The effects of the water management framework and the role of domestic consumers on urban water conservation in Botswana

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This article examines the adverse effects of a fragmented water management framework and the role of domestic water users on water conservation in Gaborone, the rapidly growing capital city of Botswana. There was a major drought in Botswana in 2004, which recurred in 2007. The drought seriously affected water availability in Gaborone, re-igniting the water conservation debate. Most urban households prior to 2004 did not practise water conservation, except in cases of enforced temporary measures, such as water restrictions and increased water tariffs imposed by the Water Utilities Corporation. From secondary evidence, the situation had not changed much in 2007.

Keywords: Botswana; Gaborone; water management framework; domestic consumers; urban water conservation; stakeholder theory

Introduction

Botswana is a water-scarce country. Over the past 40 years, however, the country has experienced rapid urban growth. This tends to strain limited water resources (Winpenny 1997, Baumann and Boland 1998, Macy 1999). The urban growth trends are as follows: 9.5% in 1971, approximately 17% in 1981, about 45% in 1991 (Campbell 1998, p. 263); and 54% in 2001. These trends have resulted in increasing water demand in most major urban centres, particularly in Gaborone. The Water Utilities Corporation (WUC) records show that Gaborone consumed about 5 million cubic metres of water across all sectors in 1982, 13 million cubic metres in 1992, quadrupling to 20 million cubic metres in 2000 from the 1982 base. Parida and Moalafi (2007) observe that urbanization is one of the major development challenges facing Botswana today in view of rising urban water demand, predicted decline in rainfall and rising temperatures by most global climate models.

The major problem is that the dominant water management approach in Botswana focuses more on the development of additional water supplies and less on water conservation and demand management (Gould 1994, 1997, Government of Botswana 1997, Somarelang Tikologo *et al.* 1998, Khupe 1998, Arntzen *et al.* 1999, Department of Water Affairs 1999, Toteng 2000, Segosebe and Parida 2006, Kalaote 2007). In 2008 there is no official water conservation policy in Botswana that has been adopted by parliament. However, various measures have been implemented towards water conservation (Segosebe and Parida 2006). In Botswana there is little documented evidence on the role urban domestic water users could play in urban water conservation.

The stakeholder theory analytical framework

According to Freeman (1984, p. 52), "stakeholders are groups or individuals who affect, or are affected by, the achievement of an organization's mission." There are numerous "stakeholders" in any given water resource management context.

The underlying principle in defining the stakeholder concept is that the firm takes into account the concerns of all groups and individuals that can affect, or are affected by, the accomplishment of an organization's purpose (Polonsky 1995). Theoretically, the stakeholder concept "must be able to capture a broad range of groups and individuals" (Freeman 1984, p. 52). The stakeholder theory and its principles are relevant in water conservation analysis (Toteng 2000, Botumelo-Mfula 2006).

Mitchell *et al.* (1998) extend the stakeholder theory to enhance its use in analysing power and legitimacy of stakeholders in decision making. Power in social science is "the probability that one actor within a social relationship will be in a position to carry out his own will despite resistance, regardless of the basis on which [the] probability rests" (Green 1998, p. 610).

Legitimacy is the rightfulness of a holder of power to exercise it (Beetham 1998). In political science, legitimacy is often associated with the rightfulness of a government to rule. In this article, legitimacy is the rightfulness of different stakeholders to influence decision making and policy process affecting water conservation.

To assess the attributes of power and legitimacy among stakeholders in the Gaborone urban water management system, a typology adapted from Mitchell *et al.* (1998) is presented in Figure 1. Three groups of stakeholders emerge: dominant, discretionary and dormant stakeholders (cf. Mitchell *et al.* 1998, pp. 299–303).

The dominant stakeholders consist of state agencies. Discretionary stakeholders consist of environmental non-governmental organizations (ENGOs). Dormant stakeholders include all other water users or consumers that do not routinely participate water management decision-making and policy processes.

