Water Resources and Coastal Zone Management

Sustainable freshwater management and public perception: The case of Barbados

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Introduction

At the centre of sustainable water management is human intervention. It is within this context that this paper examines the public's perception (from a household perspective) in relation to water management in Barbados. The research assesses the social adaptive capacity in the Barbadian context, and provides recommended policies by the public.

Barbados is a small, relatively flat, densely populated country with a tertiary economy driven by tourism and financial services. The country is ranked by the World Bank as "upper-middle income", and experiences high human development. Externalities affiliated with Barbados' development status, for example environmental degradation and resource scarcity, require urgent management interventions in order to lessen the possible negative impacts on economic and social development, and environmental conservation. One urgent imperative is water resource management. Barbados, along with being recognized as a model for small island development, is branded by the popular water scarcity index as being 'absolute water scarce', and has been ranked in the top ten most 'water scarce' countries in the world (Ministry of Physical Development and Environment, 2001a). The management of the supply and demand of this low availability of freshwater has resulted in water outages reaching a critical stage during the period 2002-2004, mainly in the northern and eastern sections of the country. The General Manager of the Barbados Water Authority (BWA), Mr. Denis Yearwood, notes for the northern section that "the situation was so severe that virtually no water flowed through the pipes to the customers in the affected areas for about four (4) weeks" (BWA 2004, 5). Barbados is therefore at a critical stage in managing its freshwater resource in the contexts of its population, resource base, the environment, and economic development.

Freshwater availability resulting from rainfall is categorized as 90% groundwater, 7% surface water, 2% spring water and 1% run off (Brewster and Mwansa 2001). There are serious challenges related to the management of freshwater quality which impacts on the volume of freshwater abstracted. Challenges include saline intrusion, agro-chemical use, and waste

disposal. Climate change will also have a negative impact on water resource management in small island states (Mimura et al 2007, Cashman et al 2007, Stern 2006, Jones and Spence 2003, Ministry of Physical Development and Environment 2001b, Frederick 1997). Cashman et al (2007, 5) note that for the eastern Caribbean "…the projection is for a substantially drier wet season (July-November) an even drier dry season (March-April) and a marginally wetter spell at the end of the year". In addition coastal inundation (Mimura et al 2007) will exacerbate the saline intrusion problem already being experienced due to over abstraction by west coast wells, and storm events can damage supply infrastructure causing water outages (Jones and Spence 2003).

Barbados' limited renewable freshwater availability has to be sustainably managed to maintain high human development. Without an effective management regime the freshwater resource will be inefficiently supplied, allocated and used, and development objectives and sustainable development on a whole will be compromised. The overarching issues for Barbados are therefore: how is a limited resource managed? Is Barbados experiencing a water demand or water supply problem? And should Barbados take a social (human rights, supply side) or economic (water is not free, demand side) approach to water management? An economic approach (demand side orientation) emphasizes the relationship between water use and GDP contribution, and deploys resources to the sectors of highest value. A social approach (supply side orientation) to water management would facilitate subsidies for water use, and bolster employment, for example, in the agricultural sector which makes a limited contribution to GDP.

Chenoweth (2008) underscores the importance of human intervention in sustainable water managment. The naturally available water resource of a country has no significant effect on a population meeting their basic needs (Chenoweth 2008). Chenoweth (2008, 19) concludes that:

> "The ability of a country to effectively tap its human ingenuity is far more significant than the natural water resources endowment of a country. It is clearly socio-economic development rather than the natural environment which is the primary determinant of the ability of a country to meet the basic needs of it is population; the link between socio-economic development and the natural environment is far from straight forward".

