

Conference Topic: Integrated Water Resources and Coastal Areas Management

Tools for the implementation of Integrated Water Resources Management (IWRM) in the Caribbean: The legacy of the Caribbean Water Initiative (CARIWIN)

Catherine Senecal and Chandra A. Madramootoo

McGill University, Brace Centre for Water Resources Management, Macdonald Campus of McGill University, 21111 Lakeshore Road, Ste-Anne-de-Bellevue, QC, Canada, H9X 3V9, catherine.senecal@mcgill.ca

While many countries and regional authorities in the Caribbean have embraced the concept of Integrated Water Resources Management (IWRM) and recognized its guiding principles as beneficial, few possessed the capacity to implement it since its enunciation in the Dublin Principles of 1992. The Caribbean Water Initiative (CARIWIN) has endeavoured over a six-year period, since 2006, to build capacity in a collaborative process with national governments, regional and international agencies. Working in conjunction with the Caribbean Institute for Meteorology and Hydrology (CIMH), CARIWIN produced three tools to support the implementation of the key components of IWRM: the National Water Information Systems, the Caribbean Drought and Precipitation Monitoring Network, and Community Water Strategies.

1. Introduction

“Scarcity and misuse of fresh water pose a serious and growing threat to sustainable development and protection of the environment. Human health and welfare, food security, industrial development and the ecosystems on which they depend, are all at risk, unless water and land resources are managed more effectively in the present decade and beyond than they have been in the past.”

The Dublin Statement on Water and Sustainable Development,
January 31, 1992, Dublin, Ireland

The International Conference on Water and the Environment, which issued the Dublin Statement on Water and Sustainable Development, was pivotal in the global paradigm shift towards Integrated Water Resources Management, now known by its widely applied acronym IWRM. At that juncture in history, there was a formal call for fundamental new approaches to the assessment, development and management of freshwater resources (UN, 1992). Four guiding principles were proposed and are summarized as follows: effective water management requires a holistic approach; a participatory approach; the recognition of women’s vital role; and the recognition of the economic value of water. The benefits of implementing IWRM were detailed as including alleviation of poverty and disease; protection against natural disasters (drought and flood); water conservation and reuse; sustainable urban development; food security and improved rural water supply; protection of aquatic ecosystems; and resolving water conflicts (UN, 1992).

With 10 years of reflection on the matter, when reunited at the 2002 Johannesburg World Summit on Sustainable Development, nations of the world, including Caribbean states, agreed to have IWRM plans in place by 2005 (Cashman, 2012). While Cashman concludes in his 2012 review of regional progress that there is an acceptance among professionals and decision-makers of a real need for re-orientation of water sector governance towards IWRM, he concedes that the reality in the Caribbean is that the process is long and fraught with difficulties. Despite this delay in policy development and institutional reform, Caribbean Water Initiative (CARIWIN) has supported efforts in the region to expand the knowledge base with respect to water resources and to strengthen capacity of institutions and personnel in order to facilitate IWRM implementation. The legacy of CARIWIN is explored in its five areas of focus: (i) decision-support tools, (ii) professional development, (iii) partnerships, (iv) research, and (v) dissemination of knowledge.

2. CARIWIN Overview

The Caribbean Water Initiative is a collaborative project, designed to address the complex challenges of water management in the Caribbean region. CARIWIN was granted \$1,000,000.00 Canadian Dollars over six years (2006-2012) by the Canadian International Development Agency, through its University Partnerships in Cooperation and Development Program. The main institutional partners are the Brace Centre for Water Resources Management of McGill University and the Caribbean Institute for Meteorology and Hydrology (CIMH), with collaborating national agencies in Grenada (Ministry of Agriculture), Guyana (Ministry of

Agriculture), and Jamaica (Water Resources Authority). These collaborating national agencies coordinated the involvement of other government agencies, non-governmental organizations, and local communities in CARIWIN sponsored events. Through CIMH, CARIWIN piloted capacity building initiatives in IWRM, aimed at the national, local government and community levels in Jamaica, Guyana and Grenada.

