REVIEW OF RESEARCH
ISSN: 2249-894X
IMPACT FACTOR : 5.7631(UIF)
VOLUME - 11 | ISSUE - 2 | NOVEMBER - 2021

RURAL HOUSEHOLDS ACCESS TO WATER RESOURCES: A STUDY ON IMPACT OF CLIMATE CHANGE IN MUSANZE DISTRICT, NORTHERN PROVINCE, RWANDA

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ABSTRACT:

Rwanda has a humid temperature climate with bio medal rainfall pattern with peaks in the months of April and November. Rainfall ranges from about 900 mm in the east and southeast to 1500 mm in the north and northwest volcanic highland areas. Agriculture accounts for 40% of GDP and provides employment for 80% of the population. Climate change has occasioned in Rwanda experiencing recurrent droughts and poor rainfall as never before. Rainfall trend analysis of rainfall is presenting that rain seasons are tending to become shorter but with higher intensity. This tendency has led to decrease in agricultural production due to drought events especially in Eastern areas; whereas in the north and southern region there is severe landslides, soil erosion due to heavy, floods causing in destruction of infrastructure and crops counting loss of human and animal lives.The specific objectives of this study were to define the role of gender, distance, covered, time taken and the impact of climate change on access to water. Considering the fat these communities are heavily reliant on open sources such a dugout ponds, rivers, and streams, the time consumed in queue is not relevant in this study. Therefore, three research questions are addressed in this study based on distance, gender and time to water sources used in Chi-Square tests of independence.

KEYWORDS: *Climate Change, access to water, agriculture, rural livelihoods, conflicts.*

INTRODUCTION

Water is vital for agricultural production and food security. It is the lifeblood ofecosystems, including forests, lakes and wetlands, on which our present and future food and nutritional security depends. Yet, our freshwater resources are declining at an alarming rate. Growing water scarcity is now one of the leading challenges for sustainable development. This challenge will develop more pressing at the world's population continues to grow, their living standards increase, diets change and the effects of climate change intensify. To reach a Zero Hunger world by 2030, we need to take action now. Water scarcity is estimated to intensify as a result of climate change. It is forecast to bring about increased temperatures across the world. More frequent and severe droughts are partaking an impact on agricultural production, while increasing temperatures translate into improved crop water demand. In addition to enhancements in water-use efficiency and agricultural productivity, we must take action

to harvest and recycle our freshwater resources and rise the safe use of wastewater. The question of water scarcity is at the very core of sustainable development. It emanates down to the fact that we simply can't produce the food we need if we don't have enough water. We need to change our habits and act now to defend this precious resource. It is one of the most important ingredient to attain a Zero Hunger world. Insufficient access to water and following water stress is undoubtedly a major global public health threat and challenge for our generation.

Rwanda has a humid temperature climate with bio medal rainfall pattern with peaks in the months of April and November. Rainfall ranges from about 900 mm in the east and southeast to 1500 mm in the north and northwest volcanic highland areas. Agriculture accounts for 40% of GDP and provides employment for 80% of the population. Climate change has occasioned in Rwanda experiencing recurrent droughts and poor rainfall as never before. Rainfall trend analysis of rainfall is presenting that rain seasons are tending to become shorter but with higher intensity. This tendency has led to decrease in agricultural production due to drought events especially in Eastern areas; whereas in the north and southern region there is severe landslides, soil erosion due to heavy, floods causing in destruction of infrastructure and crops counting loss of human and animal lives.

Rwanda's twin goals of food and security and poverty reduction. In water scarce areas across four sectors in the northern province of Musanze district, a survey of 100 households was carried out, and two shared dialogue workshops was held. In this study, the following issues were studied:

i. Access to water in relation to sources, distances covered, gender and time taken.
ii. Local perception on current (2017-2018)and future (2019-2021) access to water.
iii. The types of water conflicts encountered and their cause.

The aim of the study

The aim of the study is to enhance access to safe water supply and hygienic sanitation across the rural areas, and ensuring equitable, sustainable and productive rural economies for agricultural production, nutrition and human health of Musanze District- Rwanda

Objectives of study

1. To study access to water resources by rural households in Musanze District-Rwanda
2. To find out local perceptions on climate change in the study area
3. To study access to water in relation to sources, distances covered, gender and time taken in the study area

RESEARCH QUEATIONS

1. What access water resources exist in relation to sources, distance and time in Musanze District?
2. What are the local perceptions on climate change in the study area?
3. What are the types of water conflicts encountered and their causes in the study area?

