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Adaptation and Mitigation to Water Stress in Safana Local Government Headquarters of Katsina State, Nigeria

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Abstract: The study assessed local perception on adaptation and mitigation to water stress in Safana town. The nature of water stress and its related adaptation and mitigation correlate with spatio-temporal patterns. Six (6) major parameters that influence adaptation and mitigation to water stress used in this study include; household size, water sources, water cost, distance from source, seasonal pattern, and agencies involved in water supply. Structured questionnaires, interview, and Focused Group Discussion was adopted for the primary data survey. A total of one hundred copies of questionnaire were administered using chance approach, while key informants were used for the interview. The study area was partitioned into four cardinal locations (N, S, E, & W) and questionnaires administered in that order (25:25:25:25). Both inferential and descriptive statistics were used to analysed and test the stated hypothesis. Findings indicates that the study area is characterised by large household sizes with about 57% households having 11- ≥20, major source of water supply is borehole (98%). The season with highest water stress is march-july, more than 40% have their water source at a distance of about 400 m away from their homes. A strong correlation exists between household size and daily domestic water supply. Limited distance is covered to accessed water and with the months of March to July (42%) being the period of water stressed in time past, but government effort has yielded positively. However, the existing water facility are still rated Fair (62%), increase in water storage facilities (44.55%) and cutting down on uses (26.73%) are practical coping strategies in use. Equally, the construction of more boreholes (40.57%) in the study area, effective management and maintenance of existing water facilities (12.26%), and synergizing community-Government partnership (12.26%) respectively are key to improving sustainability in domestic water supply. Other measures suggested rainfall harvesting; increase in the number of motorized solar powered boreholes; sitting of a treatment plant in Safana LGA with water being accessed from Zobe dam; Sinking more of ring wells within neighborhoods; and rehabilitation of rusty pipes supplying water from Dutsinma treatment plant, and networking of new pipes to emerging settlement location around the town.

Keywords: Domestic Water Sources, Water Stress, Water Vendors in Safana LGA

1. Introduction

Water is life. This is a popular axiom in Africa, underpinning the high level of importance the people of the continent place on the resource. In all its forms – rainwater, aquifers, streams, ponds, springs, lakes, rivers, ocean water, snowpack ice and water vapour – water is an essential and central resource [1, & 2]. Water is essential for all socio-economic development and for maintaining healthy ecosystems [3]. The increasing stress on freshwater resources brought about by ever rising demand and profligate use, as well as by growing pollution worldwide, is of serious concern. Thus, [4] water stress is “the outcome of water scarcity and may manifest itself as drinking water insecurity, poor access, poor health, conflict over water resources, crop failure, food insecurity and/or energy insecurity”. The result is that millions of people lack access to a water supply that is safe [2], close to the home and available all year round. People frequently travel long distances to unprotected, contaminated and seasonally unreliable water sources in order to meet their daily needs. Those living in crowded, informal urban settlements often depend on water vendors and trucked water of dubious quality sold at a relatively high price.

Thus, [3] observed that nowadays, “scarcity” is one of the adjectives most related to the word “water”; thus, many studies and projects focusing on the assessment of global water demand and its availability have been developed. In fact, water demand has reached critical levels in many areas of the world, especially in countries with limited water availability [5 and 6]. The misuse of water resources, the lack of infrastructures to supply water and also climate change are some of the reasons for water scarcity, despite the vast amount of water on the planet. The Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report states that the magnitude of stress on water resources is expected to increase as a consequence of climate change, future population growth and economic and land-use change, including urbanization. In 2007, the Intergovernmental Panel on Climate Change [7] noted that a combination of climate change and other drivers (such as land use and overexploitation) will likely exceed the capacity of ecosystems to adapt, threatening the services they currently provide. The vulnerability of water systems and their sensitivity to climate change have been an active research topic in the last decade [8]. Consequently, [9] Water is essential for life on earth. Within organisms, water provides the medium in which the complex metabolic processes necessary for life take place.