Dominant stakeholders wield the most power (Mitchell *et al.* 1998). State agencies in the water management system in Botswana have both power and legitimacy. This is because the government has since 1966 been democratically elected to rule, and the mandate has been

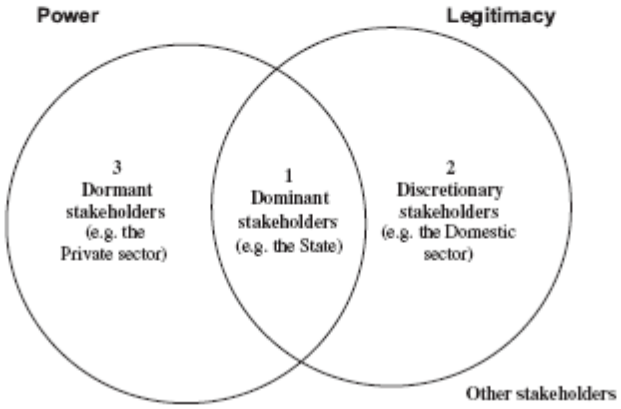

Figure 1. Stakeholder framework showing the marginal power and legitimacy of domestic users in the Gaborone Water Management System.

Source: Toteng 2000, after Mitchell *et al.* 1998.

renewed every five years since then. State agencies however have different degrees of power in decision-making and policy process affecting water conservation. For instance, the WUC and the Department of Water Affairs (DWA) have the most power and legitimacy, given by statute (Toteng 2004). Within Gaborone, WUC has even more power and legitimacy in the urban water supply system compared to other institutions. However, WUC and DWA are not the only state actors in the urban water management system. The Gaborone City Council (GCC), for instance, as the urban local government authority is a legitimate stakeholder. GCC has, however, not been assigned power by statute to deal with water supply management issues. Instead, GCC is the only institution which has much power in the disposal of wastewater. Differences in the responsibilities for DWA, GCC and WUC indicate fragmentation in the water management framework. This adversely affects urban water conservation.

Discretionary stakeholders have legitimacy but wield insufficient power to influence policy process. A major weakness of discretionary actors is that since they lack power, government officials often do not feel obliged to consult them. Most state bureaucrats recognize the existence of advocacy groups, for example, non-governmental organizations, but do not feel compelled to act on their demands (Toteng 2000). This constraint is worsened by the generally weak non-governmental organization movement in Botswana (Lekorwe 1998).

The private sector is composed of companies. Their main purpose is to make profit. The sector falls in the category of dormant stakeholders. These possess some overt and covert power to assert their will on state agencies in water management system in cases where their own interests are threatened. Dormant stakeholders, however, have potential to demand that the state should act to avert a water crisis, failing which there is a risk of disinvestment by foreign companies (World Commission on Water 2000).

Methodological overview and scope of the study

The study was based on a combination of secondary data from papers presented at the WUC annual water conservation conferences in Gaborone in 2005, 2006 and 2007, and primary data from a social survey conducted in 1998, 1999 and 2000.

Five hundred and sixteen (516) household interviews were undertaken. These represented 1.4% of all the Gaborone households in the 2001 census. The sample was small but adequate in that it was meant to complement other data collection methods, for instance, documentary evidence from various WUC water conservation conference papers. The generalization from the survey was primarily analytical rather than statistical, in line with Yin's (1994) observation on the value of case study research design.

Sectorally, the focus excluded non-urban water-using sectors such as agriculture, mining and energy production and wildlife. Time and resource constraints warranted this delimitation.

The study did not deal with technical issues such as water engineering and hydrology because the author had no engineering background, and also because "in the past, water management emphasised supply projects, hydrology and water engineering" (Kuylenstierna *et al.* 1997, p. 181), often at the expense of water conservation and demand management (Merrett 1997, Bauman *et al.* 1998, Macy 1999).

Gaborone was chosen because it is the fastest growing urban centre in Botswana; it is a primate city (Campbell 1998), and hence imposes the largest urban water demand in Botswana (Government of Botswana 1987, 1991, 1998, Arup 1991, Water Utilities Corporation 1995).

