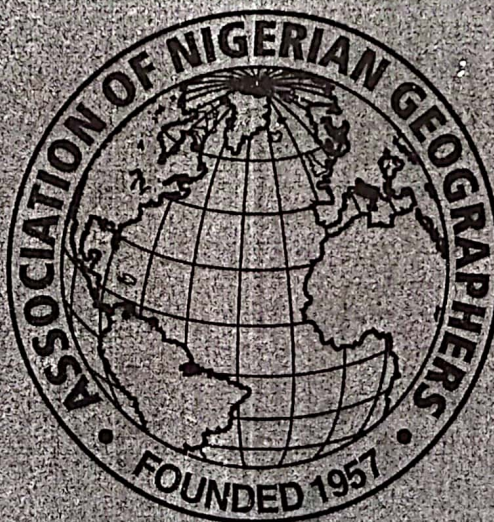


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IN HONOUR OF
LATE PROFESSOR FANIRAN**

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Edited by

Professor Ayodeji Omotayo

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Climate Change Impact on Household Water Supply and Demand in Ibadan Southwest LGA, Nigeria

Adeleke, Elisha Ademola, Olabode, Abiodun Daniel & Aminu, Musa

ABSTRACT

Households suffer acute water scarcity due to climate change, which has resulted in drying out of streams and lowering water table. This study examines the effects of climate change on water demand and supply in Ibadan Southwest Local Government Area of Oyo State, Nigeria. Two hundred and four questionnaire were administered using systematic random sampling technique. Data was obtained from archival records of the Nigerian Meteorological Agency, Ibadan and analyzed. Results showed significant changes in the demand and supply of potable water such that water sources vary with seasons causing 7% water rationing. Gender affects water consumption as reported by 14.5% of respondents. It was concluded that an increase in intense heat has affected water use behaviors in the area. It was therefore recommended that the green city concept should be adopted as this will help absorb excess carbon dioxide causing increase in the surface temperatures.

Keywords: climate, water demand, water supply, household

INTRODUCTION

Water is one of the most important natural resources because it is viewed as the key to prosperity and wealth (Asare 2004). However, in the last few decades, many countries have witnessed an emerging problem of falling water tables and aquifers getting depleted (population from United Nations, 2002). Water systems and resources are unable to provide basic functions to the rapidly growing population due to the threat posed by climate change (Gichana, 2014). According to Okafor and Ogbu (2018), the changes been experienced in the world's climate has considerable effects on freshwater resources availability with attendant impacts on the livelihoods of people, particularly in tropical areas such as Nigeria. Climate change is linked to increasing temperature and shifts in rainfall patterns and it directly or indirectly affects the natural environment and results in alterations of watersheds hydrology (Kundu et al. 2016).

Climate, freshwater, biophysical and socioeconomic systems are interconnected in complex ways so that a change in any one of these induces a change in another (Bates, (2008). Anthropogenic climate change which refers to the production of greenhouse gases emitted by human activity adds major pressure to nations that are already confronting the issue of sustainable freshwater use (Argungu, 2015). The challenges related to freshwater are: having too much water, having too little water, and having too much-polluted water. Each of these problems may be exacerbated by climate change. Freshwater-related issues play a vital role among the key regional and sectoral vulnerabilities. Therefore, the relationship between climate change and freshwater resources is of primary concern and interest (Bates et al., 2008). Socioeconomic changes, such as agriculture intensification, urbanization, and population growth, put further pressure on water resources by increasing water use for irrigation, households and industry (Dhar

and Mazumdar, 2009). Climate change together with socioeconomic changes are thus putting intense pressure on water resources and can lead to water scarcity or increased water scarcity (where the water resources are already scarce).

Clean urban drinking water supply is now a global problem, and most countries are suffering the disruption in both the urban supply of potable water and management of the demand (Gleick, 1998). Global warming and climate change have posed significant threats to securing urban drinking water supply and management. One of the major challenges with climate change is its impact on water resources and extreme hydrological events. Extreme precipitation is projected to increase significantly, especially in regions that are already relatively wet under present climate conditions, whereas dry spells are predicted to increase particularly in regions characterized by dry conditions in the present-day climate (Sillmann and Roeckner, 2008). Semiarid regions of the developing world, which are already poor and face major water resource management and food security problems, are likely to be the most severely impacted (Newburn, et al., 2011).