In the Sudano-Sahelian region of Nigeria, and in Katsina State in particular, the incidences of global climate change effects on environmental resources vis-à-vis water resources as [5] shows that household domestic water use is worst hit. [10] Observed that the annual rainfall of the area shows a slow but a consistent declining trend over the years. Water scarcity refers to the point at which the aggregate impact of all users impinges on the supply or quality of water under prevailing institutional arrangements to the extent that the demand by all sectors, including the environment, cannot be satisfied fully. Scarcity has various causes, most of which are capable of being remedied or alleviated [11]. A society facing water scarcity usually has options. However, scarcity often has its roots in water shortage [5 and 12], and it is in the arid and semiarid regions affected by droughts and wide climate variability [13], combined with population growth, and economic development, that the problems of water scarcity are most acute. Thus, it’s hypothesized that there is no significant relationship between household size and daily household water cost. To this end, the paper examines the adaptation and mitigation measures to water stress in Safana town amid the rapid urban expansion that is on-going in the study area.

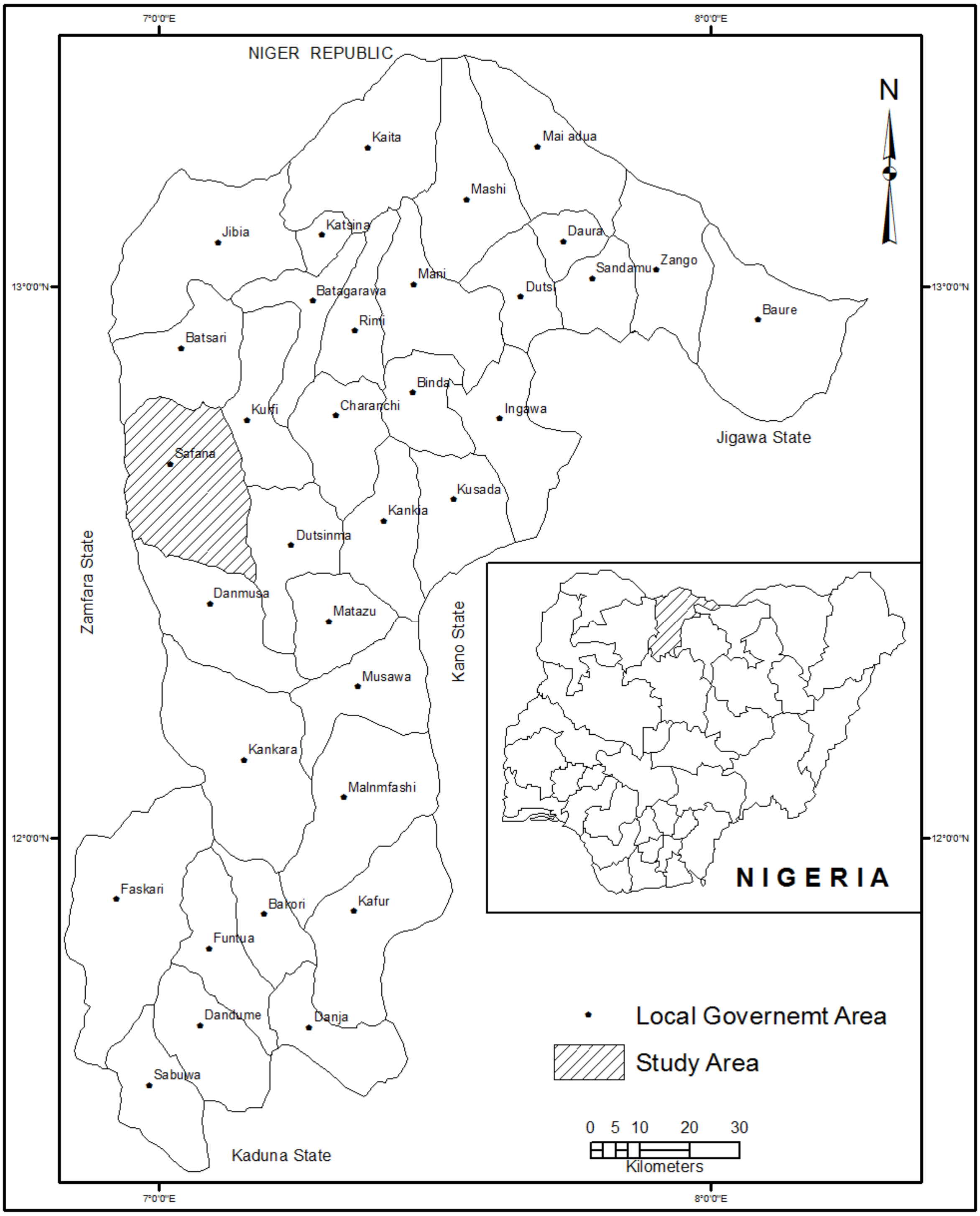
2. The Study Area

Safana is a Local Government Area (LGA) in Katsina State, which has its Headquarters in Safana town and it is on 12°24'30"N and 7°24'25"E. It is bounded by Zamfara State in the West, Dutsinma and Kurfi LGA in the East, Batsari LGA in the North, and Dan-Musa LGA in the South respectively (Fig. 1). It has an estimated human population of about 185,207, and with a total landmass of 282 km^2. The climatic pattern are characterized with mean annual rainfall of between 600-800 mm, rainfall intensity of less than 32 mm/ per hour, and mean onset of 18 May - 7 June.

Furthermore, late onset dates of 9-29 June, mean cessation dates of 27 October, and early cessation of 27 September – 7 October respectively [14].

