Households perception on water scarcity, distribution, and accessibility in Nyanza district, Rwanda

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Abstract

Limited access to water caused by its scarcity is becoming one of the most serious problems facing several developing countries including Rwanda. For this, understanding the community perception of water scarcity is more pertinent. The purpose of this study is to analyze the household's perception on water scarcity, distribution, and accessibility as well as examining the way communities and institutions deal with water insufficiency in their livelihoods in Rwanda, Nyanza district. A cross-sectional survey was conducted among local communities, local leaders and the institution in charge of water and sanitation (WASAC) where 510 respondents were conveniently and purposively sampled to respond to the questionnaires and interviews designed to collect primary data to be analyzed using SPSS software. Overall, 500 respondents were members of the community and local leaders whilst 10 respondents were staff from WASAC. The results indicated the location of the household (unplanned settlement areas) as one of the major factors that explain the inequality in water distribution and accessibility. As revealed by majority 32%, water supply infrastructure is scarce and deteriorated. Moreover, water scarcity led the community especially female to travel long distances in search of water which generally affects their livelihood. Finally, as ascertained by 46% of respondents, the hilly topographic nature of the district becomes a challenge to WASAC as it hampers the installation of sufficient water distribution networks. This study may be instrumental in tackling the severity of water scarcity issues among communities and therefore, be vital for the institution in charge to increase water services more efficaciously for water accessibility. Moreover, it can serve as a baseline when setting new plans, strategies and policies regarding equity, adequate water distribution and management initiatives in Rwanda as a whole and Nyanza in particular.

Keywords: Households perception; Nyanza; WASAC; Water accessibility; Water distribution; Water scarcity

1. Introduction

Water is a vital aspect for human being and happiness which directly affects economic and community progress (Ahiablame, Engel, & Venort, 2012; Coulibaly, Coulibaly, Sengupta, Savanna, & Umesh, 2013; 2016). About 30% of the global population is now without easy access to water, and most people live in developing countries (Keenan, 2008).

According to POST (2002), an outstanding correlation has been considered among the increase of water request and the ever-growing human demography with development as a global contributing factor. Moreover, there are restricted water sources accessible which increase competition over specific water and decreases its access to the majority of these communities with little household income technology (Montgomery, 2007). Currently, around 750 million people in the world live in utter shortage of access to improved sources of water, mainly in developing countries where social inequality is even more intense especially in the Sub-Saharan countries of Africa (Aleixo, Rezende, Pena, Zapata, & Heller, 2016).

According to Lambert, Brown, Takizawa, and Weimer (1999) in the mid of this century, water scarcity will have an effect on 2 to 7.2 billion people. Nevertheless, water organization and protection practices in developing countries is not satisfactory due to the increasing global development challenge. The main burden is therefore placed on people in developing countries (Lenton, Wright, & Lewis, 2005).

Rural areas in developing countries are frequently disregarded in the provision and distribution of water facilities and where such facilities exist, they are seldom completely utilized (Briscoe & Ferranti, 1988; Nyong, 2001; Sharma et al., 1996). The policy of water delivery, which leads to unequal allocation further, limits people's access. However, poor governance and issues surrounding water distribution, management, the way it is extracted and collected from its sources make its availability challenging (Okechi, 2015).

From the same perspective， Bakker, Kooy, Shofiani, and Martijn (2008) worried that if the universal water sources stayed properly used the delinquent of access to water would be an issue at stake for the past. Today's water crises are no longer caused through the fact of having too little water to fulfill people's desires however instead, a crisis of poor water management that billions of human beings do not access it (WHO/UNICEF, 2004). Nowhere is this more outward than in Africa where negligence and corruption by establishments, the nonexistence of appropriate organizations, organizational inertia and a lack of new and adequate funds in building human capacity and infrastructure have restricted people's access to water (Berry, 1993).

As evidenced by UNDP (2006), water distribution and accessibility policies have produced four fascinating results: countries with enough water and the direct connection of people to water; countries with adequate

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water but not the direct connection of residents to water; countries with sufficient water still have the direct connection of residents to water; countries without the direct connection of water and residents have no direct connection to water. However, distinct countries have observed specific paths in ensuring water availability and accessibility(UNDP, 2006).

The East-Africa region is continually offering a case for support. It has one of the largest water access charges, though it has severe water sources and a major internal renewable water supply within Africa (Okechi, 2015). Despite this huge water resource availability, the rivers' network and groundwater sources are mostly untapped, and very slight water is reachable to the population. This testifies that the availability of water does not directly translate to the citizens ' accessibility of water.

In the distribution and accessibility of water, several gaps or challenges are known. Urbanism and water scarcity are challenges, particularly in developing countries (Montgomery, 2007). Fast urbanization increase in developing countries is critically exceeding the likely of utmost cities to offer sufficient and enough water to their local residents (Cohen, Gaetani, Lundälv, Corliss, & George, 2006). Due to population development, growth and irrigation needs for agriculture reasons, water usage increased significantly in the last 60 years (Moe & Rheingans, 2006). Another known deficiency is improving the sustainability of community water programs which are mostly susceptible to many financial and institutional attitudes (Pruss-Ustun, 2008).

Rwanda is a country with restricted access to water, similar to several developing countries (McNulty, Mack, Sun, & Caldwell, 2016). There are factors that make the fact to be contradictory. On one hand, the area is recognized to be located in the great lakes' region. In different words, water is abundant (Rubogora, 2017). Generally, Rwanda has large water resources as a developing country. Its rivers, lakes and underground water sources have sufficient water in the structure of aquifers to serve its population. The country's main rivers and lakes have sufficient water to fulfill its water needs. Thus, given the extensive variety of rivers and lakes in the region, there should be no water scarcity (Reference). However, only a small percentage of Rwandans have access to water. Water accessibility is restricted even in the major city of Kigali and various major districts across the country including Nyanza. More vital for Rwandan peoples' access to water does not appear related to its availability or nearness to a water source. The water crisis that has been facing Rwanda in the previous years that caused a water rationing program is due to little water provide and low potential of infrastructure with the monopoly of institutions in its distribution. The infrastructure was firstly designed to cater for 350,000 people, yet the town has since grown to 1.2 million people making the sources as well as infrastructure strained and unable to provide for the huge numeral of people (kiganda, 2017). Additionally, issues concerning water for consumptive use in Rwanda include shortage, growing water supply costs, difficulties to access water sources, pollution of current sources, insufficient management

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of water resources, unsustainable policies and programs, and insufficient education among others.

Recently, residents of Nyanza district have raised challenges about water scarcity, a dry spell result in the area. These latter argued that, in the rainy season, they generally get water from the rivers, which sadly gets dry in the dry season. Consequently, they have to walk over kilometers to access water whose excellent quality is also determined suspicious (Newtimes, 2015).

From all the above-mentioned drawbacks, understanding community perception on water distribution and accessibility is increasingly more pertinent to tackle the severity of the problem amongst communities across Rwanda, and therefore be vital for the authority's incorporation with the institution in charge to control and increase water services more efficaciously for maintainable water accessibility and availability in the area. As objectives, this study aims to: 1) identify the major factors associated with inequalities in water distribution and access, 2) assess the impact of water scarcity on the livelihood of the community and, finally, 3) analyze the main challenges facing the Water Sanitation and Corporation in water distribution in the study area.

2. Materials and methods

2.1. Site description

This study was carried out in Nyanza District in the Southern province of Rwanda. The district is subdivided into 10 sectors namely: Busoro, Busasamana, Cyabakamyi, Kigoma, Kibirizi, Muyira, Mukingo, Nyagisozi Ntyazo, and Rwabicuma as shown in Figure 1. The geographical coverage of the district is 671.2 km^2 with an estimated population of 233, 669 inhabitants (estimates of 2012 general population census NISR 2012). The population density is about 342 inhabitants per km^2. The altitude ranges between 1300 and 1,800 m. Ideally, Nyanza District is placed in the tropical region with humid climate and normal annual temperature of 20^oC that affects precipitation patterns. The main economic sector in the District is the rain-fed agriculture providing the major proportion of employment to the population (estimate of about 90 %) similar to most parts of Rwanda. The main food and cash crops cultivated include coffee, maize, rice, beans, and cassava. The soil is generally fertile, but productivity has declined excessive exploitation over recent years and irregular rainfall. Depending on the Newsofrwanda (2012), Nyanza is a district that was alleged to have a serious problem with water

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shortages that affects local residents in the sectors of Busoro, Ntyazo, Muyira, and Kibilizi in particular.