In order to achieve the goal of IWRM in the Caribbean, CARIWIN proposed the strengthening of the CIMH, a regional organization whose mandate is to provide training and capacity development in climatology and water management to CARICOM member states. By integrating the IWRM approach into CIMH training and capacity development initiatives, the project will have a significant multiplier effect throughout the Caribbean. The main outputs, the decision-support tools, have achieved a high level of acceptance and have already propagated beyond the three pilot countries. Notably, these decision-support tools were not ready-made external solutions being imported to the region, but rather they were developed and nurtured with Caribbean stakeholders using an inclusive and collaborative approach. CARIWIN has the potential to make a long-term contribution to poverty reduction, gender equality, improved governance and local ownership, better health through safe water provision and enhanced environmental sustainability through more effective water management.

3. Decision-support Tools

In order to make well-informed decisions, managers and policy-makers require timely information which is relevant to the needs of society and based on sound data. Data and information to support decision-making are vital to effective water management (IHP, 2000). CARIWIN endeavoured to meet these needs in the region through the development of three decision-support tools: the National Water Information Systems, the Caribbean Drought and Precipitation Monitoring Network, and Community Water Strategies.

3.1 National Water Information Systems

A National Water Information System (NWIS) is a centralized database for a country's water-related information and a powerful decision-support tool. The NWIS is currently operational in five Caribbean countries, with several others in the initial phases of development or investigation. The system is preferred for its ease of adaptability and expandability, in addition to the fact that it is based on open source software. The NWIS has the potential to facilitate sharing of data and information for decision support at national (cross-sectoral) and regional levels.

Through a collaborative process including stakeholders from varied sectors and representing both data-users groups and data-collectors groups, the Government of Grenada developed and implemented its National Water Information System (NWIS) early in 2009. The Grenada NWIS has now become an official repository for all hydrologic, climate, land, watershed, infrastructure and water-related data in the country (St-Jacques *et al.*, 2010). Contrary to the traditionally sector-segregated data storage and analysis, the NWIS is a tool able to support decision-making in line with the guiding principle of adopting a holistic approach to water management. The development of the Grenada NWIS took into consideration the recommendations which

emanated from the United Nations Food and Agricultural Organization's prior experience in the region. One noteworthy recommendation in this context was that the types of data collected should be expanded beyond the technical, to include socio-economic, legal, environmental and institutional so that all stakeholders could have ready access to information to assist in decision making in all aspects of the water sector (Fletcher-Paul *et al.*, 2008). Water governance has been strengthened in Grenada as water managers, now armed with the NWIS, are better able to assess the resource; share information with other national agencies and stakeholders; clearly report pertinent information; and positively influence policy (St-Jacques *et al.*, 2010).

3.2 Caribbean Drought and Precipitation Monitoring Network

The role of the CIMH as a regional provider of meteorological and hydrological services has been strengthened by the Institute taking the lead in drought monitoring for the Caribbean Basin. The drought monitor, posted on the CIMH website for easy access to information by all stakeholders, is a valuable decision-support tool for water resources management. The information products posted by the monitor are generated through the analysis of raw meteorological data provided by member countries. These are used to produce a visual indication of wet or dry conditions based on the Standard Precipitation Index (SPI) which is accompanied by a verbal description of the conditions. Currently, SPIs are calculated for 1,3,6 and 12 month time intervals. This Caribbean Drought and Precipitation Monitoring Network (CDPMN) was launched in 2009 and provides a Drought Alert service for the region, which has already served to inform water managers and other socio-economic sectors of the severity of the dry spell that had gripped the region in October 2009 until the end of May 2010.

Being able to anticipate drought through constant monitoring via indices and other climatic indicators as well as biological observations allows for mobilization of resources and preparation that increases the coping capacity of communities and nations (Trotman *et al.*, 2008b). The lesson of the 2009-2010 drought was that on the Caribbean basin scale, rainfall indices gave reasonable notice as to the existence and severity of the drought, however it is clear that national scale monitoring incorporating other indicators (agricultural and hydrological) is also needed (Trotman *et al.*, 2011). One national monitor has been launched in the region, for Barbados, and efforts are being made to develop others. The CDPMN affords an opportunity for a participatory process, between CIMH, national and local governments and communities, to propose adaptation strategies and new Community Water Strategies which consider the extremes of drought and flood for water resource management. Although CARIWIN did not pursue activities at the community level, CIMH will carry on with these efforts within other programs such as the European Union funded Caribbean Agro-meteorological Initiative that focuses on farming communities.

