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[INVESTIGATING WATER SECURITY IN CAMEROON: CASE OF MUTENGENE, SW REGION]

ABSTRACT

Water plays an instrumental role in the development of any community or society, unfortunately achieving household water security in many regions of the world, especially in Sub-saharan Africa and particularly Cameroon, is of global concern. This study thoroughly examines factors affecting water security within the Mutengene Community Water System and proposes sustainable alternatives to ensuring water security amongst imminent changes. Data was obtained through the use of interviews and semi-structured questionnaires on households, field and Laboratory analyses were carried out on collected water samples. Obtained results indicate a significant scarcity in water as compared to the present population due to some climate variability and socio-economic management practices of the population with regards to their environment. Moreover the community lacks modern techniques for addressing water security and also the means for undertaking such activities. This study recommends the reexamination of the current situation and effective participation of the necessary stakeholders in addressing the imminent water scarcity so as to provide sustainable solutions amidst these variability factors surrounding the Mutengene community.

Keywords: Water scarcity, Sustainable management, Household, Population, Climate variability

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List of Acronyms

AMCOW: African Ministers Council on Water

BUCREP: Bureau Centrale des Recensements et des Etudes de Population

CDC: Cameroon Development Corporation

GPS: Geographical Position System

MDG: Millennium Development Goal

mg/L: milligram per liters

MWS: Mutengene Water System

MWSA: Mutengene Water System Authority

NIS: National Institute of Statistics

NTU: Nephelometric Turbidity Units

UN: United Nation

UNESCO: United Nation Education Scientific and Cultural Organization

WB: World Bank

WHO: World Health Organization

WMO: World Meteorological Organization

1. Introduction

Presently, guaranteeing the supply of adequate water to the world's population from an absolutely finite source is seen as a significant challenge (Harris, 2012). This is due to the fact that only one percent of the world's total water is fresh and drinkable and is poorly managed (Harris, 2012). Though population growth is a key factor affecting water scarcity, improving living standards, urbanization and supply variability due to climate change also add pressure on water security especially in different parts of the world particularly sub-Saharan Africa (Kumudu et al., 2015). It is estimated that the Earth's fresh water together as a single mass would measure some 1,386 million km3 in volume (Williams, 2014). The UN MDG report of 2015 on water, indicates that 97% of the world's population now uses improve potable water sources and of this, 2.6 billion people have gained access to improved sources of potable water since 1990, 1.9 billion people now use piped water on premises and 147 countries met the MDG target on potable water. Sub-Saharan Africa has the greatest number of people without access to improve potable water, of which 80% of these people live within the remote areas. Water stress is another feature which is gradually becoming a problem in different parts of the world today especially in Asia and Africa. This is partly due to climate change, increasing water scarcity, population growth, demographic changes and urbanization (UN, 2014). This call for concern for safe drinking water is as a result of the high rate of diseases that is 75% of all diseases are related to the poor water quality. Potable water coverage and sanitation levels in Sub-Saharan Africa are lowest than any other region of the world; In 2010, Sub-Saharan Africa accounted for 6 of the top 10 countries in the world with the largest population without access to improve drinking water sources (Folifac et al, 2014). Water stress is becoming a serious problem in sub-Sahara Africa, particularly in Cameroon, where barely 44% of the total populations have access to adequate potable water (NIS, 2011; Folifac et al, 2014). AMCOW, 2015, states that 82% of the populations living in urban centres have access to safe drinking water however the rural areas lag behind with about 45% in 2007 of the population living without access to potable water. Under ground water remains the most reliable sources of fresh water for the population around the mount Cameroon area particularly communities like Mutengene, even though traces of nitrate contamination have been observed (Ako et al., 2013). The sustainable management of these sources are facing challenges such as coordination and multiple often competing uses for the resource in a way that balances environmental concerns and socio-economic demands and there exist few models that assess the trade-offs between environmental and socio-economic impacts of water management in an integrated framework (Kragt, 2013). The provision of potable water to the population lies greatly on the water supply system in place. Water supply systems are infrastructures that involve collecting water from its source, treating, storing and finally distributing it to consumers. This water has to be of good quality and quantity in order to

satisfy the need of the population. The steady increase in the population of Mutengene and the rapid urbanization coupled with climatic variability factors are the main causes of the water stress existing in Mutengene which has been compounded further by the management system. Due to the failure during the conception of the project in integrating population dynamics into the system is the fundamental cause to this water stress. The characteristics of this water insecurity issues can be seen from the long queue at public taps with containers of all sizes and from other businesses that deals with the commercialization of water and finally the long distance travelled by the population in search of water from different quarters and streams. This study aims to highlight the existing relationship between the population, management practices and resource in determining the principal cause of the water insecurity. Thus this study looks into the availability of the water resources, its characteristics and quality and finally the current population dynamics.

