Short Communication

Water consumption patterns in a rural setting in Ngamiland district, Botswana: the case of Boro village

Itumeleng Oageng and Gagoitseope Power Mmopelwa

ABSTRACT

Water is a precious resource with a variety of uses, which include drinking, cooking, bathing, recreation, gardening, agriculture, hydropower generation, industry and maintenance of the environment. The focus of many empirical studies has been the identification of factors that determine demand for water in urban and semi-urban areas, with the aim of improving water resource planning and development. However, studies on water use patterns in rural areas, especially where water is obtained from open sources, are limited. This study aims to describe water use patterns and demand in the rural settlement of Boro in the Ngamiland district in Botswana. Data were collected from rural households using a structured questionnaire. The average per capita water use was estimated at 20.6 litres per person per day. Estimation of the water demand model showed a significant relationship between annual household income and per capita water consumed (PWC). Both the regression model and the scatter plot did not reveal any significant relationship between PWC and distance to the water source. The study recommends further work be done on the relationship between PWC and distances beyond the 'threshold' distance.

Key words | Boro, households, Okavango Delta, per capita, rural, water consumption

Itumeleng Oageng
Gagoitseope Power Mmopelwa (corresponding author)
University of Botswana,
Maun,
Ngamiland District,
Botswana
E-mail: *gmmopelwa@mopipi.ub.bw*

INTRODUCTION

Water is a precious resource with a variety of uses, which include drinking, cooking, bathing, recreation, gardening, agriculture, hydropower generation, industry and maintenance of the environment. As a life-sustaining resource, water is demanded everyday in large quantities. It has increasingly become scarce as a result of increasing competing uses, rapid population and economic growth, changing climate patterns and other factors (Smith 2004). Water demand has been the focus of many empirical studies (e.g., Admassu *et al.* 2003; Gulyani *et al.* 2005; Katsi *et al.* 2007). A common objective of such studies is identification of the determinants of demand which are critical for resource planning and development as they enable planners to determine the type, size and location of required improvement and developments of water resource systems (Surendran *et al.* 1997; Segosebe & Parida 2009).

While there is extensive literature on water use patterns and demand in urban areas, there has been little similar research in rural settings. The conditions of water consumption patterns prevailing in rural settings are different from those in urban or semi-urban areas. In Botswana, some rural communities, including those in the Okavango Delta, draw water from open sources. Water consumption patterns and other challenges faced by these communities remain unknown. This study was undertaken to describe water use patterns in the rural settlement of Boro in the Ngamiland district in Botswana with the view of sensitizing policy-makers to the challenges faced by households using open water sources. The specific objectives of the study were: (1) to estimate the quantity of water consumed in Boro village; (2) to identify consumer demand patterns; and (3) to identify socio-economic factors that affect the level of water demand in Boro village.

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REVIEW OF LITERATURE

Water sources and consumption in rural areas

Households in rural areas of the least-developed countries use several types of water sources. In rural areas of southern Africa, communities often rely on multiple sources of water where water quality is not a prime concern, for example, water from small dams and rivers is often used for washing of clothes (Nyong & Kanaroglou 1999). Typical sources of water in these areas include community taps, homestead taps, community boreholes, protected wells, rivers or streams and rainwater harvesting (Wallingford 2003). In northeastern Nigeria, Nyong & Kanaroglou (1999) found that households used water from various sources at different times of the year. The common sources of water were government- or community-constructed hand-dug wells which were used during the dry seasons and when the river flowed again during the rainy season. Thus the wells were used in both the dry season and during the rainy season. In most rural areas, water is not always tapped and metered as in urban areas (Jansen & Schulz 2006).

Per capita water use varies significantly depending on a number of conditions (Gulyani *et al.* 2005), which include the source of water and the lifestyle of the water user. At household level, a global water demand of 150 litres per day for adequate health and sanitation has been reported (WHO & UNICEF 2000). In the majority of rural areas in Africa, domestic water consumption has been estimated on average at 20–40 litres/person/day (Wallingford 2003). In rural Swaziland, per capita water consumption from the river was estimated at 2.7 m^3 per month (Farolfi *et al.* 2007). In rural areas of Ethiopia, such as in the rural area of North Gondar, the daily per capita water use has been estimated at 6.68 litres/person/day (Admassu *et al.* 2003). In Masvingo, Zimbabwe, Dube & Van der Zaag (2002) found large differences in per capita water use among poor and non-poor households. The former had lower water consumption due to their lower ability to pay than non-poor households, which used large amounts of water in non-essential services such as gardening (4,000 m^2 on average), swimming pools and washing cars.

In most household water demand studies, the influence of price, income, size of household and other variables, such as time and distance to the collection point, have been reported (e.g., Stephenson 1999; Nauges & Whittington 2009). Cairncross & Feachem (1993) reported that in east and southern Africa, water consumption hits a plateau once a supply is within approximately 1 km from the household and only increases once the supply is at the house.