Most developed and developing countries would be at the risk of severe water shortages in the 21st century due to climate change if urgent steps are not taken (Mitrica *et al.*, 2017). This is because water supply poses a huge challenge to most urban, peri-urban and rural areas in developing countries. Though these challenges are enormous, with pragmatic steps, they are surmountable. According to the American Water Works Association (2007), 11 % of the global population of 783 million people is still without access to clean water. The location of adequate supplies of water for domestic and industrial use has shaped the geographic distribution of the population,

its quality of life and its culture. An adequate supply of quality water is central to the integrity of the environment and the maintenance of the ecosystem (Veronica, 2010).

Strategic management and provision of sustainable public water supply are essential and crucial for the future of the world's economy, industrial development, protection and improvement of public health, improving the quality and standard of living, ecosystem preservation as well as poverty alleviation and eradication especially in developing countries (McDonald et al., 2014). Households in Ibadan Southwest LGA have experienced acute water scarcity in recent times. The alarming rate at which the climate is changing is making it even harder for people to get clean water. Worst still, the extreme flooding is equally polluting fragile water sources; while longer droughts are drying up streams. This study, therefore, investigates the effects of climate change on water demand and supply in Ibadan Southwest.

METHODOLOGY

Study area

Ibadan Southwest is located between latitude 7°19' and 7°23' North of the Equator and longitude 3°50' and 3°52' East of Greenwich meridian (Fig. 1). Ibadan Southwest LGA is bounded in the west by Ido LGA, in the east, by Ibadan North and Ibadan South LGAs, in the north, by Ibadan North-west and LGAs, and in the south by Oluyole LGA. It has a landmass of 244.55 km² with 12 political wards (www.onlinenigeria.com).

The Ibadan Southwest LGA has a tropical wet and dry climate (Koppen climate classification Aw). Between March and October, the area is under the influence of moist maritime south-west monsoon winds which blow inland from the Atlantic, mark-

ing the rainy season (Alagbe, 2010). Generally, total annual rainfall is about 1420 mm with a double maxima regime (June and

According to NPC (2011), the population of Ibadan Southwest local government is 355,560 persons. According to Ibadan Southwest local government-LEEDS (2009), the major occupation of the people in the local government area is trading, accounting for about two-thirds of the employment public service including teaching, industry, and manufacturing among others. It must be stressed that the LGA is a major industrial hub in Ibadan as it has an industrial estate in Oluyole LGA. Also, Dugbe, one of the commercial nervecentres of Ibadan metropolis, is located in Ibadan Southwest. Other notable commercial centres in the area include the Ogunpa, Aleshinloye, Molete markets among others.