To highlight the growth of Gaborone, the following indicators are apposite. In 1966, the time of Botswana's attainment of political independence from Britain, only 5000 people lived in the City (Central Statistics Office 1987). Between 1971 and 1981 the population of Gaborone grew at an annual growth rate of about 12%. This growth rate declined somewhat to about 8% in the

1981–1991 period. The decline is attributable to peri-urban growth rather than reversal of urban growth. Between 1991 and 2001 there has been a dramatic decline in the annual growth rate of the Gaborone population from 8 to about 3%. However, the peri-urban villages of Gaborone, particularly Tlokweng to the east and Mogoditshane to the west, have absorbed much of the population growth that would have occurred in Gaborone. The population of Tlokweng, for example, almost doubled (increased 1.8 times) from 12,501 in 1991 to 22,394 at an annual growth rate of 6%. Similarly, the population of Mogoditshane nearly tripled (increased 2.7 times) from 14,246 in 1991 to 38,816 in 2001 at an annual growth rate of about 11%. The Gaborone urbanization trends highlighted above indicate that water demand and the need to conserve this scarce resource will continue into the foreseeable future as a major urban development challenge. Gaborone therefore serves as a proxy for national urban growth trends in Botswana, and their effects on water resource use and conservation.

Rainfall patterns, water scarcity, water sources and water demand in Botswana

Botswana ranks third among the most water-scarce countries in Southern Africa after South Africa and Namibia in that order. Highlights of water scarcity indicators in Botswana are a rainfall range of only 250–650 mm (compared, for instance, to 700–1200 mm for Zambia); average rainfall of 400 mm or 233 km^3 (compared to 800 mm or 997 km^3 for Angola); the highest potential evaporation range, together with that of Namibia at 2600–3700 mm (compared to the lowest range of 1100–2000 mm in Tanzania); and the lowest surface run-off of a mere 0.6 mm or 0.35 km^3 (compared to regional highs of 104 mm or 130 km^3 in Angola, and 275 mm or 220 km^3 in Mozambique). The water scarcity scenario painted above warrants more concerted water conservation efforts in all water-intensive sectors of the national economy, such as the urban areas.

Much of Botswana is dominated by a flat topography, gentle undulations and occasional rocky outcrops. In the northwest, the Okavango River drains inland from Angola to form the world's largest inland delta – the Okavango Delta. The Makgadikgadi pans in the central northeast are a large area of calcrete plains adjoining the Delta. In the east, adjacent to the Limpopo drainage system, the land rises above 1200 m, and the Limpopo Valley gradually descends from 900 m in the south to 500 m at its confluence with the Shashe River. The flat topography makes it difficult to construct dams, and it also exacerbates rates of water evaporation.

Water scarcity in Botswana is a function of both biophysical and human factors. These according to Atlhopheng (1998) and Khupe (1994) can be summarized as follows. On the one hand are biophysical constraints, for instance, climatic factors characterized by aridity and semi-aridity, with unreliable, poor and variable rainfall in space and time; topographic constraints, dominated by very flat terrain, with very few sites suitable for dams, and shallow reservoirs. Combined climate and topography limitations include high evaporation and transpiration, which exarcerbate water loss from reservoirs (loss attributed to this factor averages four times greater than rainfall), and very few perennial rivers, mostly transboundary shared water course systems. Drought is recurrent, and it adversely affects rainfall availability, water inflow into dams and groundwater recharge. On the other hand are anthropogenic constraints, for example, over-pumping of groundwater and pollution of surface and groundwater sources from agricultural waste and waste from human settlements. Although not much can be done to alter biophysical environmental conditions that cause water scarcity in Botswana, much can be done to change human constraints.

Precipitation in Botswana

Botswana is situated close to the subtropical high-pressure belt of the Southern Hemisphere. As a result, the country is largely arid to semi-arid. Mean rainfall ranges from over 650 mm, in the extreme northeast, to less than 250 mm. Rainfall is the main form of precipitation in Botswana.

It often occurs as either light drizzle or heavy and torrential rain. Of the major forms of rainfall – namely convectional, orographic (relief), convergence and depressional (cyclonic) – the most common type in Botswana is convectional (Silitshena and McLeod 1998, p. 35). This is characterized by unstable conditions, particularly hot weather. This often involves a rapid rise of air masses due to high temperature, rapid cooling at high altitude and subsequent condensation to produce heavy rainfall. This is usually highly variable spatially and temporally and also localized. Convectional rainfall may be accompanied by thunderstorms. In northern Botswana, an area with the highest amount of rainfall in the order of 650 mm average per annum with exception to periods of severe drought, convergence rainfall is the dominant form of precipitation.