Safana LGA is geologically underlain by the Precambrian migmatites and gneisses, the metasediments/metavolcanics and the Older Granites. The migmatites (mixed rocks, generally consisting of a metamorphic host invaded by granitic material), biotite and granitic gneisses are the largest group of rocks, extending from parts of Kankara to Runka axis. They are characterized by a variety of structures and textures, and they represent reactivated older metasediments. The Older (Pan African) granites are characterized by lofty topography and inselbergs with lithological varieties of rock formation believed to have been emplaced during the Late Palaeozoic era (550±100 my). They consist of coarse-grained porphyritic granite, biotite hornblende granite and fine-grained granites, and fayalite-quartz monzonite [15].

The water resources are characterized into surface and sub-surface (ground water source). The surface sources which are highly seasonal and ranges from ponds, borrow-pits, rivers, and springs. On the other hand, the sub-surface sources ranges from wells, river-bed, and boreholes. Though seasonal variation might occur in the ways through which the different sources respond, as well as, support domestic needs, however, it reflect in the spatial patterns of water availability in Safana urban area. This is further characterized with a hydrological ratio of less than 0.2 and specific water consumption (mm/Area) of $+200 < \frac{W}{F} \leq +600$ [14]. Thus, [16 and 17] observed that the variations in flows and water levels affect the composition, structure and zonation of aquatic and riparian plant communities, and provide life-history cues for many plant and animal species. Reduced flow variation may indicate hydraulic changes, including reductions in longitudinal and lateral connectivity, hence habitat complexity.



Source: GIS Lab FUDMA, and Katsins State Lands & Survey

Fig. 1. *Katsina State Showing the Study Area.*

3. Material and Methods

The study adopted both the primary and secondary data generation approach. The secondary data approach composed of accessing information from the state National Population Commission, and the LGA secretariat in Safana town. The primary approach comprises of field assessment of water facilities, Interviews, different sessions of Focus Group Discussions (FGD), and administration of structured questionnaire. The target respondents were household heads owing to the peculiar Hausa cultural system, and coupled with the fact they are the breadwinners of the home. The entire town was partition into four major cardinal units (North, South, East, and West respectively) and a total of one hundred copies of structured questionnaire were administered using the chance sampling technique.