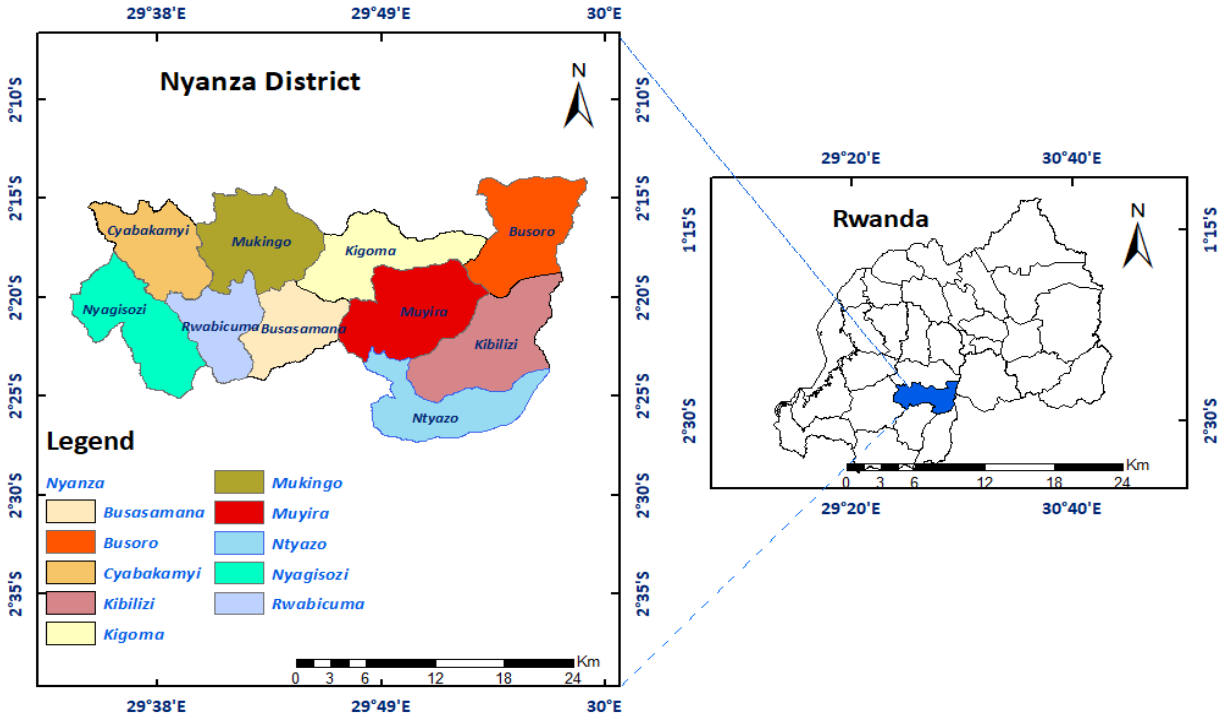

Figure 1. Location Map of the Study Area (Nyanza district)

2.2. Methodology

The current study used both primary and secondary datasets. Primary data was obtained through observations and structured interviews with communities representing institutions dealing with water. The aim of applying the designed interview was that some of the respondents designated in the study were individuals with other tasks. This expresses that it might be hard for them to have enough time for answering the questionnaire. In order to collect the data from the selected respondents, a standard survey questionnaire was also administered. Secondary data sources included journal articles, policy papers, reports of various years, nongovernmental reports on water, records from the Water Company, books and other internet sources.

Quantifying public opinions through surveys requires complete randomization so that each individual in the population has an equal

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prospect of being designated. Due to the organization and availability of the communities, completely random sampling at the community level in the Nyanza district was not possible. Therefore, convenience sampling, a nonprobability sampling technique, was used to select the households (Ross, 1978). To reach arbitrary samples in the framework of the ease survey, we used own finding to select households that are spatially dispersed to cover the entire study area and exploit the chances to capture diverse comebacks on the subject matter during the study while respecting the local cultural context. In general, a sample of 500 members of the community was drawn such that in each sector, 50 participants were selected. However, to be certain that the necessary water contexts are measured, the study selected respondents per sector and different members of water sanitation and corporation (WASAC) in Nyanza district. Hence, within WASAC, the study purposively surveyed 10 staff including the head of water distribution. Note that this study was conducted right in summer when the dry season in on pick. Therefore, the observation was based on facts that there were queues and lines of individuals who were at various natural water sources in Nyanza district. During the survey, adult men and women, having varying age were surveyed. Finally, the primary data collected amongst respondents through in depth-questionnaire were edited and coded into frequency and percentage, then analyzed using the Statistical Package for Social Science (SPSS 25) for Windows.

3. Results and discussion

This section describes the study findings from respondents per each objective as well as its discussion in relation to different previous studies.

3.1. Social demographic characteristics of respondents

Factors including social demographics and prior experience among others have been studied and considered for individual perception to different information (Jacoby, 1978). Therefore, the profiles of respondents on gender, age, marital status, level of education, and occupation were analyzed (Figure 2).

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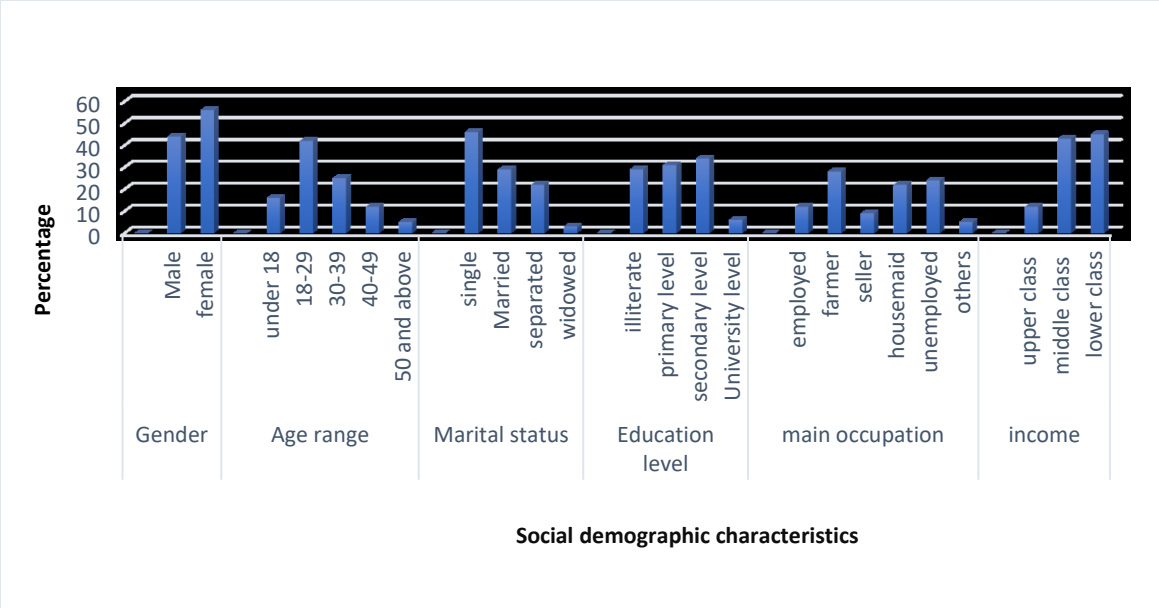

Figure 2. Social demographic characteristics of respondents

In general, age is important to the use and demand for household water (Darr, Feldman, & Kamen, 1975; Kithinji, 2015). The results indicate that for water users who participated in the study, male corresponded to 44% while women were 56%. This result was in line with the study conducted by Ariyabandu (2003) and DFID (2003) stipulating that the effect of collecting water from traditional sources (particularly through the dry season) takes its toll on the livelihood opportunities of women and girls while their demand for water is higher than men. In Rwanda, males move out in lookup of jobs in the morning, whereas females are responsible for domestic duties, including searching for water for domestic use, reflected in this study by the observed gender disparity.

In addition, age classification varies from location to time, in several cases, this reflects the differences in social class or functional capacity of the workers (Twagirimana, 2014). Based on this, the age ranges in this study was categorized from under eighteen years old to over fifty years old. 16% of the total respondents were found under eighteen years of age, 42% between eighteen and twenty-nine 25% between thirty and thirty-nine, 12% between forty and forty-nine and finally 5% was above fifty years of age respectively. Moreover, concerning the marital status of respondents, single respondents were the majority corresponding to 46%; followed by 29% of married respondent. The number of respondents with separated status corresponded to 22% and finally, only 3% of respondents argued that they were widowed. In terms of education level, about 29% of the respondents had no

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formal education, a further 31% only attended primary education, while 34 % which was the majority had secondary education and the remaining 6% had university level of education. Nyong (2001) argued that the high rate of population growth, prevalent level of poverty and education level particularly among women and the declining water availability have strong implication for maintainable water resource development which is almost the case in Nyanza district due to the insufficient level of education of respondents observed from the majority. 45% of respondents have been classified in this district as low-income communities, while 43% were in the middle class and 12% were a high class in terms of income. The fact that people with the lowest income are poorly educated undermines their understanding of bureaucratic processes in water management. This implies the ability to understand and participate in the information. Finally, results also indicated that 12% were employed in different institutions, 28% are farmers, 9% were sellers of different products, 22 % were housemaids, 24 % were unemployed and students while 5% of respondents represented other occupations (Figure 2).

3.2. Determination of factors associated with water distribution inequalities and accessibility

Rwanda is heavily blessed in terms of water but largely untapped with water resources (Newsofrwanda, 2012). Despite the abundance of water resources, the government was unable to successfully connect these resources to ensure sustainable and equitable access to adequate, sufficient, improved and inexpensive water supply for its population. The results of local household perceptions during this phase discuss various factors related to the disparities in water distribution and accessibility.

3.2.1. Distribution of household's based on their location

The household's location can affect water distribution and accessibility in a region (Jackson et al., 2001; Zondag & Pieters, 2005). The household dispersal according to their locations is presented below (Figure 3).

