Determinants of Household Water Supply Sustainability in an Emerging Town in Northwest Ethiopia

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Abstract

Accessing useable freshwater appears to be the main worry of urban citizens in Ethiopia today. The possible reasons for the problem are not yet duly addressed in scientific literatures. In this paper we analyzed the determinants of household water supply and sustainability in a rural town named Agew-Gimjabeht, Ethiopia. We captured data through questionnaires, interviews, discussions and observations. Data were analyzed using descriptive statistics and the binary logistic regression model. We found that many households (≥68%) lack adequate water supply to satisfy their family needs. The daily household per capita water was 42.13 liters. The per capita water (9.93 liter per person per day/ $l\ p^{-1}d^{-1}$) found less than the universally recommended 20 $l\ p^{-1}d^{-1}$threshold. Age, house type, micro-relief, rate of urbanization and management capacity significantly influenced households' freshwater sustainability in the town. It is recommended that urban governments design better urban management schemes and capacities to minimize water shortages.

Keywords: Water supply; Sustainability determinants; Rural towns; Northwest Ethiopia.

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1. Introduction

1.1 Freshwater Sources and Supplies

Freshwater is an indispensable resource for the survival of life on the planet Earth. It is the basis and foundation of all living organisms and equally important for sustainable socioeconomic development (UN-WATER, 2018). Potable freshwater required for household consumption is priceless and cannot be replaced by another Earth resource (Koehler, 2008). But, its amount in the human settled areas of the Planet Earth is limited. Because greater than two-third (≈69%) of the useable freshwater on Earth is frozen in the glaciers and polar ice caps (Hudart and Stot, 2010).

Earlier in the past, the widespread view of people on freshwater was consistent to an infinite enormous wealth (Jethoo and Poonia, 2011). But, freshwater is the only renewable non-living resource; depleting and finite equally. Some scientists argue that it is something similar to the top soil exhibiting both living and non-living components. However, contrasting to minerals and other water resources, freshwater is firmly unified with the biosphere. Hence, its extreme loss in the biosphere can drastically cause biodiversity and ecological health collapse (Koehler, 2008). Based on Koehler (2008) essay, three major kinds of freshwater (deposits, funds and flows) each differing by way of the inherent restoration capability is distinguished. Ground based freshwater stocks (deposits) easily deplete with excessive use and slightly regenerate or cannot be restored at the span of human lifetime. The aquifers and lakes (freshwater funds) reduce provisionally with use; yet replenish naturally provided that they are not irrevocably damaged. The flow freshwater resources in the springs, rivers and streams are fundamentally inexhaustible. But, these waters can be easily altered with excessive and improper utilization and withdrawals. So, as a depleting resource, freshwater, which is very fundamental to life after oxygen, is getting progressively scarcer and less accessible to human use all over the Globe (Koehler, 2008).

Useable freshwater is an essential drinking good to satisfy human thirsty. But, its relevance is not limited to get satisfaction. It is the center for food production, personal hygiene and to sustain biodiversity and ecosystem functions. In addition, it plays major role in poverty reduction via the use of irrigation and fishery. It can generally be considered as a strategic wealth forming the basic framework of socioeconomic development and human civilization (Koehler, 2008; Wiek and Larson, 2012). However, proper freshwater use activities are violated by poor access, inadequate delivery, low quality and quantity. When availability, accessibility and proper utilization of fresh-water are violated the continued existence of humanity is endangered. For instance, when freshwater and hygiene get lesser and lesser in an area, fatal infections easily come-up from polluted water and spoiled food items then cause severe sickness and grave deaths (Sobsey *et al*., 2008; Tesfaye, 2012). Abebe (2014) argues that insufficient access to potable freshwater supply is exacerbating sanitation and hygiene problems and the incidence of poverty in many developing countries. Shortage of adequate and clean potable freshwater thus jeopardizes food security, human nutrition and health in the developing areas of Africa and Asia (Koehler, 2008). The shortage can trigger conflict among users at village or diverse community levels (Ostrom, 1990; Gleitsmann *et al*., 2007). Availability of ample freshwater supply of adequate quality for human use and environmental health is thus essential for the long-term progress and stability of any country (Roy *et al*., 2005).

