and the rainwater harvesting of over a hundred gallons of water per guest per night. Another example is the Casuarina Beach Club in the St. Lawrence Gap on the south coast of the island, where measures taken such as alternate cleaning products and irrigation with brackish water have earned the hotel the Green Hall of Fame (Bonnell 2006b). This idea of initializing IWRM in the Caribbean through the tourism sector is furthered by Forde who states that, “The tourism sector is a major player in our [Caribbean] economic life and it may be a good entry point for us to apply IWRM in the region. Specifically two key components can be basis for case studies: water demand management –

how to reduce consumption in the sector; and water conservation – recycle and reuse" (2007). The tourism sector would therefore be a strong entry point for all-around IWRM application. The Jamaican case of sustainable tourism highlights the use of management instruments as a tool for implementation of IWRM. Within the hotel a water resources assessment was performed, devices were installed and awareness raised in order to increase efficiency instruments. Information sharing between hotels also furthered knowledge in water resource management.

Institutional roles as a tool of IWRM needs to be implemented as well, in terms of both creating an organisational framework and building institutional capacity. In reference to the latter, the Caribbean Institute for Meteorology and Hydrology (CIMH) is on the path to doing so in its partnership with CARIWIN. The achievement of CARIWIN's objective of promoting sustainable and equitable integrated water resources management (IWRM) in the region will be done through "the strategy of strengthening the capacity of CIMH, as a regional institution, to provide training and capacity development in water resources management to CARICOM member states, and through the CIMH, to propagate capacity building initiatives in IWRM at the national, local and community levels in three pilot countries - Jamaica, Grenada and Guyana. The CARIWIN project will increase the relevance and reach of CIMH while testing, developing and disseminating new capacity development and community governance models in IMRM throughout the Caribbean" (CIMH 2007).

Institutional roles as tools will have to work in combination with tools for the enabling environment, in terms of creating policies, legislative framework, and financial and incentive structures for the successful implementation of IWRM, "There remains a need to strengthen institutional capacity at the local level. Capacity building also includes a powerful legislative and regulatory framework to facilitate and guide the implementation strategies, together with the capacity to apply such legislation and enforce regulations" (Kuylenstierna 1999). The need for these tools also comes from the traditional compartmentalization of water in the region. Traditionally, three sectors for water use have been dominant: domestic, industrial, and agricultural. The Caribbean is accustomed to hierarchal, top-down governance, or the state steering society; but contemporary governance is a distributed one in which governments, society and markets interact to influence outcomes (Forde 2007).

Strong water pricing, coupled with solid environmental policies for land use and water pollution protection, should definitely be incorporated into the Caribbean. In the case of

Barbados, water use is broken down in the following manner: farming (23%), domestic (22%), industrial and commerce (7.6%), hotels and ships (2.3%), and golf courses (1.1%). This totals 67%, meaning that 33% of the water is unaccounted for, not billed, or lost to leaks (Bonnell 2006d). This is problematic for a water scarce nation such as Barbados, where the 350 m^3 per person per year water allocation is much lower than other Caribbean nations (ex. Haiti and Trinidad and Tobago) (Bonnell 2006a). A nation like Barbados needs to have stringent water pricing measures, but they cannot be in isolation since water pricing has been attempted in the country in the past and it did not make much of a difference in terms of water use (Figure 1 – Appendix I). Water quality is also becoming a problem, both for coastal waters and groundwater due to increased runoff (partially from more intense land use) as well as other pollutants (Bonnell 2006d).

CLIMATE CHANGE AND THE CARIBBEAN

It is important to note that climate change and the pending uncertainty associated with it will affect water resources in the region. Although most of the sources of climate change do not originate from the Caribbean, the region will be affected disproportionately through potential sea level rise, as well as the increased intensity and frequency of storm events and therefore mitigation and adaptation strategies need to be included within IWRM plans. It is therefore necessary that IWRM strategies and plans include measures for adaptation and mitigation of climate change. The Caribbean has begun to emphasize climate change through the Adaptation to Climate Change in the Caribbean (ACCC) project (funded by the Canadian Climate Change Development Fund (CCCDF) through the Canadian International Development Agency (CIDA)). Strengthening the technical capacity of national and regional institutions as a response to gaps and needs identified in the first three years of the now-ended previous project is one of the focuses of the ACCC. The CIMH is in one way benefiting through staff training and development aimed at strengthening its climate change capacity. The CIMH, at the same time, is providing technical assistance to the project as it undertakes the rescue of hydrological data from several Eastern Caribbean nations (CIMH 2007).