3.3 Community Water Strategies

CARIWIN produced a documented framework to guide the development and implementation of Community Water Strategies (CWS) in the Caribbean, based on IWRM principles. The focus for the preparation of the framework was on synthesizing key components of IWRM at the

community level, and lessons learned from case studies, into a manageable process to guide the development of CWS. The framework is presented as a four-phase process involving assessment, planning, implementation and monitoring, where each phase is broken down into several sub-components and associated with specific expected outputs (McGill, 2009a). This was also expressed and refined within country-specific documents for each of the CARIWIN partner countries, i.e. Grenada, Guyana and Jamaica. The CARIWIN CWS Background Documents for Grenada, Guyana and Jamaica each examine water resources management at the national level for the country in question, establishing the context for the CWS in the pilot watershed. The information is summarized from country policy documents, strategies, and on-going programs and projects (McGill, 2009b).

These four reference documents, the framework plus the three country-specific documents, were used as the basis for discussion during the CARIWIN Regional Seminar held in Guyana, January 14-15, 2010. At this event, a capacity-building exercise conducted with national partners focussed on the prioritization of the pilot community needs; preliminary identification of key players; and the steps to implementation for each country to move forward with the CWS. Each partner country was thus trained in formulating a CWS for their pilot community and CARIWIN transferred the onus onto the individual countries to lead any further development.

4. Professional Development

Continuous updating of the knowledge base among water sector personnel is critical to maintaining a skilled work force with appropriate abilities and know-how to tackle the problems at hand. CARIWIN professional development activities have each specifically targeted a particular group of beneficiaries ranging from technical personnel, senior water managers, policy-makers, to CIMH personnel and other stakeholders such as researchers, and personnel from international or regional agencies. In all, there were 301 individual professional development opportunities offered through 23 events held in seven countries. In addition to the 301 opportunities, an additional 136 persons were present in the role of presenters or experts. Details of the professional development offered through CARIWIN are listed in Annex 1. While many of these events were of the workshop, seminar, training session, or short course type, three were official programs offered by post-secondary educational institutions.

4.1 Academic programs

With additional financing from the University of Guyana, CARIWIN assisted in the development of a new academic program in the form of a Post-Graduate Certificate in Water Resource Management offered through the University of Guyana. The program consists of three courses: Hydrology and Water Resources Management; Drainage and Irrigation; and Hydraulic Structures and Geotechnical Investigation. The Stabroek News (2012) reported the Minister of Agriculture's justification for the new program as a need for renewed efforts in equipping the ministry's human resource with the necessary skills to build capacity.

With additional financing from McGill University, CARIWIN assisted in the development of the on-line professional development program titled Integrated and Adaptive Water Resources

Management and Governance offered through McGill University. This program takes a holistic look at water resources management at the watershed and sub-watershed level with a specific focus on watershed planning techniques, adaptive management strategies, capacity building approaches, water governance, and water business risk assessment to strengthen integrated water resources management capacities globally. The method of web-based course delivery facilitates the participation of working professionals around the globe.

4.2 Human Resources and Technical Capacity Building

The other events (training, workshop, seminar, high-level meetings etc.) had corollary benefits other than conferring knowledge such as: networking opportunities, exposure to the latest advancements, and consensus-building for development of decision-support tools. In addition, several of these events served as models which CIMH has adopted for use and replicated within other regional initiatives.