World population was estimated 6.9 billion in 2010, and projected to reach 9.15 billion by 2050 (Alexandratos and Bruinsma, 2012). By the mentioned time (in 2050), the worldwide freshwater demand is anticipated to rise by 55%, primarily owing to the rising demands of the increasing population, agricultural expansion, rising manufacturing industry, growing power production and household consumption. According to UNDP (2006), 1,700 meter cube water per person per year (m^3 p^{-1} yr^{-1}) is required for meeting such human basic and socioeconomic demands. Taking this threshold as a standard, there is in fact sufficient freshwater reserves at the Global level though the distribution is uneven. But, water shortage occurs due to the uneven freshwater distribution and as a result of inadequate access and poor quality. Coupled with the uneven distribution of the Earth’s freshwater, over use of both surface and underground water for agriculture alters the availability required for coming generations. Improper freshwater use practices with erection of excessive irrigation dams on upstream areas increasingly lower freshwater availability and endanger terrestrial and aquatic ecosystems. The occasion alters the sustainability of the local biological diversity and ecological functions. This finally violates the hydrological system in downstream areas (Koehler, 2008).

Ten years ago, Sobsey *et al*. (2008) remarked that around 1.1 billion people throughout the world were forced to use risky water from underground and open sources due to shortage of clean drinking water. Recent sources remarked as well over 2 billion people suffer from severe water stress globally (Mwangi, 2014; UN, 2017; Bain *et al*., 2018). Other additional sources also indicate large numbers of countries are reaching frightening stages of freshwater shortage and scarcity. For instance, countries in the middle-east, sub-Saharan Africa (SSA) and South Asia suffer from severe water shortage and stress. In SSA, the water-stressed countries are experiencing extreme population growth rates; but diminishing rates of per capita water (UNDP, 2006). Less developed areas such as Ethiopia suffer from the scarcity of safe potable freshwater for home consumption and environmental purposes due to rapid population growth rates; despite having numerous rivers and lakes (Degefu *et al*., 2015). The freshwater supplies in these countries are expected to be scarcer and scarcer in the coming decades owing to the rapidly increasing populations, growing demands, wetland alterations and climatic changes (Wintgens *et al.*, 2008; Wiek and Larson, 2012).

Cities and towns are areas where development prospects and challenges are often confronting. They are places of higher population agglomeration. In the Current decade, around 54% of world's population is living in urban areas and it is projected to reach 66% by year 2050 (UN, 2014). These urban people in 2050 are expected to emerge in developing countries (UNWWDR, 2015). However, these rapid population changes in the cities and towns are weakly equipped with urban infrastructure and freshwater schemes (Berore, 2016). The weak urban infrastructure perhaps remains unfavorable to deliver sustainable and adequate freshwater supply to households in many countries. Rival demands among various sections of the community also intricate the freshwater allotment and delivery practices. The user community participation during planning and policy formulation on freshwater development is also very low in a number of countries (Fita, 2011; Laurent *et al.*, 2012; UNWWDR, 2015). The concern of freshwater supply, access and sustainability is thus nowadays emerging to be one among the many challenges of urban areas; particularly in the developing countries.

People living in cities and towns can access household freshwater from springs, bore-holes, streams, rivers, ponds, lakes, hand-dug wells and trapped rainfalls. The water from these sources can be made available for household consumption through fetching using human and animal labour, from private standing pipes or from public taps (Kithinji, 2015). Yet, potable freshwater supply for household consumption from reliable source is rare. Due to this households are forced to collect it from defective sources. Accessing it from unreliable sources is possible only through paying higher prices; and often unsustainable, inadequate and unsafe. Freshwater from such unreliable sources are frequently contaminated by urban wastes;

thus expose urban dwellers to diverse illnesses and diseases (Bahri, 2012; Otti and Ezenwaji, 2019).

The task of accessing useable water to urban residents thus requires active planning; good governance; user community participation and suitable infrastructural schemes (Adams *et al.*, 2018). The process involves the production and storing of the water at the sources; conveying it to the treatment plants and reservoirs and then distributing it to consumers via the use of pipelines. Deficiencies associated to these procedures significantly influence the urban freshwater access efforts and processes. Scarcity of adequate water sources, ill-equipped technical support services, repeated power interruptions, inequitable water allocation dealings, poor water storage habits, weak user participation, financial constraints and absence of good governance also greatly impact urban water access functions (Tesfaye, 2012; Ashenafi, 2014; Godebo, 2015).