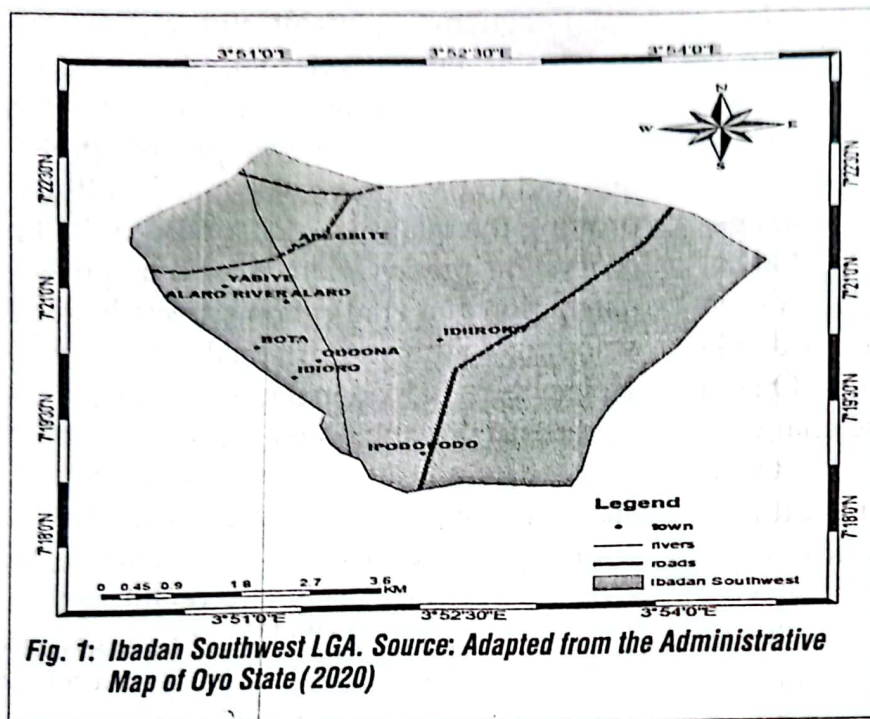


Fig. 1: Ibadan Southwest LGA. Source: Adapted from the Administrative Map of Oyo State (2020)

September. The dry season in Ibadan begins in November and ends in February and is often associated with the dry dust-laden tropical continental air mass. The average daily minimum temperature ranges between 20°C and 22°C, and the average maximum temperature range between 27°C and 35°C. The relative humidity is usually around 74.6% (Alagbe, 2010).

The area is underlain by basement complex rocks which are mainly metamorphic rocks of the Precambrian age. Granite, quartzite and migmatite are the major rock types while the minor rock types include pegmatite, aplite and diorite (Alagbe, 2010). The soils of Ibadan southwest region where the study area falls were formed from the underlying rocks especially granite gneisses, quartz-schist, biotite, gneiss and schist. They were formed under moist semi-deciduous forest cover and belong to the major soil group called ferruginous soils. (Alagbe, 2010).

Study design

Primary and secondary data were used in this study. Primary data were collected through the use of a questionnaire, which was divided into 5 sections. The sections include (a) socioeconomic characteristics of the respondents, (b) major sources of water for households, (c) the perceived effect of climate change on water use by households, (d) household water demand and supply in the study area. However, secondary data, that included climate data on rainfall, temperature, relative humidity, wind speed and sunshine hours from 1989-2018, were acquired from the archival record of the Nigerian Meteorological Agency (NIMET), Ibadan.

The study population includes all the inhabitants within the Ibadan Southwest LGA; while the sample frame for the study covered the households who live permanently in the area. During the reconnaissance survey, the researcher identified 612

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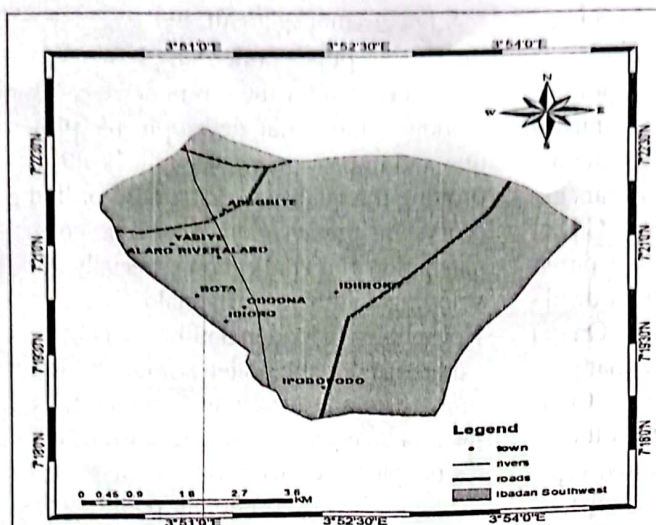


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permanent households in the study area. To collect data, this study employed a multi-stage sampling design. The purposive sampling technique was first adopted to select only the permanent households. This was to ensure accessibility to and reliability of data collected. To have an equal chance for data collection in the study area, systematic random sampling was further adopted to select 204 households. This was done by identifying the first house and subsequently selecting other houses at intervals of three, representing one-third of the identified 612 households within the study area. As such, a household head was administered a copy of the questionnaire in each of the sampled houses. A total of 204 copies of questionnaires were administered in the study. Both descriptive (mean, simple percentages, tables, charts, and standard deviation) and inferential (time series and regression analysis) statistics were used for data analysis and presentations.