CONCLUSIONS AND RECOMMENDATIONS

This report has sought to summarize the key points of IWRM: what it is; why it is necessary in a global, regional, and goal-oriented context; its principles; and the GWP IWRM Toolbox. There are many agencies that are using IWRM as part of their mandates, and attempting to implement IWRM strategies globally. Examples of projects in Central America include Costa Rica and Nicaragua, while IWRM has successfully been implemented in Jamaica and Puerto Rico. The examples of the implementation of IWRM in various other nations can act as demonstrations as to how it can be implemented in the Caribbean context. It will also be significant to incorporate climate change adaptation and mitigation strategies within IWRM plans.

Currently the literature on IWRM, and most notably in the Caribbean, is very minimal. A reason for that could be because "successful implementation of IWRM remains elusive and there are few concrete examples of it in action" (UNEP 2003). In the examples that do exist, the discussion lies mostly within cases in Latin and Central America. When implemented properly, as in the Jamaican case, IWRM is a useful tool for sustainable development and is beneficial for everyone involved, as well as the natural environment. It is therefore recommended that greater emphasis needs to be placed on thoroughly implementing IWRM in Caribbean nations as water security is becoming less and less certain, and as climate change adds another unknown dimension to the problem as well. The discovery of the lack of practice of IWRM in the Caribbean, "and the crying need to adopt this [IWRM] approach", became evident from the reports produced out of three consultations and workshops held in St. Kitts (December 2005), Antigua (January 2006), and St. Lucia (May 2006) (Forde 2007).

The mandates of a number of the agencies mentioned above only focus their attention on surface and ground freshwater resources. Eventually when IWRM is more extensively implemented in the Caribbean, freshwater resources will have to go beyond the traditional sources. Under-explored resources include rainwater (Falkenmark, M. and J. Rockström 2005) as well as other alternative sources such as brackish water and desalination (Boutkan, E. and A. Stikker 2004). UN-Water states that "rainwater is rarely integrated into water management strategies, which usually focus exclusively on surface water and groundwater. Countries need to integrate rainwater harvesting more fully into their IWRM strategies and to promote its use to

alleviate water scarcity" (2006a). As the traditional freshwater resources become more and more difficult to access, Caribbean nations will have to look at the other options around them.

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REFERENCES

Bonnell, Robert. November 2006a. *Geology and Water – The Case of Barbados.* Prepared for the course AGRI 452: Water Resources in Barbados. Bellairs Research Institute of McGill University, Holetown, Barbados.

Bonnell, Robert. November 2006b. *Intro to Barbados.* Prepared for the course AGRI 452: Water Resources in Barbados. Bellairs Research Institute of McGill University, Holetown, Barbados.

Bonnell, Robert. November 2006c. *The Hidden Threat to Groundwater.* Prepared for the course AGRI 452: Water Resources in Barbados. Bellairs Research Institute of McGill University, Holetown, Barbados.

Bonnell, Robert. November 2006d. *Water – the Condition of our World and Barbados as an Example.* Prepared for the course AGRI 452: Water Resources in Barbados. Bellairs Research Institute of McGill University, Holetown, Barbados.

Boutkan, Else and Allerd Stikker. 2004. Enhanced water resource base for sustainable integrated water resource management. *Natural Resources Forum (28).* Retrieved February 25, 2007 from http://www.blackwell-synergy.com/doi/pdf/10.1111/j.1477-8947.2004.00082.x

Cap-Net. (n.d.). *Integrated Water Resources Management.* Retrieved February 7, 2007 from http://www.cap-net.org/iwrm_tutorial/sitemap.htm

CIA. 2007. *The World Factbook.* Retrieved March 31, 2007 from www.cia.gov/cia/publications/factbook/