Viewed from the viewpoint of time, most of the rain in Botswana occurs in summer, during the months of October to April, but again this is subject to the influence of recurrent drought. In terms of spatial distribution, northern Botswana receives an average of 650 mm per annum, with a variability of about 30%. This is in contrast to an average of about 250 mm in southwestern Botswana, with a variability rate of over 80% (Bolaane 2000).

Water resources and supply sources in Botswana

As a semi-arid country, Botswana has very little surface water resources. These are concentrated in the Okavango and Chobe river systems, which are part of the Limpopo drainage basin. The Okavango and the Chobe river systems amount to about 16 billion cubic metres per annum, which is 95% of all of Botswana's surface water (Silitshena and McLeod 1998, p. 42). The remaining 5% has a yield of approximately 200 million m^3, of which 15% was harnessed in 1998. Although there is scope for the development of 85% of the 200 million cubic metres remaining potential sources, there are limitations in surface water exploitation in Botswana. These include irregular and variable rainfall; recurrent drought; high evaporation rates; flat topography, unsuitable for dam construction that also exacerbates evaporation; the predominant surface-yielding systems, for example, the Chobe and Okavango rivers which are part of transboundary and shared water systems, whose exploitation is subject to international protocols, and may result in regional conflicts.

There are two predominant sources of water supply to settlements in Botswana. First, dams are the major sources of supply to urban settlements although there is a mismatch in population distribution in relation to location of these. The major dams, for example, Shashe and Letsibogo, are located in northeastern Botswana, because this is where most suitable dams sites occur. However, most of the country's population is found in southeastern Botswana, the most urbanized part of the country. Therefore the government has to spend millions of pula (the local currency) in expensive water transfer schemes. For instance, at the close of the last decade and beginning of the present, the Botswana government spent over P2 billion (approximately US$333 million at 2007 exchange rates of US$1 = P6) in Phase 1 of the North–North South Water Carrier Project (NSCWP). This involved the construction of a dam some 300 km north of Gaborone and a pipeline to transfer the water primarily to Gaborone itself. Phase 2 of the NSCWP commenced in 2007. It is estimated to cost about P8 billion (approximately US$1.3 billion at 2007 exchange rates). This will involve the construction of the country's largest ever dam of an estimated 600 m^3 capacity, and a short feeder pipeline connecting to the Phase 1 main pipeline. Second, boreholes are the most common sources of water supply to rural settlements. In 2007 about 60% of Botswana is supplied from groundwater.

Water demand in Botswana

In Botswana there are five major water demand or consumer sectors, namely settlements, particularly urban settlements, the subject of interest in this paper. Table 1 shows water demand in Botswana in the different sectors in 1990, and as forecast to 2020 using the medium forecast.

Table 1. Sectoral water demand in Botswana, 1990–2020 (overall demand – 10^6 m^3).

Sector	1990	2000	2010	2020
Settlements	33.8	68.8	109.9	167.8
Mining, energy	22.9	33.6	52.2	58.7
Livestock	35.3	44.8	34.3	44.1
Irrigation, forestry	18.9	28.9	38.5	46.9
Wildlife	6.0	6.0	6.0	6.0
Total	116.9	182.1	240.9	323.5

Source: Department Water Affairs, Botswana (1991).

Table 2. Settlement water demand in Botswana, 1990–2020 (overall demand – 10^6 m^3).

Type of settlement	1990	2000	2010	2020
Urban centres	19.6	41.3	68.2	107.2
Major villages	7.4	17.5	27.9	43.3
Rural villages	3.6	6.3	9.5	12.6
Minor settlements	3.3	3.8	4.4	4.7
Total	33.9	68.9	110.0	167.8

Source: Department of Water Affairs, Botswana, 1991, p. 8.

In 1990, settlements accounted for 29% of the water demand in Botswana. This figure is expected to rise to 52% in 2020. From Table 1 it is apparent that by far settlements exert the largest water demand in Botswana. From Table 2, a disproportionate demand pressure is placed on the country's water resources by urban settlements in particular compared to other types of settlements.