RESULTS AND DISCUSSION

Socioeconomic characteristics of respondents

The study in Table 1 revealed that 47% of the respondents are males while 53% are females, which showed that the majority of the respondents are females. This shows that women play a central part in the provision, management, and safeguarding of water. It was gathered that 19% of the respondents are within the age of 15-25years, 48% are within 26-35years, 27% are within 36-50 while 6% are above 51years, which indicates that the majority of the respondents are in their productive ages. Considering the marital status of the respondents, the highest percentage of 61 were identified as married. This indicates a high level of water demand in the study area. With the highest 35% of secondary school education holders among

the respondents, it is very clear that respondents have enough knowledge of what their average of water demand and supply in the area. The recorded highest level of 29% self-employed by the respondents showed their availability at home at will. The income status of the respondents shows that 15% earn below ₦20,000, 42% earn within ₦20,000–₦40,000, 19% earn within ₦40,001–₦60,000, 11% earn within ₦60,001–₦80,000 and 13% earn above ₦80,000 monthly. The household size indicates 23% within 1-3 persons, 37% within 4-6 persons, 12% within 7-9 persons, and 28% have household size above 10 persons. The household size is an informed criteria for water demand and supply strategy.

Table 1: Socioeconomic characteristics of respondents

Demographic characteristics	Frequency	Percentage
Sex		
Male	96	47
Female	108	53
Total	204	100.0
Age Group	38	19
15-25years	97	48
26-35years	56	27
36-50years	13	6
51 and Above	204	100.0
Total	63	31
Marital status	125	61
Single	3	2
Married	7	3
Separated	6	3
Divorced	204	100.0
Widow/widower	58	28
Total	71	35
Educational status	58	28
Primary	17	9
Secondary	204	100.0
Tertiary	11	5

Demographic characteristics	Frequency	Percentage
None	50	24
Total	59	29
Occupation	44	22
Civil servant	19	9
Trader	21	11
Self employed	204	100.0
Artisan	30	15
Private firms	86	42
Others	40	19
Total	22	11
Monthly Income	26	13
Below ₦20,000	204	100.0
₦20,000 - ₦40,000	47	23
₦40,001 - ₦60,000	76	37
₦60,001 - ₦80,000	25	12
Above ₦80,000	56	28
Total	204	100.0

Source: Authors' Field Survey (2020)

Source and choice of water

The study in Table 2 presents 17% responses on the availability of boreholes, 28% of government water supply, 14% of the water from vendors, 34% of private compound water, 4% rainwater, and 3% other sources of water. This result showed that the most common source of water in the area is government water supply and private borehole water sources. Though rainfall in the area is on the increase but the majority of the respondents rely heavily on private compound water.

Table 2: Source of water

Water source	Frequency	Percentage
Public borehole	35	17
Govt water supply	57	28
Water vendor	28	14
Private compound water	69	34

Water source	Frequency	Percentage
Rainwater	8	4
Others	7	3
Total	204	100

Source: Authors' Field Survey (2020)

Table 3 shows the reasons for the choice of source in the area. Twelve percent of the respondents stated that they choose their source of water because it is cheap, 53% stated that there is no alternative, 30% stated that the source is close to their residence while 5% stated the source is clean. The result shows that the majority of the respondents choose their source of water because they have no alternatives.