HYPOTHESES

The first H0 states that distance covered has no effect on water sources used by households, while the H1 states that there is an effect.

The second H0 states that there is no relationship between gender and water sources used by household, while the H1 states that there is a relationship.

The third H0 states that there is no association between time taken and water sources used by households, while the H1 states that there is an association. These key questions will be measured in greater detail in the analysis together with other issues such as perceived impacts of climate change on access to water, the type and causes of water conflicts.

Rural household's access to water is both timely and important. Such insights grounded on field evidence are irreplaceable especially for the Sustainable Development Goal Target 6.4, which intends to address water scarcity and to extensively reduce the number of people suffering from water scarcity by 2030.

MATERIALS AND METHODS

Musanze city is approximately 91km from Kigali on the major Kigali- Musanze-Rubavu-Goma road and it limits with Uganda and DRC in the North. Gakenke district in the South, Burera district in the East and Nyabihu district in the West. Rwanda's mountain gorillas (Gorilla beringei) are found in the Volcanoes National Park and making Musanze district the most popular tourist destination in the country.

The district development strategy for Musanze district intends at certifying the district vision of being " An admirable centre of Tourism Industry " with three goals like : improve attractive Tourist Sites, promoote sustainable agro prossessing and basic infrastructure. These goals are united with eight objectives such : identification of seven new tourist sites, put place new tourist facilities, increase local revenues, incease food security , extend basic infrastructure, facilitate the accessibility to clean water, promote exportations and creation of new off farm jobs. Some of the challenges that have been well-known throughout the implementation of District Development Planning (DDP) are limited access to reasonable and social housing units, lack of appropriate solid waste tratment facilties and lack of systematic sewage management, lack of tourist infrastructures and youth unemplyment.

Reference was also made to National Strategy Transformation 1(NST1) priorities and the existing potentialities in the District, which have been well-defined in the Local Economic Development Strategy as to promote new eco- tourism development that will lift the growth of the district by creating new off farm employment and thus, increase local revenue collection.The monitoring and evaluation of Musanze District Development strategy will certify an effective monitoring and evaluation system founding on implementation processes of what is highlighted as key pillar of economic growth for the ten years ahead.

The following are some sources of funds for Musanze District Development Strategy: the Central government transfers, district own revenues from taxes and fees, the private sector, local and external Non-Government Organizations, Faith -Based Organizations and other development partners. Four sectors were selected for this study by Waterspout Project. This project has as its objective to convert access to safe drinking water through the application of integrated social sciences, education, and solar technologies in vulnerable communities in the continent of Africa.

The case study sites were selected as follows: Kinigi, Nyange, Musanze and Cyuve.The motivation for the selection was centered on locating communities surrounding ponds and streams that were in use as sources of domestic water supply, but where these unsafe water sources were being largely used at homes and in schools. Administrative units using local boundaries in the Musanze District attended as a guide in the selection of the four case study areas.Three of the four case study sectors are greatly dependent on surrounding dugout ponds and wells, while the fourth sector depends onon a stream closer to the community. Although the fourth sector has tap water, it was not completely functional at the time of the survey that took place between June and September 2018. However, the dugout ponds and wells do not contain water all-year-round and these communities have to access water from distant river and or function boreholes form neighboring communities. The District comprises of central mountain highlands of irregular topography composed of peaks and plateaus separated by gorges rising up to 3900m.This District has a soil erosion and land slide. The climate change and high acidic soil are the greatest threats. This District has also rich soils (suitable land for agribusiness), fruits and vegetables, livestock breeding and transformation, sufficient and seasonal rainfalls as strengths for its development in agriculture. The hydraulic network in the district is made by temporary torrents and permanent water resources. Torrents flow during strong storms, and they are forced by water coming downhill fromthe volcanoes, some 20 km away. These torrents cause severe erosions, sedimentation and crop losses. The main torrents known are Susa, Muhe, Rwebeya, Rungu,Cyuve, Kansoro and Mudakama.

