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Seasonal Variability and Water Scarcity Adaptations in Buea Urban, South West Region, Cameroon

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Abstract
Nowadays water scarcity in developing countries has remained disturbing and creates various impacts especially on the urban areas at best average economic conditions. This seems to be amplified by growing urbanization, climate change and seasonality. Although located in a mountainous area with abundant rainfall received over the years, Buea has been significantly stressed by water scarcity driven by seasonal changes. This study aims at identifying the seasonal variability in water supply and various adaptation mechanisms to water scarcity in Buea. Making use of mixed research design, the study used the systematic random sampling technique. 200 questionnaires were distributed to the sampled populations in the Molyko, Buea Town, Federal Quarters and the Great Soppo neighbourhoods in Buea. Field observations and interviews were used in the study in order to assess the water supply and seasonal variability as well as the various water scarcity adaptations that have been put in place by the sampled population. Linear regression was usedto identify variability in the trends of climatic parameters of temperature and rainfall in Buea. The chi-square test was used to verify the assertion that the water scarcity adaptation measures put in place are a function of seasonal variability in Buea. The findings revealed that drilling of boreholes, fetching of water from neighbouring streams and springs in the municipality, rainwater harvesting among others were revealed by this study to be some of the water scarcity adaptations that have been put in place. Results also revealed that the various water scarcity adaptations put in place is not a function of seasonal changes in Buea. Income was seen to be one of the key determinants of the choice as well as the type of water scarcity adaptation put in place. Concerning the challenges faced, the study revealed that limitations to water scarcity adaptions are very significant across the different sampled localities in the Buea. Financial difficulty(32.5%) was the greatest challenge faced poor water development of water supply infrastructure (21%) as well as limited knowledge on water scarcity adaptation were identified.

Keywords: water scarcity, seasonal variability, climate change, Buea, CAMWATER, rainwater harvesting

Introduction

Variability in the climatic parameters of temperature and precipitation have been observed in most parts of the world with precipitation intensity and extremes (high and low) identified (Bates et al., 2008). These alterations can result in changes in annual and seasonal flow regimes, groundwater and surface water interactions which can therefore, affect raw water availability, and which can also affect water quality and biodiversity.

Seasonal variations in the climatic parameters of temperature and precipitation have induced water stress condition in south-western and south central Africa, parts of the horn of Africa to the east, as well as the Sahelian regions with relatively lower per capita water usage on the continent of Africa (Bhaga et al., 2020) Nearly all regions of the world are expected to experience a net negative impact of variability in climatic

parameters of temperature and rainfall on water resources which will influence its supply as well as having far reaching effects on freshwater ecosystems (Abbaspour et al., 2009).

The Fast-growing nature of the town increases pressure on water supply with the town's seasonal nature of precipitation, which has been witnessing an increase in the intensity of rainfall and an increase in the length of the dry season over the years. The urban water supply primarily depends on rainfall for its recharge. The reduction in precipitation most especially in the rainy season mounts serious pressure on the available water supply within the town resulting in water shortages. These challenges purposed by seasonal variability in Buea coupled with the rapid population increase in the town has placed so much pressure on water supply and thus intensifying water scarcity in Buea especially during the dry season. These service deficiencies primarily felt most by the urban poor that make up the greater segments of the urban population in Buea.

They lack the political will or funding to extend municipal systems to far-flung settlements within the municipality where the urban poor are concentrated. In that case, the inequitable distribution of entitlements, that is, the ability to access resources best explains why some people have access to adequate water supply in the town and others do not. Power relationships in the town of Buea determine the extent of municipal water services, rationing requirements, and the quality of water distributed to various neighbourhoods. With the urban poor being, the most affected.

In order there for to adapt to water scarcity in Buea as a response to seasonal variability, women and children are forced to walk long distances to fetch water from surrounding springs and streams in the town. In addition, the population has also resorted to the digging of wells and the drilling of boreholes as adaptive water supply measures predominantly during the dry season and water rationing also has been put in place by CAMWATER (Cameroon Water Utilities Company). As well, as rain water harvesting especially in the rainy season. The adaptive strategies that have been put in place in the Municipality have gone a long way to beef up urban water supply especially during the rain dry season when water scarcity is at its peak.

Boreholes constructed are more resilient to changes in the climatic parameters of temperatures and precipitation but are very expensive to construct and the pumps are equally more difficult to maintain and hence frequently break down. This research is therefore out to investigate the trends in the climatic parameters of rainfall and temperature, the effects of seasonal variability on water supply, the various water scarcity adaptations put in place and the challenges faced in the implementation of these various water supply adaptations.