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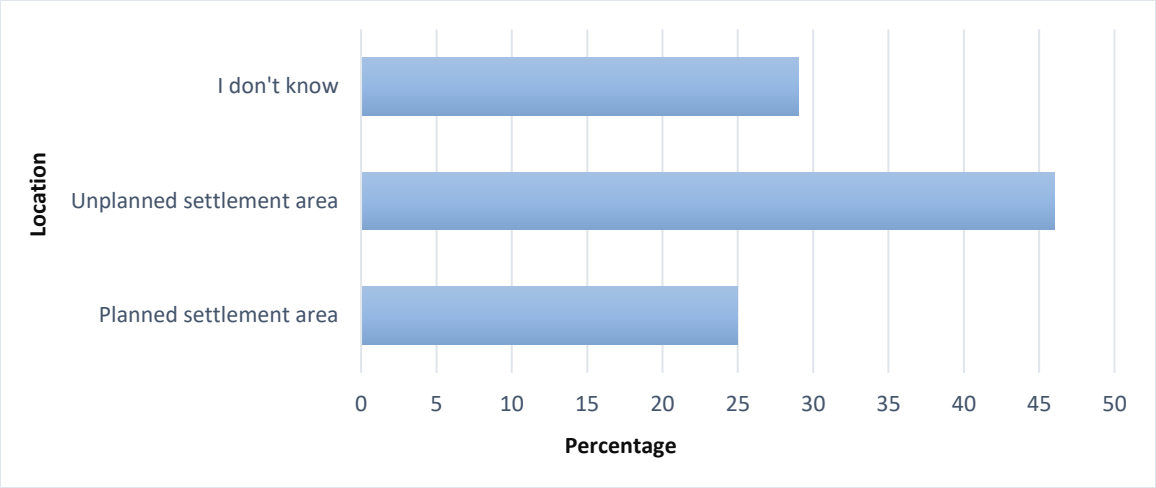

Figure 3. Location of the households

In relation to household location and water access (Engel, Iskandarani, & del Pilar Useche, 2005), housing location was found to be one of the factors that significantly explained differences in water distribution and access. The results as illustrated in figure 3, shows that most of the households live in the unplanned area, as the majority of respondents reveal 46%, whilst 25% live in a planned area. The remaining 29% of respondents revealed that they did not know whether they live in a planned or unplanned settlement area. this result corroborates with the study conducted by Mahama, Anaman, and Osei-Akoto (2014) who argued that households in slums and unplanned settlement areas are more likely to have limited connectivity to piped water partly due to the chaotic nature of their settlements. Often, poor communities ' water is hardly included in urban and regional settlements planning, which ultimately affects households in terms of access to water services that communities live in a planned settlement area. Same in this study, in most cases, due to their income level (Figure 2) which push them to reside in unplanned settlement area, people are almost never directly linked to the public utility because they face inappropriate administrative procedures when it comes to connecting them to official water sources partly because of nonexistence of security guarantees for land and pipelines as well as the complications of affordability. Certainly, their places of residence serve as a fence to getting access to water facilities because of undeveloped infrastructure networks. For example, in some places, road accessibility is always poor, and this implies complications in the wastes' removal. Hence, it becomes very tough for households in these expenses to get connected to these services.

3.2.2. Community perception of the Current Trends of water availability and accessibility

The availability and accessibility patterns of water in an area can be used to indicate water

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scarcity and can influence the perception of water distribution (Carney, 2003).

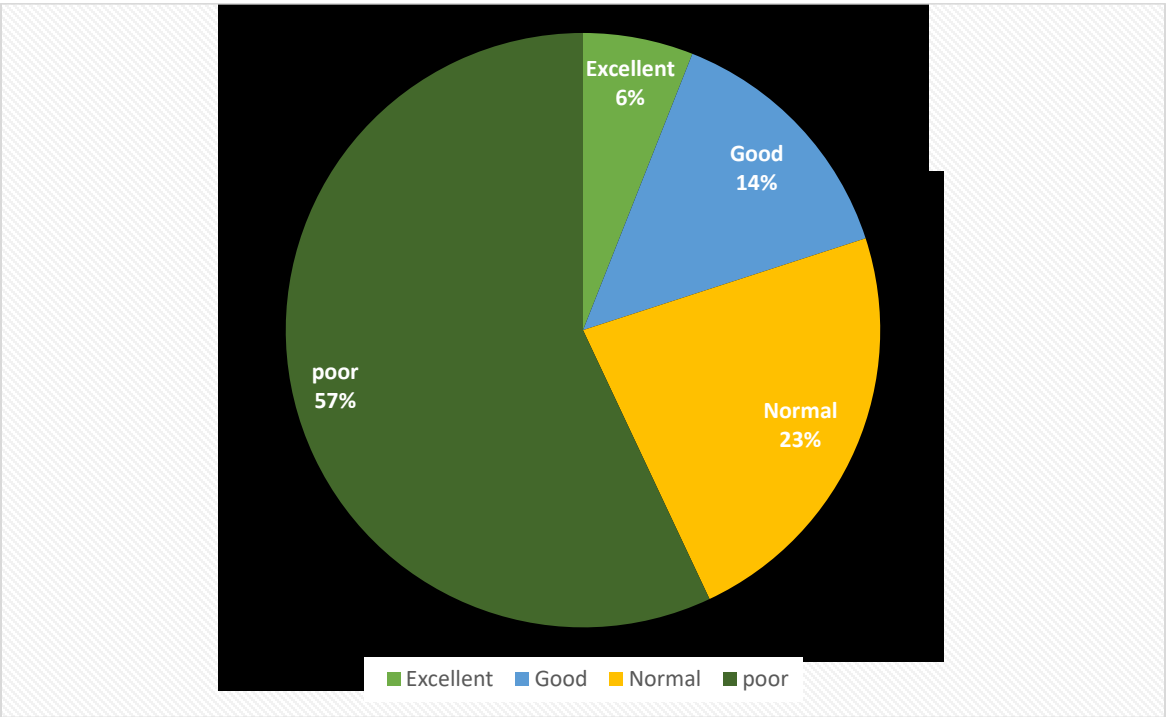

Figure 4. The Current Trends of water availability and accessibility

The outcomes of household perceptions showed that water is available and accessible at a poor rate in the district. 57% and 23% argue that water is available and accessible at a normal rate. Furthermore, 14% of households confirmed that they receive and have access to high water levels while only 6% said that the availability and accessibility of water were excellent. This majority highlights that water in this area is scarce in one way or other because of its poor availability and accessibility, which can also lead to poor affordability. Normally, this situation could be linked to where households living in unplanned settlement areas do not have a piped infrastructure for easy access to available water (Figure 3)

3.2.3. Households perception on the rate of equitability of water supply and distribution

Inequality in household access to water can lead to variances in the way in which each household perceives the accessibility of water and its way of delivery or distribution in the area (Carney, 2003; Chambers & Conway, 1991).

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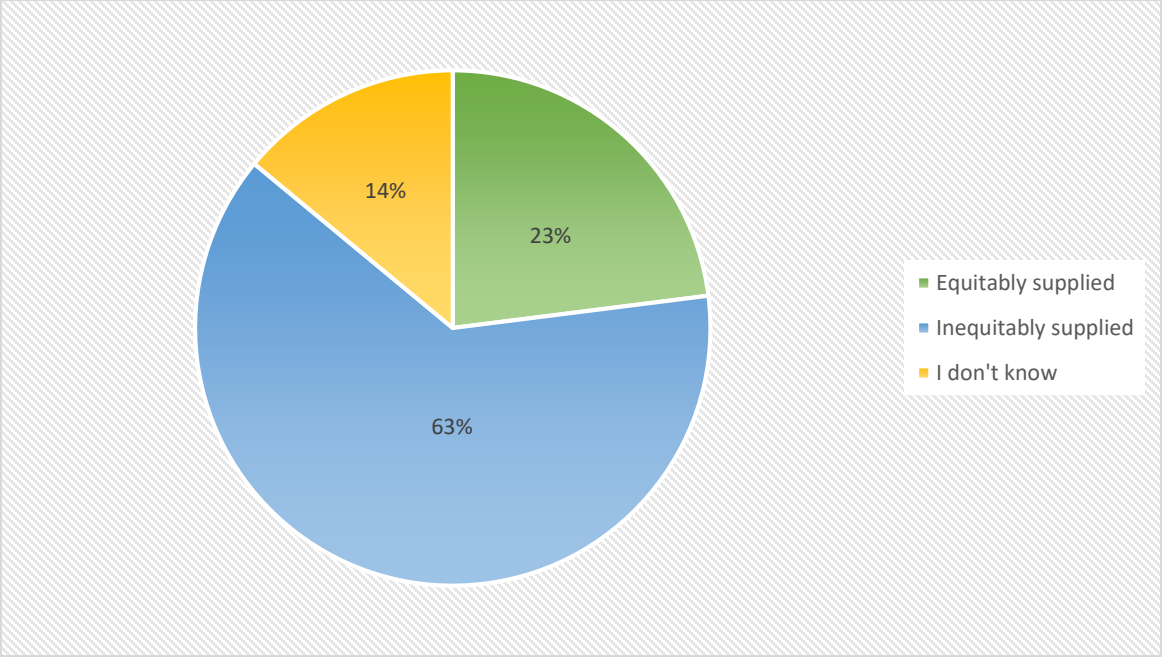

Figure 5. The equitability of water supply and distribution

The results as revealed by majority of respondents (63%), showed that water is inequitably supplied and distributed to the community while 23% of households mentioned that it is equitably supplied and distributed; and finally, 14 % did not know about water supply and distribution issue.