Table 3: Reason for choice of water choice

Reason for choice of source	Frequency	Percentage
Cheap	25	12
No alternative	107	53
Close to residence	61	30
Clean	11	5
Total	204	100

Source: Authors' Field Survey (2020)

Relationship between socioeconomic characteristics and water sources

Table 4 presents the relationship between source of water and socioeconomic characteristics of respondents. The result shows that 2.1% of the choice of source of water is accounted for by sex of respondents, 12.8% of choice of water is accounted for by age of respondents. In household where there are young children, these children are sent to get water irrespective of the distance. Furthermore, 56.6% of choice of source of water is accounted for by marital status of re-

spondents, 4.7% of the choice of water is accounted for by education of respondents while 13.5% of the choice of water source is accounted for by the occupation of the respondents. This implied that in terms of sex, females fetch water more than male and that children are sent to get water regardless of the distance because they are more dependent compared to other groups of people in the society.

Table 4: Relationship between source of water and socioeconomic characteristics

Model	R	R square	Adjusted R square	Std. error of the estimate
Sex	0.145	0.021	-.192	3.20851
Age	0.358	0.128	-.257	6.34257
Marital	0.752	0.566	-.047	5.05863
Education	0.248	0.047	0.154	4.8044
Occupation	0.367	0.135	-0.04	3.25878
Income	0.445	0.195	0.031	5.21471
Household size	0.387	0.149	-0.027	6.87871

Predictors (constant), Source of water. Source: Authors' field survey (2020)

As shown in Table 4, 19.5% of the choice of source of water is accounted for by the income of the respondents while 14.9% of the choice of water source is accounted for by the household size of the respondents. It was shown that marital status has a strong linear relationship of 57% with the source of water. This implied that married people demand more water compared to other groups. It is however believed that the level of education does not influence the choice of water because people demand water whether liter-

ate or illiterate at the same proportion and different points.

Description of climatic elements between 1989 and 2018 in the study area

The Climatic variables in the area during the study period are presented in Table 5. The mean rainfall, relative humidity, sunshine, temperature, and wind for the study period were 126.6mm, 79.7, 5.1, 3.8, and 4.3 respectively with a coefficient of variation of 22.6%; 2.94%, 4.71%, 1.60% and 15.8% respectively. These results generally showed that the means for the annual rainfall, relative humidity, sunshine, temperature and wind in the area during the period of study are homogeneous.

The pattern of rainfall in the area during the period under study is presented in Fig. 2. The lowest rainfall was recorded in 1994 while the highest was recorded in 2008. The linear trend line equation ($y=1.9872x + 95.845$) is positive; this implies that the area experienced an increase in rainfall during the period of study. The equation also showed a predictive increase rate of 3.7% per annum. Increasing rainfall will provide water for agricultural activities, domestic

Table 5: Climatic elements in the study area (1989-2018)

Variable	Rainfall	RH	Sunshine	Min T	Max T	Wind
Lowest	75.5	75.6	4.5	21.4	30.9	2.5
Highest	173.2	85.2	5.5	23.70	33.3	6.0
Mean	126.6	79.7	5.1	22.5	31.8	4.3
STD	28.6	2.34	0.24	0.65	0.51	0.68
CV%	22.6	2.94	4.71	2.89	1.60	15.8

Source: Authors' field survey (2020)

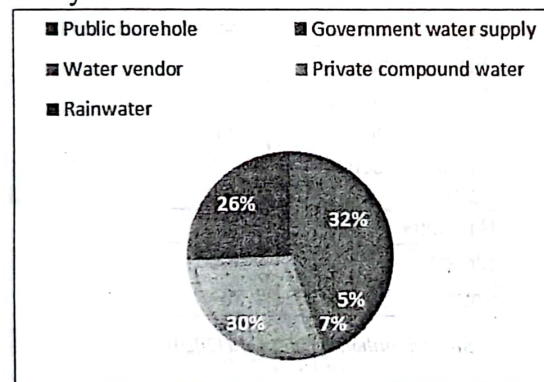
use and industrial uses. Farmers will depend less on practicing irrigation agriculture and this will boost their income. Residents can practice rain water harvesting while water will also be available in all the sources for a longer period. Excess rainfall

for domestic use while 38% said frequent rainfall does not decrease water demand for domestic consumption. This shows that majority of respondents see frequent rainfall mitigating water demand for domestic use. During rainy season, residents practice rainwater harvesting, storing the water for future use. This reduces water demand from other sources. Furthermore, rainfall replenishes water sources such as well and streams, and thus the availability of water in these sources results in decrease in the demand for water from other sources.