Generally, therefore, urban settlements are a major water-consuming sector in Botswana, despite the fact that very little water conservation effort is carried out in these areas. For instance, in 1998 Gaborone accounted for 13.4 million cubic metre of water per annum, a figure expected to escalate to 40 million cubic metre in 2020 (Silitshena and McLeod 1998, p. 47). However, in 2007 there was still not much voluntary water conservation effort in the urban areas of Botswana, except that public standpipes had been disconnected in most of the low-income suburbs.

Highlights of the structure of the water management framework in Botswana

The overall responsibility for planning, developing and managing water resources in Botswana is vested with the Ministry of Minerals, Energy and Water Resources (MMEWR). Daily operations of the administrative and legal responsibilities for water management are divided among several institutions (Toteng 2002, 2004). These include central government ministries, a quasi-governmental agency (the WUC) and rural and urban councils. These institutions assume different roles in the service provision and supply of water in urban and rural settlements, resource development and management. The water management institutional framework in Botswana has changed little since independence in 1966. It is geared more to water supply than water conservation and demand management (Kalaote 2007). The roles of the various key water agencies are highlighted below.

The Department of Water Affairs

The Department of Water Affairs (DWA) in the MMEWR is in theory responsible for national water policy guidance. "In theory", because, as noted by Segosebe and Parida (2006), Botswana

does not have a national, formal, integrated and consolidated national water resource conservation or demand management policy. This is notwithstanding the fact that various water conservation initiatives have been experimented with from time to time throughout the country (Segosebe and Parida 2006). The DWA has tended to focus on assessing, planning, development and maintenance of water resources for domestic, agricultural, commercial and industrial uses. However, through the user card inserted on rural communal water standpipes initiative, DWA has in the last few years been piloting this water conservation initiative among domestic users. DWA and other agencies derive direction for water planning and management from different laws, which are largely fragmented and disjointed.

The Water Act (1968), the principal water legislation administered by DWA, defines the ownership of rights of the use of water, grants water rights and servitudes, and provides for matters incidental thereto (Toteng 2002). The Water Act also establishes the Water Apportionment Board (WAB).This is a semi-judicial structure that allocates water rights for both ground- and surface water sources.

Officers from MMEWR dominate WAB. The DWA serves as both the chair and secretariat of the board. Other officers are from other government departments and the WUC. The minister also appoints three members of the public. Invariably these have been prominent personalities, often closely associated with the ruling elite. WAB's independence is therefore questionable. ENGOs and community-based organizations (CBOs), as part of civil society, for example, are not represented in the board. The power of the minister under the Water Act to determine the composition of WAB, and the fact that bureaucrats dominate the board clearly place WAB under state bureaucratic and political control. This underscores the dominant state power in water management in Botswana (Toteng 2004).

The Water Works Act (1962) (as amended, 1983) is another law administered by the DWA in conjunction with urban local government councils. The Water Works Act seeks ". . . to provide for the constitution of authorities in townships (as constituted and defined in the Townships Act (1951)), to confer certain duties and powers upon such authorities, to provide for the acquisition of existing waterworks and to provide for matters incidental thereto" (p. 42 of the act). Further, the act provides for the establishment of water authorities in settlements designated for such authorities by MMEWR, and defines their powers and duties. Some of the key provisions under the act are specification of the right by the water authorities to acquire existing works; to reduce or curtail water supplies in incidences of drought and other water shortage emergencies; set water charges to consumers; control of water misuse and pollution; and supply to non-statutory designated areas; authorizes the making of regulations as deemed appropriate by the MMEWR minister to guard against wasting water, suspension of water supplies, and inspection and testing of water meters and related appliances.

The Water Utilities Corporation

The Water Utilities Corporation (WUC) is a public enterprise, wholly owned by the Botswana government. It operates under the oversight of the MMEWR. Its primary mandate is to provide for and maintain a portable water supply system to all urban centres in Botswana. In future, the mandate of WUC is envisaged to extend to peri-urban settlements. As a public enterprise, the corporation operates on commercial basis. WUC was created through the Water Utilities Corporation Act (1970), and it has been operating successfully since 1972. During the late 1980s, WUC was commended by the World Bank as one of the most efficiently managed water public enterprises in Africa. Most of the urban centres depend on dams for their water supply needs. Gaborone is one of these centres.