Materials And Methods

The Study Area

Buea is the sub-divisional headquarter of Buea Sub-Division in Fako Division in the South West Region of Cameroon. It is also the regional headquarters of the South West Region. The Buea Municipality is located between latitudes 4^{o} 12' - 4^{o} 31' North of the Equator and longitudes 9^{o} 9' - 9^{o} 12' East of the Greenwich meridian. It is bounded to the West by Mount Cameroon, to the East by Tiko Sub-Division, to the North by Muyuka Sub-Division and to the South by Limbe Sub-Division (Kimengsi et al., 2015) as presented in Figures 1

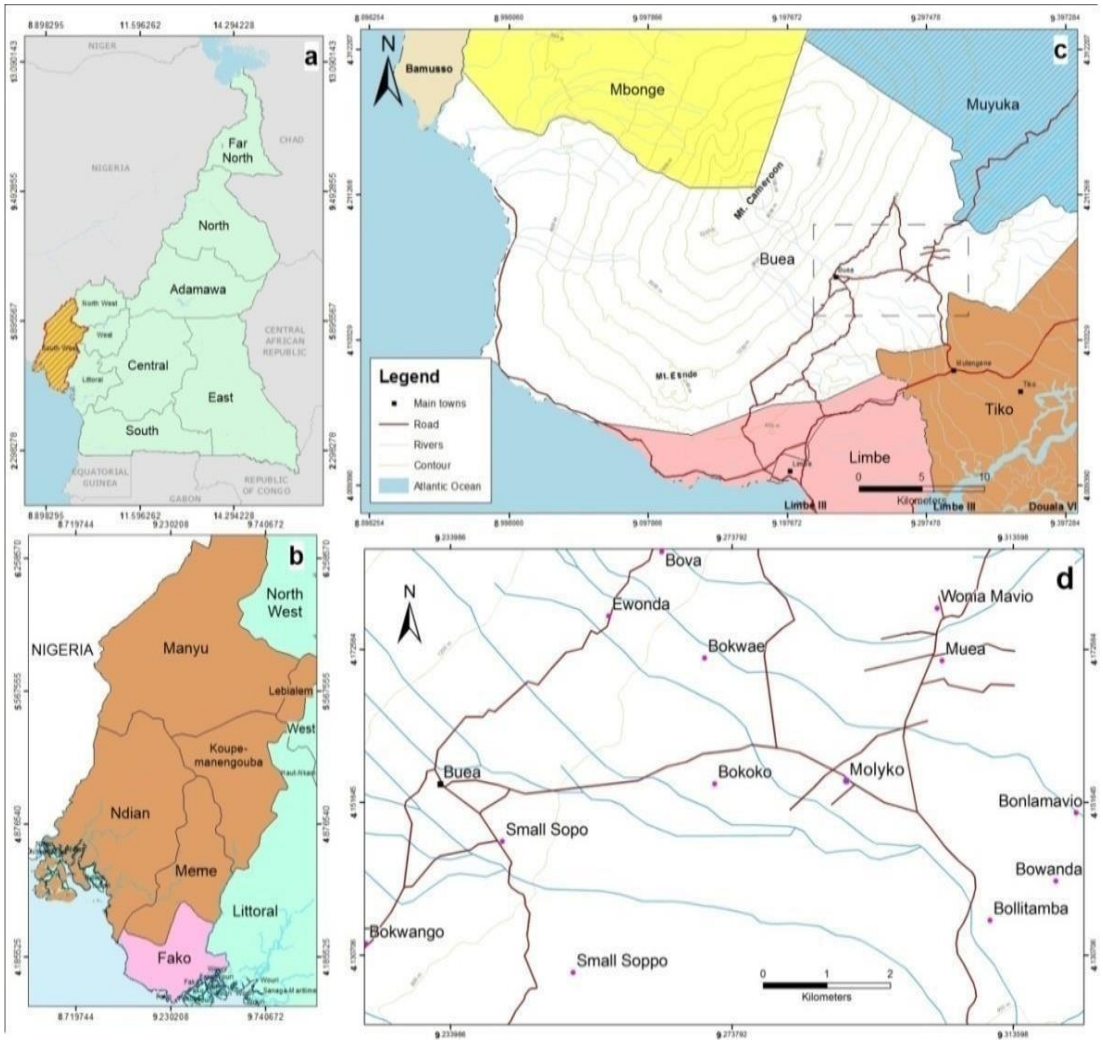

Figure 1: Location of Buea Municipality in Fako Division of Southwest Region in Cameroon

Source: Kedia (2015)

The area characterized by a hilly topography, which is characterized by many rocks and gravels due to volcanic eruptions. The soil type consists of basalts and it is because of the first volcanic activity around the Fako Mountain area, which occurred in the cretaceous system. These soils have been weathered and partly covered by more deposits that are recent, thus, the soils are black and in these areas are well drained due to the general hilly nature of the terrain and the fact that they are free draining. This has thus influenced the location of streams in the town as well as the catchments in the town. Most catchments are found mostly in areas of with relatively gentle topography like the case of Molyko and Small supper. As oppose to areas around Buea Town where water scarcity is critical. In addition, the nature of these slopes also influences various water adaptation type of water scarcity adaptation. Such as the construction of boreholes becomes very difficult as well as too expensive in areas with steep slopes.

Methods

The study is a survey aimed at assessing seasonal variability and adaptation to water scarcity in the town of Buea, challenges and the way forward. To achieve this objective, both he quantitative and qualitative data was collected. The quantitative data was made available through information on the perception of the population on the impacts of seasonal variability on water availability, quality as well as the quantity. Qualitative data was also obtained through observations that were carried out in the various catchments, water supply infrastructure, as well as the water supply adaptation strategies that have been put in place by the local population in the study area. With the view of attaining the study objectives, data from primary and secondary sources were also used. The primary sources included the administration of questionnaires,

interviews with individuals and field observations. Secondary data sources included journals, published and unpublished information, articles, books, the internet and libraries. The questionnaires were administered randomly to the heads of households in four selected quarters. The questionnaire was designed to meet the objectives of the study. The study sites selected for the study included Buea Town, Molyko, Great Soppo and GRA. A total of 200 questionnaires were administered with 60 administered in Molyko and Great Soppo respectively and 40 each for GRA and Buea Town. Data collected was analyzed using the linear regression, Chi square test and the results presented using tables, bar graphs and figures.