IMPACT OF CLIMATE CHANGE ON WATER DEMAND AND SUPPLY

Water supply

Fig. 3 presents the responses to water sources varying with the season. Thirty-two percent of the respondents stated that public borehole varies with season, 5% indicated government water supply, 7% stated water vendor, and 30% stated private compound water while 26% stated rainwater harvest respectively. This result shows that rainwater, public and private boreholes are the most common water sources in the study area.



ity is presented in Table 7. Seventy-two percent of the respondents stated that water quality varies with the season while 28% stated that water quality does not vary with season. During the rainy season, flooding could lead to pollution of water sources leading to poor quality of water. Consumption of this poor quality of water will lead to various health issues among residents in the area. People observed that good consumable water is normally collected from different source points during the dry season. As noted by Assaf (2009), the situation is also compounded by the uncontrolled use of fertilizers, which has increased the contamination of underlying aquifers (Assaf 2009).

Table 7: Variability in water quality

Variability in water quality	Frequency	Percentage
Yes	147	72
No	57	28
Total	204	100

Source: Authors' Field Survey (2020)

Table 8 presets the responses to flooding affecting water. Seventy-eight percent stated that flooding affects water in the area while 22% stated that flooding does not affect water in the area. Flooding leads to pollution of water sources thereby reducing the quantity of potable water available for use. Thus, residents tend to spend more money on sourcing water.

As stated in Table 11, 65% of the respondents stated that prolonged dry season reduces the quantity of water while 35% stated that prolonged dry season does not reduce the quantity. This result shows that a

could also lead to flooding destroying properties and farmland. It could also lead to pollution of water sources in the area. Nonetheless, fluctuations in rainfall patterns over

is obvious that during the hot season, people tend to bath frequently during the days and this increases water use. Increases in the frequency or severity of some extreme weather events, such as extreme precipitation, flooding, droughts, and storms, threaten people's health during and after the event (USGCRP, 2016).

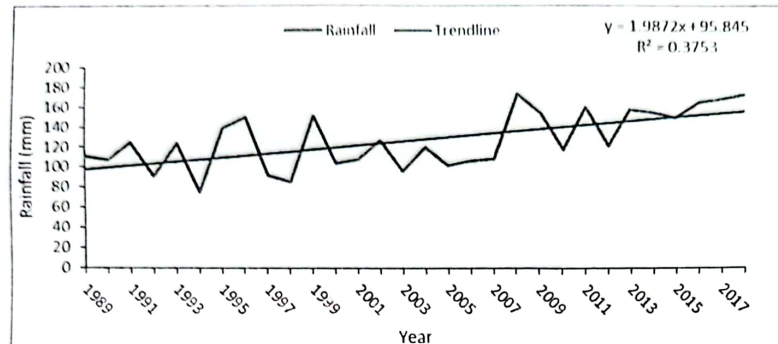


Fig. 2: Pattern of rainfall. Source: Authors' computation (2020)

the year can spell a negative impact on water supply and also on demand to a lower extent the study area. This is because people who solely rely on rain harvest water will collect a low amount of water during the years of downturns. As noted by United Nations (2020), by 2050, the number of people at risk of floods will increase from its current level of 1.2 billion to 1.6 billion. In the early to mid-2010s, 1.9 billion people, or 27% of the global population, lived in potential severely water-scarce areas. In 2050, this number will increase to 2.7 to 3.2 billion people.

PERCEIVED EFFECTS OF CLIMATE CHANGE ON WATER USE BEHAVIOR

Bathing

Table 2 depicts the responses to intense heat increasing bathing frequency, with 77% stating that water used in bathing increases during intense heat, while 23% revealed that

Gardening

Table 2 presents the responses to intense heat-increasing water for gardening. Fifty-three percent of the respondents stated that intense

heat increases water for gardening while 47% stated that it does not increase water used for gardening. During intense heat, the transpiration level of plants is high and this makes plants to lose water. This is seen as the drying up of plants thus watering the plants is done to keep it flourishing and this consumes water.