Descriptive statistical technique was adopted in the summary and presentation of the data whereas, the inferential statistical technique was used to test for the significant level of relationship between household size and daily cost of domestic water supply (Pearson's product moment correlation coefficient).

$$rp = \frac{\sum XY - \frac{\sum X \sum Y}{n}}{\sqrt{\left(\left(\sum X^2 - \frac{\sum X^2}{n}\right)\left(\sum Y^2 - \frac{\sum Y^2}{n}\right)\right)}} \quad \text{(Equ. 1)}$$

$$t = rp\sqrt{\frac{n-2}{1-rp^2}} \quad \text{(Equ. 2)}$$

Df = N-2 at α 0.05.

4. Results and Discussions

4.1. Household Size and Domestic Water Sources

The estimated household sizes as captured in the study area is presented in Fig. 2 below.

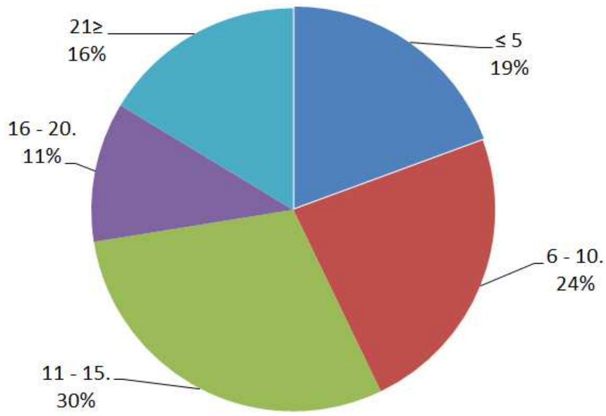


Fig. 2. *Household size in the study rea.*

It is obviously clear that most of the household sizes in the studya area ranges from 11- 15 [30%] which to some extent is relatively large. The reason might partly be connected to the polygamus acceptability and communual system that is been uphold in most Hausa/ Fulani cultural communities.

Equally, domestic household water sources are accessed from ponds, boreholes, wells, and rivers as presented [Fig. 2].

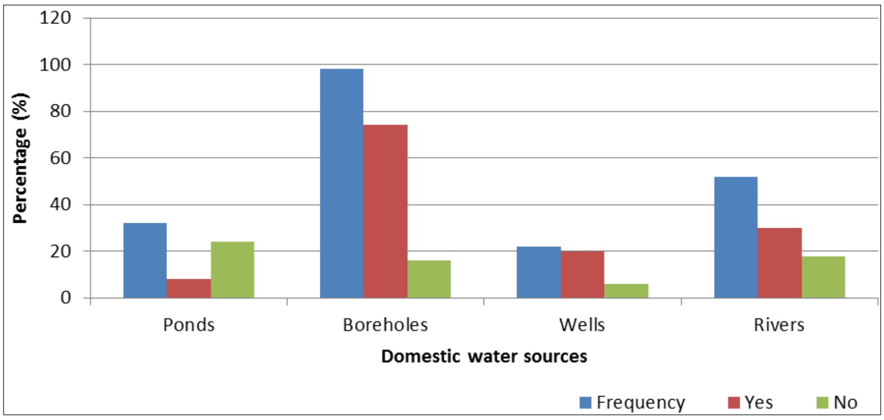


Fig. 3. *Domestic water sources and reliability.*

Borehole [98%] constitute the highest and stand out as the most reliable water source [Fig. 7b & 8], and moreover, the FGD carried out in the field further collaborated it. The ponds are more or less borrow-pits that only contain water during the rainy season, boreholes (either manual or motorized) which are either public or commercial [Fig. 7a & b, 9, 11, & 13], wells [Fig. 10] and rivers [Fig. 12].