Results And Discussion

Seasonal variability and water supply in Buea

Water supply within the town of Buea stood at 1970800 m^3 in 1976 and increased to 2070800 m^3 in 2020 annually (Buh et al., 2021). Indicating an increase of 100000m^3 in 2020. Throughout the year, the amount of water supplied to the town reduces considerably during the rainy season as well as the dry season. The total amount of water supplied to the town daily during the rainy season (11400m^3) as oppose to the daily dry season (9400m^3). With the town's daily water demand of 11000m^3 for areas covered by CAMWATER there is a shortage in the daily water supply of 1600m^3 in the dry season. This indicates therefore that the dry season within the town of Buea is characterised by severe water scarcity. This Stems down from the reduction in amounts of water supplied by the utility supply company CAMWATER charged by the state to supply urban areas of the country with portable water for the various activities of which the town of Buea is one among. Water supply within the town over the years has noticed some fluctuation which correspond to the variations in seasons, indicating that the amounts of Water supplied to the town follows a pattern which corresponds to seasonal variability.

Water supply in Buea is in the hands of CAMWATER that has delegated Camerounaise Des Eaux (CDE) to sell potable water. CDE is directly involved in the supply of potable water to the inhabitants of Buea. The Buea Municipality has three major catchments which include:

Table 1: Distribution of Catchments in Buea and the volume of water produced daily in the rainy and the dry season

Catchments	Capacity	Volume of water pumped out/day	Observations
German Spring	5300 m^3	1000 m^3	+2000m3 (during peak of rainy season -wash period) Only 300m3 during dry season. This is about 10 times lower
Small Soppo	7000 m^3	4800 m^3	may pump less due to power failure
Mosel	7000m^3	3000 m^3	may pump less due to power failure
	DRY SEASON	**RAINY SEASON**	

Total volume produced/day		9400 m^3	11400 m^3
Current demand for areas covered by CDE		11000 m^3	11000 m^3
Deficit (-) and Excess (+)		-1600 m^3	+400 m^3

Source: (Mbua, 2013)

Table 1 shows that the total volume of water produced daily by the 3 catchments in Buea during the rainy season is 11400m^3. While for the dry season, it stands at 9400m^3. With the daily demand of the areas covered by CAMWATER which stands at 11000m^3 daily. This indicates a shortage of 1600m^3 during the dry season. This explains the reason for the severe water scarcity experienced by the town during the dry season. This thus makes the population of these areas to seek various means of adapting to these water shortages in order to meet up with their water needs during this season.

The water shortage in the town of Buea is alarming especially during the dry season coupled with the low capacity of CAMWATER and CDE to cater for the water demand of the population of the town especially during the dry season. The water transport (pipes) and storage facilities (tanks) are old coupled with heavy water loss caused by leakages. The current water supply capacity is therefore insufficient for the town of Buea with an estimated population of more than 90,000 and is still on the rise.

Table 2: The perceived impacts of seasonal variability on water supply

Items	[1]Mean	Std. Dev.
Heavy rains generate runoff which damage pipes and block some	2.69	0.797
Rainfall is lesser over the years	3.02	0.712
There is the reduction in sizes of streams and springs	3.06	0.866
Reduction in the amount of water supplied to the town of Buea	3.09	0.713

Source: Field work, 2021

[1]2.5 is mean decision level: any mean score below 2.5 is a tendency towards disagreement (Not significant); a mean score above 2.5 is a tendency towards agreement (Significant)

Table 2 present the impacts of seasonal variability on water supply in the town of Buea. the sampled population indicated that the greatest impact of seasonal variability on water supply was the reduction in in the amount of water supplied to the town of Buea (3.09), followed by the reduction in the sizes of streams and springs within the town and rainfall is lesser over the years. This was observable especially during the dry season. This amplifies the reason why severe water shortages recorded within the town of Buea within this period. Heavy rains generate runoff, which damage pipes, and block some recorded the least though it was significant especially during the rainy season, which the damages resulting from this may reduce the amount of water supplied to the town.

Seasonal variability and water supply

Given that, water supply is a dependent on a couple of factors, which influence it among which is seasonality, this study investigated the impacts of seasonal variability on water supply and the results presented in figure 2.

Based on the results presented on figure 2, respondents (94.5%) agreed to the fact that temperatures have increased with changes in seasons, 72.5% held that rains come late than before, 75.5% opined that rainfall is less over the years and more variable as expressed by 81% of the respondents. 65.5% were of the view that the weather is unpredictable. As a result, water supply is affected in that; streams are drying up (77.5%), decline in quantity of water supply (73%), reduction of water supplied to the town (89%) and 68.5% of the respondents were of the view that heavy rains generate runoff which damage pipes and block some.