CIMH. 2007. *Cooperative Projects*. Retrieved March 31, 2007 from http://www.cimh.edu.bb/curprojs.htm

Cordero, Sarah. (n.d.). *Costa Rica - Introducing Water Use Charges to pay for Environmental Services Case #1.* Retrieved March 19, 2007 from http://www.gwptoolbox.org/gfx/content/ACF621.pdf

Falkenmark, M. and Rockström, J. (2005). Rain: The Neglected Resource. *Swedish Water House Policy Brief Nr. 2*.Retrieved February 25, 2007 from http://www.siwi.org/downloads/Reports/2005_Blue_Green_Policy_Brief.pdf

Forde, Lester. 2007. *IWRM in the Caribbean: Some of the Challenges*. Retrieved March 30, 2007 from http://cariwin.mcgill.googlepages.com/LesterIntegratedWaterResourcesManage.pdf

GWP. (n.d.a). *About US.* Retrieved March 29, 2007 from http://www.gwpforum.org/servlet/PSP?chStartupName=_about

GWP. (n.d.b). *Caribbean.* Retrieved March 19, 2007 from http://www.gwpforum.org/servlet/PSP?iNodeID=2903

GWP. (n.d.c). *GWP Toolbox.* Retrieved March 19, 2007 from http://www.gwptoolbox.org/

GWP. 2003. *Toolbox: Integrated Water Resources Management.* Retrieved March 19, 2007 from http://www.gwptoolbox.org/gfx/content/ToolBox%20text%20book%20Ver2%20Eng.pdf

GWP-C. n.d. *GWP Caribbean*. Retrieved March 19 from http://www.gwpforum.org/gwp/library/carribean_jan06.pdf

GWP-C. 2007. *Global Water Partnership – Caribbean.* Retrieved March 29 from http://www.gwp-caribbean.org/

Kuylenstierna, Johan. 1999. Capacity Building – A Key Aspect of Successful Integrated Resource Management. *WMO Bulletin*. 48: 182-187.

Meade, Bill. (n.d.) *Jamaica – Implementing Environmental Management Systems (EMS) for Sustainable Tourism Case #153.* Retrieved March 19, 2007 from http://www.gwptoolbox.org/gfx/content/ACF420D.pdf

Milton, David K. (n.d.). *Nicaragua - Evaluation of the National Water Action Plan Case #12.* Retrieved March 19, 2007 from http://www.gwptoolbox.org/gfx/content/ACF600.pdf

Mizanur Rahaman, M., O. Varis, and T. Kajander. 2004. EU Water Framework Directive vs. Integrated Water Resources Management. *Water Resources Development*. 20 (4): 565-575.

Ortiz-Zayas, J.R. and F.N. Scatena. 2004. Integrated Water Resources Management in the Luquillo Mountains, Puerto Rico: An Evolving Process. *Water Resources Development.* 20 (3): 387-398.

Ringler, C., Rosegrant, M.W., and Paisner, M.S. 2000. *Irrigation and Water Resources in Latin America and the Caribbean: Challenges and* Strategies. Retrieved March 28, 2007 from http://www.ifpri.org/divs/eptd/dp/papers/eptdp64.pdf

San Martin, Orlando. 2002. *Water Resources in Latin America and the Caribbean: Issues and Options.* Retrieved February 25, 2007 from http://www.iadb.org/sds/doc/ENV-OSanMartin-WaterResourcesinLaC.pdf

Thomas, Jean-Sebastien and Bruce Durham. 2003. Integrated Water Resource Management: looking at the whole picture. *Desalination.* 156: 21-28.

UNDP. 2006. *Millennium Development Goals - MDGs.* Retrieved March 12, 2007 from http://www.undp.org/mdg/basics.shtml

UNEP. (n.d.). *About UNEP*. Retrieved March 12, 2007 from http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=43&ArticleID=3301&l=en

UNEP. 2003. *GEO: Global Environment Outlook – Integrated Water Resource Management.* Retrieved March 13, 2007 from http://www.unep.org/geo/yearbook/yb2003/082.htm

UN-Water. 2006a. *About UN Water*. Retrieved March 13, 2007 from http://www.unwater.org/about.html