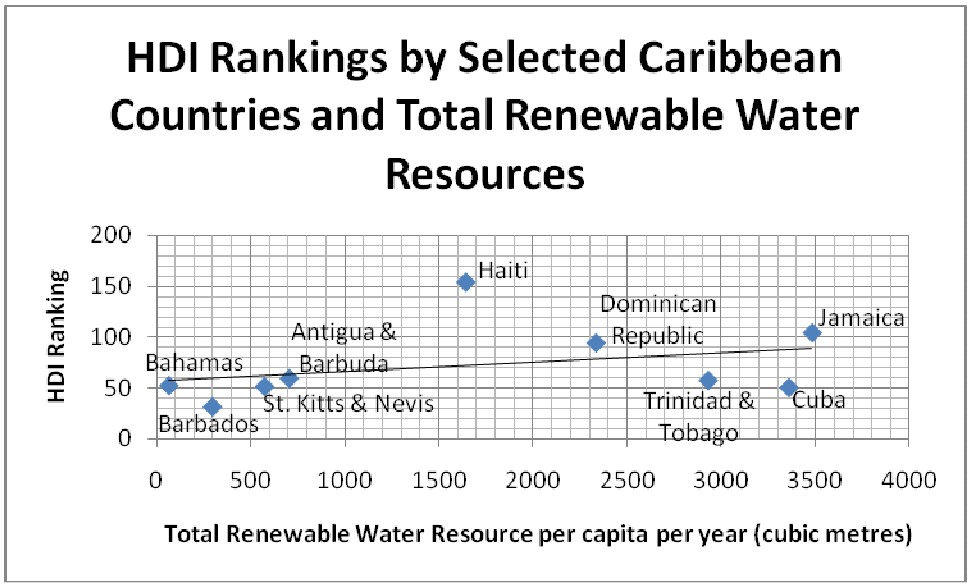
Shiva (2002) also underscored the importance of the human element in meeting the water needs of the population. Shiva (2002, 119) noted that "Scarcity and abundance are not nature given – they are products of water cultures". Shiva (2002, 120) referring to Rajastjan, the desert sate of India, also reported that "…scarcity has been transformed into abundance through human ingenuity and labour". Human ingenuity, at the macro and micro levels, guides management regimes resulting in efficiency in allocation and use.

Population

Barbados recorded a population of 273,400 in December 31, 2005 (Ministry of Economic Affairs and Development 2006) and is the most densely populated country in the Caribbean with 634 persons per square kilometer. Some 53.3% of the population live in the urban parishes of St. Michael and Christ Church (Barbados Statistical Service 2002).

The Human Development Report 2006 has rated Barbados as 31st in the world (HDI=0.879), the highest ranked Caribbean country, because of impressive levels of literacy, life expectancy and GDP. From 1992 to 1994 Barbados was ranked as high as 20th. The Human Development Index (HDI) indirectly depends on the constant availability of clean freshwater to the public in order to attain relatively high standards of living. From Figure 1 it can be concluded that the HDI ranking is not dependent on the amount of total renewable water resources. The graph shows a negative linear relationship; the higher the HDI ranking, the less renewable water there is available.

Figure 1:



Dataset sources: UNDP 2006, FAO aquastat database

In 2005 the population comprised 131,900 males (48.2% of population) and 141,500 females (51.8% of population), and the adult population was recorded at 211,200 persons (77.2% of population) (Ministry of Economic Affairs and Development 2006). Barbados experienced low rates of population growth 0.3% in the 1970s, 0.28% in 1980s and 0.35% in the 1990s (UNEP 2005). In 2005 the growth rate was 0.3% compared to 0.2% in 2004 (The Ministry of Economic Affairs and Development 2006). Therefore over the last thirty years the population grew by approximately one thousand people per year.

The population theory of Thomas Malthus states that rising populations will deplete the limited available resources resulting in misery for mankind. Malthus suggested that an exponentially increasing population would not be sustained by a linear-type resource availability function. The population theory has been challenged as it does not consider the fact that the ingenuity of the population can result in economic development and affordability of necessary resources (Feitelson and Chenoweth 2002, Chenoweth 2008).

An Economist.com article by John Peet on July 17 2003 notes that generally:

> "Domestic consumers are hardly ever to blame for water shortages. As much as 50% of the water in piped systems is lost through leakage. More important, wherever in the world water is scarcest, which is mostly in developing countries, irrigation for agriculture gobbles up at least 75% and sometimes as much as 90% of the available water. In richer countries, industry and energy use a surprisingly large amount. Domestic users everywhere account for a relatively small share. Any shortages should thus be blamed on farmers and manufacturers, not on swimming-pool owners".

In the case of Barbados, the domestic sector is a significant consumer of water, consuming approximately one third of potable supply. In 1996 the domestic sector consumed 38.83% of water supply (Barbados Water Authority 1997 cited in Ministry of Physical Development and Environment 2001a), and data for the period 2002-2007 indicate that domestic consumption decreased to 34% (FAO Aquastat database). Over the last ten years domestic demand has remained relatively constant percentage wise with a small reduction of approximately five percentage points.