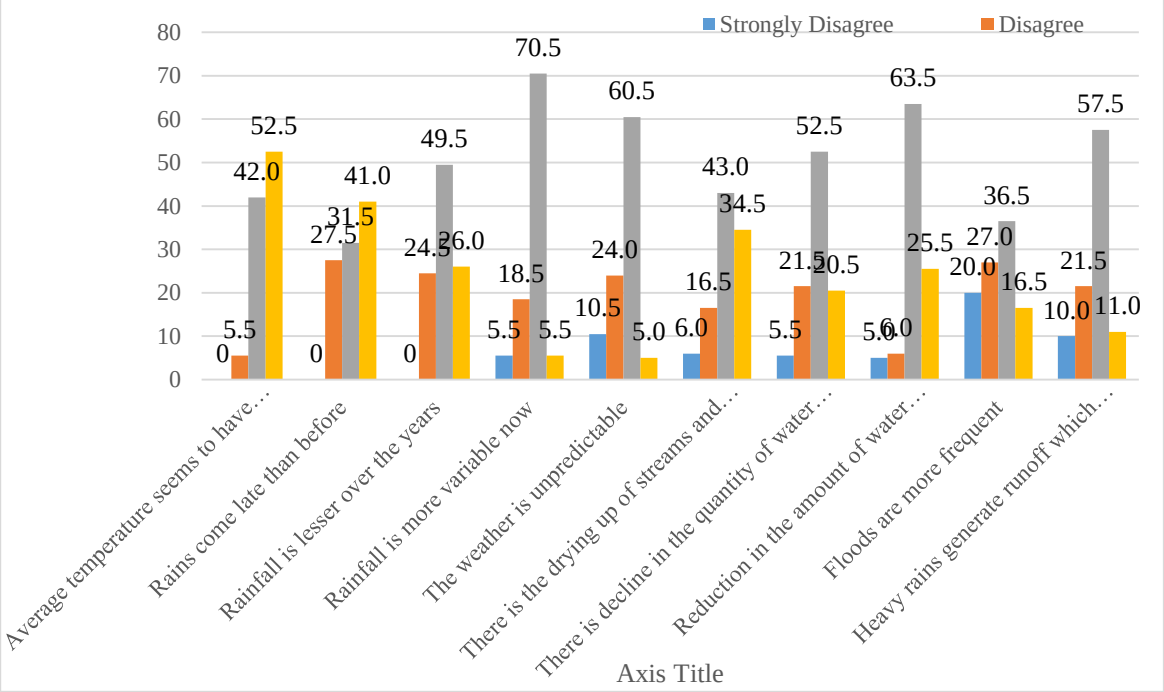

Figure 2: Respondents level of agreement on the impacts of manifestation of seasonal variability and impacts on water supply in Buea

Source: Field survey, 2021

Water scarcity adaptation options in Buea

The increase in the population in the town of Buea does not correspond to the quantity of water supplied by the 3 major catchments in the town. This has resulted in serious water shortages and scarcity that obtained in the town. Thus, intensifying water scarcity as the water demand capacity of the town is unmet (Mbua, 2013). Water supply challenges have evolved from 2-hour shortage in the 1970s up to between 4 and 7 days of no water supply in the year 2021. The evolution of the population of Buea from 1976-2020 has been marked by drop in the annual water consumption per capita of the population from 85.9 m^3 in 1976 to about 11.2 m^3 in 2010 and about 15.3 m^3 in 2020.

Table 3: Evolution of water consumption per capita for Buea (1976-2020)

Year	Water supply (m^3)	Population	Consumption/head (m^3)
1976	1970800	22.948	85.9
1977	1970800	23.49	84.0
1989	1970800	63853	29.9
1993	1970800	78632	25.0
1998	1970800	105000	18.0
2008	1970800	141111	13.9
2010	1970800	176000	11.2
2020	2070800	300000	15.3

Source: adapted from Buh et al., (2021)

Poor placement of pipes for water distribution and supply is also another call for concern as presented in plate 1. Fieldwork revealed that the water supply pipes are barely placed on bare surfaces which makes them prone to destruction by moving cars as well as children playing around the pipes. In addition, it was also realised that in some places especially in the Molyko, Buea town and Great Soppo the population instead of fighting toward repairing them they allow the broken pipes throughout the neighbourhoods. This situation presented is evident in plate 1 below.

Plate 1: The placement of water distribution pipes in Molyko

Source: Fieldwork, 2021

Photo A in plate 1 shows water distribution pipes placed on bare surfaces which can be easily damaged by the children playing around. Photo B shows water supply pipes on roads that have been damaged by cars in Molyko.

Another problem is that of catchment degradation. This is connected to population increase because as more and more people stream into Buea, there is a high demand for space for the expansion of settlement and other urban functions. This often result in the encroachment of buildings as well as agricultural activities and other activities in to the catchment area. This presents a serious challenge such as the uncontrolled nature of houses constructed around the catchment area, which further amplify water scarcity and the agricultural activities around these areas together with their activities result in the consequent reduction in the size of the catchment as well as its output and may further result in the pollution of the surrounding streams during heavy rain fall which enable the runoff to carry fertilizers in to the water system thus resulting in pollution of water in the catchment.