Rehydration

Table 2 presents the responses to intense heat increasing the consumption of water for hydration. Eighty-four percent of respondents said they consume a lot of water during intense heat, while 16% indicated otherwise. Thus, majority consume lots of water to stay hydrated in intense heat. Hence this infers that there is a need for more water during this period.

Table 6: Water use behavior

Response	Bathing		Gardening		Hydration		Domestic use	
	Freq	%	Freq	%	Freq	%	Freq	%
Yes	157	77	108	53	171	84	127	62
No	47	23	96	47	33	16	77	38
Total	204	100	204	100	204	100	204	100

prolonged dry season reduces water quantity in the area.

Table 8: Factors affecting water supply in the study area

Response	Flooding		Prolonged dry season	
	Freq	%	Freq	%
Yes	159	78	132	65
No	45	22	72	35
Total	204	100	204	100

Source: Authors' Field Survey (2020)

Water demand

Fig. 4 depicts the impact of climate change on water demand. 12% stated that climate change leads to reduced water demand, 40% stated it has led to finding alternative sources of water, 30% stated practice of water rationing and 18% stated other reasons. These results imply that climate change has spelled a significant change in the rate of demand and supply of potable water in the study area.

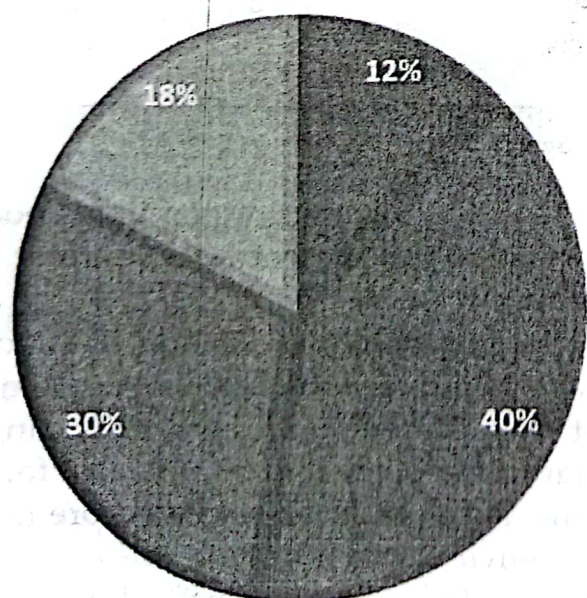


Fig. 4: Impact of climate change on water demand.
Source: Authors' field survey (2020)

Coping strategies for water shortage

a. The practice of water rationing

Table 9 presents the practice of water rationing in the area. 77% of the respondents stated that they practice water rationing while 23% stated that they do not practice water rationing. This result shows that the majority of the respondents practice water rationing by reducing the rate of water consumption and increasing conservation.

Table 9: Practice of water rationing

Practice of water rationing	Frequency	Percentage
Yes	158	77
No	46	23
Total	204	100

Source: Authors' field survey (2020)

b. An alternative source of water

Table 10 presents the alternative source of water adopted by respondents to cope with climate change. 15% stated public borehole, 14% stated government water supply, 30% stated water vendor, 6% stated private compound water, 22% stated rainwater while 13% stated streams.

Table 10: Alternative Source of water to cope with climate change

Alternative source	Frequency	Percentage
Public borehole	31	15
Govt water supply	29	14
Water vendor	62	30
Private compound water	11	6
Rainwater	45	22
Stream	26	13
Total	204	100

sources availability with amplifying impacts on the livelihoods of people in the study area. The major source of water in the area is compound water and climate change has led to an increase in intense heat which has affected water use behavior in the area. The study recommends that rainwater harvesting should be practiced by residents

the period of the excess, which can be used for various purposes during the period of deficit. The state government needs to improve the water supply in the area. This can be done by extending water pipes to many places in the area to ensure that everyone has access to sustainable water as a critical climate change mitigation strategy.

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