Practical and hands-on learning was an integral part of the professional development activities delivered. A review of documentation indicated that the Caribbean faces many challenges in managing its water resources in a socially acceptable, environmentally sustainable, and economically efficient manner due to problems which include *inter alia* poor hydrological data collection and analysis (IHP, 2000). CARIWIN installed pilot hydrometric stations and weather stations in each partner country, i.e. Grenada, Guyana and Jamaica. These were used for demonstration and training purposes with respect to installation, operation, and maintenance of the equipment as well as data management and the integration of the data into Water Information Systems for storage and analysis. These in-country stations allowed CIMH to train their member country personnel on site, and therefore in greater numbers than would normally have been possible at the CIMH campus in Barbados. In addition to the use of these stations for training purposes, the stations are generating additional data uploaded to the national networks for hydrological and meteorological monitoring. To similar ends, CARIWIN also provided hand-held water quality monitoring equipment to CIMH and to each partner country.

5. Partnerships

In setting recommendations for the implementation of Integrated Water Resources Management in the region, twenty-two Caribbean countries participated in a workshop organized by the Caribbean Council for Science and Technology, with support of the Inter-American Development Bank. One out of the four main recommendations of the workshop focused on the need to develop strategic partnerships and networks for fostering information sharing and exchange (IDB, 1999). Furthermore, in the preamble to the St. George's Declaration of Principles for Environmental Sustainability in the OECS, the signatories recognize that their situation requires a collaborative approach:

“ACCEPTING that their small size and limited technical, financial and human resources constrain the ability of Member States to unilaterally undertake all the actions required to achieve their own goals and their international obligations regarding sustainable development...” (OECS,2006).

In this regard, the development and propagation of the National Water Information Systems included strategic partnership building between the national governments and their counterparts in other Caribbean countries and the CIMH, FAO, CEHI, GEF-IWCAM, GWI and UWI. In the case of the Caribbean Drought and Precipitation Monitor, the collaboration was extended to include CDEMA, NOAA, Agriculture and Agri-Food Canada, EU and the National Drought Mitigation Center. These partnerships with regional agencies were extremely significant in that they sparked synergies and led to coordinated efforts. For example, the FAO contributed financial support, technical backstopping, and knowledgeable professional personnel towards the development of the NWIS in Grenada, which could not have materialized in the same form or within the same time frame without. Another example is the continual collaboration with CEHI throughout the development of the NWIS and beyond as CEHI took on the role of champion for a coordinated regional approach to water management by leading the organization of a Caribbean Water Information System Experts Meeting in 2011 with representatives from twelve countries in attendance. This leveraging of technical, financial and human resources from institutions with compatible objectives made it possible to achieve results with an impact of far greater magnitude than would belie the modest initial investment.

6. Research

Scientific research conducted through CARIWIN contributed to the advancement of effective water resources management in the Caribbean region and the conferment of five Master of Science degrees and one Doctoral degree. The results advance the knowledge base in the areas of drought monitoring and household water supply and storage.

6.1 Drought monitoring

Trotman and Mehdi (2008) concluded that the determination of drought indices was an important step in the development of an integrated water resources management program. Research has since evaluated the application of established drought indices such as the Standard Precipitation Index (SPI) and Normalized Difference Vegetation Index (NDVI) to the Caribbean context, particularly, the applicability of both the NDVI and SPI for representing soil water conditions at three sites in Jamaica was evaluated by Richards and Madramootoo. The SPI was found to have good correlation and therefore to have significant potential as a drought indicator (Richards *et al.*, 2010). Furthermore, Stoute, Trotman and Charlerly studied the application of internationally accepted drought indices PDSI and PSI to the practice of drought prediction in Barbados. The calculated indices showed a high correlation with soil water content analyses. With these research results, the CIMH adopted the use of the SPI as the drought indicator of choice for the Caribbean Drought and Precipitation Monitor published on the CIMH website.

The applicability of the Soil Water Assessment Tool (SWAT) was evaluated for use in an agricultural watershed in Jamaica. Despite the fact that the model had some difficulties in simulating high-runoff events, it was determined that SWAT is a suitable model for use in simulating streamflow and holds much potential for future agricultural water resources planning in all Jamaica watersheds, in particular, as it can be used to determine agricultural water-saving

strategies (Richards and Madramootoo, 2010). Richards and Madramootoo (2010) also published the land use and soil parameters that were used for this model so that they may be used as a reference in the development of future hydrologic simulations in Jamaica.