Adoption of changes/adjustments in water utilization as a response to seasonal variability

Given the increasing variability in water supply situation due to seasonality in climatic parameters of rainfall and temperature, the sampled population in the study area were found to have adopted or made some changes and adjustments in their water utilization manner. Across all the selected localities under investigation, in the Molyko neighbourhood, 73.3% of the respondents had adjusted or adopted adaptation measures, which recorded the highest. Followed by Buea Town with 72.5% and Great Soppo and Federal Quarters both stood at 70% respectively (figure 3). Therefore, all of the sampled population expressed that they have adopted some changes and equally adjusted in their water utilization pattern. This indicates the depth to which the problem of water scarcity is affecting the population of Buea. As at least 70% of the respondents from the respective localities are adopting changes representing significant majority against a smaller proportion with a contrary opinion.

Adaptations strategies

The sampled population in the study has put in place other water scarcity adaptation measures in other to strive during periods of severe water scarcity within the town goes through especially during the heart of the dry season**.** The different measures adopted by the sampled respondents who adjusted to the seasonal changes in water supply are presented in figure 3.

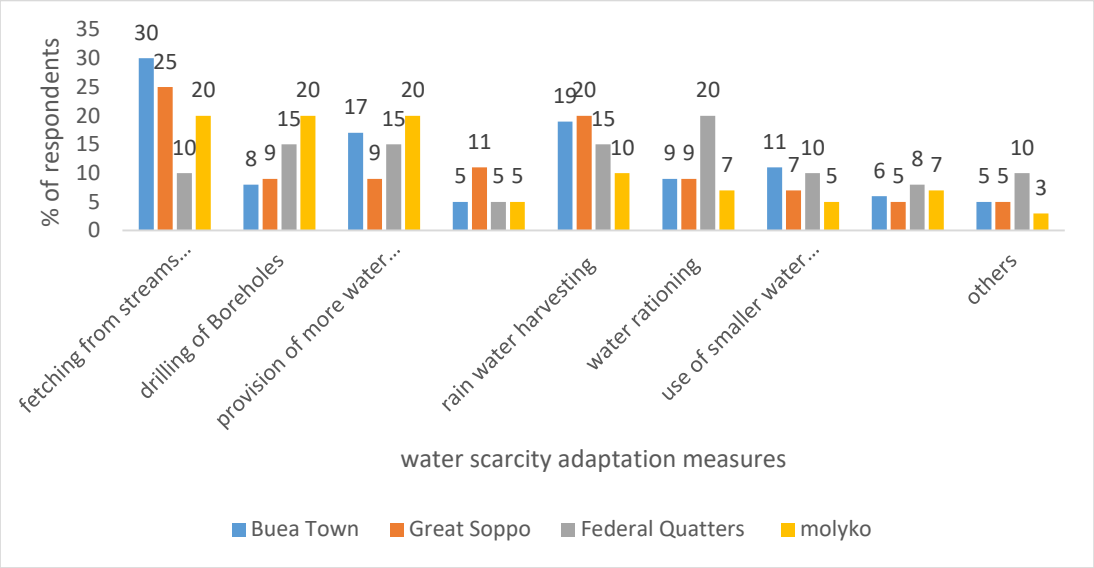

Figure 3: Adopted measures

Source: Field survey, 2021.

With regard to the measures adopted by respondents, in the Buea Town neighbourhood, fetching water from neighbouring springs and streams accounted for about 30%. This is because the difficult nature of the relief of these areas makes it very expensive for the drilling of boreholes. More so, this part of the town is occupied by the low-income earners or the urban poor.

In the Great Soppo neighbourhood fetching of water from neighbouring springs and rivers recorded about 25%. This is because the relief of the area makes it very expensive to drill a borehole as well as the fact that this part of town is inhabited by low-income earners.

In Federal Quarters water rationing (30%) was the highest water scarcity adaptation that was put in place. This results from the fact that this part of the town is occupied by the wealthy and the administrative officials in the region. The supply of water by CAMWATER is more regular as compared to other parts of the town. As opposed to buying of water from vendors that recorded the least.

In Molyko, fetching of water from springs and streams, drilling of boreholes and provision of more water storage facilities were the highest water adaptation strategies put in place with each recording 20%. This result from the fact the relatively gentle nature of the relief eases the drilling of boreholes. The high populations in this part of the town with diverse sources of incomes have prompted the adoption of these strategies. Moreover, others recorded 3% which was the least.

Fetching of water from neighbouring springs and streams

As an adaptation to water scarcity especially during the dry season when water scarcity is at its peak, the study revealed that the population of Buea will get water from the neighbouring streams and springs in the Town. The majority of those who have to walk for long distances to get water are the children. They move to neighbouring springs such as the spring around the Biaka area as well as streams such as the River Ndongo. It was further revealed that a certain portion of the sampled population use their cars. This is particularly very common among the high-income earners or the well to do within the study area. While others also use trucks or wheelbarrows as well as using their heads especially those who are unable afford trucks or wheelbarrows equally. This is very common among the low-income earners who constitute the

urban poor. The sampled population within the study area identified carrying points such as koke, Behind Biaka as well as the entrance to the Prime Minister's lodge for the population of Buea town.

The drilling of Boreholes

Another adaptation according to the study was the drilling of boreholes. The drilling of bore holes whose cost was estimated between 3 to 6 million as revealed by field work was seen to be one of the most reliable as well as one of the most sustainable form of water scarcity adaptation strategy put in place by the sampled population in the study area. The bore hold construction under taken by individual homeowners as well as homeowners pairing up to drill them. In addition, an interview with an authority of the Buea council revealed that the council has constructed more than 25 Boreholes with the town of Buea with some local as well as international NGOs. The construction of these boreholes is relatively expensive and this has prompted some people to resort to the digging of wells.