2. Material and Methods

2.1. Study Sites

The study area is Mutengene (Figure 1). The town of Mutengene is situated within Tiko sub-division, in the Fako Division, South West Region of Cameroon. It is located between latitude 4° 5' 58" North and longitude 9° 18' 29" East of the Prime Meridian. The general climate of the area is equatorial type, largely comprised of sub-humid tropical climate (Molua, 2002; Lambi and Molua 2006). The weather is largely controlled by equatorial and tropical air masses, characterized by average mean temperatures of 25^0 C and rainfall of 1,700mm (Molua, 2002).The main human activities in the region are agriculture, petit businesses and works in factories and plantations.

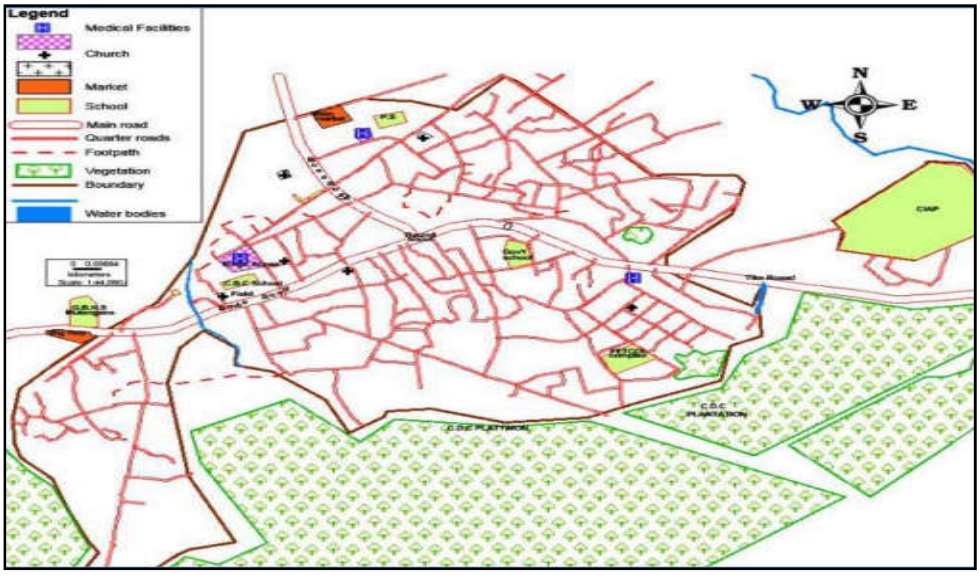

Figure 1: Map of Mutengene (Google maps)

2.2. *Mutengene* tap-water

The water samples used in this study were collected at two different points; the catchment and at the first point of collection which is a public stand tap at the entrance of the Mutengene town and bottled in a sterilized amber bottles that were autoclaved. Their physico-chemical parameters were tested in a laboratory for the verification of their quality as stipulated by WHO for Drinking-water Quality in third edition (2008) and fourth edition (2011).

2.3. Data Collection

Fieldwork consisted in conducting observations and surveys on the local population residing in Mutengene. Approaches used were basically through direct administration of semi-structured questionnaires and interviews, which allowed respondents to speak freely on the subject of water security. Then focus group discussion with the MWSA. Individuals subjected to the interview were randomly selected. In order to obtain more reliable information, heads of household or individual of age equal or greater than 18 years were chosen and in some cases children were interviewed who were carrying containers in search of water. In Mutengene, 180 semi-structured interviews and questionnaires that were administered in all the various quarters of Mutengene, and the household were randomly selected. The total survey in Mutengene was completed in two months. The information collected includes perception of the local population concerning water security, population increase, water management authorities and climate variability factors.

Also to complete the information tools such as stop watches, buckets, GPS, and digital camera were used for the carrying out of *in-situ* field study. As for secondary data and information, bibliographical documents were reviewed. After data collection, Excel software was used to type and analyze data. In the counting phase, responses were classified and corresponding percentages were calculated, based on the number of respondents. In this study, it is about descriptive statistics, whereas standard formulas and equations were used for calculating velocity, flow rate and population growth rate.

3. Results and Discussions

3.1. Perception of the local population on water security

Analysis of the local population on water security was mainly based on identification of the signs, the causes and consequences of the water insecurity issue on their livelihood. Based on the administered questionnaires and semi-interviews conducted in the field, the following were gotten from the respondents. Among the identified problems relating to water insecurity, these ones standout and they

express the level of the stress the population is facing in their adapting to these water insecurity challenges.

