Journal of Environment and Earth Science
ISSN 2224-3216 (Paper) ISSN 2225-0948 (Online)
Vol.7, No.6, 2017

Determinants of Domestic Water Use in Bauchi Metropolis: A Model Perspective

Victor Istifanus
Urban and Regional Planning Department
Abubakar Tafawa Balewa University Bauchi (ATBU)

Abstract
There are various uses of water; domestic, commercial, industrial and agricultural. However, water is a scarce resource and water shortages are experienced in Nigerian cities. Several factors are reported- inability to abstract water from source, rapid urbanization, changes in life style and economic activities, inadequate information on pattern of water use and determinants of water use. Determinants domestic of water use vary from place to place and their significance also vary. This study aimed at analyzing the determinants of domestic water use in Bauchi metropolis Data was collected using stratified systematic random sampling. 381 household were sampled and analyzed using SPSS software. The regression analysis has this model. $Y = - 0.012 + 0.989X_1 + 1.997X_2 + 1.009X_3 + 1.002X_4 + 1.005X_5 + 0.996X_6 + 0.998X_7 + 1.997X_8 + 1.005X_9 + 1.000X_{10} + 1.010X_{11},$. Result of the analysis reveals that price, gender, occupation and water source were leading determinants, while religion, household size, and education followed. The multiple correlation coefficient in R= 1.000 indicates that all the variables tested correlated positively with the dependent variable- domestic water use. As a further measure of the strength of the model, the SE of the regression (0.051) was compared with the STD of average water use (6.871). Since SE is much lower than STD, showed that the model is really fit for explaining the determinants of domestic water use in Bauchi metropolis.
Keywords: determinants, domestic, water use, model.

1. Introduction

Thousands have lived without love not one without water (W.H. Auden). Development of human society is heavily dependent upon availability of water of suitable quality and in adequate quantities for a variety of uses ranging from domestic, commercial and industrial (Vigneswaran and Sundaradive, 2004). Water stressed urban environments suffer water scarcity both due to physical variables but also to human and social factors. Thus understanding which factor (s) that lay behind domestic urban water uses is critical both in theory terms and also in technical (practical) and theory related matters. There are different sources of water among which are lakes, rivers, wells, springs, rain water and municipal water supply. While the amount of water needed for drinking is a few litres per person per day, the amount needed to grow enough food for that person is 50 times larger (Gleick, 1993). Despite this the situation in developing countries characterized by high level of poverty and lack of access to clean water creates challenges for planning urban water systems to meet the demand or needs of both connected and the unconnected households for policy makers (Basari *et al.,* 2008). For example the Millennium Development Goal Report (MDGR) (2013), reported that in Nigeria only 32% of households had access to clean water

World Health Organization (WHO) (2003), defines domestic water as water usually used for all usual domestic purposes including bathing and food preparation. Domestic water use or household water use consists of drinking, bathing, washing cloth, and dishes, flushing toilets and landscaping Donnelley and Cooley, 2015)

Many factors contribute to total water use at household level. Mini and Smith (2000), used multiple regression models in water demand study in Ramallah, Sudan and found household size to be dominant factor of domestic water use. The rate of domestic water use was also found to depend on tariffs, water price, income, education, marital status and gender etc (Cook *et al.,* 2004 ; Zhang, 2005; Arbues and Villanua, 2006; Schnliech and Hillenbrand, 2007; Corbella *et al.,* 2009; Otaki *et al.,* 2010; Ayanshola and Salami, 2010; Fielding *et al.,* 2012; Romano, Salvali & Guerrini, 2014).

Lack of adequate data on domestic water use has been hampering urban water supply planning and policy making. This partly result from inadequate information on what factors lies behind domestic water use. For effective planning and supply of urban domestic water, it is important to identify the factors that determine domestic water use so as to guide policy makers and water managers. This study therefore intend to satisfy the growing interest in which factors affect domestic water use by focusing on socio- cultural factors of domestic water use.