When the individuals drill boreholes, some external connections are made to other members of the community so that they could be provided with the water. However, the operation of some of these external connections are operated just for a few hours and most at times twice daily. These boreholes connected to tanks, for which permits the water pumped electrically could be stored. This will definitely carry households for days depending on the kind of building.

In other to better adapt to water scarcity, fieldwork revealed that the sampled population have resorted to the purchase of water storage facilities in their homes as a coping strategy. These storage facilities include tanks of various capacities which are at times determined by the income of the individual with most home owner going in for larger tanks with capabilities from about 1000 l upward. While the lower income earners go in for the relatively smaller containers for water storage such as containers which might be as small as 1.5 to 20 l for water storage.

Buying water from vendors

Furthermore, it was revealed from field work that the in habitants of the town in order to adapt to water scarcity buy water from vendors as well as mineral water produced by companies such as Supermont and Tangui especially for drinking. In addition, the residents also buy water from the local water vendors as well as pay for the water to be supplied in their homes by tricycles as well as cars equipped with large tanks. The price range for water supply by tricycles, range from 100 FCFA to 200 FCFA for 20 l in some localities. As well as from 5000FCFA, supplied by cars with water tanks and can even be much more in Buea town, molyko and Great Soppo at the heart of the dry season. Thus, the tricycle owners collect containers from household to carry water and supply them as.

Reduction in the quantity and volume of water used per activity

Fieldwork revealed that the population of Buea urban adjusted with regards to the reduction in the quantity and volume of water used per person per day especially during the dry season. For instance, two people sharing a bucket of water for bathing, in an attempt to conserve water as well as reducing the quantity of water for certain activities like bathing. By this strategy, therefore the population of the town have become more aware of the need for a behavioural change as a response to water scarcity within the town of Buea.

The use of smaller water distribution pipes

Fieldwork also revealed that the population of Buea in other to adapt to water scarcity is reconsidering the type as well as the sizes of the water supply pipes being used in their buildings. The usage of large water distribution pipes in buildings is gradually being abandoned in favour of smaller water distribution pipes which are able to supply and reduce water wastages in buildings. Thus, they are capable of distributing the available volume of water in an entire building faster even with a reduction of water supplied to the building. Most of the new building within the town of Buea are increasingly seeing the use of smaller water supply pipes while renovations are ongoing in most of the much older buildings in Buea.

Rain water harvesting

This is one of the most used adaptation strategies within the town of Buea especially during the rainy season that spans for over a period of about 8 months. Within this time, the population collects rainwater to supplement their water supplies. This adaptation strategy was revealed by fieldwork to have been evolving over the years in the town of Buea. This has seen the usage of larger tanks with most respondents especially home owners collecting all of the rain waters from the entire roof and channelling them in to large tanks where the water is stored for usage afterwards. These tanks are filled within a relatively shorter period especially during intense rainfall. The number that can afford this are very limited when compared to the population of Buea as most of them are high-income earners. The majority of the sampled population with barely very little earnings use low storage capacity such as buckets with capacities averagely 30 l. Thus, the rainwater collected can only carry them for a few days.

Water rationing

Water rationing was also identified from fieldwork as one of the water scarcity adaptation strategy that has been put in place by CAMWATER in the town of Buea especially during the dry season when water scarcity is at its peak. An interview conducted with an official of CAMWATER in Buea indicates that the volume or storage capacity of their water catchment is $7200m^3$, which is low and unable to satisfy the water needs of the increasing population of Buea municipality especially during the dry season. This makes it very difficult for this utility supply company to constantly supply the population of the town with the much-needed water for their various needs. This company therefore in other to adapt to the water scarcity carries out water rationing in which some parts of the towns are provided with water following a schedule that has been put in place by the company. Which may at times last for hours up to days in some quarters. The research equally revealed water rationing done within the town of Buea favours Federal Quarters as water is frequent even at the heart of the dry season at the detriment of other neighbourhoods like Buea Town, Great supo and Molyko.

Table 3: Evolution of water supply intervals in Buea (1960-2020)

Year	Supply interval
1960	None
1970	2 hours
1975	3 hours
1980	4 hours
1990	6 hours
1995	24 hours
2000	48 hours
2005	72 hours
2011 to 2020	94 -168 hours

Source: **Adapted from Buh et al., (2021)**

The supply interval in the town of Buea has been increasing over the years. The least was in 1970 (2 hours). This is because at this time the population and the urbanisation and expansion of the town was low. The period from 2011 to 2020 saw an increase in this supply interval ranging from 94 – 168 hours in some neighbourhoods. This is explained by the increase variability in rainfall and temperature, rapid increase in population and the rapid rates of urbanisation observed in town.

Seasons of high adoption of adjustments

With regards to the fact that variations in the quantity of water supply differ with across the months and the seasons, respondents equally adopted adjustments and adaptation measures differently in different seasons as follows.