Research in the area of drought monitoring is contributing to the region's effort to move from a response-driven approach towards a strategic approach focused on prevention and mitigation of drought disasters.

6.2 Household water supply and storage

Research was conducted in an aboriginal community in rural Guyana in order to suggest best practices and provide information based on IWRM principles which may serve to inform decision-making for water supply and water safety investments. A study to compare the rates of adoption at the household level between three drinking water treatment options was conducted using the Biosand slow-sand-filter, the ceramic candle filter, and the application of a chlorine product marketed as Chlorosol. Of the three treatments tested, it was found that ceramic candle filters performed best in terms of the rate of adoption (Young-Rojanschi *et al.*, 2009).

An investigation was also conducted in the same community on the feasibility of scaling-up Domestic Rain Water Harvesting (DRWH) to improve water security. Intven argued that DRWH systems were shown to be a relatively low cost option for universally improving a households' geographical and temporal access to a water source. As domestic rainwater harvesting (DRWH) was already accepted and used by the majority of community residents, albeit mainly in an informal manner, it was concluded that facilitating the installation of formal DRWH systems will have a large impact on household water security.

Both of these studies at the household level incorporated the guiding principles of a) adopting a participatory approach to formulating recommendations for water management solutions and of b) the recognition of women's vital role in the provision of water. This research contributes to the body of knowledge in the region with regards to the results, but also with regards to the process of applying IWRM principles within research projects in order to inform water management decisions.

7. Dissemination of Knowledge

Knowledge gained, but not shared is of little use to the advancement of society. The Caribbean Water Initiative has, to date, published 10 papers and posters, made 8 conference presentations in the Caribbean and around the world, published innumerable freely accessible resources on the CARIWIN website as well as provided new information on the CIMH website. This is part of an informal capacity building strategy encompassing public awareness which seeks to disseminate experiences and learning related to IWRM. One example in which CARIWIN has emphasized public awareness raising is with respect to the economic value of water. Trotman in particular clarifies the link between drought disasters and their resulting impacts on various economic sectors. Specifically, he highlighted that the impacts of the 2009-2010 drought in the Caribbean included water rationing; major crop losses; increases in food prices; drop in hydro power

production; increased water delivery costs for irrigation; *etc.* (Trotman *et al.*, 2011). Trotman also reminded that during the drought of 1998, Guyana experienced water rationing, cessation of logging and river transport in some places and the loss of livestock (Trotman *et al.*, 2009). Further, he informed that, due to drought and major losses in the sugar sector, the Jamaican government provided the sector a US\$100 million assistance package in 1997. This recognition of the economic value of water is incorporated into dissemination of knowledge activities. As a result, the region has developed and implemented a drought monitor, the CDPMN, in order to assist planning and improve resilience in the region.

8. Conclusions

The Caribbean region, despite the uneven completion of institutional and policy reforms required to allow IWRM practices to flourish, has experienced recent advancements towards the IWRM paradigm. In particular, the recognition of increased effectiveness in the management of water resources was experienced in various spheres of the Caribbean Water Initiative. Several examples were provided to demonstrate the improvements to water management where the four guiding principles were embraced *i.e.* of adopting a holistic approach; adopting a participatory approach; recognizing women's vital role in water management; and recognizing the economic value of water. Of particular promise for the region are the decision-support tools such as the National Water Information Systems, the Caribbean Drought and Precipitation Monitoring Network, and the Community Water Strategy frameworks which are all three shown to be meeting real and immediate needs of the region, but which will undoubtedly need to be continuously revisited and upgraded in order to maintain relevance in the water management context. CARIWIN supported and nourished these decision-support tools for IWRM by promoting professional development opportunities, partnership building, scientific research, and the dissemination of knowledge. IWRM is a valid and necessary objective for protection against natural disasters (drought and flood); food security and improved rural water supply; and poverty alleviation among other positive outcomes and it is in the best interest of Caribbean nations to strive towards the strengthening of IWRM decision-support tools.