2. Materials and methods

This study was carried out in Bauchi metropolis the capital city of Bauchi State Nigeria in 2015. Data was collected from randomly selected households with the use of structured questionnaire. The questionnaire was designed based on information need on the factors that are thought to affect domestic water use. The target

respondent were the head of households and where he or she is unavoidably absent, any reliable member of the household was interviewed. The factors considered were marital status (MS), household size (HS), gender (G), age (A), occupation (O), education (EDUC), income (I), religion (R), source of water (SW), type of house (TH) and price of water (P). The data collected was analyzed using SPSS software. Statistical tools such as mean and standard deviation were used. Regression analysis and analysis of variance (ANOVA) were also performed on the data.

In order to establish the structural relationship between the variables and household water demand and to reveal determinants of the variation of water use and consumption, multivariate statistical analysis was performed. The model of the following form was used to establish the said relationship (Ayanshola & Salami, (2009))

Q=F(X,, X2----X3 + E.

Where Q is the dependent variables or household water consumed per day, F denotes the Function of Explanatory Independent Variables and E Standard error.

X1 is marital status, (MS), X2 is household size (HS), X3 is gender (G), X4 is age (A), X5 is occupation (O), X6 is education (EDUC), X7 is income (I), X8 is religion (R), X9 is source of water (SW), X10 is type of house (TH), X11 is Price (P).

To further establish whether relationship exist between the independent variable and the dependent variable, the study hypothesized;

H_0: There is no statistically significant relationship between socio-cultural determinant and domestic water use in Bauchi metropolis

H_1: There is significant relationship between socio-cultural variables and domestic water use in Bauchi metropolis.

3. Results and Discussion

Regression Analysis

Table 1: Descriptive Statistics *of Determinants*

	Mean	Std. Deviation	N
Water Use	32.47	6.871	381
Marital status	1.22	.413	381
HH Size	6.70	3.408	381
Gender	1.32	.467	381
Age	4.06	.907	381
Occupation	3.26	1.836	381
Education	2.87	.862	381
Income	6.10	2.274	381
Religion	1.04	.207	381
Source of Water	2.15	1.483	381
Type of House	3.63	.719	381
Price	.12	.323	381

Table 2: Coefficients *of Determinants*

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	.012	.033		.350	.727
Marital Status	.989	.009	.060	112.051	.000
HH Size	.997	.003	.494	370.397	.000
Gender	1.009	.007	.069	151.929	.000
Age	1.002	.003	.132	339.215	.000
Occupation	1.005	.001	.269	673.003	.000
Education	.996	.003	.125	319.067	.000
Income	.998	.002	.330	608.146	.000
Religion	.997	.016	.030	62.097	.000
Source of Water	1.005	.004	.217	232.260	.000
Type of House	1.000	.007	.105	143.918	.000
Price	1.010	.013	.048	79.037	.000

a. Dependent Variable: Water Use

Table 3: Model Summary of the Regression Analysis

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	1.000[a]	1.000	1.000	.051

a. Predictors: (Constant), Price, Age, Gender, Education, Occupation, Type of House, Income, Religion, Source of Water, Marital Status, Household Size

ANOVA

Table 4: Determinants of Water Use

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	17937.893	11	1630.718	635382.744	.000[b]
	Residual	.947	369	.003		
	Total	**17938.840**	**380**			

a. Dependent Variable: Water Use

b. Predictors: (Constant), Price, Age, Gender, Education, Occupation, Type of Household, Income, Religion, Source of Water, Marital Status, HH Size

Standard multiple regression analysis was used to assess the significance of the socio-cultural determinates (independent variables- MS, HS, G, A, O, EDUC, I, R, SW, TH, and P), hypothesized to predict the dependent variable (water use). The analysis has the model

$Y = - 0.012 + 0.989X_1 + 1.0997X_2 + 1.009X_3 + 1.002X_4 + 1.005X_5 + 0.996X_6 + 0.998X_7 + 1.997X_8 + 1.005X_9 + 1.000_{10} + 1.010X_{11}$ where X_1 is marital status, X_2 is the household size, X_3 is the gender, X_4 is the ages of the respondents X_5 is the occupation, X_6, education of the respondents, X_7 is the income earned per month, X_8 is the religion, X_9 is the source of water, X_{10} is the type of house and X_{11} is the price of water bought. Here the household water use is a function of eleven sets of independents variable which are believed to yield the estimated result.