Due to the paradigm shift from water for agriculture to water as a human right the focus of water management is meeting basic needs of human beings. On its website, the World Health Organization defines reasonable access "as the availability of at least twenty liters per person per day from a source within one kilometer of the user's dwelling" (http://www.who.int/whosis/indicators/2007ImprovedAccessWaterSanitation/en/). Gleick (1996) posits that 50 litres per person per day is the required minimum to satisfy basic human needs.

Gender and Water Management

Persons often question how gender and water resource management are related, especially in a country like Barbados with a tertiary economy, high human development and nearly 100% pipe to house coverage. There are no readily apparent gender differences in water management in a tertiary economy.

CAP-NET and GWA (2006) note however that the people-water relationship is primal and is a result of cultural and social values and differences, including those of gender. From inception water resource management and policy formulation have been male dominated despite women playing a critical role with regard to practical management strategies as users at the local level which include but is not limited to hygiene management and tending to the sick and elderly.

A sustainable management approach attempts to rectify this imbalance by recognizing the use values and recommendations of both men and women in the management process. The Ministry of Housing, Transport, Water and Works (2006, 5) notes that "A gender approach means that attitudes, roles and responsibilities, resources and position of men and of women are taken into account in all aspects of management". CAP-NET and GWA (2006) note that there are significant gender differences in use, access and management of water. The Ministry of Housing, Transport, Water and Works (2006, 3) also that "…water and the lack of water affect men and women differently, based on the different roles and responsibilities they hold in society

and the resources available to them". The Ministry of Housing, Transport, Water and Works (2006) also refers to varying use priorities between male and females. Whereas men prioritized cooking, bathing, drinking and watering crops, women prioritized cleaning and cooking, bathing, washing clothes and flushing toilets (Ministry of Housing, Transport, Water and Works 2006). Schneiderman and Reddock (2004) report that these varying priorities can result in domestic stress as has been the case in rural communities in Trinidad and Tobago. Schneiderman and Reddock (2004, 184) note that

> "…cases of women rationing water in the home and men becoming irate as a result, husbands refusing to fetch water when they came home from work, and wives wanting not to 'hug up' with husbands who have not had adequate water for bathing".

A women's group organized a water project to address the domestic woes (Schneiderman and Reddock 2004).

The Ministry of Housing, Transport, Water and Works (2006) notes three key elements of a gender approach. The first is trying to understand the differences and relations among and between women and men. The second critical element involves incorporating women's and men's perspectives, needs and interests. Finally a gender approach must entail equitable participation approaches. CAP-NET and GWA (2006) note that a gender perspective involves a targeted approach, creative solutions, increased flexibility, and a healthy environment. Barriers to a gender approach include blindness (no recognition), neutrality (a lack of differentiation hiding differences) and cultural stereotypes (CAP-NET and GWA 2006). Gender approaches are also subject to tokenism, isolation and policy evaporation (CAP-NET and GWA 2006).

GWA (2003, 45) states that "South Africa stands out as a country where a focus on gender and poverty eradication permeates all aspects of water policy". The South African experience involved a water rights campaign, participatory approach, provision of information for women, the establishment of catchment management areas, and the use of vernacular language (GWA 2003). Balanced work opportunities and pay, and a national quota of one third of staff must be women were legislated (GWA 2003). The South African experience also involves training programmes on gender for water professionals and practitioners. Emanating from the South African experience are thematic questions which focus on needs and the problem, decision making, information ownership and access, work responsibilities, costs and benefits, risk and vulnerability, and macro policies affects (GWA 2003). There is however no blueprint for gender approaches (GWA 2003) and cases would vary based on culture.

Adaptive Capacity

Beyond the demand side management phase of water management is the adaptive phase in which the demand sectors adapt to reduced water consumption initiated in the demand side stage. During the demand phase there is a decoupling of population growth and water demand (Turton 1999). This decoupling is influenced by the use of technology and the adaptability of social resources. The adaptive phase influences natural resource reconstruction (Turton 1999). Turton (1999, 26) states that:

> "Once this [natural resource reconstruction] has been reached, it can be said that the social entity [of adaptive capacity] is stable and balanced, with sustainability of water use being the prevailing condition".