3.1.1 Signs of water insecurity crisis

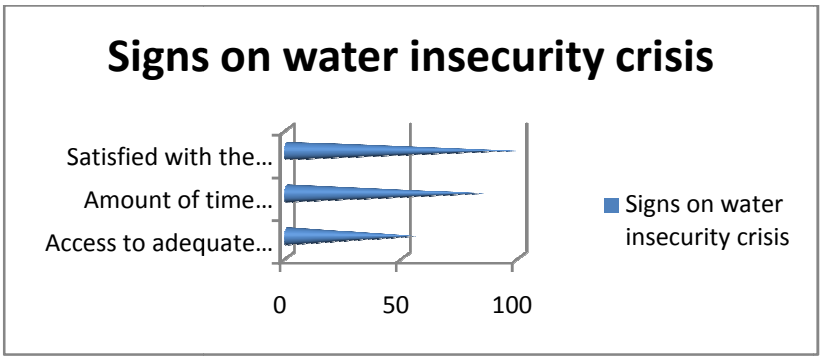

Figure 2: Signs of water insecurity crisis

Among all the quarters surveyed in Mutengene, 98.3% of the people agreed that there is a water insecurity issue in Mutengene that was increasing year after year and this has caused them to buy 200L and 20L containers for storing and preserving water. This phenomenon is noticed especially in increasing numbers of hours spent fetching water and with the increasing rationing in the distribution of water and their frequent cuts. Table 1 shows an example of the water insecurity phenomenon on the population from the responses of the questionnaire affecting the locality of Mutengene. About 96.7% depend on the MWS for their household water, whereas about the remaining 3.3% have alternative sources such as boreholes and springs. From the 96.7% depending on the MWS, yet about 84.9% spend approximately about 3-6Hours fetching water and storing in containers in anticipation for the next time water is to flow (rationing period). The remaining 15.1% spent approximately more than 6 hours fetching water and storing in containers. This is as result of limited or no access to public stand taps or to household with pipe-born water or boreholes, thus they are obliged to travel long distances in search of water. According to UNESCO, 2006, the average amount of water needed by a person daily is 50liters and 20liters for extreme cases, from *Figure 2*, about 45% said they needed less than 45L a day, and then 55% required more than 45L a day. Comparing this to UNESCO standard, its shows that a majority of the population daily water demands is less than 50L, which is basically for domestic purposes (bathing, cooking, dish-washing, house dry-cleaning) though is not extreme but the severity of the situation is on the amount of time spent fetching water and the stress involved in the procedure. As for the washing of their dresses they got water from nearby streams or the dresses are taken to the streams to be washed, thus accounting for the less than 50L daily demand. In addition to these characteristics of water insecurity, the local

population also highlighted knowledge on some of the causes. Expressed causes were notably the rapid population increase and climate variability factors (long dry season and short rainy seasons).

3.2 Rapid Population Increase

During the initial conception and designing of the Mutengene Water System (MWS) in 1970's, the population dynamic was never taken into consideration, as such it was conceived to accommodate about 10,000 people. Looking at *Figure 3* below, it shows the rapid population growth of Mutengene from 1976, according to NIS, 2011 and BUCREP, 2015, using population growth rate, mutengene has increase by about 300% from when the MWS was designed. At conception, the spring had a flow rate of about 2000L/min during the rainy whereas presently it is about 300L/min. This shows that the spring flow rate has drop by about 85%, which is largely as a result of the changes in climate variability factors and further compounded by the increase in population and the constant extending of the system through elongation of the distribution that's leads to lose in pressure along the distribution pipes. Most often pipe dimensioning is also not taken into consideration, thus this wrong pipe dimensioning increases the lost in pressure especially along the valves, causing breakages and leakages.

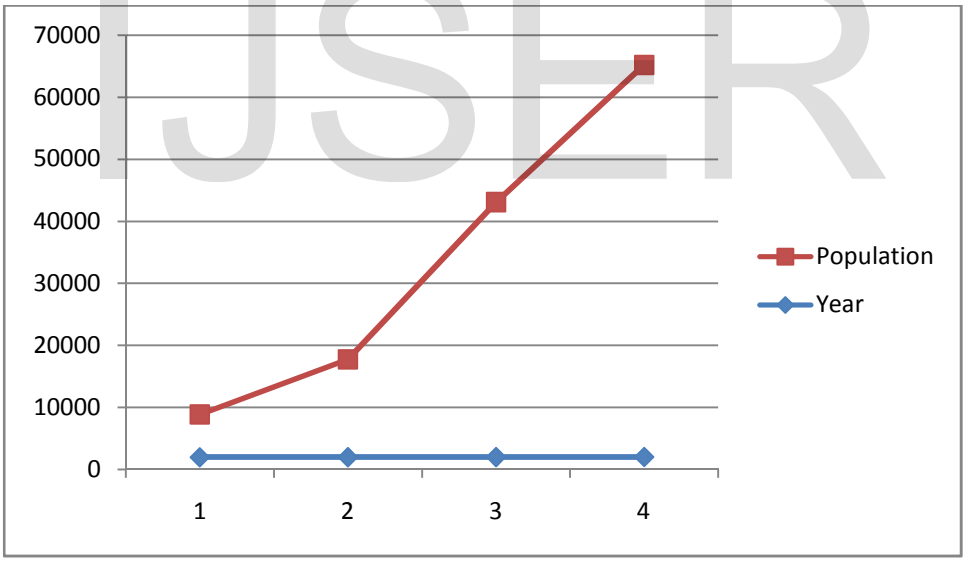

Figure 3: Population growth of Mutengene and Stream flow rate (1976-2016)