Consequently, since our calculated value 't' value (14.73) is greater than the critical value of 't' (2.0) at 95% confidence, the hypothesis that state that there is no significant relationship between household size and daily household water cost is rejected (α 0.05). The correlated value (0.83) shows a strong relationship as further presented in the scatter graph regression equation (Fig. 4)

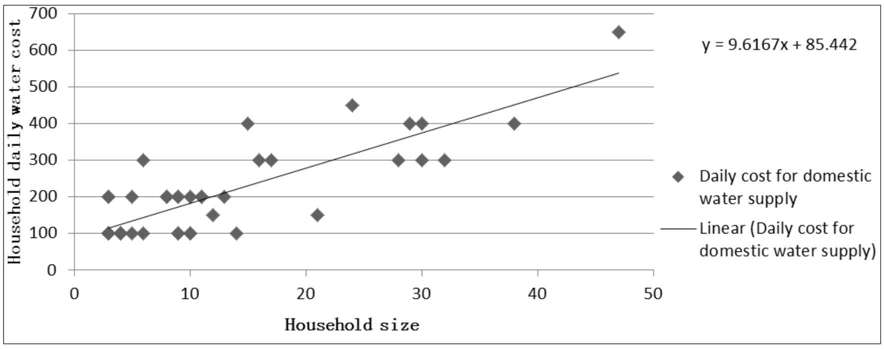


Fig. 4. *Daily Household domestic water cost from water vendors.*

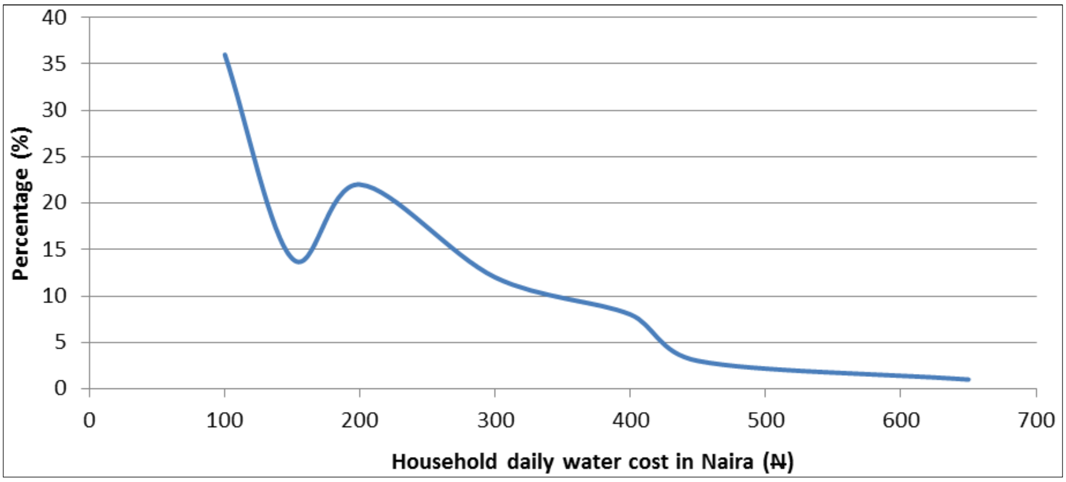


Fig. 5. Household daily water cost from water vendors.

4.2. Water Cost and Estimated Distance

***Table 1.** Accessing daily domestic water supply.*

Accessing Domestic Water Supply	Frequency	Percentage (%)
House maids	6	3
Women	14	7
Children	56	28
Household heads	48	24
Water vendors	78	39
Total	202	100

Source: Authors Field Work, 2015

Owing to the vital role of water to man's daily needs, domestic water supply in the study area is largely through water vendors (Table 1). However, there are public and commercial boreholes. The public boreholes are either manual or the motorized using solar panels. The commercial boreholes are powered by generators and attract charges that are influence by seasonality and availability of fuel.