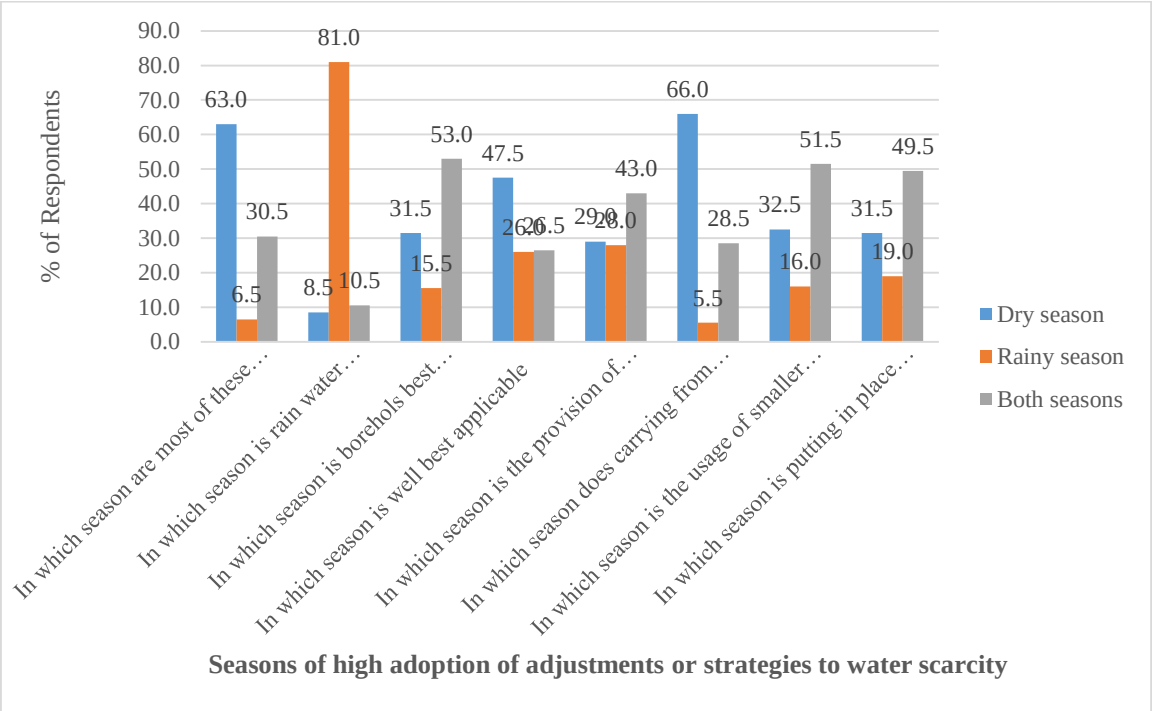

Figure 4: Seasons of high adoption of adjustments or strategies to water scarcity

Source: Field survey, 2021

Success of water scarcity adaptation measures in Buea

The findings revealed that Federal Quarters (80%), recorded the highest level of success in the various water scarcity adaptations put in place in the area. This is because of the fact that this neighbourhood is inhabited by the high-income earners and the well to do people in Buea. This was followed by Molyko (75%) Great Soppo (69%) and Buea town (62%). This indicates that throughout the study areas the various water scarcity adaptation put in place have recorded a considerable degree of success. The non-success recorded in the various water scarcity adaptations are highest in Buea Town (38%) and Great Soppo (31%). As the majority of those inhabiting these neighbour hoods are the poor urban dwellers.

Investigations further assessed the reasons for the failure of the water scarcity adaptation measures put in place. This investigation revealed that the sampled population in the study areas had the reasons presented in figure 5 as the main points why despite all they have put in place to combat water scarcity, they have not been able to attain high levels of success or made some of these strategies to register or attained the much-expected high level of successes.

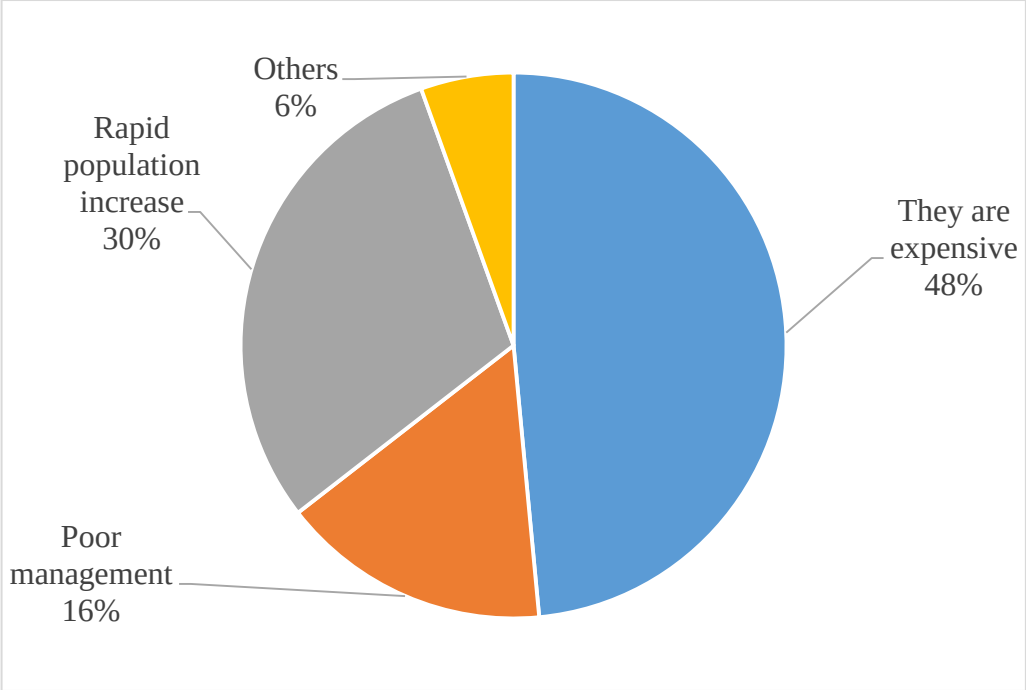

Figure 5: Reasons for non-success of water scarcity adaptation measures.