UNESCO, 2006 proposed that the average daily volume of water needed by a person is 50L and 20L in extreme cases, nevertheless from this study at the present flow rate; it will take about 12hrs to refill the storage tanks (200m^3). Thus the MWSA are currently rationing water so that each quarter has days when their water flows, with a minimum of once a week to daily flow, depending on the location of the quarter. This shows that with the current flow rate and population, the MWS cannot satisfactorily guarantee enough domestic water, thus the underlying cause of this water security crisis.

3.3 Variability in climatic conditions

Changes in climate and variability in other climatic factors have a direct impact n the availability of fresh water distribution, as these factors serve in the cyclic replenishment of this vital resource for human survival.

3.3.1 Comparing the Temperature and Rainfall data from 1960-1990 and 1991-2015 for Cameroon

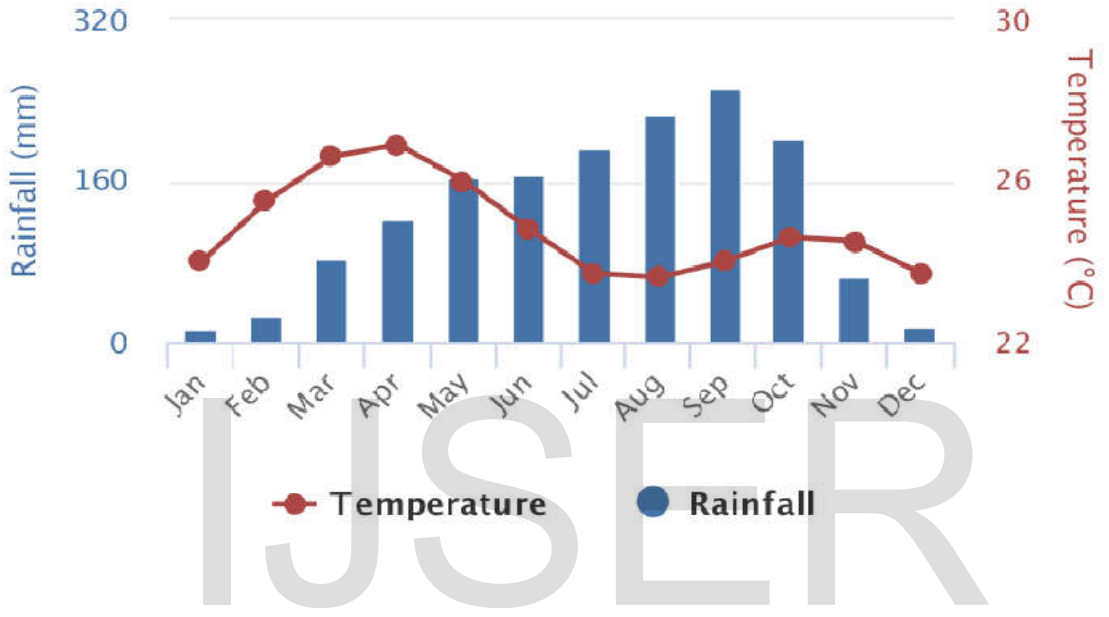

Figure 4: Temperature and Rainfall (From 1961-1990) for Cameroon

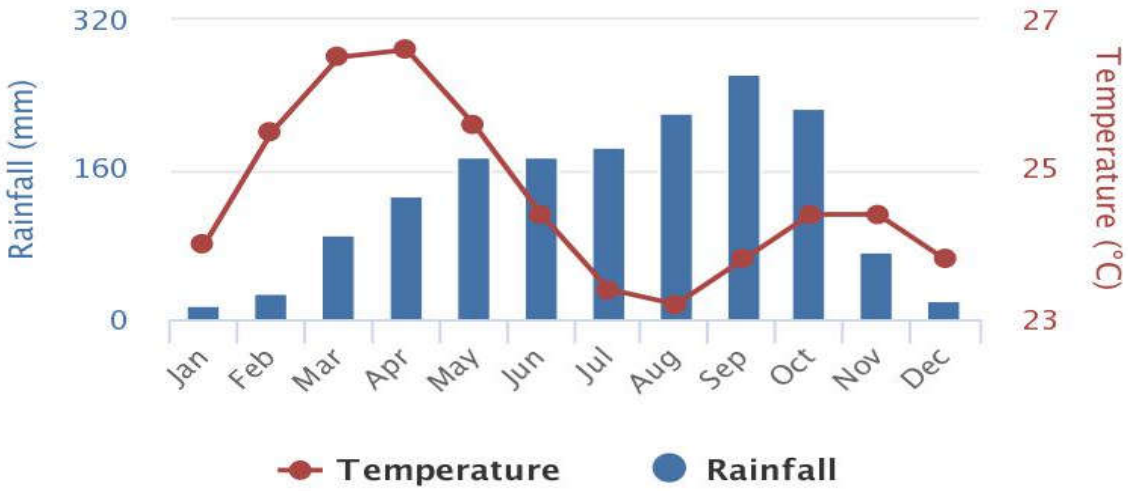

Figure 5: Temperature and Rainfall (From 1990-2015) for Cameroon

Figures 4 and 5, shows the averages of temperature and rainfall data (http://sdwebx.worldbank.org) on Cameroon from 1960 to 2015). According to the World Meteorological Organization, since the start of the twentieth century the global average surface temperature has risen by 0.74 ± 0.18°C, and as seen when comparing the tables, there is a sharp contrast in the changes of temperature most especially through the past four decades. Looking at the data for Cameroon we notice that as for rainfall for the past thirty years that is from 1961 - 1990, the monthly average has been 133.48mm whereas those from 1991 – 2015, which is just over twenty four years has an average monthly average of 130.14mm, lacking by 3.34mm over the next six years to verify if there have been an increase or a decrease. Whereas those of temperature has seen remarkable variations, data from 1961 – 1990 (thirty years period), has an averagely monthly temperature of 24.55^{o}C but data from 1991 – 2015 (twenty four years), now has an average monthly temperature of 24.93 ^{o}C. This shows an increase in 0.34 ^{o}C over the past twenty four years has been noticed for temperature thereby supporting the fact that temperatures have been increasing in Cameroon. The climate system has a direct relationship on human activities *figure 6* below shows an inter-connected relationship of the climate system with all human activities, from drinking to evapo-transpiration.

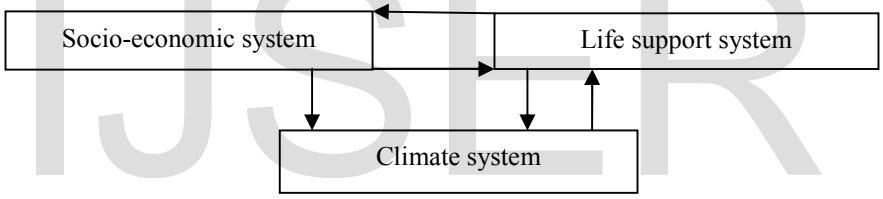

Figure 6: Inter connected relationship of the climate system, socio-economic and Life support system (Climate Change, 2010)

As a result of this direct relationship, the population of Mutengene in adapting to these imminent changes and to accommodate the population increase too, farming has been intensive into the national territories around Mutengene like the *France farmland area* and further into *Tole and Bwenga area.* Also new layouts have been allocated to the population to settle the ever growing population and thereby clearing down of the plantation area. Especially with the little or no coordination of these activities, they inevitably further compound the intensiveness of this climate variability factors for the population which certainly has a direct impact on the water security of the community especially on the spring flow rate.