UN-Water. 2006b. *Coping with Water Scarcity – A strategic issue and priority for system-wide action.* Retrieved March 12, 2007 from www.unwater.org/downloads/waterscarcity.pdf

World Atlas.Com. n.d. *Map of the Caribbean.* Retrieved February 11, 2007 from http://worldatlas.com/webimage/countrys/carib.htm

World Bank. 2007a. *About Us – the Water Resources Management Group.* Retrieved March 13, 2007 from http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTWRM/0,,contentMDK:20441076~hlPK:1307119~menuPK:1304484~pagePK:148956~piPK:216618~theSitePK:337240,00.html

World Bank. 2007b. *Water Resources Management.* Retrieved February 10, 2007 from http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTWRM/0,,menuPK:337246~pagePK:149018~piPK:149093~theSitePK:337240,00.html

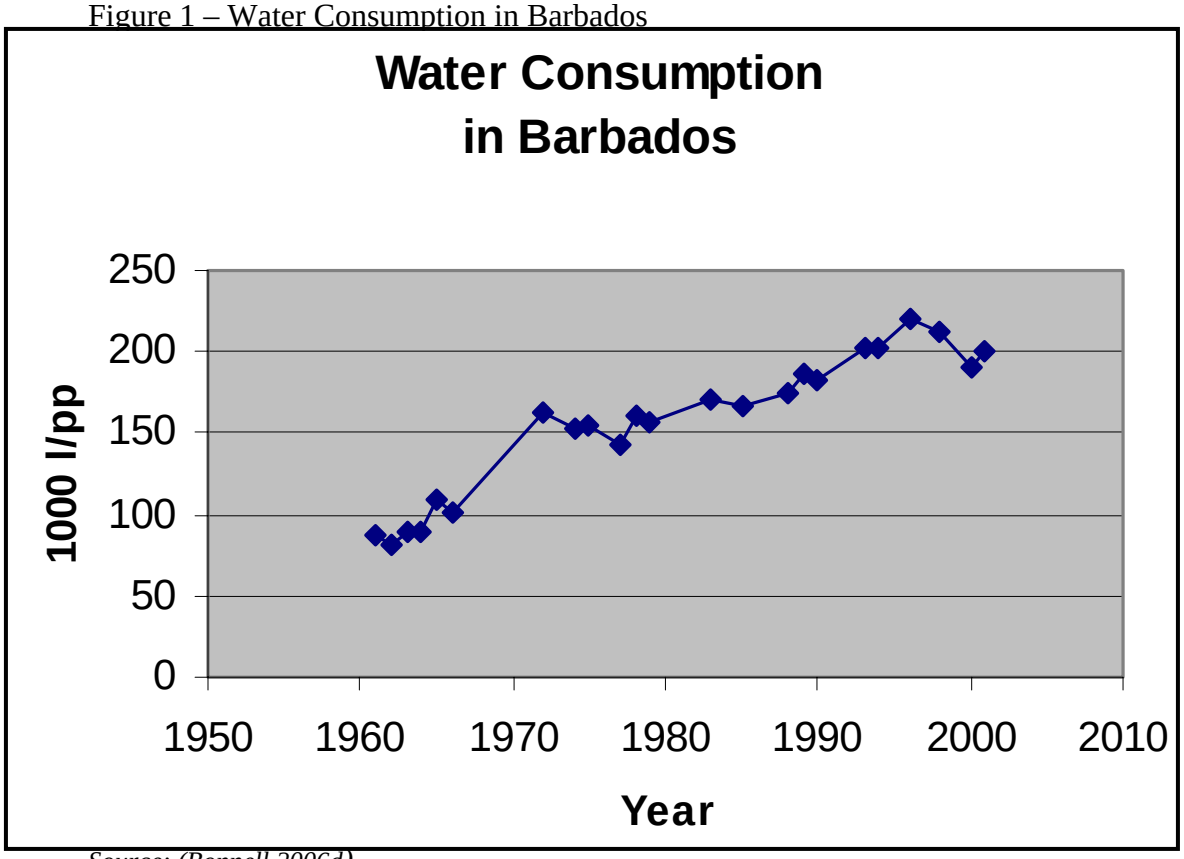
WMO. n.d. *The Dublin Statement on Water and Sustainable Development.* Retrieved March 29, 2007 from http://www.wmo.ch/web/homs/1stpage.html