1.2 Sustainable Freshwater Supply

Sustainable freshwater supply refers to clean and affordable freshwater supply available to all persons with no discrimination on a continuous basis to satisfy their basic needs (drinking, food preparation, bathing, cloth washing and related household sanitations) (Gleick, 1996). According to World Health Organization (WHO, 2003) standards, the minimum basic water requirement is 20 liters per person per day (l p^{-1} d^{-1}); although there are no clear compromises among the scientists. Gleick (1996) recommended 50 liters of fresh water p^{-1} d^{-1} to satisfy the mentioned basic needs. He proposed 3 l p^{-1} d^{-1} for survival (for drinking) in normal temperate climatic settings. He then suggested an increased threshold of ≈ 5 l p^{-1} d^{-1} with consideration of both temperate and tropical climatic conditions. He recommends 20 l p^{-1} d^{-1} for sanitation. For bathing, he suggested ≈70 l p^{-1} d^{-1} (a range of 45-100 l p^{-1} d^{-1}) in developed countries and 15 l p^{-1} d-^{1} (or between 15-25 l p^{-1} d^{-1}) for developing regions. Average amount of freshwater required for food preparation in Gleick (1996) report is 10 l p^{-1} d^{-1} to achieve basic requirement or (≈10-20 l p^{-1} d^{-1}) to meet regional levels.

Sustainability of the potable freshwater supply and use can be achieved by ‘protecting the water environment’. This can be made through involving stakeholders such as user communities, governmental and Non-Governmental Organizations (NGOs) and the private sectors (Tadesse *et al.,* 2013). Sustainability can also be retained by addressing equity between rival uses; current and upcoming demands, and between human and other needs

(Armstrong, 2006; Adams and Smiley, 2018). In other words freshwater supply, use and sustainability can be viewed as the result of the interactions between socioeconomic and environmental variables. It must consider both the local and Global water potential plus the demands of the coming generations (Del Borghi *et al.*, 2010). However, sustainability of future freshwater use is complicated by increasing current demands and limited supplies (Roy *et al*., 2005). Rapid population growth rates, insufficient infrastructures and faster rate of urbanization are other factors affecting the sustainability of potable freshwater supply in poor communities. Absence of good governance and unsustainable development greatly impact the quality, access and sustainability of freshwater supplies.

Household freshwater supply access and use in Ethiopia is one of the lowest in the world. For instance, the per capita freshwater use ($l\ p^{-1}d^{-1}$) in 1990 was only 13.3 for the country (Gleick, 1996). This 13.3 $l\ p^{-1}d^{-1}$ is below the minimum absolute freshwater (20 $l\ p^{-1}\ d^{-1}$) recommended by the WHO (2003) for basic human needs. In 2014, only 55% of the households all over the country were getting access to improved potable freshwater supply. This is almost higher compared to the only 25.6% households' access to water in the year 2000. Nonetheless, access to pipe water is still very low; only 33% in 2014 (UN, 2015). For Amhara Region where the current study site is located, the potable household freshwater coverage is not exceeding 60%; meaning, 40% of the households do not have access to clean potable freshwater supply (Shimelash, 2013).

There are several studies on household water access and supply in different parts of Ethiopia. To cite some, the paper by Ashenafi (2014) explored the urban water supply and use in Asayta town, northeastern part of Ethiopia. Similarly, a research conducted by Abebe (2014) assessed the urban household water supply in Gimbichu town, southern part of Ethiopia. Berore (2016) evaluated the Welkite town water supply system, in the Gurahge Zone, Ethiopia. The paper of Gebre (2016) also examined the causes and impacts of water shortage on urban households in Burayyu town, central Ethiopia. All these studies described the water access and supply systems in the different towns of Ethiopia. This study mainly differs from the mentioned studies in that it focuses on describing the determinants of household freshwater supply sustainability in an emerging rural town named Agew-Gimjabeht, in the northwestern highlands of Ethiopia.

2. Research Methods and Materials

2.1 Description of the Study Area

The study area, Agew-Gimjabet town is found in Awi Zone, in the northwestern highlands of Ethiopia. It is located 420 kms northwest of Addis Ababa at $10^0$51’ N and $36^0$54’ E (Figure 1). The town covers 627 ha land at an altitude of 2320 m asl on a basaltic plateau in Ankesha-Gugusa Woreda (District). The entire size of the domicile woreda measures 1029.24 km^2 area between 1800-2900 m asl elevation ranges. The main climate is *Woina Dega* (sub-tropical). The average yearly temperature and rainfall values range between 15-20^0C and 1000-2000 mm, respectively. Three discrete rainfall periods (summer, autumn and spring) are experienced in the area. Summers are of high rainfall spells whilst autumns and springs are characterized with modest and slight rainfall events, respectively (ANGWFEDO, 2017).

The name Agew-Gimjabeht has been known as a rural church village (Gimjabeht-Mariam) since 1673 with the establishment of the Saint Marry Church by Atsie Yohannes I (Tsadiku Yohannes, 1667-1682 AD). Recently, the size of the village expanded and got the status of town and has served as a district administrative and market-service center during the past 35 years. The town now is inhabited by 17,898 people (8,488 males and 9,410 females) in two Urban Kebele Administrations (UKAs)[2]. Afan Oromo, Amharic, Awigna, Guraghegna and Tigriegna are spoken by different number of people. Christianity and Islam are followed by the town dwellers (ANGWFEDO, 2017). Schools, health centers and financial institutions are among the main public institutions found in the town.