DATA COLLECTION AND ANALYSIS

This present study started with a Shared Dialogue Workshop (SDW) on water resources with opinion leaders and other stakeholders in the MusanzeDistrict. Within the context of Water SOUTT, a

SDW is a forum that conveys academic as well as technicians, educators , politicians, practitioners, community leaders and householder members together at regular intervals (one every six-month-period) to ascertain challenges and obstacles to , and opportunities for, the approval of solar technologies at the household, community, and regional level (Etongo et al., 2018)

The social Science Work Package of the project emphases on socio-cultural, institutional and governance concerns around water during the SDWs. Therefore, the third and the fourth SDWs that happened in November 2017 and May –June 2018 were specifically organized and addressed issues around access to water. Household survey and field visits to the study sites completed the data collection process. Given that livelihood activities are alike across the case study sites, namely dependence subsistence farming / livestock and the use of similar water sources (Fagan et al., 2018). A random sampling method was applied which resulted in the selection of 100 households.

Questions enquired in the household survey encompassed what water sources were used; available water sources, distance covered by households to access water, household perception on their present (2017-2018) and future (2019-2021) access to water, types of water conflicts met and their causes. The collected data were frequently categorical and satisfy the following assumptions for Chi-Square Test for independence.

Assumption 1: Data sets having at least two variables measured at an ordinal or nominal level (that is categorical data)

Assumption 2: The two variables should entail of two or more categorical independent groups. Example of independent variables that meet these criteria comprise distance to main water source (4 groups: 2 km), gender of household heads (2 groups: Male and Female), and time taken to water sources (5 groups: 2h). The complementary qualitative data from the Shared Dialogue Workshopon issues around water was analyzed using Verbatim Transcription and Word Satat7 content analysis software thatallowed us to identify the key themes emanating from the discussion. The Word start 7 software was used because of its ability to find the themes or relationships in verbatim responses, focus group transcripts, or other text sources. It involved four main steps as follows:

1. Identification of the main themes;
2. Attributing coeds to the main themes;
3. Classification of responses under the main themes, and,
4. Integration of themes and responses into narratives.

Furthermore,descriptive methods using Chi-Square tests of independence were applied to test the three hypotheses. The results are presented in the form of column graphs using Statistical Package for Social Science (SPSS).

RESULTS AND DISCUSSION: ACCESS TO AVAILABLE WATER RESOURCES

The majority of the surveyed households in the study area collected water from dugout ponds (60%). The use of rivers was reported by 31%, while another 10.4% of the households were collected (Figure 2).

Water usage is determined by economic policy, population change, consumption patterns, water from dug wells, technological infrastructure and water policy (Fagan et al., 2017). This is so because the installation of large- scale water treatment plants in rural Rwanda is difficult due to the scarcity of resources and dispersed settlement. Additionally, a Chi- Square test was shown to confirm if the distance covered by households had an effect on the water sources used. The test result showed that the distance covered by households did have an impact on water sources used because the H0 was rejected in favor of the H1given that p<alpha (Table1).

Table -1 Percentage distribution of respondence showing distance covered for water collection

			Distance covered				Total
			<500m	500-900m	1km	>2km	
Gender	male	Count	11	8	26	24	69
		Expected Count	7.6	5.5	17.9	38.0	69.0
	female	Count	0	0	0	31	31
		Expected Count	3.4	2.5	8.1	17.0	31.0
Total		Count	11	8	26	55	100
		Expected Count	11.0	8.0	26.0	55.0	100.0

Source: Computed from primary data N= 100

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	36.759[a]	3	.000
Likelihood Ratio	48.467	3	.000
Linear-by-Linear Association	24.833	1	.000
N of Valid Cases	100		

a. 2 cells (25.0%) have expected count less than 5. The minimum expected count is 2.48.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.606	.000
	Cramer's V	.606	.000
N of Valid Cases		100	

The relatively high percentage of households using dugout ponds relates to minimal resource requirement for construction where rainwater-harvesting ponds constitute an important feature on the Musanze landscape.

Taps were found only at Kinigi and were undergoing rehabilitation at the time of the survey. Our research identified that most of the constructed ponds are not functional with overall poor performance levels and insufficient impacts to local communities was widely observed.