3.4 Changes in land use pattern

3.4.1 Urbanization and Changes in standard of living

According to WB working paper of 2012, it shows that Cameroon's urban population is approximately 49 percent (7.4 million) of the total population; thus Cameroon is considered a highly urbanized country by

sub-Saharan standards. Mutengene in the early 1970's was predominantly; farming dominated territory and inhabited by farmers mostly from the NWR in particular who came to the SWR in search of greener pastures. Mutengene is located at a cross route linking major neighboring cities such as Douala, Buea and Limbe. This strategic location of the town has made it an easy settlement for many people. The closeness of the town to the industrial zone of *Ombe* and the CDC plantations in the neighboring towns has attracted people from different cultural backgrounds to settle in Mutengene especially as the town is accessible. Thus the town is fast growing into an urban center with people coming from far and wide to seek greener pastures in the plantation or in the industries thereby considerable changing the landscape and land-use pattern of Mutengene for the accommodation of the ever increasing population needing modern infrastructures for the smooth functioning of the community. This increase in population has brought various forms of economic activities to help cope with the demand of the inhabitants. Despite the town not hosting any administrative building within the Tiko sub-division, it is still the major town within the sub-division. Mutengene host the main 'Police Academy and is the main city for the Baptist Pharmaceutical centre and hospital, which are pull factors as they currently employ more than two hundred permanent workers. According to a studies by Glaeser, 2013, examining the link between agricultural production and urbanization, supports the fact that global food supply has reduced the need to develop a domestic agricultural surplus before building cities depending directly on the size of the country. Relating to the case of Mutengene which was basically an agrarian society, has changed over the years and due to the availability of land but this has not hampered her agricultural activities a lot rather has made it more open for others to easily integrate into the society and live in harmony with the rest of the population. The influx of people from diverse background has brought in different cultures and habits thus changing the living conditions of the original inhabitants of the town. The consumption pattern of the inhabitants has changed over the years to one which required products or activities which consumes much water than previous ones. This is seen in the *Table 1* below which shows a list of the major activities the population is involved in for making ends meet. This has also giving way for the creation of small medium businesses to provide services to satisfy the need of the population. All of these people too have increase the demand for water, thereby adding to the pressure for this invaluable resource.