Suburban - residential, market (commercial), administration, social amenity, transport terminal, agricultural, sport and recreational areas are the major land uses in the town. Mixed agriculture is practiced by considerable number of the people living in the town to augment livelihood gaps. Small-scale enterprises are major occupations for many people. Small-scale business (shopping and hotel services), milling, bakery, lumbering, brick-making, retail shopping of different commodities including grain selling and electronics are important occupations of the people.

[2] UKAs are lower urban administration units

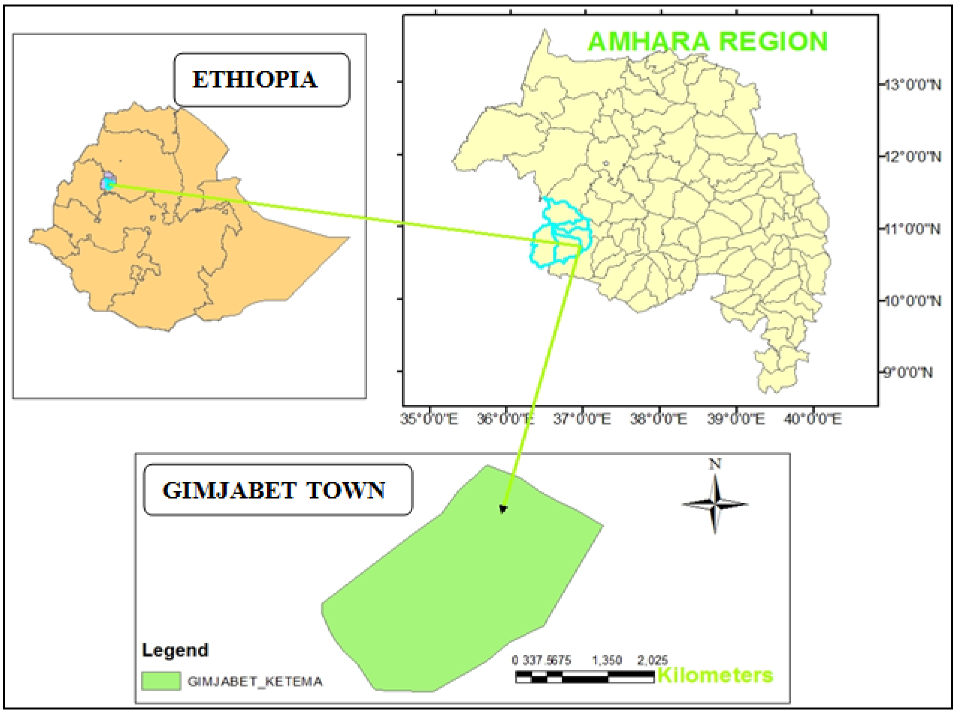

Figure 1. Map of the study area (Adapted from Ethio-GIS, 2007 data).

2.2 The Research Method and Data

2.2.1 Research design

The study used the concurrent triangulation mixed method model which involves concomitant gathering and analysis of quantitative and qualitative data. The approach employed manifold information sources and techniques to generate both numerical and qualitative information using several perspectives such as questionnaires, in-depth interviews, focus group discussions (FGDs) and field observations. These approaches and methods help to verify the information and to reach at accurate conclusions.

2.2.2 Sampling and data generation

The study urban area; Agew-Gimjabeth town, is restructured into two UKAs for the reason of governance. Scarcity of access to potable freshwater is a pervasive constraint of the households in the two UKAs. Hence, both were considered in the study. A total of 357 sample representative households were identified from 3321 households using systematic random sampling technique for the questionnaire survey. Yamane (1967) sample size determination procedure was followed to reach at the 357 sample population. Because this method offers large number of samples compared to other models, it was used to determine the sample households in this paper. Following deciding the size of the sample population, 204 and 153 household respondents were identified from 01 and 02 UKAs, respectively using the proportional-to-size allocation method through systematic selection procedure. Sixteen knowledgeable household heads (four women and four men in each UKA) for FGDs and six elders (one woman and two men in each UKA) were also purposively selected for additional in-depth qualitative data gathering on households' perspectives, behaviours, attitudes and experiences.