Due to the findings of the majority, it can be confirmed that water is not evenly supplied and distributed in this district. This result is in contrast with the human development Report (2006), the UN Committee on Economic, Social and Culture in a study conducted by Mehta (2006) specifying that water is a vital right entitled to adequate, clean, acceptable, physically accessible and equally, available and accessible for everybody's personal and residence use. This contradiction still reveals and can be used as

an indicator of the district's water shortage problem.

3.2.4. Household's perception of the factors associated with the inequality in water supply and the distribution

Water availability and accessibility of present communities are associated with various challenges. These challenges seem to be due to various factors that create a disparity in the dispersal of this resource to the community. Some factors as revealed by households are presented below (Figure 6).

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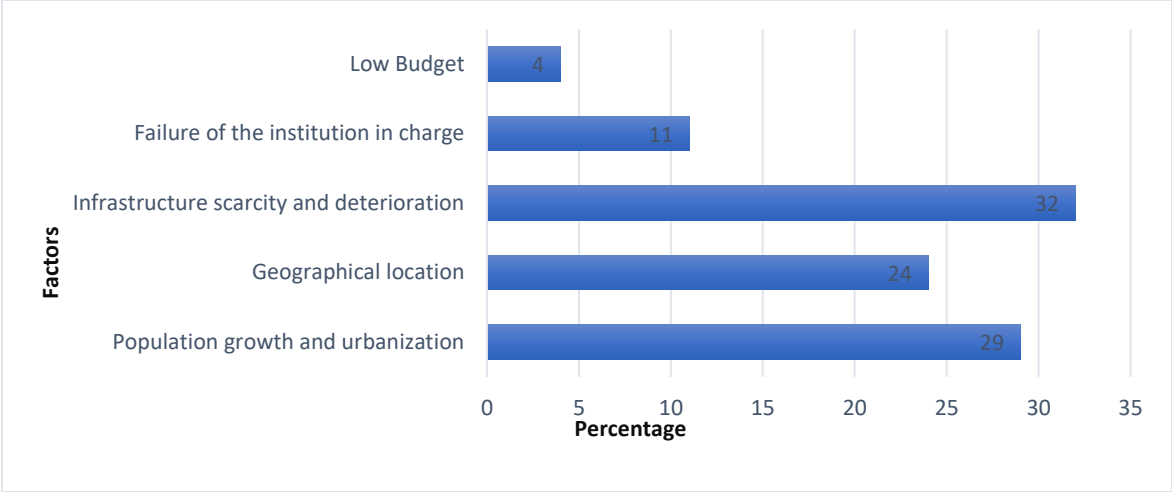

Figure 6. Factors associated with the inequality in water supply and the distribution

The difference in perception has crucial relevance to the household's reactions when expectations cannot be met and can influence household water-use patterns (Nyong, 2001). Majority (32%) of respondents mentioned that the facts that infrastructure that supplies water has been deteriorated cause them to have poor and low availability of water (Figure 4) and result into the inadequate dispersal of this resource. Furthermore, 29% said that population growth and urbanization largely contribute to the poor supply of water while 24% argued their geographical location affects them in terms of water distribution and accessibility. Besides, there are other respondents (11%) who argued that the problem of inequality in terms of water distribution and accessibility is caused by the failure of the institution in charge of water supply (WASAC) and finally 4% said that water supply sector is provided with insufficient budget in the annual national budget allocation.

As above pointed, some households claimed that water deficiency is due to the weakening of water supply infrastructure. This finding was in conjunction with that of M. Kjellén (2006), who stressed that the infrastructure for water supply that was largely installed long ago not only suffers from under-maintenance and old age but also the challenges of supplying water to the population larger than it was originally set up to serve. During the surveying process, it was noted that water infrastructure along the roads has become too old, poorly functioning and insufficient, uncovered and much of them leaking from the pipes. The predominant water demand within Nyanza district cannot cope with all these problems. Furthermore, population growth is a factor that is generally challenging when talking about water supply (Falkenmark & Widstrand, 1992; Vörösmarty, 2000). The present study area mostly suffers from population growth which is challenging because it compromises with the social services needed including water supply. This situation confirms the result obtained from the current research since respondents argued population increase as one of the main factors that accelerate water shortage and unequal distribution in the household's locality. Furthermore, in various areas of the district,

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water supply services fail to meet population demand and available water sources such as boreholes, local wells do not meet international standards as agreed by the World Health Organization (WHO).

Nyanza's geographical location is a major obstacle to water sources (Newtimes, 2015; Republic of rwanda, 2013-2018). Due to the inadequate dispersal of water and the fact that several areas are not naturally and geographically well located, not everyone in this district has full access to adequate water. Consequently, due to the geographic location of the household, it is too expensive to provide every household with water supply because homes are so widely scattered and other families are still living on hilly and steep zones, mountainous areas with low incomes making them find it difficult to fund or maintain a water supply. Though water is a fundamental right for humans (UN, 2014), some of the populations in Nyanza District live in unplanned settlements (Figure 3), where most inhabitants of water supply and quality are living in miserable poverty (Agarwal, 2013). These areas of settlement are not officially linked to the water pipeline network.

3.2.5. The impacts of water scarcity on the community's livelihood

The topic identifies the impact of water shortages on community livelihoods in the district of Nyanza owing to the myriad water shortage challenges.

a. Confirmation of respondents on the shortage of water

Starting with the study, the respondent revealed information about whether or not there was a deficiency of water in the district. Two options (Yes and No) were provided to show that water deficiency in this district is a real problem.

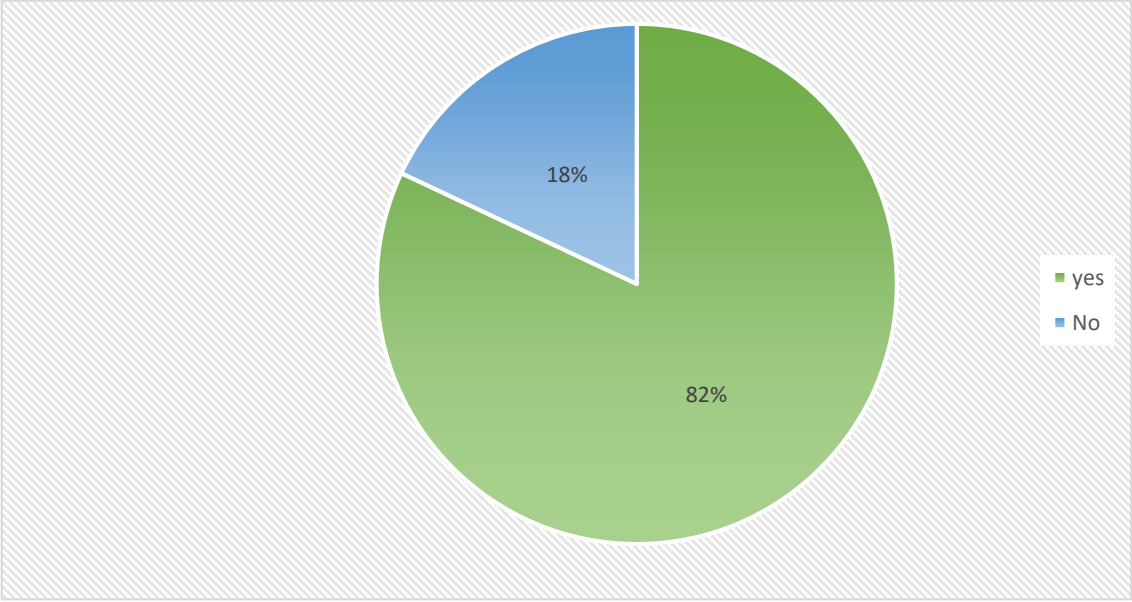

Figure 7. Distribution of respondents who reported a shortage of water

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As disclosed by 82% of the respondents, the majority agreed on water scarcity in the district. Thus, only 18% mentioned the availability of water. The results enable the valuation of the various effects of water scarcities on the livelihood of the community in the district under investigation.

b. The major sources of household water supply

After knowing whether water shortage was a problem in this district, the study sought to know the major sources of water in the area.