Some of the challenges that affect the performance of rainwater harvesting ponds based on field observations. Key informants and from SDWs are scarce site selection, absence of biophysical survey during design and construction, leakage and evaporation losses, poor management of the ponds and the impacts of climate change. Furthermore, another statistical test was shown with the H0 to find out that there is no relationship between gender and water sources used by households. The test result failed to reject the H0 given that p>alpha (Table 2). As such, water sources are not gender sensitive, but rather, accessibility is likely to be influenced by availability. The problem will no doubt be further compounded given that climate models have forecast temperatures in Rwanda will rise over the coming years.

Table -2 Percentage distribution of respondence showing Main source of water

			Main water source					Total
			Dig well	protected spring	Tape water	river	dugout pond	
Gender	Male	Count	20	21	19	9	0	69
		Expected Count	13.8	14.5	13.1	13.8	13.8	69.0
	Female	Count	0	0	0	11	20	31
		Expected Count	6.2	6.5	5.9	6.2	6.2	31.0
Total		Count	20	21	19	20	20	100
		Expected Count	20.0	21.0	19.0	20.0	20.0	100.0

Source: Computed from primary data N= 100

Chi-Square Tests

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	76.858[a]	4	.000
Likelihood Ratio	96.295	4	.000
Linear-by-Linear Association	60.625	1	.000
N of Valid Cases	100		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 5.89.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.877	.000
	Cramer's V	.877	.000
N of Valid Cases		100	

On the other hand, rainfall has observed a high degree of variability during the last five decades and is expected to continue and to be convoyed by frequent and severe droughts, thereby increasing the burden on water. Immediate problems rise for households and specifically women and girls in our study that shown that female were more dominant than males in accessing water from different sources (Table 2).

Additionally, our result indicated that distance had an effect on access to water (Table 1) of which some of the surveyed households travelled more than 2 km to collect water. The main reasons provided to us during a field visit in the area in July 2017 was that nearby sources such as dugout ponds and wells easily dry-up (Figure 3), while few available water sources also suffer from constant pollution from livestock droppings.

The test result between water sources used by households versus time taken to arrive at these sources presented a 5% level (p<- 0.05) statistical significant (Table 3). Information gathered from SDWs and during a field visit to the sites further confirm our findings of households using rivers at distant location as reliable water sources. Travelling longer distances to access water is not a surprise in rural Rwanda as supported by an earlier study in which approximately 60% of those residing in rural

areas travel more than 1hour and up to 3 daily to collect water. This burden falls disproportionately on women who are exclusively responsible for collecting water and with such time demands. It is not surprising that per capita water use especially in rural areas in Rwanda is low.

Table -2 Percentage distribution of respondence showing Time taken to arrive at water source

			Time taken to arrive at water source					
			<10 min	10 min - 30min	30min-1h00	1h-2h	> 2h	Total
Gender	male	Count	8	13	24	24	0	69
		Expected Count	5.5	9.0	16.6	18.6	19.3	69.0
	female	Count	0	0	0	3	28	31
		Expected Count	2.5	4.0	7.4	8.4	8.7	31.0
Total		Count	8	13	24	27	28	100
		Expected Count	8.0	13.0	24.0	27.0	28.0	100.0

Source: Computed from primary data N= 100

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	87.533[a]	4	.000
Likelihood Ratio	104.983	4	.000
Linear-by-Linear Association	53.383	1	.000
N of Valid Cases	100		

a. 2 cells (20.0%) have expected count less than 5. The minimum expected count is 2.48.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.936	.000
	Cramer's V	.936	.000
N of Valid Cases		100	

WATER AND CLIMATE CHANGE: LOCAL PERCEPTION AND FIELD EVIDENCE

Most households in this study perceived a weakening concerning their present access (2015-2017) Water. The details provided by one of the households in May Kinigi is that "their family has been living here than 50 years and several nearby streams have disappeared and water in ponds gets evaporated easily compared to five decades ago". Another household said. "We are not experienced that kind of drought, we had in 2015 in the last thirty years. Not only did we lose our livestock, but all surface water except for a river which 2 hours from our community completely dehydrated. It is obvious that water resources are under vulnerable to the impacts of climate change and the main environmental challenge, in addition to land degradation, that Rwanda and neighboring counties are facing today is water scarcity. Other reasons for water scarcity stated by key informers in the Musanze District include poor management of water points, lack of adequate water infrastructures.

Table 2. A cross-presentation between gender and water sources used.