Water allocation

Rural areas devote most of their water use to agriculture as it is one of the main economic activities. In some parts of the world, rural households keep livestock as a livelihood resource, and the source of water for their livestock may be different from that for human use (Upadhyay 2004). However, in communal livestock management systems, humans and livestock often compete for water as rivers and streams are often the only sources available (Soussan *et al.* 2002). In rural Zimbabwe, Katsi *et al.* (2007) observed that households allocated water to a number of activities such as dairy farming, poultry farming, watering livestock, brick-making and brewing beer. In that study, the number of households brewing beer was high and due to the large volumes of water required for this activity, people were not allowed to draw water for beer-making from communal sources.

METHODS

The study was undertaken during the month of June in 2010 in the small rural village of Boro in the Ngamiland district in northern Botswana (Figure 1). Boro village (latitude 19°55′12″S; longitude 23°30′0″E) is located approximately 15 km east of Maun, the administrative centre of the district. The village lacks piped water, electricity, a medical clinic and modern solid waste disposal facilities. The main source of water is Boro River which traverses the village. Boro River is located at the distal end of the Okavango Delta, which receives water from the Angolan highlands. Due to water flow changes in the Okavango Delta system, Boro River receives a good supply of water during the dry season (winter). The average annual rainfall in the area is 113 mm and most rainfall is recorded in summer.

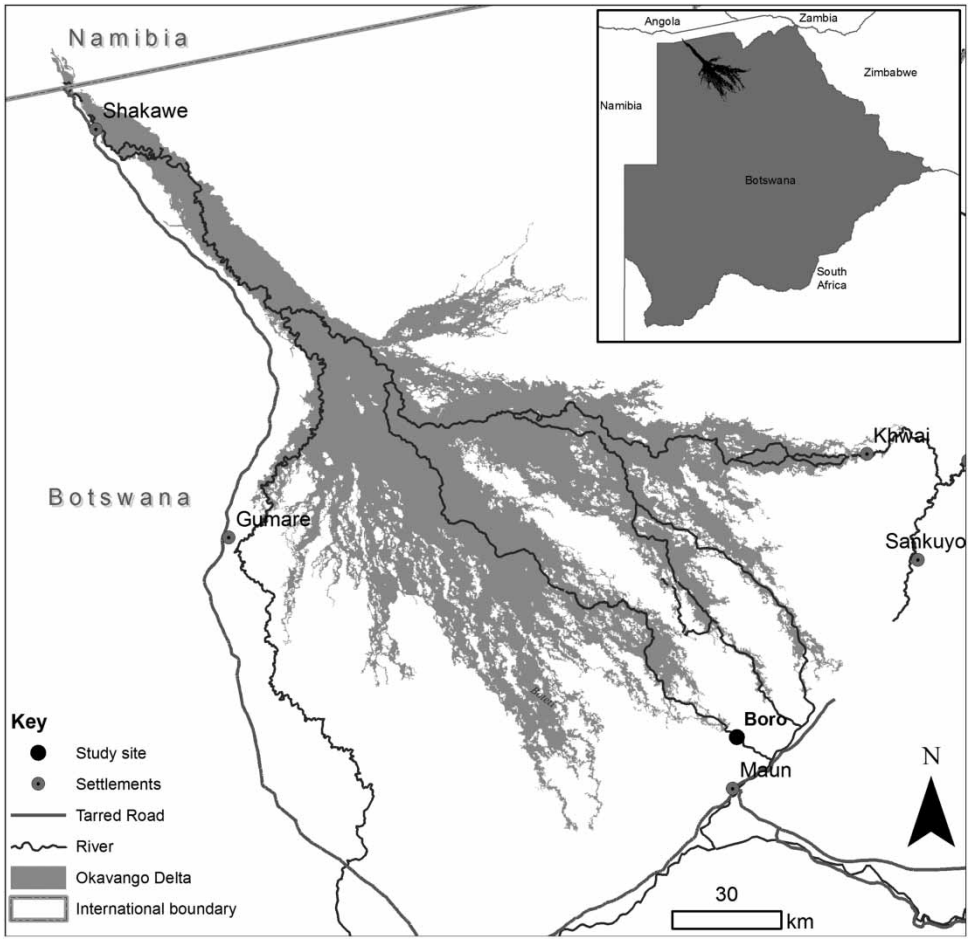

Figure 1 | Map showing location of Boro village.