WWC. (2007a). *Implementing Integrated Water Resources Management.* Retrieved March 13, 2007 from http://www.worldwatercouncil.org/index.php?id=1403

WWC. (2007b). *World Water Council: An International Multi-Stakeholder Platform for a Water Secure World.* Retrieved March 13, 2007 from http://www.worldwatercouncil.org/

APPENDIX I - FIGURES

Figure 1 – Water Consumption in Barbados



Source: (Bonnell 2006d)

APPENDIX II - TABLES

Table 1 – Millennium Development Goals and Linkage with Water Scarcity

MILLENIUM DEVELOPMENT GOALS (MDG)	LINKAGE WITH WATER SCARCITY
Eradicating extreme poverty and hunger	Access to water for domestic and productive uses (agriculture, industry, other economic activities), which has a direct impact on poverty and food security. Vulnerability to water-related shocks including droughts. Impact of water scarcity on both irrigated and rain-fed agriculture for expanded grain production; for subsistence agriculture, livestock, fish and other foods gathered in common property resources; capacity to produce cheap food with impacts on nutrition in urban and rural areas
Achieving universal primary education	Incidence of catastrophic events such as droughts that interrupt educational attainment; drought preparedness programmes
Promoting gender equality and empowering women	Access to water, in particular in conditions of scarce resources, with important gender related implications, affecting affect the social and economic capital of women in terms of leadership, earnings and networking opportunities
Reducing child mortality and improving maternal health	Improved nutrition and food security, which reduces susceptibility to diseases. Equitable, reliable water resources management programmes that reduce poor people's vulnerability to shocks, which in turn gives them more secure and fruitful livelihoods to draw upon in caring for their children.
Promoting global Partnerships	Access to water, and improved water and wastewater management in human settlements that reduces transmission risks of mosquito-borne illness such as malaria and dengue fever
Ensuring environmental Sustainability	Adequate treatment of wastewater, which contributes to less pressure on freshwater resources, helping to protect human and environmental health. Improved water management, including pollution control and water conservation, as a key factor in maintaining ecosystem functions and services
Combating HIV/AIDS, malaria and other diseases	Water scarcity increasingly calls for reinforced international cooperation in the fields of technologies for enhanced water productivity, financing opportunities, and an improved environment to share the benefits of scarce water management

Source: (UN-Water2006b)

Table 2 – Summary of tools from Toolbox

TOOLS – IWRM
A THE ENABLING ENVIRONMENT
A1 POLICIES – Setting goals for water use, protection and conservation
A1.1 Preparation of a national water resources policy
A1.2 Policies with relation to water resources
A2 LEGISLATIVE FRAMEWORK – Water policy translated into law
A2.1 Water rights
A2.2 Legislation for water quality
A2.3 Reform of existing legislation
A3 FINANCING AND INCENTIVE STRUCTURES – Financial resources to meet water needs
A3.1 Investment policies

A3.2 Financing options I: Grants and internal sources
A3.3 Financing options II: Loans and equity

B INSTITUTIONAL ROLES

B1 CREATING AN ORGANISATIONAL FRAMEWORK – Forms and functions

B1.1 Reforming institutions for better governance
B1.2 Transboundary organisations for water resource management
B1.3 National apex bodies
B1.4 River basin organisations
B1.5 Regulatory bodies and enforcement agencies
B1.6 Service providers and IWRM
B1.7 Strengthening public sector water utilities
B1.8 Role of the private sector
B1.9 Civil society institutions and community based organizations
B1.10 Local authorities
B1.11 Building Partnerships

B2 BUILDING INSTITUTIONAL CAPACITY - Developing human resources

B2.1 Participatory capacity and empowerment in civil society
B2.2 Training to build capacity in water professionals
B2.3 Regulatory capacity

C MANAGEMENT INSTRUMENTS

C1 WATER RESOURCES ASSESSMENT – Understanding resources and needs

C1.1 Water resources knowledge base
C1.2 Water resources assessment
C1.3 Modelling in IWRM
C1.4 Developing water management indicators
C1.5 Ecosystem assessment