1. 0 cells (.0.0%) have estimated count less than 5. The minimum estimated count is 5.89.Not assuming the null hypothesis.
2. (b) Using the asymptotic standard error assuming the null hypothesis.

Especially with the high dependence on water sources that are extremely vulnerable to the impacts of climate change, one of the case study communities , May Kinigi have taps that were expected to be practical a month after our survey. Households in this community were persuaded that their water problems will be answered by tap water being provided, but anxious about the functionality of the taps given the previous very long period of breakdown. Therefore, both current and future access to water, especially under a changing climate, would necessitate water technologies that are practical and can be easily sustained.

CONFLICTS OVER ACCESS TO WATER

These conflicts happened across different stakeholders, and manifested as verbal accusation and physical fighting as reported by 69 and 31 of survey households respectively.

Additionally, disputes were also described to have occurred with the water use communities WUCs), and also with government representatives at the district level. Both Bureaus have the mandate to improve community access to water.

Shortage of water is main cause of conflicts in the case study community. Pollution from livestock droppings and the breakdown of dug wells were also cited. Excessive demand on water resources for agricultural, domestic, and industrial activities combined with a growing population contribute increasing demand for irrigation and livestock watering. However, some of the households perceived their current access to water has remained the same while others were of the opinion that it has amplified during the said period. Next greatest mentioned reason for the rise in current access to water was the previous of water tanks that were fixed at schools and health centres. Majority of households mentioned the role of the government in carrying water in trucks from distant locations to fill-in the tanks especially during the dry season. This gas repercussions for water resources for various uses such as domestic, livestock watering and even for the traditional irrigation systems used by smallholder farmers which have been practiced for centuries.

To make matters worse, it has been assessed that two-thirds of the world population will be living in areas facing water stressed conditions by the year 2025 (Ahmad, 2002). Adequate and accessible water supply is a precondition for socio-economic development and it is clear that water resourcing still remains a major health and livelihood challenge in Rwanda in general and in Musanze in particular. In relation to their expectations for enlightening future access to water, many of the surveyed households were of the opinion that it is unpredictable. One household explained that." One of our neighboring community use to have alike problem on water but now they have an illusory borehole, but for use, we cannot tell what will occur in the future concerning access to water". (H2). It is not a surprise that the majority of the households surveyed are not certain concerning their future access to water.

With walls that easily collapse and also visible is a rainwater tank and a white storage tank close to the school building (Figure 4).

With financial support from World Vision International, a stone wall was constructed in May 2017 to protect walls from collapsing and also from livestock to water shortage and conflicts. In three of the study areas, with the exception of Kansoro, water sources were accessed by humans and livestock together. It is clear that as stated in the present results from information gathered from visits to the study sites and the discussion at SDWs that conflicts rose because of livestock droppings in water sources making it unfit for some domestic uses presenting agricultural and domestic needs clashing.

LIMITATION OF THE STUDY

This study faces a number of limitations. First, it could have been much better to have a dichotomous group: enhanced access and unimproved access to water. With these two categories, the

factors that affect water users in both groups could be well-known easily. But this was not the case because these communities are extremely dependent on unprocessed water sources and May Kinigi had taps were not practical at the time of survey.

To overcome this limitation, water sources used by the survey households were considered. Next, self-reported assessment by households can be biased, especially if the issue under investigation is considered sensitive. This was the case with the question that emphases on the type of water conflicts encountered by household members. Although issues concerning rape are cited during SDWs, households that have a member who is victim of rape, are not willing to share such information.

Figure 5. Water sources predominantly used across the four study communities with visible signs of cattle sharing three of the four sources with human.

CONCLUSION AND POLICY RECOMMENDATIONS

Despite the occasional provision of water by the government by bringing water in trucks, climate change was extremely perceived to have reduced current access to water while future access was highly unpredictable. Furthermore, at least 40% of households stated that a member had encountered conflict while accessing water, conflict that demonstrated itself as verbal accusation and physical fighting. The majority of such instances of conflict resulted from water shortage, followed by pollution from livestock droppings. The government have replied to the scarcity of water by bringing in water tanks with truckloads of water especially to some primary schools and health centres in the case study areas. However, the majority of the surveyed households perceived their future access to water as unpredictable given that some springs, hand-dug wells and rainwater harvesting ponds are completely dried-up during certain period of the year. The consequences therefore are that longer distances are covered to access water from relatively more reliable sources such as rivers or from neighboring communities with boreholes and water pumps that are functional.