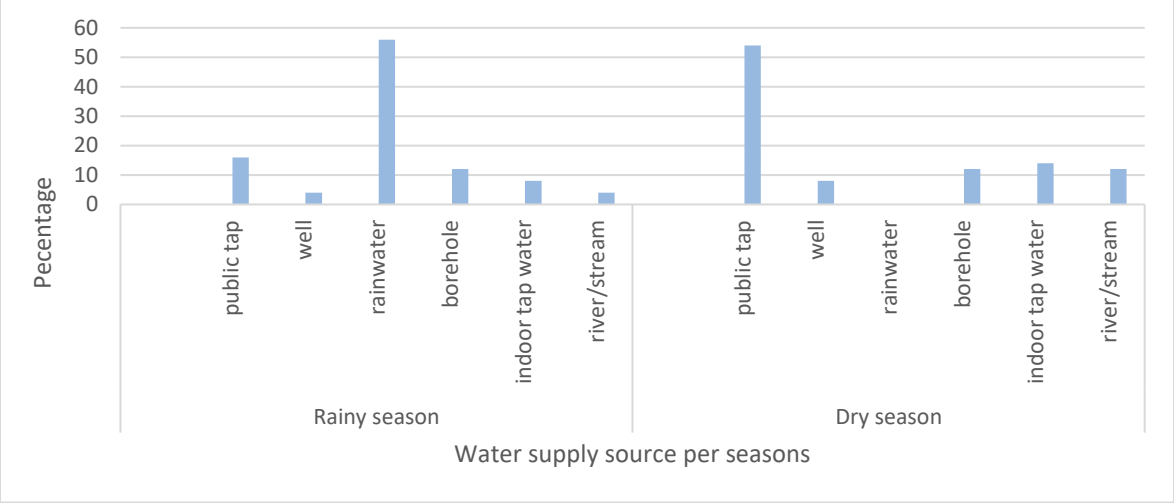

Figure 8. Illustration of major sources of water supply based on seasons in Nyanza district

There are various water sources available in Nyanza including public taps, indoor taps, boreholes, rainwater, dug wells, rivers/streams. Because of seasonal variations, the use of these sources varies accordingly. The results of the present study, as reveal by majority of households (56%) show that rainwater is the main source in the rainy season, while this source contributes nothing in the dry season, primarily because of the absence of rainfall. About 16% and 54% of households get water from public taps in rainy and dry season respectively. Another source of domestic water in the study area, is borehole, a main source of water for household activities during the dry season peak. In rainy and dry seasons, they contribute to 12 and 28 percent of household water supply. Responses also showed that 4% and 8% obtain water from dug wells during the rainy and dry season. It was therefore observed that most of these wells were thoughtfully covered and protected. Rivers/streams contribute only about 4% and 24% of water supply to households during the rainy and dry season. Similarly, it has been found that households with their own taps (indoor taps) were insignificant because only 8% and 14% of the households get water from their own taps during the rainy and dry seasons. These results implicate that boreholes, public taps and river/streams are the main sources for water during the dry season as they were mentioned by the majority while the community depends on rainwater in the rainy season. Generally, access to a source of water in this district does not require a connection of the household but

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instead, a source of water is available within the district. For households, self-reported better access to water was associated with proximity to the source and, to a smaller degree, with using more public or shared sources.

As previously argued by Arouna and Dabbert (2008) in their study, the seasonal variations play a part in the availability and accessibility of water. As such, in this study respondents argued that water accessibility and availability from these sources (Figure 8) is unpredictable in the dry season because, during this period, only water from cavernous aquifers is available, and the public boreholes and wells penetrate only into the average aquifers. In the surveying process, households attributed the low availability and accessibility of water in public wells and boreholes to their low depth. Moreover, during the rainy season, most of the households highlighted that rainwater is their most common source of water, although even during this season they still claim water is deficit because there are no sufficient storage facilities in their homes that can be used in the rainy season. In a research conducted by Kahinda, Taigbenu, and Boroto (2007) and Abdulla and Al-Shareef (2009), it was said that households without water tanks or another effective means of water storage during rainy season are affected by water shortages but in this study, the fact was different because it was revealed that rainwater is harvested using cooking pots, wash basins and small tanks of 100 liters (when available) and it would be put into immediate use. This result marked that even the respondents play a part in the deficiency of their domestic water outstanding to poor harvesting when water becomes available. This situation is exacerbated by their economic status to access the required water tanks with enough storage capacities.

3.2.6. Reasons why households use water

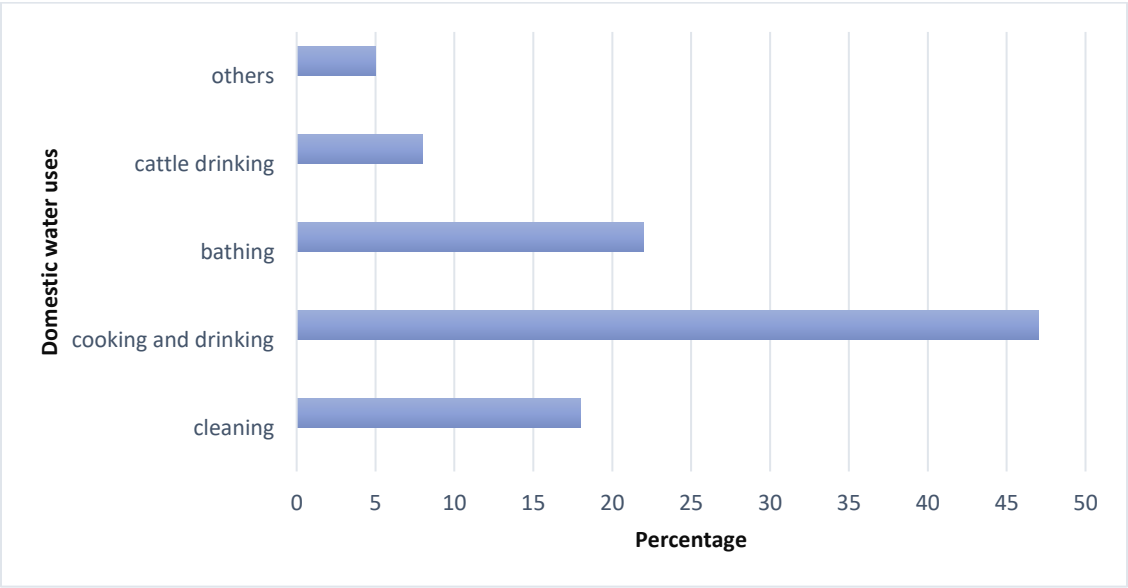

Figure 9. Domestic water uses by household

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Majority 33% of the respondents argued that they rely on a water primarily for cooking and drinking while 22% and 18% said that they use water both for bathing and washing. Additionally, 8% of respondents mentioned that water is also used for their cattle drinking and finally 5% indicated other different activities in their daily life.

The reduction in the extent of water that households use for different activities is an indication of their change to water deficiency (Nyong, 2001). The impacts of water scarceness are more acute in the dry season in Nyanza district. This implicates that the scarcity of water will directly affect the above-mentioned activities. Based on the activities pointed by majority, the lack and scarcity of water will in one way or another affect their cooking and drinking system where some families will change their eating system and sometimes will be observed a delay in their eating time because of fetching water to a long distance and time spent to the water source (Figure 10).

Regarding bathing and cleaning, water scarcity confirms the near absence of household cleaning activities which imply poor sanitation and hygiene with different health implications, especially to female. Some respondents stated that they had their bath about twice a day when there is water, but the situation is different when there is a scarcity of water because they start bathing only once a day or have no complete bath at all and this can have a serious health impact as far the well-being and social welfare is concerned.

Note that these impacts are mostly observed during the dry season because in this period water scarceness has become a normal situation for households. In the rainy season, the situation is different due to the availability of rainwater where even farming is an activity that can be added to the above revealed (Figure 9).

3.2.7. Distance traveled, and time is spent for water collection

All are entitled to access safe and equitable amounts of water for drinking, cooking and other domestic purposes. Water stations should be close enough to households so that the minimum water supplies can be used to indicate availability and accessibility of water in an area (Gleick, 1996; G. Howard, Bartram, Jamie, Water, Sanitation, World Health Organization, 2003; Team, 1993).

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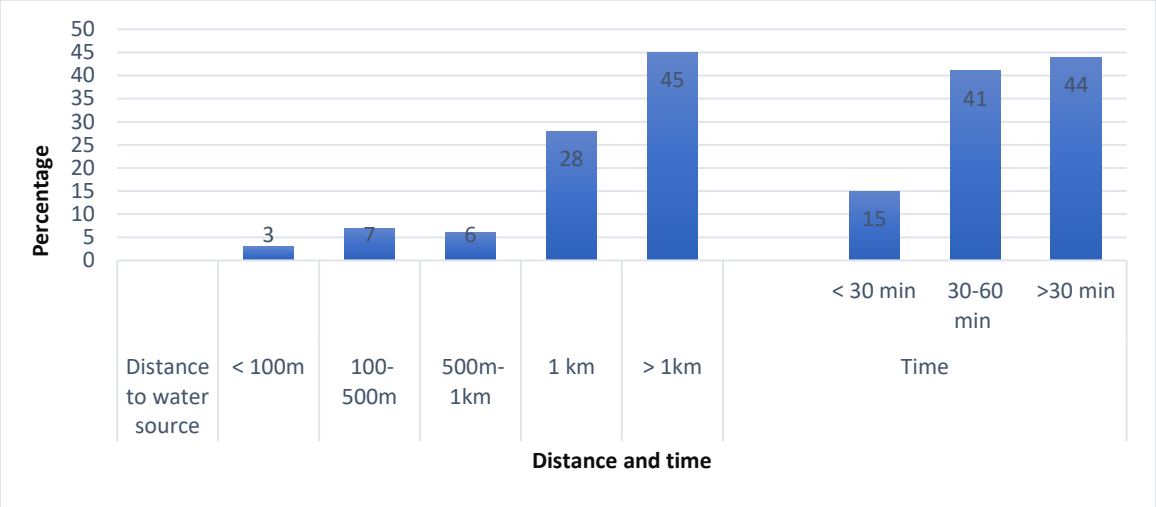

Figure 10. Distance to water source and time spent to collect water

The majority 45% and 28% of household in this study were not connected to any water pipe leading them to fetch water in one and over a kilometer of distance, respectively while 6% mentioned that they travel a distance between 500m and 1km. furthermore, 7% and 3% argued that their sources of water were not far from their locality and only travel a distance between 100m and 500m and others own their private water source in their locality which is less than 100m of distance respectively. Concerning the time, the findings showed that the further households are going to collect water, the longer the time spent for going and coming back. Therefore, majority 44% of respondents said that it takes more than an hour to collect water while 41% argued that they spend time between 30 minutes and an hour. Lastly, only 15% revealed that they only spend less than 30 minutes. These results have shown that the time spent collecting water is confirming that the community living in the district of Nyanza cannot easily access enough water.