WUC uses graduated or stepped tariff charges as an instrument for water conservation in urban centres. The variable tariff structure is part an unwritten water pricing policy, outlined below. The varied tariff structure is justified on the ground that it reflects the difficulty and costs of supplying water to respective urban centres. Gaborone is located in the south-east region of Botswana, the most expensive area to supply with water (Water Utilities Corporation 1995). The difficulties for supplying water to the Gaborone area are primarily attributable to the distant location from the main surface water sources, found in northern Botswana; the bulk of the country's population is concentrated in the south-east region within 50 km of Gaborone, hence the higher water demand in the area. In 2001, about 50% of Botswana's entire urban population was concentrated in the south-east planning region in which among others exist Gaborone, Lobatse, Tlokweng, Mogoditshane, Mochudi, Ramotswa and Molepolole (Gwebu 2003).

The highlights of the tariff structure has four bands of water consumption by volume: Band 1 – 0–10 m^3, Band 2 – 11–15 m^3, Band 3 – 16–25 m^3 and Band 4 –: 25+ m^3, which correspond in monetary terms to US$ equivalent of $0.47, $1.41, $1.80 and $2.49 in that order at 2007 exchange rates. There is no distinction of tariff rates between households and industry. Band 1 incorporates a "lifeline" 10 m^3 maximum allowance per month to cater for basic needs of the poor. There are also some standing charges, for example, for a construction contract sum equivalent of $60,000 to $1.6 million a $4000 refundable deposit was required in 2007.

Besides the statutory areas, WUC supplies bulk treated water to the DWA for onward distribution to some large and peri-urban villages. Because of equity concerns in government water pricing policy, any increase in water tariffs is subject to government approval.

WUC derives its legal mandate and status from The Water Utilities Corporation Act (1970). The act specifies how the corporation is constituted; stipulates procedures, powers and responsibilities of the WUC board, the role of the minister and method of appointment of WUC board chairperson and the chief executive; specifies the principles pertaining to finances and the setting of water tariffs; and authorizes WUC to borrow funds and enter into contracts on its own cognizance (Toteng 2002).

In the discharge of its functions the corporation is expected to collaborate with other public agencies. Institutional fragmentation and lack of adequate collaboration hampers water conservation synergies. Since the 2004 drought, WUC has been running annual water conservation conferences from 2005 to foster institutional linkages. This was prompted by a major drought that left the Gaborone dam capacity at its lowest of about 17% full (or 83% empty) in August 2004. There is no legal requirement for WUC to consult with stakeholders. As noted, since the 2004 drought the corporation realized the value of consulting with most stakeholders as part of their drought management strategy. This has since been extended to all urban areas under the corporation's jurisdiction.

Part of the WUC strategy is a set of water restrictions, first implemented in 2004, and re-enforced in 2007. This can be summarized as follows (as shown in *The Botswana Gazette* newspaper of 16 May 2007):

- Watering of residential gardens with hoses, sprinklers and irrigation systems should be done in the evenings only.
- The use of potable water for car washes is allowed only where water-efficient technology is adopted.
- The use of potable water for institutions and hotel gardens is permitted subject to the condition that they should install wastewater treatment plants for watering gardens.
- Watering of playing fields, sports grounds, golf green courses, etc. is prohibited.
- The washing of pavements using potable water is prohibited.
- Watering of council parks and recreational gardens with potable water is prohibited.
- Institutions should replace all automatic flushing urinals with manual systems.

The WUC target in the 2004–2005 drought related water restrictions was to achieve a 25% reduction in water consumption. A higher target of about 35% was however achieved; this shows that water users were responsive to the emergency situation (Mudanga 2006, Khumalo 2007). This also indicates that the lack of a water conservation culture could be addressed through public education initiatives.

Wastewater use is not a significant part of Botswana's urban water conservation policy. The responsibility for water disposal lies with the urban municipalities. There is no policy framework and physical infrastructure arrangements for wastewater to be processed to potable quality status and reused to augment urban water supply by the WUC. As a result, wastewater in the urban areas of Botswana is generally a wasted resource. This is despite water scarcity in the country and escalating urban water demand. Part of the problem is the limited mandate and lack of institutional arrangements to enable the WUC to access, process and reuse wastewater (Kalaote 2007, Khumalo 2007).