Source: Field survey, 2021.

Respondents outlined a number of reasons as to why the adopted measures were a failure. Among the measures the sampled population in the study area identified that the most reliable and long-term water scarcity adaptations measures were very expensive (48%) which made the putting in place of these strategies very difficult if not impossible in some areas. This was followed by rapid population increase (30%) which was seen to mount more pressure on some of the strategies and equally affected their durability as well as functionality, then poor management (16%) registered the least.

Conclusion and Way forward

Field investigations revealed that the populations of the town in the sampled study sites have noticed some variations relating to the quantity or the amount of water supplied during the rainy season as well as during the dry season. Given the increasing variability in water supply situation due to seasonality in climatic parameters of rainfall and temperature, the sampled population in the study area were found to have adopted or made some changes and adjustments in their water utilization manner

The study recommends that the government should increase investment towards catchment area management as well as drilling of boreholes. In addition, advancing research and technology geared towards improving water supply in a water stressed town like Buea. This will permit for more efficient and effective water scarcity adaptions in the study area.

The government should ensure that the population is educated on the different water management practices such as water conservation, reuse to minimize the wasteful use of water. Moreover, the government should invest in modern rain water harvesting technology which will ensure the effectiveness and efficiency as well reduce the amount of waste water lost during the rainy season as well as during any rain fall event. This will thus boost water supply.

It is also recommended that, for enough water to be harvested, appropriate techniques could be designed to harvest flood water for storage in surface dams and underground reservoirs during the rainy season to be used during the dry season which is characterised by severe water scarcity

The water billing system should be designed in such a way that the people who consume less are rewarded, which is aimed at reducing water extravagancy in the usage of the utility by the population of the town.

CAMWATER should equip the various catchments with solar power to reduce its dependency on ENEO that is highly unreliable for power supply, which is very much needed to pump water from some of the catchments in to the water supply system of the town.

The Council together with other stakeholders should assess population growth, water needs and demand as well as water quality standards to be able to make projection in the future, the water needs and requirement of the population and the different economic activities in the study area. Moreover, the water supply sources and infrastructures need to be upgraded in order to the growing need of the population today and in the future. The council should target the issue of developing new catchments, harnessing new sources of water and enhancing catchment rehabilitation to increase the volume of water needed to supply the entire population.

The council should purchase borehole drilling equipment as well as train council staff on how to conduct feasibility studies on the location of boreholes as well as the manipulation and maintenance of these equipment. Which will reduce the expenditure of providing boreholes within the study area as well as cautiously increasing the number of these boreholes in the study area.

The council should also subsidise the prices cost of drilling a borehole within the town of Buea which will make it more affordable to the low-income earners who make up majority of the population in the study area. The population of the town should adopt more behavioural changes, which aimed at reducing water being wasted.

The population should inform the competent authorities once any leakage is identified along the water supply pipes in the study area. The household as well as members of the various localities should group themselves and put resources together in order to finance the drilling of boreholes, which is the most reliable form of water supply adaptation.

References

1. Bates, B.C., Kundzewicz, Z.W., Wu, S. and Palutikof, J.P. (2008) Climate Change and Water. Technical paper of the Intergovernmental Panel on Climate Change, IPCC Secretariat. Intergovernmental Panel on Climate Change, Geneva.
2. Bhaga TD, Dube T, Shekede MD, Shoko C. Impacts of Climate Variability and Drought on Surface Water Resources in Sub-Saharan Africa Using Remote Sensing: A Review. *Remote Sensing*. 2020; 12(24):4184. https://doi.org/10.3390/rs12244184
3. Abbaspour, K.C., M. Faramarzi, S.S. Ghasemi and H. Yang (2009), Assessing the impact of climate change on water resources in Iran, *Water Resour. Res.*, 45, W10434, DOI: 10.1029/2008WR007615
4. Kimengsi, Jude & Sani, Amawa. (2015). Water Rationing in the Buea Municipality: Patterns, Effects and Coping Strategies African Journal of Social Sciences, Vol.6, No. 3, 2015 Jude .N. Kimengsi & Amawa Sani G.. African Journal of Social Sciences, Vol 6 No. 3.
5. Kedia, N. (2015). Water quality monitoring for rural areas- a Sensor Cloud based economical project. *2015 1st International Conference on Next Generation Computing Technologies (NGCT)*, 50-54.
6. Buh, E.N., Mbua, R.L., & Zeh, A.F. (2021). Increasing Challenges of Potable Water Supply and Its Implications on the Population of Buea Municipality, Cameroon. Environmental Science, Sociology, Geography, 13(4): 12-22, 2021, DOI: 10.9734/ARJASS/2021/V13I430220
7. Mbua, Roy. (2013). Water supply in Buea, Cameroon : analysis and the possibility of rainwater harvesting to stabilize the water demand. *PHD Dissertation 2013*