Consequently, the economic status of some of most of the household heads warranted them assigning the duty of fetching water to either their children [Fig. 7a & b & 8] or they themselves [Fig. 9] taking up the responsibility of fetching the water meant for the domestic purposes.

Thus, household daily pay at least one hundred Naira (₦100) as a unit cost for a manual truck trip of water that contain eight jerry-cans (about 160 liters) which are demanded by households [Fig. 5]. The vendors usually patronize the commercial boreholes [Fig. 11 & 13] which are faster, and are charged between twenty to thirty naira (₦ 20 - ₦30) per truck filled-up, depending on the season and the demand. Thus, the operators of such commercial boreholes make between two thousand five hundred to three thousand five hundred naira (₦ 2,500 - ₦ 3,500) daily depending on the boom in market (demand for water).

Most often, the estimated distances covered to access water daily in the study area ranges from less than 100 m (30%), 101 m-200 m (14%), 201 m-300 m (8%), 301 m-400 m (4%), and 401 m equal or more than (44%). Consequently, water facilities within the neighborhood are accessed over shorter distances (30%) whereas, water vendors cover over 401 m.

4.3. Water Stress and Assessment of Water Facilities

The period of the year in which water stress is high is captured as presented below (Fig. 6).

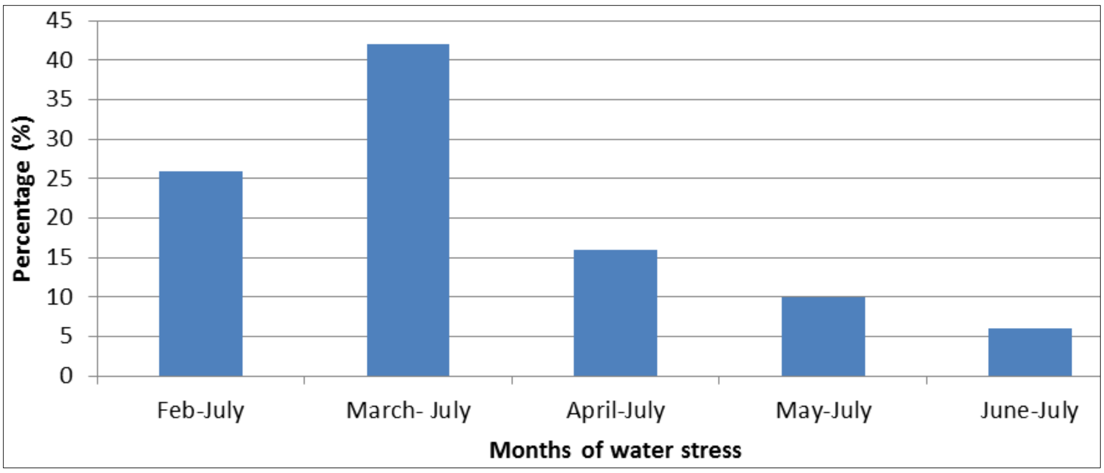


Fig. 6. The peak periods of water stress.

Table 2. *Assistance for portable water facility.*

Assistance for water facility	Frequency	Percentage (%)
Government	68	34.3
Individuals	38	19.2
Politicians	36	18.2
Community	22	11.1
NGOs	34	17.2
Total	198	100.0

Source: Authors Field Work, 2016.

The months ranging from March to July (42%) appears to be the period of water stress, and incidentally coincided with the hot season. Prior to the rapid sitting of boreholes by individuals, government, Non-Governmental Organizations (NGOs), and Politicians, the untold hardship that most people were subjected to in the past six to ten years was terrible (FGD) owing to the failure and deterioration in the existing water facilities [Fig. 9]. It was the ponds and river-beds [Fig. 11 & 12] that were only the major water sources. The Government (34.3%) has been playing a significant role in the sinking of numerous boreholes that are distributed over the towns. Individuals (19.2) and Politicians (18.2%) have contributed tremendously to the distribution and sinking of boreholes (Table 2).