Adaptive capacity is made up of structural and social components (Turton 1999, Feitelson and Chenoweth 2002). The structural component involves an institutional setting, strong financial support and research regime, and multidisciplinary intellectual capital or technocrats (Turton 1999). The structural output includes strategies and policy options (Turton 1999). The social component is more complex and involves the willingness and ability of the population (male and female) to accept water management initiatives designed by technocrats (Turton 1999). The social component also takes into consideration the ability of the technocrats to elucidate strategies that will be considered reasonable and legitimate (Turton 1999). There needs to be collaboration between both components and the dynamism of their interaction needs to be taken into account (Turton 1999).

Social adaptive capacity is very important in determining the trade-offs inherent is sustainability. Determining trade-offs between stakeholders are key to developing a pragmatic approach to sustainable water management. There is a number of trade-offs possible between the economic, social and environmental approaches to water management and provides flexibility for different national circumstances. Achieving water management for sustainable development is dependent on economic, environmental and social forces being in dynamic balance. Environmental-economic approaches have been traditionally ignored in policy leading to market failure and environmental pollution Socio-economic approaches involve a number of controversial trade-offs such as full price of water and the human right to water. An environmental-social approach is also a challenging reconciliation of phenomena such as climate change adaptation and supply side approaches.

Perception of Water Resource

Two hundred households were surveyed from five parishes. Semi-structured interviews of water experts were also conducted.

Firstly, as it relates to water use, the majority (97%) of households sourced water from indoor pipes, and 0.5% from pipe in yard. Only 1.5% of households sourced potable water mainly from a public standpipe, and 1% got potable water from their neighbour. In addition, the majority (90.0%) of households surveyed had water closets that were not linked to a central sewage system. Only 2.5% of the households were linked to a central sewage system. Being connected is related to location of sewage treatment plants. Only 6.5% of households had pit latrines and 0.5% used the neighbour's facility. Therefore 97.5% of the households are responsible for the disposal of sewage onsite. The present sewage management structure for households poses a challenge for groundwater quality management.

Females comprised 56.5% of the respondents, and this represents a good female representation being achieved by the study when compared to national demographic statistics. The perspectives and recommendations of the female respondents are critical inputs for developing a water resource management strategy. As much as 61.9% of the female respondents, and 65.5% of

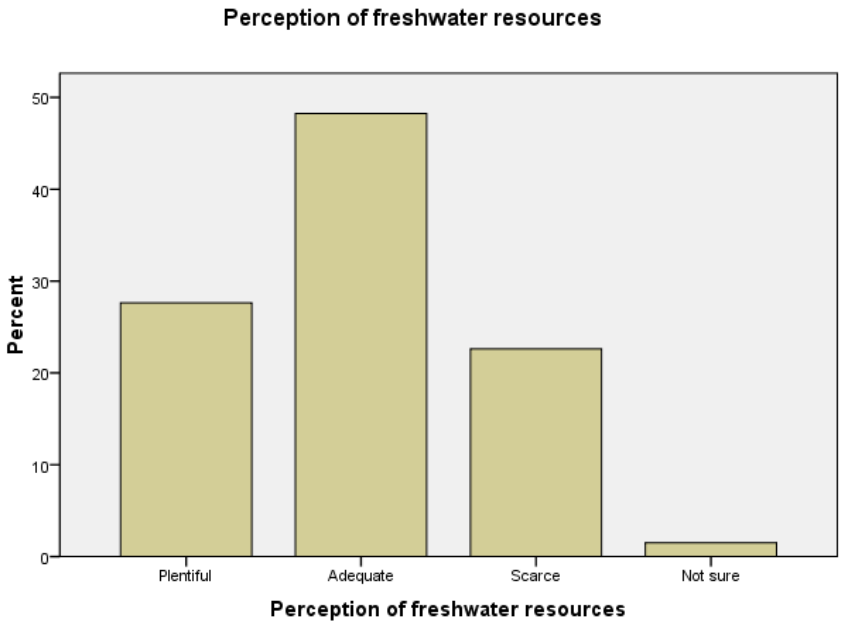
male respondents were from the urban parish. The analysis highlighted socio-economic, and techno-centric differences between sex of respondent.