For each of these variables, the value in the column marked sig (p- value) was checked. This showed whether this predictor made a statistically significant contribution to average domestic water use. If p- value is less than 0.05, the variable made significant contribution to the prediction of average domestic water use (consumption). For values greater than 0.05, the variables did not make significant contributions to the prediction of domestic water use. In this case all the eleven variables included in the equation made statistically significant contributions to the prediction of average domestic water use in Bauchi as their p-values 0.000 are less than 0.05.

The correlations between variables included in the model are checked for, to see whether the independent variables show at least some relationship with the dependents variable. The model reaches statistical significance/sig = 000: this really means P<0.05 (Table 2). Each of the variables included in the model were also examined to see which of them contributed to the prediction of the dependent variable. Both standardized and unstandardized coefficients are reported (Table 2). In order to compare the effects of different variables, it is appropriate to look at the standardized coefficients, rather than unstandardized ones. Standardized means that these values for the coefficients correspond to the expected change in the independent variable equal to its standard deviation. Thus, in a sense each of the coefficients has been converted to the scale so that one can compare them. A large standardized coefficient implies that a change of one standard deviation (SD) in the variables will result in a large change in per capita water consumption.

However, there is no particular reason to expect that a one unit change in standard deviation for the variable is that much more relevant than a one unit change in the variable itself, and the use of one standard deviation (SD) change is not applicable for binary variables. In this case there is a need to use unstandardized beta coefficients (Dagnew, 2012). Therefore, the unstandardized beta coefficient found all the variables analyzed were statistically significant at 0.05 % (Table 2).

The value of the R^2 indicates how much of the variance in the dependent variable daily domestic water use or consumption is explained by the model (Table 3). The adjusted R^2 statistics corrects the value of R^2 statistics to provide a better estimate of the true population value. For small samples it is better to report the adjusted R^2 rather than the normal R^2. The adjusted R^2 square also indicates that the model explains 100 % of the variance in the dependent variable. Therefore the explanatory variables in the model explain 100 % of the variance domestic water consumption as $R^2 = 1.000$ (Table 3) According to the guidelines provide in Pallant (2010), this is a respectable result for household level cross-sectional data.

The coefficient of determination at 95 % level of confidence indicates that all variables MS, HS, G, A, O, EDUC, I, R, SW, TH and P correlate substantially with the dependent variable domestic water use (Water Consumption). In terms of hierarchy of determination the study reveal that P, G, O, SW, A & TH were higher, while I, R, HS, EDUC and MS followed. The highest determinant is price while the least is marital status (Table 2).

As a further measure of the strength of model fit, the standard error of estimate of the regression (0,051) (table 3), was compared to the standard deviation of average water use (6.871) (table1). Since the standard error

of estimate is much lower than the standard deviation of average water use showed that the model is really fit for explaining the determinants of domestic water use (Ayanshola and Salami, 2010). To confirm the result additional analysis of variance (ANOVA) was carried to test the hypothesis postulated. From the AVOVA result the value F=635382.744 is greater than 0.05, the null hypothesis is rejected and the alternative hypothesis is accepted (table 4). Therefore there is significant relationship between socio-cultural factors and domestic water use in Bauchi metropolis.

Therefore theoretically the regression analysis and the analysis of variance (ANOVA), has establish that all the socio-cultural variables analyzed were significant in predicting domestic water use It also analyzed the contribution of each variable to domestic water use (Table 2).