The access by the community to water is a crucial development element and a crucial element of the Millennium Development Goals and Sustainable Development (UN, 2014). Many households in the developing country lack pipe water or access to nearby community water sources, especially in rural areas in sub - Saharan Africa (WHO/UNICEF, 2014). Moreover, in a study conducted by G. B. Howard, Jamie Water, Sanitation World Health Organization (2003), it is stressed that distance is a key issue in determining access to water and its distribution. The further away the source of water is to a household, the lesser the amount of water consumed. For instance, in areas where people walk for more than one-kilometer spending over 30 minutes collecting water.

As the results show (Figure 10), long distances from an improved water source like a public tap, boreholes and natural sources of water, especially during the dry season, are often traveled through the households to collect water. The Joint Water and Sanitation Monitoring Program of the World Health

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Organization states that water access means the source is less than 1km from its useful place and that at least 20 liters can be obtained reliably per household member a day (Cairncross & Cuff, 1987; WHO/UNICEF, 2013). The above statement was in total opposition from the results obtained in this study as it was found that people walk more than a kilometer and spend more than an hour for water collection which is an evidence of water scarceness in Nyanza sector.

3.2.8. Distribution of respondents by water collection responsibility

The study also required to know who was responsible for the water collection in the household. The question, who is usually going to your household to fetch the water was asked during the survey.

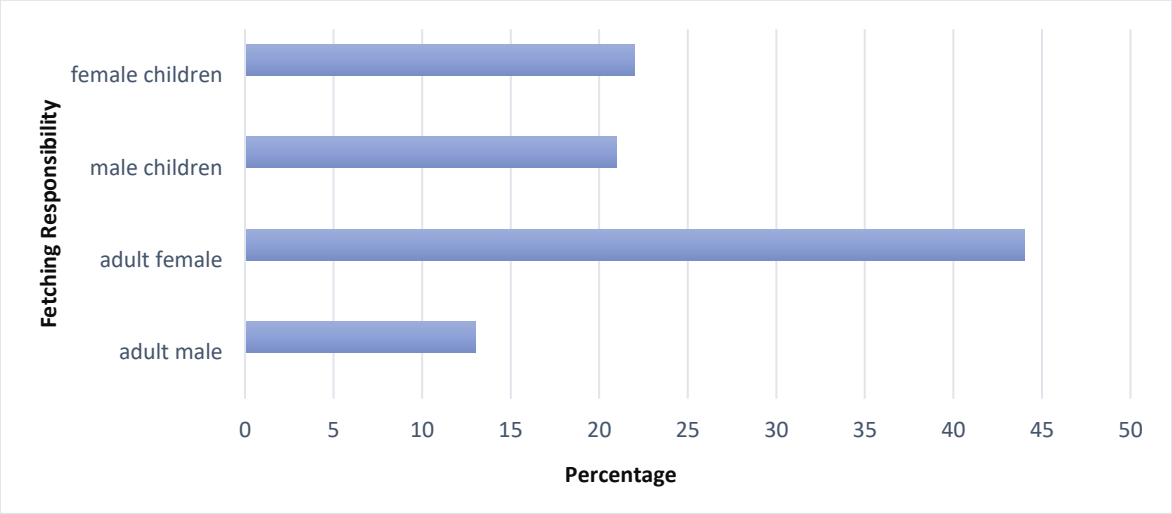

Figure 11. Responsibility of fetching water in the household.

As mentioned by 44 percent and 22 percent of respondents, it was noted that adult females and young females bear the greatest responsibility to collect water for their households. The young male followed with 21 % and lastly, only 13% represented adult male as responsible for collecting water for the house. In the past literature, it is stressed that women are primarily responsible for the collection of water (Crow, 2002; Nyong, 2001; Stevenson et al., 2012). The general view is that in rural areas of developing countries, females are the main collectors of water. This is confirmed by the results of this study, in which adult women and young women were the main domestic water collectors (Figure 11). With the same point of view, the African water development report as quoted by Alaci and Jiya (Alaci, Jiya, & Omata, 2013), poor access to water and the attendant water scarcity affect women and girls disproportionately with the situation is worse in rural areas due to institutional and cultural barriers, including those of inequalities in rights, decision-making power, mindset and responsibilities over water for productive and domestic activities.

Kithinji (2015), described women's role in domestic water use by noting that they are responsible for making sure that their families have a day - to - day water. They

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suffer as a result of their role as domestic water supplies, cares and managers of the houses when resources are scarce.

3.2.9. A general review on experienced problems and impacts of water scarcity and accessibility on the community's livelihood

Combined all the issues involved, all problems affecting the livelihood of the community have been revised in general as a result of water shortage and its availability in the Nyanza district. Thus, below is presented the most experienced problems as exposed by the respondents.

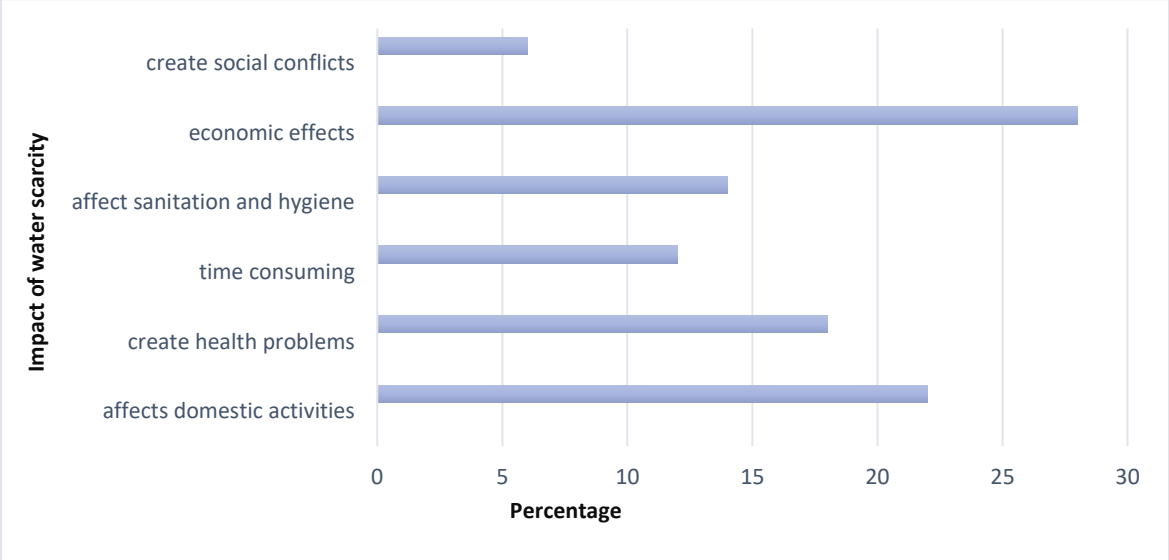

Figure 12. Perception of households on the impacts of water scarcity on their livelihood

Majority 28% of households declared that water scarcity and its accessibility has created economic impacts followed by 22% who declared that water shortage always affects their domestic activities. Furthermore, the scarcity of water has increased health problems; poor hygiene and sanitation as mentioned by 18% and 14% of households respectively. Additionally, 12% argued that the search of water consumes their time for other activities and finally, this problem creates various social activities as argued by 6% of households.

As illustrated in Figure 11, females bear most of the burden of water scarceness and accessibility as they are the major collectors of water. This clearly confirms that they are the ones who mostly experience, understand better and suffer a lot from its negative effects. The way these impacts (Figure 12) affects their livelihood is as summarized below:

a. ***Economic effects:*** Land and water resources management is essential to livelihoods in the community but rural development decreases without them (Isaac, 1995). Generally, the economy of Rwanda relies much on agriculture and as mentioned earlier agriculture is the primary source of income for a clear majority of the people in Nyanza district. The agricultural sector is the main

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vulnerable economic sector to water scarcity in this district. Consequently, this condition is causing the collapse of agricultural productivity which further lead to the crisis and unemployment according to households questioned. However, with this socioeconomically struck in the district, households managed to avoid famine, household fragmentation through migration and local conflict between owners with wells and without. To summarize further; there are dominant outlines of socioeconomic impacts in Nyanza's livelihood due to the declining agriculture caused by water scarcity. These are the losses of stable income, food insecurity, decreased market value, loss of social and financial security.

b. ***Health problems, poor sanitation, and hygiene:*** Generally, water shortage comes with a range of public health concerns (Organization, 2004). The scarcity of water is a pressing problem creating a considerable health disadvantage which is a continuous threat to communities 'livelihood. Its impacts are more damaging in the rural areas of Nyanza where, in the non-accessibility of water, the population is largely pushed to use the natural source water (rivers and streams) which quality is seriously suspicious for their subsistence. This situation causes an increase in the incidence of waterborne diseases like diarrhea, typhoid, cholera, or dysentery which keep children out of school and leave families into miserable poverty. Despite this, a poor supply of water prevents good hygiene and sanitation. Limited water accessibility in Nyanza decreases the amount of water that is used for hygiene in the household and remain a scary challenge for concerned citizens.