Fig. 7a. *Children fetching water from manual borehole.*

Fig. 7b. *Children fetching water from Manual borehole.*

Fig. 8. *Motorized solar powered public Borehole.*

Fig. 9. *Abandoned & Broken down Wind-mill well.*

Fig. 10. *A covered public well.*

Fig. 11. *Commercial Borehole.*

Fig. 12. *Water being scooped from riverbed.*

Fig. 13. *Water vendors queuing to fetch water.*

Presently, the existing domestic water sources/ facilities was rated Good (14%), Fair (62%), and Poor (24%). Thus, most of the respondents rated the water facilities (boreholes) as being Fair (62%) considering the untold hardship that they were subjected to in the past.

4.4. Coping Strategies and Approach Improving Water Stress

Table 3. *Coping strategies to domestic water management.*

Strategy	Frequency	Percentage (%)
Cutting down on uses	54	26.73
Water re-use	24	11.88
Increase in storage	90	44.55
Regulate domestic use	34	16.83
Total	202	100.00

Source: Authors Field work, 2016

The coping strategies adopted by most people in the study area are broadly summarized under the following categories as presented below (Table 3).

It is clear that depending on the household size, and coupled with the intensity or severity of water scarcity: in time past, supply far outweighed the demand thereby, manifesting into acute water shortages (FDG). However, despite the relative improvement in supply and options in water facilities, yet most people believed that an increase in water storage facilities (44.55%) and cutting down on uses (26.73%) as potential coping strategies to domestic water management.

Many methods of improving sustainable domestic water supply that can meet-up with the growing demand in the study area, which has been occasioned by rapid urbanization that is currently witnessed within the LGA headquarters. The suggested methods are as captured in table 4.

Table 4. *Methods of improving sustainable supply that can meet-up with growing demand.*

Method	Frequency	Percentage (%)
Construction of more boreholes	86	40.57
Dam construction	24	11.32
Dredging of the Safana river	6	2.83
Effective Management and maintenance of existing water facilities	26	12.26
Assistance by Nongovernmental Organizations	6	2.83
Community-Government partnership (RUWASA & LGA)	26	12.26
Sitting of treatment plant	16	7.55
Sinking of more wells	8	3.77
Wealthy individual effort	8	3.77
Rainfall harvesting	6	2.83
Total	212	100.00

Source: Authors Field Work, 2016.

The above suggested (Table 4) shows that construction of more boreholes (40.57%) in the study area, effective management and maintenance of existing water facilities (12.26%), and synergizing community-Government partnership (12.26%) respectively as key to improving sustainability in domestic water supply.

However, most of the people suggested the following to be potential areas that can improved on domestic sources of water supply that can be tapped: rainfall harvesting; increase in the number of motorized solar powered boreholes; sitting of a treatment plant in Safana LGA with water being accessed from Zobe dam; Sinking more of ring wells with neighbourhoods; and rehabilitation of rusty pipes supplying water from Dutsinma treatment plant, and networking of new pipes to emerging settlement location around the town. These are among some of the issues raised that when looked into will augment for the existing water facilities, and will further cater for the increasing demand for domestic water supply that is occasion by urban expansion and increase in population.

5. Conclusion

Water as an essential daily domestic requirement for household requires effective planning and management. It is no hoax that Safana LGA headquarters is witnessing astronomical development and urbanization that in time past impacted negatively on domestic water supply vis-à-vis acute water shortages. However, it is not uhuru as increase in population as occasioned by urban expansion will continually build-up pressure on the existing water facilities. At present, water vendors provide the services for domestic water supply which is majorly accessed from boreholes. However, household size determined the daily cost on water purchased between the middle and a times the low income class. Owing to the growing concern, increase in the number of boreholes facilities, wells, and other alternatives like rainfall harvesting, sitting of treatment plant, and increase in household water capacity was suggested as the way forward.

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