Activity	Percentage on ranking
CDC plantation worker	20.56
Company/ Industrial workers	23.89
Farmers	11.11
Traders/Business people (petite traders) like welding, tailoring etc	8.33
Teachers and Civil servants	12.78
Medical personnel's	9.44
Others	13.89

Table 1: List ranking major activities carried out by the population

3.5 Management practices of the MWSA

The MWSA is made up of a team comprising of the Secretary General, Administrative and Technical bureau and finally the Management bureau comprising of local population as seen below. They are responsible for the smooth running of the system from the catchment areas to the distribution valves.

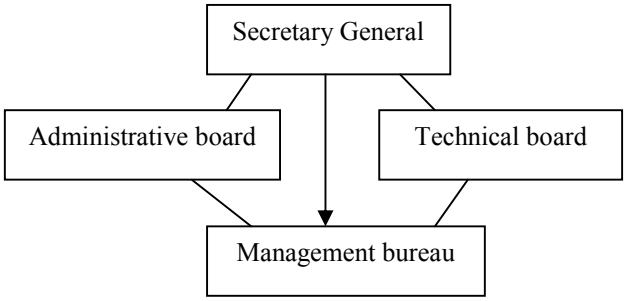

Figure 7: Administrative Bureau Framework

The secretary General serves as the acting chairman of the MWSA. The administrative bureau comprises of three (03) persons, including the secretary general whereas the technical bureau comprises of six (06) persons with little or no experience in the water sector rather put in filial connection to the members of the management bureau. The responsibility of the secretary general is assigning responsibilities and tasks to the various members of the management and operational (administrative and technical) bureau, starting from the catchment to the distribution and the collection of levies.

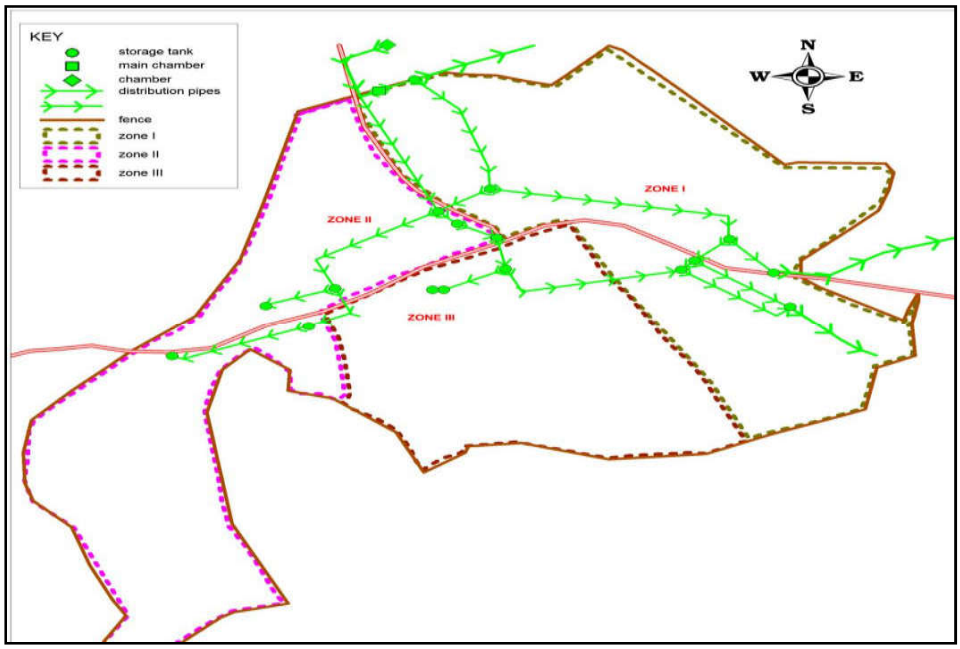

Figure 8: Water distribution network of Mutengene

On a daily basis the technicians are involved in the maintenance and the distribution of water based on the zoning system, within the distribution network. Most have been drained as plumbers, for maintaining detected faults along the network whereas the three (03) of the technicians are in charge with rationing the distribution of water by opening and closing of the valves. Looking at the distribution map and the zoning system of Mutengene, we noticed that the main distribution lines are not evenly distributed making some over populated areas to be supplied with just a single line, thus over-working the line resulting in pressure drop. Also the topographic in not taken into consideration when the distribution lines were established making gravity to interfere in the flow rate of the water within the system resulting many breakages and leakages along the distribution. Finally from the observation within the field, the various diameter pipes affects the flow rate, for the distribution pipes are not to be of the same diameter with those taking water to individual households. Along the distribution networks, there were many areas where the pipes were exposed, as such making it vulnerable for breakage. The rocking nature of the soil makes it difficult for digging deep with rudimentary tools, thus the digging is made shallow thereby exposed for eventual accidents. All of these vulnerabilities and lack of basic knowledge and working tools further compound the Mutengene water security crisis.