Water pricing policy in Botswana

The water pricing policy in Botswana is the responsibility of the MMEWR. The actual urban water tariff levels are initially determined by the WUC, to be implemented with government approval. Water pricing policy in Botswana is based on three main considerations: equity, efficiency and affordability (Arntzen 2007, Khumalo 2007). Equity means that all citizens of Botswana should have access to safe water to cover at least their basic needs (Government of Botswana 1991, p. 284). In most urban areas, until about 2005, when most communal water standpipes were discontinued in favour of private water connections to encourage water conservation, there was 100% access to piped potable water in towns. Some poor urban residents in low-income areas are known to have had difficulties because they could not afford private water connections. The effectiveness of the water pricing policy objective is to make water users recognize that water in the country is scarce and expensive to provide, and provision of the water resource should be cost-effective (Government of Botswana 1991). Affordability "requires that no one should be denied access to water necessary to meet their basic needs because they cannot pay" (Government of Botswana 1991, p. 284). However, there are concerns that "the access to basic need argument" may over time be adversely affected by the discontinuation of communal standpipes in urban centres.

In the urban areas, water pricing is based on full cost recovery and application of long-run marginal costs (LRMCs) of supply (Arntzen 2007, Khumalo 2007). LMRC of water has been defined as the present value (PV) of the total systems cost over a period of 50 years, divided by the discounted quantity of water delivered by that system. LRMCs may vary according to different assumptions in the context of specific investment programmes, water supply market area, forecast rate of growth and discount rate.

Summary survey results to determine the role of domestic consumers on water conservation

The results summarized in this section were obtained from 516 questionnaire interviews in the social survey comprising 41% male and 59% female respondents.

- *Housing types*. Of the domestic users, 70.7% lived at low-income sites and in service housing areas, which are ordinarily not serviced with in-house water connections; 10.3% lived in housing provided by the Botswana Housing Corporation (BHC) connected to in-house water; and 16.1% lived in medium- and high-income, water-connected private and BHC houses.

- *Type of water supply*. Of the domestic users, 49.4% depended on off-site public standpipes; 20.9% relied on on-site private standpipes; 26.4% had in-house piped water connection; and 4.3% relied on other sources.
- *Ownership of "white goods."* Respondents were asked about ownership of "white goods." Examples are washing machines, showers and bathtubs. Of the respondents, 64.7% did not own "white goods", 1.9% owned washing machines and 27.9% had in-house bathtubs. There was low ownership of "white goods." The lower the level of white-goods ownership, the less is the likely water use.
- *Gardening*. Gardening in semi-arid environments affects water use. The vast majority of respondents (81.9%) did not practise gardening (18.1% practised gardening). The majority of garden owners (60.2%, $N = 93$) stated that they watered them once a day in a normal dry day; 31.2% watered them twice a day; and 8.6% had other types of arrangements. The methods for watering gardens were as follows: 47.3% used hose pipes, 14.0% used sprinklers, 31.2% used buckets and 7.5% used other methods.
- *Wastewater reuse*. The majority (58.9%) stated that wastewater should not be used because it is dirty; 40.5% however thought that it is a good idea to reuse wastewater. Most respondents, 63.2% ($N = 144$), did not approve of reuse of treated wastewater because of quality concerns; 63.2% thought that the water should be used for things such as watering non-vegetable plants and controlling dust; 0.4% thought that it could be used for cooking and drinking; and 36.4% thought it should only be used for cleaning.
- *Wastewater recycling*. Respondents were asked whether wastewater should be recycled: 66.3% were against wastewater recycling; 31.0% said it should be used for cleaning; and 2.7% did not know what should be done with it. Most respondents, 91.5% ($N = 337$), stated that recycled water should be used for other things, for example, cleaning, controlling dust and watering non-vegetable plants. The distribution of responses was other uses, 54.6%; cleaning, 36.9%; and cooking and drinking, 8.5%.
- *The need to pay for water*. Of respondents, 70.7% thought that it is a good idea to pay for water; 28.7% were opposed to payment; and 0.6% did not have an opinion. The reasons advanced for payment were the following: it encourages water conservation; it helps maintain service level quality in water distribution and future network expansion; and it reminds the user that Botswana is a water-scarce country.
- *Water availability in Botswana*. About half of all those interviewed (49.6%) recognized that Botswana is a water-scarce country; 24.4% thought available resources were adequate; 16.5% said water in Botswana is abundant; and 10.5% were ignorant of the issue.
- *The duty to conserve water*. There was consensus among domestic users (72.3%) that the duty to conserve water lies with individuals rather than the state; 19.6% felt the state has to conserve water; 6.6% gave other reasons; and 1.5% did not have any opinion on the matter.
- *Impact of freshwater use on the biophysical environment*. Only 17.2% felt that abstraction of water for human use had adverse effects on the biophysical environment; 53.9% thought that there was no effect; and 28.9% were ignorant about the issue.
- *Impact of wastewater disposal on the biophysical environment*. Eighty-eight percent were of the view that wastewater disposal has adverse effects on the environment; 6.8% thought there was no effect; and 6.8% did not know about the issue.
- *The responsibility to conserve water*. Of domestic water users, 72.3% were of the view that individual persons ought to take responsibility for wise water use rather than rely on state action.
- *Role and power in water planning and management*. Eighty-seven percent of the household stakeholders in the survey stated that they were not consulted or involved in anyway in local water-planning processes. The water management system in Botswana is therefore generally insular to public participation.