Following identification of the study samples, both close and open-format questions pertaining demographic, biophysical, socioeconomic, water supply access, use and sustainability issues were designed for numerical data generation. The questions were first prepared in English and then translated into the local language Amharic to ease the barrier of communication. Then, preliminary surveys were undertaken from 20 residents met at random occasions so as to check the relevance and validity of the questions. After that, the questionnaires were improved by deleting irrelevant concepts and adding new ones observed important during the pretest. Finally, the questions were distributed to the 357 sample households for final data gathering. During the survey, three university graduate interviewers were recruited, trained and assigned to assist respondents who cannot read and write. The questionnaires were filled from the beginning of March to the end of May 2018 under close supervision of the lead researcher.

Simultaneously, the in-depth interviews and FGDs were facilitated by the lead researcher. Pre-designed guiding questions were used during the in-depth interviews and FGDs. Detailed field notes were also compiled in the due process. Field observations were undertaken before, after and during the questionnaire survey time by walking across the different corners of the town. This has provided the opportunity to visualize the actual state of affairs at the field about the prevalent water sources, the walking distances between water points and the dwelling houses, the existing water utilization conditions and about freshwater supply and sustainability issues. Additional background data were gathered from books, office archives, governmental and non-governmental reports, research articles and internet sources.

2.2.3 Methods of data analysis

Data analysis is one of the important elements of research study help to covert the raw survey data into a meaningful information. Accordingly, the data captured through different ways in this study were analyzed using quantitative and qualitative techniques. The quantitative data captured from the questionnaire survey were first edited, coded and encoded into the Statistical Package of the Social Sciences (SPSS Version - 20) and then explored using descriptive statistics and the binary logistic regeression model. The descriptive statistical measures were mainly employed to describe the amount of freshwater collected and consumed by the households.

The binary logistic regression model was employed to appraise the factors affecting household freshwater supply sustainability in the study town. The fitness of the model to the data was evaluated using the Pearson's Chi-square, Hosmer-Lemeshow goodness-of-fit statistics (Hosmer and Lemeshow, 1989) and the classification table of the sample cases. Multicolinearity among the continuous variables was tested by using the Variance Inflation Factor (VIF). The colinearity effects among the dummy variables were also checked through the Contingency Coefficients (CC). In most regression literatures, VIF >10 and level of tolerance nearer to zero (0) imply prevalence of high multicolinearity among continuous predictor factors. Similarly, CC >0.75 is the sign of existence of relevant multicolinearity impact among dummy/categorical factors (Gujarati, 2004). Hence, the multicolinearity effect among the predictor variables used in the linear multiple regression model was checked in these ways. The dependent variable used in the binary logit model was the perceived sustainability of household potable freshwater supply; i.e. a dummy variable one (1) if sustainable and zero (0) otherwise. Fifteen predictor variables (Table 1) selected based on the diverse literatures cited in the introduction part above are regressed to evaluate their influence on the criterion variable mentioned.

Table 1. Definition of explanatory variables used in the regression modeling

Explanatory variables	Description	Direction of influence
Sex	Dummy	±
Age (Years)	Continuous	+
Family size (№ household members)	Continuous	+
Formal education attendance	Dummy	+
Income in Ethiopian Birr (ETB)	Continuous	+
Employment	Categorical	+
House type	Categorical	+
Pipe connection	Dummy	+
Distance of water point from home (meters)	Categorical	-
Water service cost (ETB)	Categorical	-
Topography	Ordinal	±
Power fluctuation	Dummy	-
Season	Dummy	±
Management capacity	Ordinal	±
Rate of urban expansion	Ordinal	±

The qualitative information obtained from in-depth interviews, FGDs and field observation were concurrently analyzed to augment the quantitative results at each section of the data analysis.

3. Results and Discussion

3.1 Demographic and Socioeconomic Characteristics of the Studied Households

A total of 357 households were assessed to capture adequate information in this urban household freshwater supply sustainability study. About 51% of the households were managed by women while the rest 49% were led by men. Over 83% of the studied household heads were married (coupled) whilst 15.7% were non-married (single). On the other side, almost 92% of them have passed through formal education and only 8% were not formally educated. Many of them (63%) were workers in government offices and some others (37%) were engaged in non-governmental businesses such as trading, milling, shopping, carpentry and small-scale enterprises (Table 2).

The total number of people sheltered in the mentioned households counted 1515 and the average was 4.24 p^{-1} h^{-1}. The maximum family size for the considered households was recorded eight; yet the minimum was one implying that there are heads without children. The mean age of the family unit leaders described was 34.5 years.