3.6 Quality of water

The quality of water can change very rapidly in any given system over a short period of time when the system is subjected to occasional failures as a result to contamination for various medium. The lack of adequate protection measures for the MWS especially around the catchment area may lead to large scale contamination which will subsequently cause high health associated illnesses. Deterioration in water quality during distribution due to leakages have proven to cause adverse health effects to humans, as chemicals and trace elements gets into the system. Thus continuous monitoring and chemical analysis is been carried out especially as very little water treatment is done. Various physic-chemical tests were carried out on the collected samples for verification of the quality, because the community is surrounded with agricultural activities which use a lot of chemicals and pesticides. Thus trace elements and other rare tests were undertaken as seen in the *Table 2* below.

3.6.1 Physico-chemical analyzes

Parameters	Unit	Results		WHO for Drinking-water Quality in third edition (2008) and fourth edition (2011)
		Intake catchment	Sample tap	
pH	pH meter	7.5	7.3	8.2 – 8.8
Temperature	^{o}C	24.0	24.0	25 ^{o}C
Colour	Hazen	2.5	2.0	Not exceeding 5 Hazen units

	unit			
Turbidity	NTU	0.50	0.4	Not exceeding 1.5 NTU
Iron as Fe	mg/l	0.0	0.0	Not exceeding 0.1 mg/L
Aluminium	mg/l	0.03	0.03	Not exceeding 0.10 mg/L
Nitrites	mg/l	0.0	0.0	3 mg/L
Nitrates	mg/l	1.0	0.5	50 mg/L
Fluoride	mg/l	0.5	0.5	± 10% of nominal level (0.5mg/L)
Free residue chlorine	mg/l	0.1	0.1	0.5 – 1.5 mg/L
Arsenic	mg/l	0.00	0.00	0.01 mg/L max

Table 2: Physico-chemical tests carried out at PAC laboratory Limbe

The various parameters analyzed, were for chemicals resulting from the massive usage of fertilizers and some basic properties for quality water. Comparing the values of *Table 2* above, gotten from the analysis carried out in the laboratory to the WHO standard values of 2008 and 2011 shows that Mutengene water is of good quality for drinking. When looking at the values from the two samples used, there is a small variation in pH from 7.5 to 7.3, the exact factor accounting for the drop in 0.2 pH values along the pipe line is not clear. As for the drop in colour from 2.5 to 2.0 and turbidity from 0.5 to 0.4 NTU, these are as a result of settling down of tiny suspended particles which makes these values to reduce. Finally there is a change for the values of Nitrates, dropping from 1.0 to 0.5 mg/L. Generally the reasons for these changes according to our research can be attributed to the types of materials used in the transportation of water and also the brake pressure tanks where water is stopped and allowed for pressure to build along the pipe lines. This sort of activities permits the water to be vulnerable for any sudden change that can be a potential risk to the quality of water. Overall the Mutengene water is of good quality for drinking as compared to those of urban towns like Douala and Yaounde.

4. Conclusion and Recommendation

4.1 Conclusion

From the obtained results, the main reasons for the water security crisis experienced in Mutengene presently is as a result of the rapidly increasing urbanizing population and the drastic drop in the flow rate of the catchment springs which are attributed to the variability in the climate system parameters, that are further compounded by the imminent changing landscape to accommodate the sprawl population through the felling of former plantations for habitation zones. The poor management practices of the MWSA is also a leading contributing factor to this water security crisis which has led some of the personnel to be corrupt and involve in the irregular supply of waters to zones known to host influential or wealthy persons

more than those other zones of less wealthy persons. Therefore, we can conclude that the problem of water scarcity in the town of Mutengene is due to both technical, institutional and management factors.

4.2 Recommendation

This study shows tremendous possibilities for the rehabilitation and improvement on the currently existing water security crisis in Mutengene. For this study recommends the re-examination of the current situation and effective participation of the necessary stakeholders in addressing the imminent water scarcity so as to provide sustainable solutions amidst these variability factors surrounding the Mutengene community. Starting with the education and the integration of these stakeholders and neighboring communities in a participatory approach for resolving this crisis.