Prior to undertaking the study, the researchers visited the village leader (headman) to inform him about the study and to seek permission to interview members of the community. After permission was granted, a sampling frame of households in the village was constructed by listing all the households in Boro. The sampling frame comprised 60 households, and because this sampling frame was not very large, all the households were interviewed. A structured questionnaire was used to collect primary data in this cross-sectional survey. The interviews were directed to heads of households. The questionnaire comprised sections on demographic and socio-economic variables, sources of water, and water collection and storage. Prior to data collection, the questionnaire was pre-tested in nearby localities.

The data were captured and analysed using SPPSS version 17.0. Descriptive data analysis on household water consumption included representing the data in the form of measures of central tendency, frequency tables and charts.

To estimate the water demand model, data from respondents were collected on dependent and independent variables. The dependent variable was daily per capita water consumed (PWC) in litres. To estimate the amount of water consumed by households, the researchers measured the sizes and numbers of containers used by households to collect water, as well as the frequency of water collection. The independent variables were the gender (GENDER) of the respondent, distance in metres walked by the respondent to water source (DIST) and annual household cash income (INCO). The water demand model did not include price as one of the independent variables as households collected water freely from the river. The coefficients (βs) of independent variables

were econometrically estimated to determine their statistical significance in the following linear regression model:

$$PWC = \beta_1 \text{GENDER} + \beta_2 \text{DIST} + \beta_3 \text{INCO} + \beta_4 \text{CONSTANT}$$

RESULTS AND DISCUSSION

Profile of respondents

Table 1 shows demographic and socio-economic characteristics of the respondents. Most (63%) of the respondents were females. The mean household size was 6.7 (SD = 5.035). The majority of respondents were in the age group 41–50, while the age group of 90–100 had the smallest number of respondents. More than half of the respondents (60%) reported that they had never been to school, while 18 and 22% had completed primary and secondary education, respectively.

Table 1 | Gender, age, education and employment status of respondents

Variable	No.	Percentage
Gender		
Male	22	37
Female	38	63
Age (years)		
20–30	13	22
31–40	13	22
41–50	16	27
51–60	6	10
61–70	6	10
81–90	5	8
91–100	1	1
Education		
None	36	60
Primary	11	18
Secondary	13	22
Employment		
Unemployed	20	34
Formal	23	38
Self	17	28

Water sources and storage

Almost all the interviewed households (98%) used the river as their primary water source. Only one household used an alternative source of water which was the water tank commonly known as *jojo*. The *jojo* is usually used to store harvested rainwater from house roofs during the rainy season. Most of the respondents indicated that when water flow in the river decreased they got their supply from hand-dug wells, which fall short of their normal demand. Some indicated that they asked borehole owners for water.

The main water collectors (75%) were women, rather than men and children. The fact that women bear the burden of collecting water is similar to the finding of Upadhyay (2004) who also argued that this role has an impact on the women's time available for other activities in the household.

The most common type of water collection container is the 20-litre plastic container, locally known as *sekupu*, which was used by 53% of the respondents. The second most common water container was the 20-litre bucket which was reported to be used by 52% of the respondents. Most households stored water in plastic containers, although a small proportion indicated that they stored water in 200-litre drums. The types or sizes of water containers used by women are similar to those used in some parts of Zimbabwe. For instance, Katsi *et al.* (2007) found that water was collected in jerry cans or 25-litre buckets.

Household water consumption

The highest per capita water consumption was estimated at 100 litres/person/day and the lowest was 5.3 litres/person/day. Most water users (40%) had a daily per capita consumption ranging from 11 to 20 litres (Figure 2). The average water consumption was estimated at 20.6 litres/person/day. This figure is within the estimated average water use of 20–40 litres/person/day in the majority of rural Africa as reported by Wallingford (2003). This per capita figure is also almost equal to the global requirement of 20 litres/person/day for hygiene purposes as adopted by WHO & UNICEF (2000).

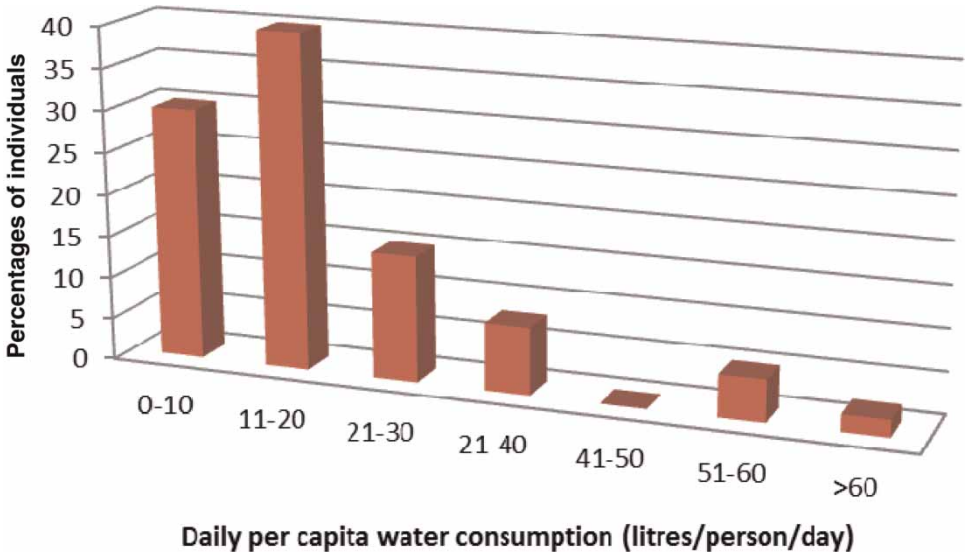

Figure 2 | Daily per capita water consumption in Boro village.