References

- Cashman, A. 2012. Water Policy development and governance in the Caribbean: an overview of regional progress. *Water Policy*. 14:14-30.
- Fletcher-Paul, L.M., C.A. Madramootoo, and H. Thomas. 2008. A review of Water Information Systems in the English-speaking Caribbean - challenges and lessons learnt. Caribbean Environmental Forum. 24-25 June, 2008. St. Georges, Grenada.
- Inter-American Development Bank (IDB). 1999. Integrated Water Resources Management: Institutional and Policy Reform. IDB, Washington.

International Hydrological Programme. 2000. An overview of selected policy documents on water resources management that contributed to the design of HELP (Hydrology for the Environment, Life and policy). Technical Documents in Hydrology, No. 38. UNESCO, Paris.

McGill University (McGill). 2009a. Community Water Strategies: A framework for implementation. https://secureweb.mcgill.ca/cariwin/sites/mcgill.ca.cariwin/files/cws_framework_v2.pdf

McGill University (McGill). 2009b. CARIWIN Community Water Strategy Background Document: Great River Watershed, Grenada. https://secureweb.mcgill.ca/cariwin/sites/mcgill.ca.cariwin/files/cws_grenada_december2009.pdf

Organisation of Eastern Caribbean States (OECS). 2006. St. George's Declaration of Principles for Environmental Sustainability in the OECS. pp 30. OECS, St. Lucia.

Richards, J. and C.A. Madramootoo. 2010. An investigation into the feasibility of using SWAT at the sub-basin level for simulating hydrologic conditions in Jamaica. Caribbean Environmental Forum. 21-25 June, 2010. Montego Bay, Jamaica.

Richards, J., C.A. Madramootoo and A. Trotman. 2010. The development of the SPI and NDVI for 3 study sites in Jamaica, with an investigation into their use in understanding soil water during water stressed conditions in Jamaica. Caribbean Environmental Forum. 21-25 June, 2010. Montego Bay, Jamaica.

Stabroek News 2010. Twenty-four engineers for hydrology studies under UG-McGill pact. February 1, 2010. Georgetown, Guyana. <http://www.stabroeknews.com/2010/archives/02/01/twenty-four-engineers-for-hydrology-studies-under-ug-mcgill-pact/>

St-Jacques, M-C., C. Senecal, T. Thompson, A. Haiduk, A. Trotman, and C.A. Madramootoo. 2010. National Water Information Systems: A tool to support Integrated Water Resources Management in the Caribbean. Caribbean Environmental Forum. 21-25 June, 2010. Montego Bay, Jamaica.

Trotman, A., D. Farrell, and C. Cox. 2011. Drought early warning and risk reduction: A case study of the Caribbean drought of 2009-2012. World Climate Research program Drought Interest Group Meeting. 2-4 March, 2011. Barcelona, Spain.

Trotman, A., B. Mehdi, A. Gollamudi, C. Senecal. 2008a. Drought and Precipitation Monitoring for Enhanced Integrated Water Resources Management in the Caribbean. Caribbean Environmental Forum. 24-25 June, 2008. St. Georges, Grenada.

Trotman, A., L. Pologne, S. Stoute, B. Mehdi, C. Senecal, and A. Gollamudi. 2008b. A proposed approach to monitoring and assessing drought in the Caribbean. Second Turkey-Israel Workshop on Drought Monitoring and Mitigation. June 16-29, 2008. Turkey.

Trotman, A., A. Moore, S. Stoute. 2009. The Caribbean Drought and Precipitation Monitoring Network: the concept and its progress, in Climate Sense. Tudor Rose, UK.

Young-Rojanschi, C., C.A. Madramootoo, L. Intven, and C. Senecal. 2009. Comparing three HWTS options in St. Cuthbert's Mission, Guyana. International Research Colloquium of the Network to Promote Household Water Treatment and Safe Storage. September 21-23, 2009, Ireland.

United Nations (UN). 1992. The Dublin Statement on Water and Sustainable Development. International Conference on Water and the Environment. January 31, 1992. Dublin Ireland.