4. Conclusion and Recommendation

Analysis of the data from sampled households showed that the regression model is fit for domestic water use. It found out that the eleven socio-cultural variables were significant predictors of average domestic water use. It further found out that in terms of hierarchy, price, gender, occupation and source of water were the highest predictors while marital status made the least contribution to domestic water use in Bauchi metropolis. The model is recommended for use in municipal cities with similar socio-cultural characteristics with Bauchi metropolis. It can be used to estimate quantity of water use in the study areas.

Reference

Arbues, F. & Villanua, I. (2006). Potentials for Pricing Policies in Water Resource Management Estimation of Urban Residential Water Demand. Zaragoza Spain Journal of Urban Studies, 43, 2421-2442.

Ayanshola, A.MF. & Salami, A.W. (2010). Modelling of Domestic Water Demand at Household Level in Illorin Nigeria. Retrieved May 6, 2014 from http://www.unilorin.edu.ng/publications/ayanshola/modelyofresident

Basari, M., Ishamb, J. & Reilly, B. (2008). The Determinants of Water Connection and Consumption . Empirical Evidence from a Cambodian Householeds Survey. World Development Journal, 36(5), 953-968.

Cook, Z., Urban, S., Maupin, M., Prah, R. & Church, J. (2001). Domestic, Commercial, Municipal and Industrial Water Demand Assessment and Forcast in Ada and Canyon Countries. USA: Adoho Department of Water Resources.

Corbella, H.M. & Puyol, D.S. (2009). What lies behind Domestic Water Use? A Review Essay on the Drivers of Domestic Water Consumption., Boletin de la A.G.E. No. -, 297-314.

Dagnew, D.C. (2012). Factor Determining Residential Water Demand in North Western Ethopia, the case of Metrowi. UK: Unpublished Master of Professional Study Correll University .

Donnelly, K. & Cooley, H. (2015). Water Use Trends in the United States, Pacific Institute. USA.

Feilding, K.S., Rusell, S., Spirinks, A & Manked, A. (2012). Determinant of Household Water Conservation: The Role of Demographic, Infrastructure, behaviour and Psychosocial Variables. Institute for Social Research, University of Queensland Brisbane.

Gleick, P. H. (1996). Water Requirement for Human Activities: Meeling Basic Needs;. Water International (IWRA) 21: 83-92.

Mini, Z. & Smith, M. (2000). Statistical Domestic Water Demand Model for. West Bank Water International, 25(3), 464-468.

Millennium Development Gold Reports. (MDGR). (2013). Nigeria: Progress Report on Water and Sanitation in Nigeria UNDP.

Otaki, Y, Otaki, M., Aramaki, T. & Sakura, O. (2010). Domestic Water Demand Analysis by Household Activities. Tokyo: University of Tokyo Inter Faculty Initiative on Information Studies.

Pallant, J. (2010). A Step by Step Guide to Data Analysis using the SPSS Programm; SPSS Survival Manual. 4th Edition International Bestseller, Open University Press, MacGraw-Hill Education.

Romano, G., Salvali, N. & Guerrini, A. (2014). Estimating the Determinants of Domestic Water Demand in Italy. Journal of Water Open, 6, 2929-2945. Retrieved March 5, 2015 from http://www.indi.com.journal/water

Schleich, J. & Hillenbrand, T. (2007). Determinants of Domestic Water Use in German. Working Paper Sustainability and Innovation number. Fraundesfe Institute System and Innovation Research. 3(1) pp27-34

Vigneswran, S. & Sundaradivel. (2004). Recycle and reuse of Domestic Waste Water in Wastewater recycle, reuse and reclamation (ed). Sarava Numuthus.

World Health Organization. (W.H.O). (2003). The Right to Water Geneva.

World Health Organization. (W.H.O). (2003). Retrieved July 21, 2015, from Domestic Water Quantity, Service, Level and Health: from http://www.who.int/watersanitationhealth/

Zhang, H.H. (2005). Domestic Urban Water Use. It Implication for Municipal Water Supply in Bejing. Journal of Habitat International.