Just less than half or 48.2% of respondents considered the amount of freshwater resource available in Barbados to be adequate, and 27.6% considered the volume plentiful. This public perception can be the manifestation of two phenomena. Firstly, the perception implies a possible disconnect between the public view and the reality of low freshwater availability in Barbados. Mwansa (2006) noted that:

> "The public does not understand. You have to start from history. The public has been told over the years we had unlimited water resources; we sat on top of a lake of water; we had the best water in the world without understanding, if we had the best water in the world, what made it so. You are then asking them now without explaining clearly to change their perception. That is what causes the disconnect".

However, the perception can also imply that the majority of households do not experience severe water outages, and therefore households as a sector have not been significantly impacted by the management of the low freshwater availability. Approximately one quarter or 25.8% of the households experienced at least one water outage in the previous twenty days, and Less than one fifth (15.0%) of respondents considered water outages in their community a problem. In a Caribbean360.com article on July 2, 2009, the Acting Minister of the Environment, Water Resources and Drainage, Senator Haynesley Benn was noted as stating that "the relative ease with which customers received water through their taps, made it difficult for them to be convinced that Barbados was labelled water scarce". Only 22.6% of respondents considered water to be scarce, and 1.5% were unsure. There is no statistically significant relationship between perception of the amount of resources and (1) location of residence ($p=0.141$); (2) economic status ($p=0.117$); (3) sex of respondent ($p=0.147$); (4) water outages being a problem ($p=0.631$). Figure 2 shows the perception of the amount freshwater available.

Figure 2:



Respondents prioritized domestic allocation first, and then agriculture. Tourism was prioritized third. The public therefore considers agriculture to be fundamental to the Barbadian way of life. This social perception contradicts implemented development and water allocation policies. This highlights another possible disconnect between public perception and the allocation of the water resource by development policy makers who have positioned tourism as the catalyst for becoming a developed nation with a tertiary or service oriented economy. Mwansa (2006) noted that there is no allocation policy that chooses one sector over another. There is a policy framework developed in 1997 which has allocation categories to be applied in cases of water supply emergencies or drought (Mwansa 2006). In these cases a particular water use could be prohibited. Table 2 shows the median water allocation rank for each sector by respondents.

Table 1: Water Allocation Ranking Framework by the Public

Water demand sector	**Median rank**
Domestic	1
Agriculture	2
Tourism	3
Manufacturing	4
Environmental conservation (ex situ)	5

There is a statistically significant relationship at the 95% confidence interval between prioritization of agriculture, and location of residence (p=0.043). The relationship is moderate in strength (Cramer's v=0.226). A greater percentage of rural households gave agriculture an allocation priority of 1 and 2. There are no statistically significant relationships between prioritization of agriculture and (1) economic status (p=0.159); (2) sex of respondent (p=0.214). There are no statistically significant relationships between prioritization of other demand sectors and (1) location of residence; (2) economic status; (3) sex of respondent.

Only 16.6% of respondents stated that water should be taken out of agriculture and allocated to other economic sectors like tourism. Tourism contributes more to the Gross domestic product compared to agriculture. The majority of respondents queried "what would we eat?". This represents another disconnect between the public perception and the food production reality as 70% of the food consumed locally is imported. Therefore Barbados depends significantly on virtual water for agriculture. More than a third or 44.4% of respondents stated that farmers should be able to access potable water for irrigation. This again highlights the importance of farming to the public. There is a statistically significant relationship at the 95% confidence interval between re-allocation of water from agriculture, and location of residence (p=0.040). The relationship is weak in strength (Phi=0.180). The majority of respondents willing to re-allocate water to other sectors were from urban households. There is no statistically significant relationship between re-allocation of water from agriculture and economic status (p=0.423). There is no statistical relationship between re-allocation of water from agriculture and sex of respondent (p=0.060).

Many issues were perceived to be the main problem for water management in Barbados. Some 22.3% stated that wastage is the biggest problem, and 16.8% stated leaking water mains. Less than a fifth or 16.2% were unsure of a significant management challenge. Some 8.1% of respondents stated pollution by illegal dumping of solid waste, only 4.6% stated drought, 4.1% stated high domestic demand, and 4.1% stated ineffective service and management by the Barbados Water Authority. Some 3.6% stated general pollution was the main challenge, 3% stated high agricultural demand, and 2.5% stated inadequate water collection. Other challenges stated include agro-chemical pollution, saline intrusion, lack of awareness, inaccessibility by the

poor, pollution by sewage, old infrastructure, lack of financing, lack of pumps, agricultural and golf course consumption, siltation during rainfall, road works, lack of wells, water bill neglect, no recycling, too much runoff, rural water shortage, and high tourism demand. With regard to social adaptive capacity for water management, the public considers wastage by demand sectors, and leaking water mains as the priorities for policy development and investment.