Table 2. Basic information on household characteristics (N=357)

Household related variables	Category	№	%
Sex	Female	181	51
	Male	176	49
Marital status	Coupled	301	84
	Single	56	16
Formal education attendance	Yes	328	92
	No	29	8
Employment in government offices	Yes	225	63
	No	132	37
Home ownership	Own	298	83
	Rented	59	17
Pipe water connection access	Yes	243	68
	No	114	32
Access to sufficient & sustainable potable freshwater	Yes	112	31.4
	No	245	68.6
Facing water interruption	Yes	337	94
	No	20	6

The youngest head was 20 years old whereas the eldest was aged 60 years. The mean monthly income of the surveyed households reached Ethiopian Birr (ETB 3472.49). But, there appears a big gap between the lowest (ETB 200) and the highest (ETB 130,000) monthly incomes (Table 3). The total amount of freshwater collected and used by the 1515 households was 15040 liters per day (l d^{-1}) which is equivalent to 42.13 liters per household per day (l h^{-1} d^{-1}); or 9.93 l p^{-1} d^{-1}. The above reported evidences indicate that the per capita water used by households is too small and differing across the different household groups.

Table 3. Basic information on households' demography, income and freshwater use **(N=357)**

Variables	Total	Minimum	Maximum	Mean	Standard Deviation
Age of the head (years)	-----	20	60	34.53	7.82
Family size (№)	1515	1	8	4.24	1.45
Household income (ETB)	-----	200	13000	3472.49	1944.32
Water use (l $h^{-1}d^{-1}$)	-----	20	80	42.13	17.80
Water use (l p^{-1} d^{-1})	-----	-----	-----	9.93	-----
Total water use per day	15040	--------	-----	-----	-----

Source: Computed from the household survey data (March - May, 2018)

3.2 Households' Perception on Freshwater Supply and Sustainability

The UN declaration on the rights to water (UNDP, 2006) notes that all persons are entitled to get access to adequate, clean, and reasonably affordable freshwater supply for personal and family service. Sustainable household freshwater supply in this paper thus refers to clean and affordable water supply availability to all the households studied with no discrimination on a continuous basis to satisfy family basic needs (drinking, food preparation, bathing, cloth washing and related household sanitations). With this understanding, the surveyed households were asked to tell whether they get sufficient water for their domestic uses. Surprisingly, over 68% of them replied that they have no adequate access to sustainable potable freshwater supply. Only 31.4% of the households confirm that they have the opportunity to get such water (Table 2). Table 3 indicates that the per capita water collected by the studied households is ≤10 l p^{-1} d^{-1}. This water satisfies minimum threshold required for only food preparation (10 l p^{-1} d^{-1}) proposed in Gleick (1996). It is much lower than the 50 l p^{-1} d^{-1} average suggested by this author. It is even less by half from the lowest requirement (20 l p^{-1} d^{-1}) set by WHO (2003).

Referring Table 4, many households (68.3%) reported that they access the water they need from private standpipes and 68% (Table 2) indicated that they have their own pipeline connections at their homes. Yet, 32% of the households indicated that they didn't have their own pipeline connections at their homes due to financial problems; corrupted bureaucracy in the water office; spare part shortages; and because living in rented houses as learned from FGDs. Some 17% of such households reported living in rented houses against to 63% living in their own constructed homes (Table 2). Yet, living in ones' own constructed homes or having a pipeline connection appeared not guarantying sustainable freshwater supply. For instance 94% of the households (Table 4) complain that the piped freshwater does not regularly reach their standpipes due to frequent interruptions and limited amounts (supplies) at the sources and reservoirs. About 71% of the households reported that they get water once in two or three days. Other 12.6% and 10.6% respondents complain that they get it once in a week or once in four to five days, respectively. Only few users (<6%) replied that they get water every day from their standpipes.

Households perceive different factors cause frequent water irregularities. Over 76% of them indicated irregularity of the water supply system occurs due to electric power interruptions (Table 5). More than 66% respondents confirmed high rate of urbanization led to reduced water volumes reaching the standpipes. Over 17% perceived the rough micro-relief influences the amount of water reaching their standpipes. Another 45.7% households revealed the water reaching their standpipes vary with the change in seasons. Greater than 83% respondents also reported water management at home and outside home is very weak. Key informants and FGD participants remarked that there is corruption and lack of equity in water distribution in the town. According to these people the water supply in the town frequently interrupts because of weak management and corrupted water technical staff.