c. ***Creation of Conflicts among communities and migration:*** The consequences of lack of water in Nyanza have become very dangerous because it threatens the livings of society, leading to augmented competition over a progressively scarce resource. This competition naturally leads to conflicts and if not dealt with properly, it becomes violent. In addition, water scarcity has contributed to migration and the displacement of people due to tension and the reduction of agricultural productivity from drought encompassing negative effects on their livelihoods that also threatens their food security as well as causing poverty.

d. ***Effects on domestic activities:*** A lot of time and energy are used in water collection and in some instances; water may not be obtained or obtained after walking a long distance (Figure 10). Consequently, there is a reduction in the time available for productive work while domestic chores suffer. It was reported that sometimes when the women went to fetch water in the evening, they would be late in preparing supper for their families something that some of their spouses picked a quarrel from; hence causing a misunderstanding and conflict. It was also stated that this water collection sometimes caused delays in food preparation leading to children sleeping

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late and this had an effect in their school performance the following day.

e. ***Queuing at the water stand for a long time (time-consuming):*** As earlier discussed, some households are located in unplanned and unauthorized settlement areas (Figure 3). Consequently, respondents argued in these areas that people spend hours waiting at water stand posts in a queue. Limited duration and timely water supply also increase community social tension (Figure 12), leading to frequent street disputes, sometimes violent, leading to fighting. Extreme queuing times are indicators of inadequate water shortage and accessibility (Kayaga, 2007; M. M. Kjellén, Gordon, 2006). Also, this can be due to either an inadequate and insufficient number of water points or inadequate yields at water sources. In this study, the water scarceness problem was found to be closely related to the inadequate distribution of water due to various factors as shown in Figure 6. Water consumption per capita is reduced and the potential negative impacts of increased queuing times may increase the consumption of unsecured surface sources and reduce the time required for other essential water collectors work.

3.3. The main challenges faced by WASAC to effectively distribute water in Nyanza

The WASAC (Water and Sanitation Corporation) is a water distribution and sanitation institution characterized by Rwanda's government policies. They are faced with the delivery and equal dispersal of water to identify the problems, the water distribution issue as claimed by households has been addressed by this institution.

3.3.1. Shortage and unequal distribution of water in Nyanza district

On this objective, the study started by investigating whether they know the problem of Nyanza district in terms of water scarcity due to a deprived and inequitable distribution.

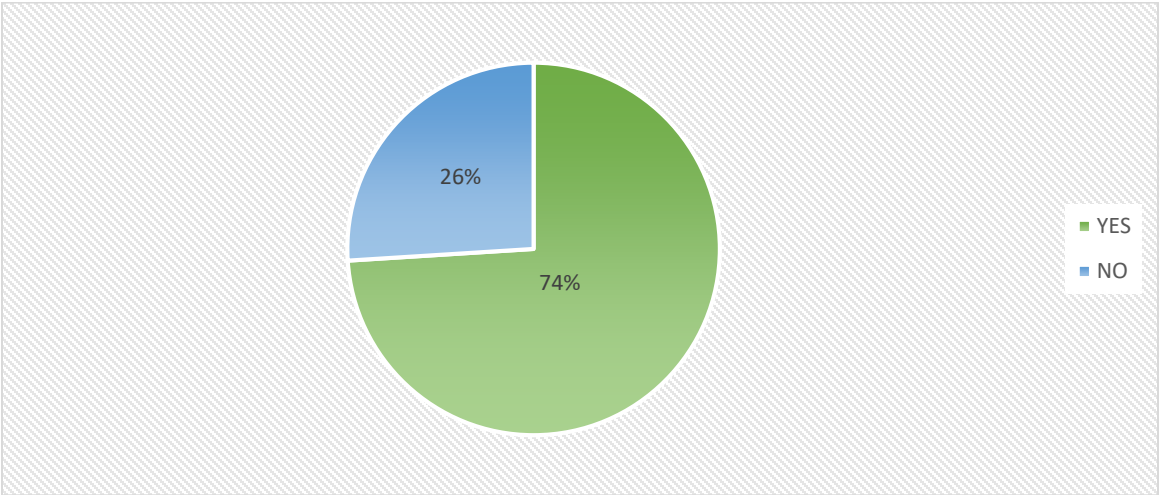

Figure 13. WASAC members who reported shortage and unequal distribution of water

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As stated by the majority 74 % of WASAC members, the district of Nyanza is really suffering from water scarcity, while only 26 % responded negatively to this question. This outcome matches the one obtained when the households were asked the same question (Figure 7). This is another outcome that confirms water scarcity and distribution in this district as a serious issue.

3.3.2. WASAC's revelation on the faced challenges in the equitable distribution of water

However, outstanding to the nature of the territory itself, all districts do not face the same challenges as the water System in Rwanda. The following are the challenges faced by WASAC in the equitable water dispersal of the district of Nyanza.

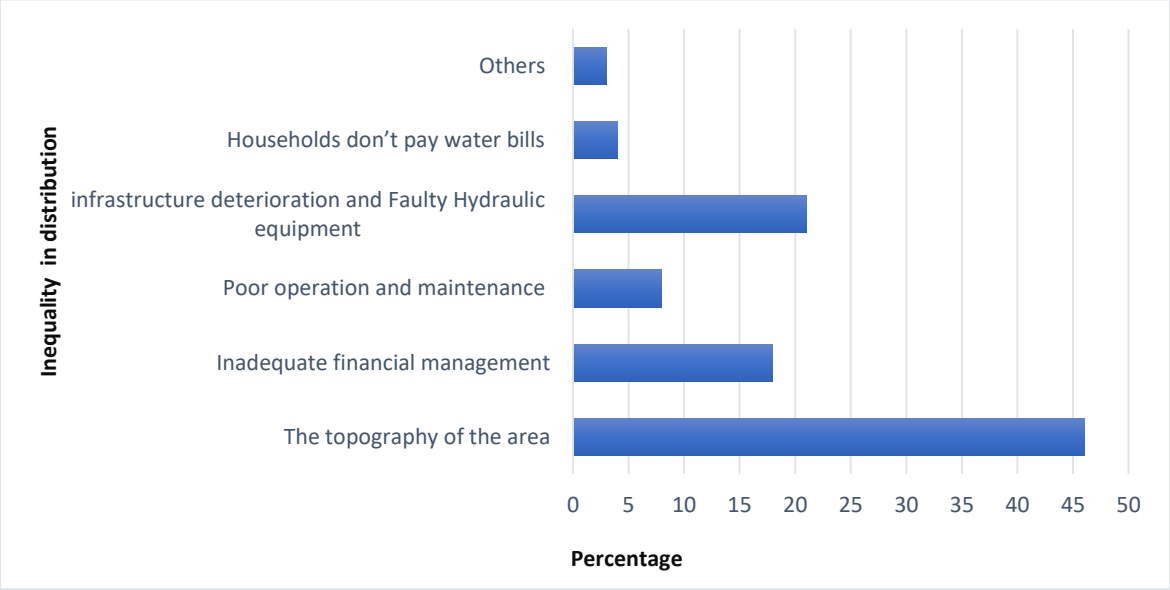

Figure 14. WASAC members who reported shortage and unequal distribution of water

Among these challenges, the majority 46% of WASAC members mentioned that the geographical characteristics of households' localities made difficult the process of installing sufficient water distribution networks for equitable water supply in the district. Additionally, 18% and 21% declared that the inadequate financial management and infrastructure deteriorated by the community as well as faulty hydraulic equipment respectively remain big challenges as less financial resources available for service hampers the real provision of water quality services and reparation of damaged water distribution infrastructure. Only 8% argued that poor process and conservation also play a part in the inadequate distribution of water to households. Finally, it has been revealed by 4% of WASAC members that some households in the district do not pay water bills to the extent of deciding to stop transfer water in their areas. About 3% represented other challenges such as the low national

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budget for the water sector, corruption, community perception, and carelessness as stated by WASAC members.

People in different institutions usually presume that to satisfy and equitably distribute water that meets household consumption depend on the amount of water that is discharged into a network which pushes them to take insufficient water production as the challenging problem in the inadequate water supply (Nyende-Byakika, Ngirane-Katashaya, & Ndambuki, 2016). However, in another study conducted by Germanopoulos (1985) and Eusuff and Lansey (2003) specified that similarly important is the distribution network through which the water is supplied. This view supports the results obtained from the current study where water dispersal networks are said to be not sufficient to supply water in many areas of the district due to the geographical characteristics of Nyanza district.

The topography is a very significant aspect that facilitates water movement and flows in some areas than in others (Karanth, 1987). This case has been stated as a challenging factor to impartial delivery of water and was found meaningful and significant since the Rwandan country is said to be entirely well known as a land of thousand hills because of its hill's relief largely consisting of steep hills and mountains with average altitude of about 1000m above sea level (Asumadu-Sarkodie, Rufangura, Jayaweera, & Owusu, 2015). Thus, the water distribution is miserable especially for the households situated in mountainous areas, as families might spend even one constant month without water, and when it arises, it is available for one day only and goes for another month (Afrialliance, 2017). Therefore, this relief characteristic also affects Nyanza district in standings of water distribution and availability in many households, they frequently fail to get water since it does require high water pressure to travel hills and mountains and reach their taps regardless of other factors.