Only 15.6% of respondents supported privatization of management. The general feeling was water rates would increase if the water provider was privatized. One respondent noted that "poor people will suffer". Regarding the commodification of water and the cost concern of the public, an interesting comparison is the cost of bottled water and petrol. In May 2009 in Barbados one litre of petrol was BDS$ 2.02, and one litre of bottled water was BDS$ 5.00. Comparing the cost of tap and bottled water, Mwansa (2001) noted that 1000 litres of tap water cost BDS$ 1.50 while the same volume of bottled water costs at least BDS$ 2,800. The cost issue affiliated with privatization is however considered irrelevant once the problem of water shortages is addressed. An Economist.com article by John Peet on July 17 2003 states that:

> "Water delivery and treatment are highly capital intensive businesses. Wherever that capital investment comes from, somebody has to pay for it: if not users, then taxpayers or aid donors. For the people who now have no access to clean water, what matters is whether water comes out of the tap, not who delivers it".

A position by one respondent supporting privatization was there is a need for competition, "need a choice". There is no statistically significant relationship between privatization support, and location of residence ($p=0.513$). There is also no statistically significant relationship between privatization support, and economic status ($p=0.364$). However, there is a statistically significant relationship at the 95% confidence interval between privatization support and sex of respondent ($p=0.014$). The strength of the relationship is moderate (Cramer's $v= 0.208$). A greater percentage of males supported privatization.

Only 5.5% of respondents supported the removal of all public standpipes, and 2% were unsure. Approximately 32% (32.3%) of respondents supported the removal of some standpipes. Respondents noted that they seldom see standpipes, highlighting that some have been removed already. The fact that the minority support the removal of standpipes reveals the social value of water in the Barbadian society. A supply side approach to water resource management is premised on a social view of valuing water. Public standpipes provide water at zero financial cost (social water) to the population of Barbados. Barbados developed a dense network of public standpipes in the past. The public standpipes are owned by the BWA, and are mainly situated in rural areas and low income urban areas. The number of standpipes has been decreasing over the years due to the excellent water infrastructure coverage, and the economic status of households. A single male occupant of a household in Ellerton, St. George stated that working class people are complaining about the removal of standpipes with the development of high income housing in the same area. The TPDO has embarked on a programme of 'infilling' to maximise land use for housing. Rural communities are therefore populated with new middle to high income homes because there is available land to build, and there is no need to develop new infrastructure such as roads and utilities. The Ministry of Health investigates community usage of standpipes when there is the plan to disconnect (Mwansa 2006).

In general, household respondents responded favourably to keeping standpipes as part of the water management framework in Barbados. Households stated that standpipes always have water even when taps are off at home. One respondent noted that standpipes are needed because of frequent outages in some areas. Standpipes are also perceived as landmarks and are needed so that persons can access water on road trips. There are no statistically significant relationships between support for removal of all standpipes, and (1) location of residence (p=0.237); (2) economic status (p=0.158); and (3) sex of respondent (p=0.150). There are also no statistically significant relationships between support for removal of some standpipes, and (1) location of residence (p=0.602); (2) economic status (p=0.492). There is however a statistically significant relationship at the 99% confidence interval between support for removal of some standpipes and sex of respondent (p=0.009). The relationship is moderate in strength (Cramer's v = 0.242). A greater percentage of males supported the removal of some standpipes.

The majority or 85.5% of respondents supported rain harvesting at the household level, albeit primarily for secondary uses. Only 2% used rainwater for primary uses, and only 1.5% used rainwater stored as a coping strategy during water outages. More respondents supported rainwater harvesting compared to desalination and recycling for domestic use. This support is a significant consideration for the social adaptive capacity required to manage the low freshwater availability in Barbados. This support for rainwater harvesting should be harnessed through public education and training in order to motivate a cultural and attitudinal shift towards rainwater for primary uses. In a discussion after a Caribbean Water and Wastewater Association (CWWA) conference presentation by the author on October 5, 2006, it was highlighted that there is opposition however by housing contractors to the mandate of rain harvesting infrastructure because of the additional time and resources required to complete a new house. There is a statistically significant relationship at the 95% confidence interval between support for rainwater harvesting, and location of residence (p=0.015). The relationship is moderate in strength (Cramer's v = 0.206). A greater percentage of rural households supported rainwater harvesting. There are however no significant relationships between support for rainwater harvesting and (1) economic status (p=0.075); (2) sex of respondent (p=0.106).