C2 PLANS FOR IWRM – Combining development options, resource use and human interaction

C2.1 National integrated water resources plans
C2.2 Basin management plans
C2.3 Groundwater management plans
C2.4 Coastal zone management plans
C2.5 Risk assessment and management
C2.6 Environmental Assessment (EA)
C2.7 Social Assessment (SA)
C2.8 Economic assessment

C3 EFFICIENCY IN WATER USE – Managing demand and supply

C3.1 Improved efficiency of use
C3.2 Recycling and reuse
C3.3 Improved efficiency of supply

C4 SOCIAL CHANGE INSTRUMENTS – Encouraging a water-oriented society

C4.1 Education curricula on water management
C4.2 Communication with stakeholders
C4.3 Information and transparency for raising awareness

C5 CONFLICT RESOLUTION – Managing disputes, ensuring sharing of water
- C5.1 Conflict management
- C5.2 Shared vision planning
- C5.3 Consensus building

C6 REGULATORY INSTRUMENTS – Allocation and water use limits
- C6.1 Regulations for water quality
- C6.2 Regulations for water quantity
- C6.3 Regulations for water services
- C6.4 Land use planning controls and nature protection

C7 ECONOMIC INSTRUMENTS – Using value and prices for efficiency and equity
- C7.1 Pricing of water and water services
- C7.2 Pollution and environmental charges
- C7.3 Water markets and tradeable permits
- C7.4 Subsidies and incentives

C8 INFORMATION EXCHANGE – Sharing knowledge for better water management
- C8.1 Information management systems
- C8.2 Sharing data for IWRM

Source: (GWP Toolbox 2003)

Table 3 – Population and water indicators for Caribbean nations

Country	Population	Area (km^2)	Population Density (persons/ km^2)	Main Administrative Divisions	Annual Withdrawal per capita (m^3/cap)	Ratio of H_2O withdrawal to H_2O availability
Anguilla	13, 677	102	134.1	------	-----	-----
Antigua & Barbuda	69, 481	442.6	156.9	6 parishes	-----	-----
Aruba	100,018	193	518.2	-----	-----	-----
The Bahamas	305,655	13,940	21.9	21 districts	-----	-----
Barbados	280,946	431	651.8	11 parishes	-----	-----
Belize	294,355	22,966	12.8	6 districts	109	Low (<2.5%)
Bermuda	66,163	53.3	1241.3	9 parishes	-----	High (>10%)
British Virgin Islands	23,552	153	153.9	-----	-----	-----
Cayman Islands	46,600	262	177.9	8 districts	-----	-----
Cuba	11,394,043	110,860	102.8	14 provinces	870	High (>10%)
Dominica	72,386	754	96.0	10 parishes	-----	-----
Dominican Republic	9,365,818	48,730	192.2	31 provinces	446	High (>10%)
Grenada	89,971	344	261.5	6 parishes	-----	-----

Guadeloupe	-----	-----	-----	-----	-----	-----
Guyana	769,095	214,970	3.6	10 regions	1819	Low (<2.5%)
Haiti	8,706,497	27,750	313.7	10 departments	7	Medium (2.5-10%)
Jamaica	2,780,132	10,991	252.9	14 parishes	159	Medium (2.5-10%)
Martinique					-----	-----
Montserrat	9538	102	93.5	3 parishes	-----	-----
Netherlands Antilles	223,652	960	233.0	-----	-----	-----
Puerto Rico	3,944,259	13,790	286.0	-----	-----	-----
St. Kitts & Nevis	39,349	261	150.8	14 parishes	-----	-----
St. Lucia	170,649	616	277.0	11 quarters	-----	-----
Saint Vincent & the Grenadines	118,149	389	303.7	6 parishes	-----	-----
Suriname	470,784	163,270	2.9	10 districts	1192	Low (<2.5%)
Trinidad & Tobago	1,056,608	5128	206.0	-----	148	-----
Turks & Caicos Islands	21,746	430	50.6	-----	-----	-----
U.S. Virgin Islands	108,448	1910	56.8	-----	-----	-----

Source: (CIA World Factbook 2007 and Ringler, Rosegrant, and Paisner 2000)