In their study, Hunter (2009), found that in developing countries there are no reliable hydraulic systems which can challenge much of the expectation for improvements in water system objectives and have negative effects in terms of good quality and quantity water dispersal in an area. This supported the findings of this study where WASAC members argued that the fact that many hydraulic systems are not functioning properly in Nyanza district makes it hard to estimate effective access to the water supply which leads to a serious shortage of water. Generally, irregular supply is approved by necessity rather than by design and results in serious system impairment (K. Vairavamoorthy, Gorantiwar, & Pathirana, 2008). Thus, lack of expertise, poor operation, maintenance and insufficient cost recovery (Figure 15) are the main explanations foremost to the defective and failure of the hydraulic systems. Therefore, the water pressure is very low and insufficient water in the farthest and uppermost points are distributed in different households.

According to several studies Dahasahasra (2007), K. A. Vairavamoorthy, Ebenezer Lin, Zhuhai Ali, Mohammed (2001), faulty hydraulic systems produce unsatisfactory

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pressure in less favored areas. Such circumstances may be beneficial for falling water losses, but they also produce disparities in the distribution (K. Vairavamoorthy et al., 2008). Furthermore, insufficient funding and mismanagement are among the main causes of the origin of inadequate water supply (Totsuka, Trifunovic, & Vairavamoorthy, 2004). System improvements in these situations do not originate from increasing the water supply sources, but from improving system infrastructure and management. Nevertheless, inadequate financial management and the lack of funding do not permit operators to make large investments, so they should look for profitable long-term planning strategies.

Finally, through the survey process, WASAC's officers claimed for many of its customers not paying their water bills, while the state has the power to force citizens to pay the bills. This sometimes led to households being disconnected to water systems and finding different sources of water (Figure 8). In addition, sometimes lack of water is triggered by illicit connection where people fraud and connect themselves to WASAC water networks after being disconnected to escape water bills.

3.3.3. WASAC's perception of the aspects of the water supply system that need quick improvement for sustainable water distribution in the district

In this study, WASAC members have anticipated different aspects that require quick improvement and intervention to balance water supply and demand. The anticipated interventions to increase supply and reduce demand will be important by increasing access and availability of water in various district areas to reconcile the gap between withdrawals and supply.

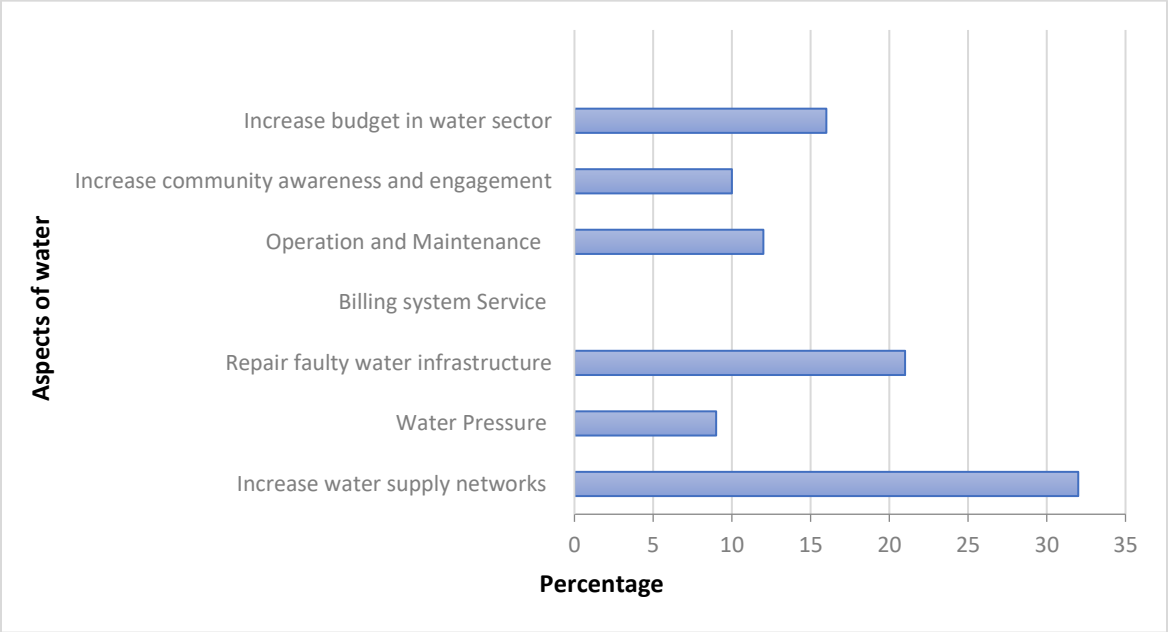

Figure 15. Aspects of the water supply system that need improvement

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For adequate and maintainable water supply in Nyanza district, WASAC members have proposed different aspects and measures that require a quick intervention and improvement. Majority, as proposed by 32 %, said that the number of households that have access to water will increase with 21 % saying that the weakening water infrastructure must be replaced and upgraded to avoid pipeline blocks, unnecessary water loss due to leakage and other problems resulting from damaged infrastructure that can be operated and maintained as argued by 12% of respondents. In addition, 16% of WASAC members proposed that the budget allocated to water should be increased by 16% in order to increase all the necessary water supply for numerous households, while the increase in community awareness and commitment, as proposed by 10%, is important to disseminate water information for effective use and the collection of the insights of households. Finally, 9% mentioned the increase in water pressure for the benefit of households in hilly and steep slope areas.

Ilaya-Ayza and (Herrera (2011); 2016) in their studies, they found that with the possible climate change impacts and rapid population growth, water supply networks faced many challenges in the last decades. Thus, due to demographic growth, water supply networks must increase. Thus, as a result of demographic growth, water supply networks need to increase. Similarly, many of Nyanza's water supply networks are facing problems related to population increase (Figure 6) and their activities playing a role in water scarcity and unequal distribution. In increasing water supply networks, larger demand for water will be supplied to many households. Water Supply systems produce insufficient pressure in a less favored settlement such as those located on high points or far away (Dahasahasra, 2007; K. A. Vairavamoorthy, Ebenezer Lin, Zhuhai Ali, Mohammed, 2001). However, they also create supply inequality (K. Vairavamoorthy et al., 2008). Therefore, the increase of the water supply networks must be preserved at a positive pressure so that there is sufficient water in every point of departure to ensure that untreated water cannot enter the water supply network in the ground. Moreover, water systems face challenges owing to the deteriorating infrastructure and most of the time, from pumps to pipes, these infrastructures are often out of sight and out of mind (Henry, 2011; Walters, 2011). The WASAC members revealed that there is no secret that water infrastructures are struggling to sustain with current demands due to its deterioration caused by various factors such as their quality itself, human activities, age, the shifting geology and the way they are designed, installed and maintained. When the failure of these infrastructures happens, the public is on the hook for both the disturbance and the repair. Therefore, this aspect needs quick intervention concerning the way water infrastructure is designed, built, utilized, maintained and renewed using relevant technologies if the demand for water by household is to be satisfied.

To do so, the budget allocated to the water sector needs to be increased because, a successful water supply implementation requires reliable, adequate and sustainable financing (Harvey, 2006; Rogers, 2002).

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Unfortunately, Rwanda's financing gap, in general, is the immediate challenge to the understanding of water access. Water and sanitation fight for financing, when the government has to contend with difficult economies and a host of other problems. Consequently, other basic services such as education and health are most often given priority over the water supply, which shares the same budget as the sanitation sector (MININFRA, 2010). Therefore, with these facts together with the ever-increasing demand of water by households and different factors associated to its scarcity, unequal distribution (Figure 6) in different parts of the country such as Nyanza are wake-up calls to step-up its investments in the efficient, productive, equitable and sustainable management of its water resources.

Concerning community awareness and engagement, The WASAC members also stated that through a well-designed and properly resourced dialogue process is crucial to address concerns and raise awareness on the protection of water sources, efficient, and effective water use; and the collection of water, particularly during rainy seasons, which will in some way help tackle the water shortage problem in households in the district of Nyanza and other parts of Rwanda with similar problems. Finally, the lack of proper operation and maintenance of wastewater systems, leaks, and high energy consumption were one of the problems that faced the water sector (Brikké, 2000). Development and maintenance of existing infrastructure have often been focused on expanding service delivery (Van Zyl, 2014). In the same context, the WASAC members argued that, without strong operation and maintenance, the water supply system risks declining to a level where service providers are compromised, leading to higher water losses and financial losses for consumers. In the maintenance and operation of a water distribution system, improving the design and building practices will also play a vital role and ensure adequate distribution of water to families.

3. Conclusions

The study inspected the household's perception of water scarcity, distribution, and accessibility in Nyanza district. The results showed that water shortage and lack of equity in its distribution and accessibility have led households to use suspicious alternative sources in terms of quality; which implies different health, economic and social problems. WASAC seemed to make households and government better aware of the key factors associated with the problems, both technically, financially and socially. This is very important as it can be used as a baseline when setting up new policies regarding equity and adequate water distribution. Conclusively, equity and adequate distribution of water need a high level of efficiency. Therefore, the study suggests the promotion of rational extension of the networks not only by placing additional pipelines that reach the point of demand, but that this process should be escorted by reinforcement, rehabilitation, or replacement of the network water mains. Furthermore, the water storage tanks should be built and situated strategically in all areas of the district to guarantee and ensure households have unhindered access to water.

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