Results show 69% of the survey households collected water were from dugout ponds and 31 % from rivers. Chi-square test showed a statistical significance and at the 1 and 5 % level, respectively for distance covered and time taken to water sources. Although gender was not significant statistically, females (N=69) were more involved than males (N=31) in fetching water. Immediate problems arise for households and specially women and girls that travelled more than 2 km to collect water. Climate change was mentioned as the key driver that reduce access to water resources whereas tanks with water brought in truck by the government was reported as reason for current increase in access to water. However, future access to water was perceived as unpredictable due to the impact of climate change. At least 40% of households reported that a member had encountered conflict while accessing water. Conflict that manifested itself as verbal accusation and physical fighting. The majority of such instances of conflict resulted from water shortage, followed by pollution from livestock droppings. Project interventions that promote watershed rehabilitation through different ecosystem-based adaptation approaches should be supported locally to restore nearly degraded water sources while improving the functionality of boreholes and existing taps to ensure access and sustainability of water infrastructures.

Generally, per capita water use in the case study location and the rural areas in Rwanda is low given the most household members travel more than 2 hours to collect water, the majority of whom are women and female children. Aside from the low per capita water use, different type of conflicts were recorded such as verbal accusation and physical fighting in addition to dispute between stakeholders. It is clear that as reported in the results from information gathered during a visit to the study suites and the discussions at SDWs, that conflicts arose of livestock droppings in water sources making it unfit for some domestic uses showing agricultural and domestic needs clashing.

Project interventions that promote watershed rehabilitation through different ecosystem-based adaption approaches should be maintained locally to restore nearby degraded water sources while improving the functionality of boreholes and existing taps to ensure access and sustainability of water infrastructure.

Water allocation is also important to avoid waste and conflicts. For example, water from pounds should be allocated for other domestic purposes such as washing, cleaning to avoid the waste of water. Such sources should be used for small-scale irrigation and for the watering of livestock.

CONFLICTS OF INTERESTS

The author has not declared any conflict of interests.

ACKNOWLEDGEMENTS

Lastly, they are thankful to all the stakeholders and community members for the time taken out to participate in the baseline survey across the four rural communities in Musanze District, Rwanda.

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Appendix -1

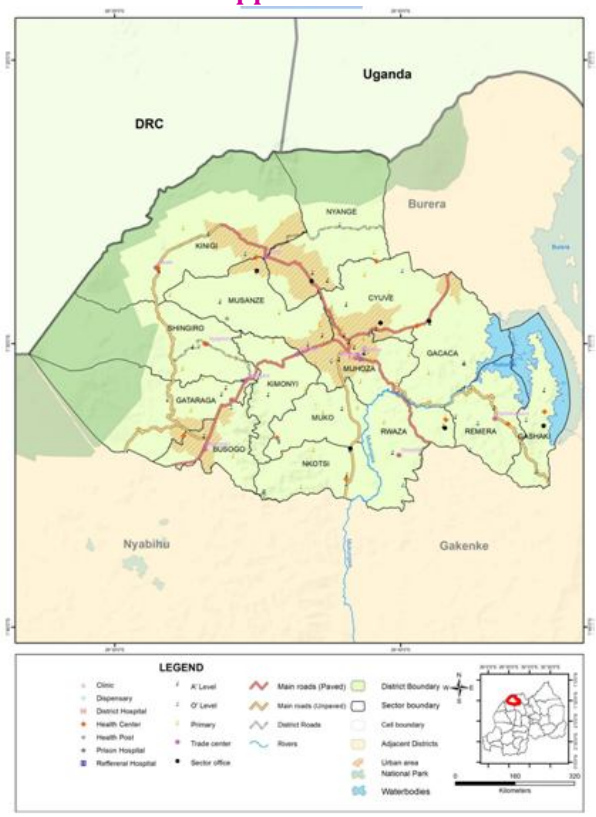

Figure 1: Case Study Location in Red

Figure 2. Primary sources of water used by households

Figure-2A hand-dug well close to a primary school in Kinigi

Figure 2. Primary sources of water used by households