Only 64% of respondents supported desalination in Barbados mainly for primary uses. A minority of respondents considered desalination only for secondary purposes or industrial use. Some 15% of respondents were not sure if they supported desalination. Some 8.6% of respondents stated taste as the reason for not supporting desalination. Another 2.5% stated cost, 2.0% did not trust the technology, and 2.0% stated the need to fix leaking mains first. Other reasons include polluted sea, hardness and a preference for groundwater. There are no statistically significant relationships between support for desalination, and (1) location of residence (p=0.081); (2) economic status (p=0.300). There is a statistically significant relationship at the 99% confidence interval between support for desalination and sex of respondent (p=0.008). The relationship is moderate in strength (Cramer's v = 0.221). A greater percentage of males supported desalination.

Less than half or 47.5% of respondents supported the use of recycled water (grey and black) in Barbados, and 11.5% were unsure. Some 39.2% of respondents only wanted the recycled water to be used for secondary purposes in Barbados. Only 8% of respondents were willing to consume recycled water at the household level. There are no statistically significant

relationships between support for recycling water and (1) location of residence (p=0.291); (2) economic status (p=0.199). There is however a statistically significant relationship at the 95% confidence interval between support for recycling, and sex of respondent (p=0.040). The relationship is weak in strength (Cramer's v = 0.179). A greater percentage of males supported recycling.

Water policy recommendations by the public

Household recommendations highlight what the public is willing to support for the implementation of a sustainable water strategy. Household recommendations included better maintenance (15%), public awareness (11%), and better management, response, and planning by the BWA (7.5%). Approximately 6% of household respondents recommended recycling, 4% wanted additional wells, 3.5% recommended the storage of more spring water, and 3.5% thought that desalination was needed. Better solid waste management was suggested by 2% of household respondents. Other minority recommendations included reuse (1.5%), cost recovery (1%), enforcement of regulations (1%), lower water rates (1%), privatization (0.5%), research (0.5%), chemical spray control (0.5%), social water (0.5%), specific tourism supply initiatives (0.5%), and well monitoring and security (0.5%).

A criticism of IWRM is its lack of success stories because of an impractical conceptualization (Biswas 2004). Implementation consideration is an important aspect of policy development, and the success of policy implementation depends on the trade-offs between bureaucratic and public interests. Areas of policy conflict between the bureaucrats and the public are: desalination; perception of quality and efficiency of management; perception of availability of water resource; allocation for agriculture; recycling of waste water; and raising water rates. Areas of policy synergy are: Government oversight of water resource supply; rainwater harvesting (for secondary purposes); and non-revenue water reduction. There are more areas of conflict than synergy. Areas of conflict require further dialogue, and public awareness. This first phase of the implementation strategy (short term) is important to the social adaptive capacity. This first phase of implementation involves education programmes on all media to change the perception and behaviour of the public. Multiple policy outcomes are dependent on resources and the relationship between the public and the bureaucracy. Allocation for the human right to water as in the case of South Africa, where a volume of water for basic human needs is provided free of charge at the household level, is a social incentive to implement the strategy.

Conclusion

Effective water governance is a complex phenomenon which drives sustainable development. The main management issue is the level of compromise that will be accepted by the public and the policy makers between a social and an economic approach to water management and development. With the global paradigm shift from supply side to demand side management, there is also a shift from social to economic approaches to management. However, any sustainable management strategy must be cognizant of the social adaptive capacity required. Therefore a sustainable balance within the local context must be attained using primarily

economic means but also adopting social management practices such as allocating freshwater for some food production and the human right to water. For policy areas where significant compromise is necessary, public education and awareness using evidence supporting the decision is necessary. Full disclosure by water managers on issues (for example, water quality) will allow for informed public participation which can impact positively on water security through changed behaviours, and self policing. Transparency is therefore a tool for sustainable management of freshwater.

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