Table 4. Households' freshwater information (N=357)

Information type	Responses	№	%
Potable freshwater sources (Multiple responses)	Springs	62	17.4
	Rivers/streams	5	1.4
	Hand-dug well	45	12.6
	Rainwater	16	4.5
	Public tap	37	10.4
	Private tap	244	68.3
Distance of water point from home (in meters)	<200	252	70.6
	201-400	59	16.5
	401-600	21	5.9
	>601	25	7.0
Availability of pipe water in a week (Multiple responses)	Daily	21	6
	Once in 2-3 days	253	71
	Once in 4-5 days	38	11
	Once in a week	45	13
Water cost per month (ETB) for 1 m^3 water	≤6	349	97.8
	>6	8	2.2

Few households (<3%) remarked that they pay >ETB 6 per month on average for their water gauges (Table 4). A considerable number of households (some 7%) reported also travelling > 600 meters to reach at water points.

Due to the above reasons, many households are forced to use water collected from unsafe sources. Over 17% of the households indicated they collect it from springs. Some others (12.6%) reported that they access it from hand-dug wells. Over 10% of the residents get it from public standpipes (locally named *Bono*). A considerable number of households (4.5%) revealed that they collect and use rainwater. Few households (1.4%) collect it from nearby rivers and streams (Table 4).

The aforementioned evidences normally confirm that the people in Agew-Gimjabeht town access potable freshwater from two main sources (i.e. from piped and non-piped sources). Piped water is often clean, safe and easily collected. But, it is not apparent and reliable for all the residents. Consequently, many people in the town are forced to use non-clean water from unsafe sources such as hand-dug wells, open springs, streams and rivers and from public standpipes, or else, purchase it from private standpipe water owners at higher prices so as to satisfy their household water requirements. Similar cases were reported for many towns in Ethiopia (e.g. Delesho, 2006; Abebe, 2014; Ashenafi, 2014).

Table 5. Household freshwater sustainability influencing factors (N=357)

Influencing factors (multiple response items)	% of respondents
Power interruption	76.47
High rate of urbanization	66.11
Seasonal change	45.66
Rough micro-topography	17.93
Weak management capacity	83.75

3.3 Determinants of Household Freshwater Sustainability

This section of the paper attempts to identify what factors control the freshwater supply and sustainability in Agew-Gimjabeht town with the binary logistic regression model. During running the model data fitness was checked from the Pearson's Chi-square and the Hosmer-Lemeshow goodness-of-fit statistics. Consequently, the Model-χ^2=210.713, P=0.000 (Table 6) indicating a fairly better fitting model at 15 degrees of freedom. The Hosmer-Lemeshow test also indicated a fitting model (χ^2 = 13.875; P=0.085, df: 8). The classification table of the sample cases also showed 86% overall percentage with similar 86% correct prediction for both households who felt and not felt freshwater supply and sustainability constraints. The VIF among the continuous variables and CC among the dummy/categorical variables indicated having no multicolinearity problems (observed < 10 & 0.75, respectively).

In the final model, ten variables (sex, family size, education, employment, power fluctuation, and distance from the water point, season, monthly water service cost, pipeline connection and monthly household income) discovered statistically non-significant in predicting the supply and sustainability of potable freshwater in the study area. Other five factors (age of the household leader, house type, rate of urbanization, micro-relief of the area and water management capacity) showed significant response in predicting the supply and sustainability of household freshwater in Agew-Gimjabeht town (Table 6).

Table 6. Binary logistic regression results

Variable	B	S.E.	Wald	Sig.	Exp(B)
Sex of the household head	0.512	0.369	1.929	0.165	1.669
Family size (№ of household members)	0.009	0.156	0.003	0.955	1.009
Age of the head in years	0.063	0.028	4.967	0.026	1.065
Formal education attendance	0.919	0.691	1.769	0.184	2.506
Employment in government institutions	0.462	0.400	1.334	0.248	1.587
Power interruptions	0.662	0.488	1.843	0.175	1.939
Distance to water points (meters)	0.116	0.203	0.328	0.567	1.123
House type	-1.024	0.450	5.173	0.023	0.359
Rate of urban expansion	-5.296	0.795	44.379	0.000	0.005
Type of season	0.395	0.342	1.332	0.249	1.484
Monthly water service cost (ETB)	-0.054	1.185	0.002	0.963	0.947
Type of micro-topography	-2.187	0.449	23.765	0.000	0.112
Water management capacity	4.649	0.818	32.284	0.000	104.441
Pipeline connection	0.236	0.380	0.388	0.533	1.267
Monthly household income (ETB)	0.000	0.000	0.574	0.449	1.000
Constant	-6.492	1.968	10.881	0.001	0.002
Model-χ^2	210.713				
-2 Log likelihood ratio	233.430				
Nagelkerke R^2	0.626				
Hosmer & Lemeshow test	χ^2=13.87			P= 0.085	DF=8
Correctly predicted for Yes responses	86				
Correctly predicted for No responses	86				
Over all prediction	86				