REFERENCES

A. BARRIE PITTOCK, 2ND Ed. 2010, *"CLIMATE CHANGE: The Science, Impacts and Solutions"*

Ako, A. et al., 2013. *Nitrate Contamination of Groundwater in Two Areas of the Cameroon Volcanic Line (Banana Plain and Mount Cameroon area)*. Retrieved May 8, 2016, from Journal of Applied Water Science: http://link.springer.com/article/10.1007/s13201-013-0134.

AMCOW, 2012, "*A Snapshot of Drinking Water and Sanitation in Africa – 2012 Update: A regional perspective based on new data from the WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation Cairo"*.

AMCOW, 2015, "*Water Supply and Sanitation in Cameroon: Turning Finance into Services for 2015 and Beyond.*

Brinkhoff, T., "*Population of Mutengene, SOU, Cameroon 2015*". Retrieved June 25, 2016, from quandl: https://www.quandl.com/data/CITYPOP/CITY_MUTENGENESOUCAMEROONpopulation-of-Mutengene-SOU-Cameroon

BUCREP, 2014: *Rapport national sur l'état de la population: Edition 2014.*

BUCREP, 2015: *PROJECTIONS DEMOGRAPHIQUES;3è RGPH.*

Cheng K., Kelly A. K., Renwick D. V., and Yang, S., "*Evaluating Access to Drinking Water in Northern Ghana, 2013"*

Climate variability and climate change and their impacts on Kenya's agricultural sector Mario Herrero, Claudia Ringler, Jeannette van de Steeg, Philip Thornton, Tingju Zhu, Elizabeth Bryan, Abisalom Omolo, Jawoo Koo, and An Notenbaert, 2010

Désiré Tsozué, Bertand Roger Haiwe, Jean Louleo, Jean Pierre Nghonda, "Local Initiatives of Land Rehabilitation in the Sudano-Sahelian Region: Case of *Hardé* Soils in the Far North Region of Cameroon". *Open Journal of Soil Science*, 2014, 4, 6-15. Published Online January 2014 (http://www.scirp.org/journal/ojss) http://dx.doi.org/10.4236/ojss.2014.41002

Edward L. Glaeser, "NBER WORKING PAPER SERIES A WORLD OF CITIES: THE CAUSES AND CONSEQUENCES OF URBANIZATION IN POORER COUNTRIES", Working Paper 19745. http://www.nber.org/papers/w19745, December, 2013

Emmanuel M. Nyambod, "Environmental Consequences of Rapid Urbanisation: Bamenda City, Cameroon". *Journal of Environmental Protection*, 2010, 1, 15-23. doi:10.4236/jep.2010.11003. Published Online March 2010 (http://www.SciRP.org/journal/jep) Copyright © 2010 SciRes *JEP* 1.

Ernest L Molua and Cornelius M Lambi, "CLIMATE, HYDROLOGY AND WATER RESOURCES IN CAMEROON, 2006"

Folifac, F., Tamu, C., and Banseka, H, "*Cameroon Challenges in Kumbo community to improve water supply management 2009" (#364).*

Harris, A., "The Drop in Demand, Climate Change Sustainability". *Engineering and Technology Magazine*, 19 November 2012, pp. 50–51

http://sdwebx.worldbank.org/climateportal/index.cfm?page=downscaled_data_download&menu=historical

Kragt, M., "*Hydro-economic modeling in an uncertain World: Integrating cost and benefits of water quality management". Water Resources and Economics,4*, 1-21, 2013

Kumudu Rathnayaka , Hector Malano , Shiroma Maheepala , Biju George, Bandara Nawarathna, Meenakshi Arora and Peter Roberts, "Seasonal Demand Dynamics of Residential Water End-Uses". *Water* **2015**, *7*, 202-216; doi:10.3390/w7010202

National Institute of Statistics, "Annual Statistic of Cameroon 2011"

The World Bank, "UPGRADING LOW INCOME URBAN SETTLEMENTS COUNTRY ASSESSMENT REPORT CAMEROON", AFTU 1 & 2, January 2002.

UN, 2014: *World Water Development Report 2014, Vol. 1, World Water Day*. Retrieved May 09, 2016, from UNWATER: www.unwater.org/worldwaterday

UN, 2015, August 12; *The 2030 Agenda for Sustainable Development.* Retrieved June 3, 2016, from UN website: http://www.fao.org/3/a-i4997e.pdf

UNESCO, 2006; *World water assessment programme: Meeting Basic needs.* Retrieved May 21, 2016, from UNESCO website: http://www.unesco.org/water/wwap/facts_figures/basic_needs.shtml

Williams, M., "*What Percent of Earth is Water"?* 2014, December 1. Retrieved March 27, 2016, from Universe Today: http://www.universetoday.com/65588/what-percent-of-earth-is-water/

World Health Organization, 2017,"Guidelines for Drinking-Water Quality" Fourth Edition Incorporating the First Addendum