Factors affecting water demand/consumption

A regression analysis showed a significant relationship ($p < 0.10$) between annual household income and PWC (Table 2). This finding is consistent with results of research work carried out in other parts of the developing world (e.g., Sandiford *et al.* (1990) in rural Nicaragua and Arouna & Dabbert (2010) in Benin). The argument is that relatively wealthier households can afford to increase their water consumption because of the resources they have.

The regression results did not show any significant relationship between distance to the water source and the PWC. The mean distance walked to the water source was 559 m (0.559 km) and the longest distance walked to the water point was 1,500 m (1.5 km).

Most studies have found an inverse relationship between walking distance to the water point and the level of water consumption by households (e.g., Admassu *et al.* 2003; Wallingford 2003; Gulyani *et al.* 2005). The lack of a significant relationship between walking distance to the water point and PWC probably results from the fact that the mean distance to the water source falls within the water access distance range of 0.5–4 km in ungazetted settlements in Ngamiland district, as found by Mazvimavi & Mmopelwa (2006), and also falls within the water accessible distance of 1 km to the source, as reported by WHO & UNICEF (2000). The results are also in agreement with Baggaley *et al.* (2006), who indicated that up to a particular threshold the distance to water source does not affect the amount of water brought into the household or its subsequent use, while above this distance to water source corresponds to a drop in the amount of water consumed.

The relationship between distance to water source and daily per capita water use was also shown by a scatter plot

Table 2 | Estimated regression coefficients of water consumptions in Boro village

	Unstandardized coefficients		Standardized coefficients		
Parameter	**B**	**Std error**	**Beta**	***T*-statistic**	**Significance**
Constant	13.198	8.949		1.475	0.146
Gender	1.059	4.595	0.032	0.231	0.818
Distance to water point	0.003	0.004	0.107	0.825	0.413
Annual income	0.001	0.000	0.254	1.895	0.063*

* = significant.

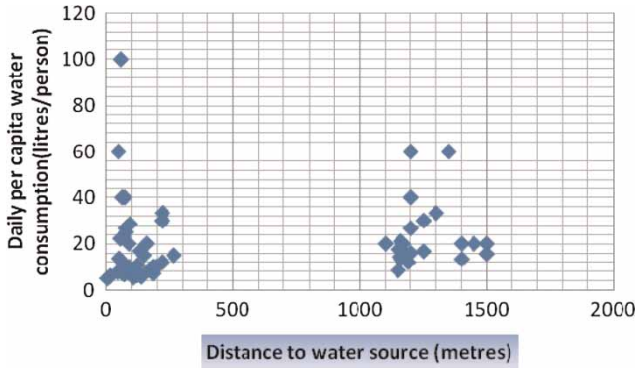

Figure 3 | Relationship between daily per capita water consumption and distance to the water point.

(Figure 3). The scatter plot showed a bimodal distribution. The highest per capita water use among households located closer (0–300 m) to the water source was 100 litres/person/day. However, this value was the daily per capita consumption for a single household, and for most of these households, the per capita water consumption ranged between 0 and 40 litres/person/day.

The highest per capita water consumption among households located further away (between 1,100 and 1,500 m) from the water source, was 60 litres/person/day and this was attributed to only two households. Per capita water use for the rest of the households ranged between 0 and 40 litres/person/day.

Given the similar per capita water consumption for the households located closer to the river source and those located further away from the river source, it does not appear that any relationship exists between per capita water consumption and location (distance) of the primary water resource. The reason for this apparent lack of relationship could be attributed to the fact that households located closer and further away from the water sources are within an accessible distance to the water point. Most studies, however, have found a per capita reduction in water use for households located beyond an accessible distance.

CONCLUSION

The average daily per capita water consumption in Boro was estimated at 20.6 litres/person/day. Water was collected mostly by women who were also overwhelmed by other household activities. The most commonly used water collection container was the 20-litre plastic container which was also used for water storage. While the scatter plot did not reveal a clear relationship between distance to the water point and daily per capita water use, future research should investigate how households located beyond 1.5 km (as a result of growth of the village) will affect per capita consumption.

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