Age: Age of the household head was assumed to influence household freshwater access and sustainability with the view that aged people can have better socioeconomic opportunities that have been retained through the long period of life experience. Fortunately, age appeared appreciably increasing the potential of households' capacity of accessing sufficient and continuous freshwater supply in the study area (significant at P<0.05). When the age of the household leader reaches the level of adulthood his potential to access resources required by the family grows and the water reaching the family increases by about 1.07 levels (Table 6).
Table 6. Determinants of household water supply and sustainability

***House ownership*:** House type where the respondents live can determine the amount and type of freshwater collected by people. This is because people living in their own homes have the potential to access their own piped water connections and can get pure water supply from their private standpipes. With this view house ownership was hypothesized to positively influence household sustainable water access and supply for it initiates households to build their own pipeline connections. Unexpectedly, after running the model, the regression output indicated a significant but negative influence of this variable on household freshwater sustainability. Under normal circumstances, living in one's own house appeared significantly decreasing households' capability of accessing sufficient and continuous freshwater supply by about 36% (significant at P<0.05; Table 6). A study by Getachew (2015) in Tora town offered dissimilar results. This part hence requires additional investigation.

***Rate of urbanization*:** Urbanization presents new prospects for enhanced access and management of freshwater for both sanitation and drinking. Conversely, problems are magnified in urban centers and now exceeding our capability of setting new solutions (Khatri and Vairavamoorthy, 2007). Increased populations and new technologies are entailing strong pressure on freshwater resources in many towns and Cities. They often influence freshwater access, supply and quality through increased freshwater requirements and by extended effluence problems (Guppy and Anderson, 2017). Therefore, it has both a deterring and enhancing effect on household water sustainability. In this study, the rate of urbanization entailed negative significant effect on household freshwater sustainability at P =0.000 level. It is observed decreasing household freshwater sustainability by about 0.005 times (Table 6). This in general reveals that the rate of urbanization statistically influences household freshwater sustainability in the studied town.

Micro-topography**:** Micro-topography of the freshwater source location plus the type of terrain of the standpipe area can determine the continuous supply and amount of freshwater reaching the users. The nature of terrain influences the movement, continuity, timing and amount of freshwater delivery at any one particular area through its micro-gradients. So, it is believed to affect the sustainability of the access and supply of the freshwater to the households. Hence in this paper, it is found significantly determining the sustainability of the household water supply (P=0.000). The effect is negative; deterring the water supply sustainability by about 0.11 times (Table 6).

Water management capacity**:** Improved water management approaches can enhance the supply, use and sustainability of freshwater resources at home and elsewhere in the surrounding environment. Integration among the different sections of the population and institutions; proper planning, decision-making, and appropriate coordination can also contribute to these endeavors. Planned management exercises broadly ascertain the basis for integrated approaches to guarantee the achievement of the planned goals and solve freshwater related problems (Shimelash, 2013). With similar intention, freshwater management capacity of the households at home and outside home was anticipated to positively influence household freshwater sustainability in the study urban area. As expected, it was found significantly and strongly increasing household freshwater sustainability by about 104.44 times with a P-value of 0.000 levels (Table 6).

4. Conclusions

This study evaluated the factors influencing the supply and sustainability of freshwater in a rural town named Agew-Gimjabeht in the northwestern highlands of Ethiopia. Data used in the study were gathered from questionnaire surveys, FGDs, in-depth interviews and field observations from March to May 2018. The results revealed that households access water from public and private standpipes, springs, streams, hand-dug wells and rainfalls. However, the per capita water collected and consumed by households in the town was found $\leq 10\ l\ p^{-1}\ d^{-1}$ i.e. less than the universally accepted absolute minimum threshold (which is $20\ l\ p^{-1}\ d^{-1}$). Over 68% of the studied households reported that they do not get sufficient and sustainable water because of limited supplies at the sources; frequent power interruptions; and weak management systems. Freshwater supply sustainability in the town was discovered significantly influenced by age of the household heads, house types, rate of urbanization, micro-relief of the area and water management capacity at home and outside home. Evidences in general proved that the level of the existing freshwater supply system in the town cannot meet the required optimum standards with regard to coverage, reliability, accessibility and sustainability.

Provision of sustainable freshwater supply systems fitting the growing urban demands is suggested to minimize the existing freshwater sustainability problems. All governments and public agencies in urban areas thus ought to develop sustainable freshwater supply schemes; uninterrupted power systems; equitable use of water resources; and respect the universal water right of citizens.

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