- *Knowledge about water supplying authority*. In the urban areas of Botswana, the WUC is responsible for potable water supply. It was found that 76% knew about this role; 12.4% thought that the GCC was responsible; 6.8% thought it was the duty of the DWA; and 6.8% did not know which authority was responsible. Cumulatively, 26% or about a quarter did not know which authority was responsible for water supply.

Pearson's chi-square tests

- Pearson's chi-square test was used to establish differences of opinion between groups based on three independent variables – level of formal education, whether or not respondents paid for or got water for free and house type. Income was not tested because the data were scanty and unreliable; most respondents were reluctant to reveal their income.
- The first test was of education against "paying for water," water availability in Botswana, use of wastewater, recycling of water, rainwater harvesting, impact of freshwater abstraction on the biophysical environment and impact of wastewater disposal on the biophysical environment. The second test was for house type against its influence on voluntary adoption of household-level water conservation initiatives. The third test, "paying for water," was against the differences between water payers and non-payers, regarding whether or not it is a good idea to pay for water; and attitudes and perceptions towards water availability in Botswana between payers and non-payers. The results showed a positive relationship only between level of education and three dependent sub-variables, namely whether or not it is a good idea to pay for water, reuse of wastewater and personal willingness to use recycled water. The results showed that people with more education were more agreeable to water conservation measures, and those with less education were less agreeable. In the other two tests based on house tenure and payment for water as independent variables, there were no differences between the sub-samples.

Conclusion

The article discussed how the urban water management framework and lack of water conservation among domestic consumers adversely affects urban water conservation in Gaborone, Botswana. Secondary documented data was used to discuss the rainfall patterns, water scarcity, water sources and water demand in Botswana. Primary data from the social survey were used to assess the role of domestic users in water conservation in terms of their attitudes and perceptions. That role was found to be limited, both by their lack of adequate knowledge on the need to conserve water and lack of institutional framework to encourage water conservation.

Some key observations are as follows: the institutional framework for supporting urban water conservation in Botswana is generally weak and fragmented, except with respect to the use of the water-pricing instrument; domestic water users had a marginal role and power to influence water conservation policy, though they have a much bigger potential to play this role; most domestic water users felt it was the responsibility of individual persons to ensure water conservation; recycling of wastewater and water pricing were widely accepted as viable water conservation strategies by domestic water users, but the opportunity has not been utilized through water policy reform; and lack of an integrated water conservation institutional framework hampers water conservation generally and marginalizes the potential role of domestic users. In terms of the stakeholder theoretical framework posited at the start of the paper, state agencies wield much power that can transform the water conservation landscape, but domestic users remain largely powerless.

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