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Mapping Water Distribution in Grouped Settlements of Rulindo District, Northern Province of Rwanda

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ABSTRACT: It is certain that without water, there would be no life of any kind on the earth and that, without water readily available in adequate quantity and free of pathogenic organisms, man's progress is tremendously hindered. In Rwanda, there are abundant water resources which could be explored to ensure access to water among its residents. Nevertheless, the existing distribution system in some cases, do not reach those in need. Therefore, the present study aimed to map water distribution in grouped settlements of Rulindo district, Northern Rwanda. The employed primary data were collected by using the Global Positioning System (GPS) to locate existing and new planned water distribution system on both old and new settlements across the study area. These points were then incorporated into Geographic Information System (GIS) to produce maps of old and new settlements. Thereafter, the respective water distribution systems were mapped by utilizing the Spatial Multi-Criteria Evaluation (SMCE) techniques which also helped to identify and mapthe existing water distribution points in selected sites of Rulindo district. The results revealed that in Rulindo district, more than 90% of households in both new and old settlement had access to clean water. Although water is available, it is good to assess the variable water quality. This will facilitate policy makers to make sure that the communities in their respective locations are safe and accessing safe water as well.

Keywords:Settlement, Water distribution, Rulindo district, Spatial Multi-Criteria Evaluation

I. INTRODUCTION

It is certain that without water, there would be no life of any kind on earth and that, without water readily available in adequate quantity and free of pathogenic organisms, man's progress is tremendously hindered. In fact, men built most of their early communities near the water courses which served their economic, social, and physiological requirements. Safe and readily available water is important for public health, whether it is used for drinking, domestic use, food production or recreational purposes. In fact, water is essential to sustain life, and a satisfactory (adequate, safe and accessible) supply must be available to all (World Health Organization, 2017).

In addition, in most instances, wells and clean surface water were so close by, that fetching was not considered a problem. However, population growth, weather fluctuations and social upheavals have made the daily chore of carrying water highly problematic and a public health problem of great magnitude for many, especially women, in the poor regions and classes of the world (Sorenson et al.,2011).As reported by the United Nations Educational, Scientific and Cultural Organization (UNESCO,2019), water supply and sanitation support in rural areas is more challenging due to the settlements location mostly in environmentally fragile areas, development models dominated by diverse cultural values, poor economic condition, and associated cost recovery challenges. In many cases, scattered settlements, dominated by agro-based economy and limited water resources give rise to challenges for infrastructure provision.

Most of the existing water infrastructure is decentralized systems (e.g. community water collection point, public stand post, pit latrines and septic tanks in some cases). Such infrastructure systems have also fallen into disrepair due to technical, financial and managerial limitations. Rural population often depend on local water sources (wells, hand pumps, river), which are in many cases contaminated (UNESCO, 2019). In Rwanda, access to improved drinking water sources has increased in Rwanda (NISR, 2016). Resettlement program in Rwanda anticipates that a proportion of at least 70 % of households living in

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rural areas will be settled in integrated viable settlements that offer economic opportunities, favor rational land use and management and promote access to basic amenities such as clean water (MININFRA, 2019; RHA, 2019).

However, so far there is lack of empirical evidence of the situation related to water distribution systems especially in the rural areas. Therefore, this study was conducted in order to map water distribution system in the new grouped Settlements and to compare the water accessibility situation in the new grouped settlement to that of the old villages of Rulindo District, Northern Rwanda

II. METHODS AND MATERIALS

2.1. Description of study area

This study was conducted by considering the district of Rulindo, one of the five districts that make up the Northern Province while the remaining are Gakenke, Burera, Gicumbi and Musanze districts. The surface area of Rulindo district is estimated at 567 km2 with a population of 288,452, among them 136,058 people are male and 152,394 female which result in density of 509 /sq.km and an average annual growth rate (2002-2012) of 1 % (REMA, 2013).

Rulindo district has 17 administrative Sector namely: Base, Burega, Bushoki, Buyoga, Cyinzuzi, Cyungo, Kinihira, Kisaro, Masoro, Mbogo, Murambi, Ngoma, Ntarabana, Rukozo, Rusiga, Shyorongi and Tumba, 71 Cells and 494 villages. The district is rural, and is comprised of steep hills and valleys, with springs and rivers serving as the traditional water sources. According to the third Integrated Household Living Conditions Survey (EICV3), published by NISR (2012), 74.6% of Rulindo district households use an improved drinking water source.

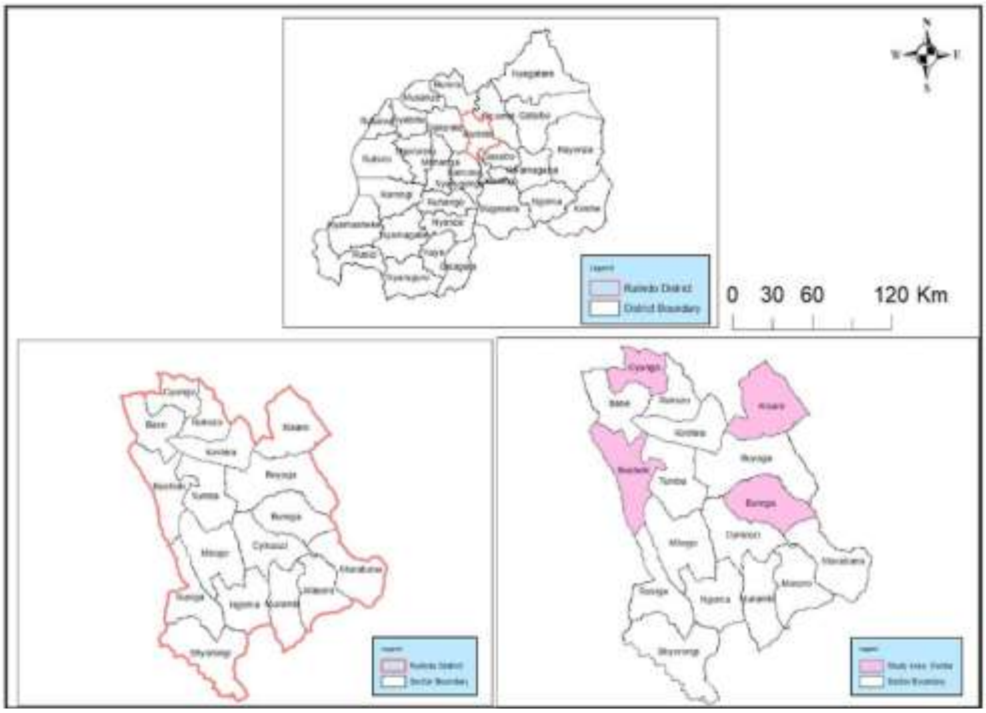

Figure1 Map of the study area in Rulindo district

2.2Data collection and analysis

During this study, the authors collected data related to distribution within the selected sites and households. All data were shapefiles of the considered study areas which were collected by using the GPS and treated with use of ArcGIS 10.5. These tools enabled the authors to utilize the shapefiles of households by overlapping them on the planned water distribution. This facilitated the study to indicate the water accessibility within the selected sites. The Figure detailed the utilized methodology for this study.

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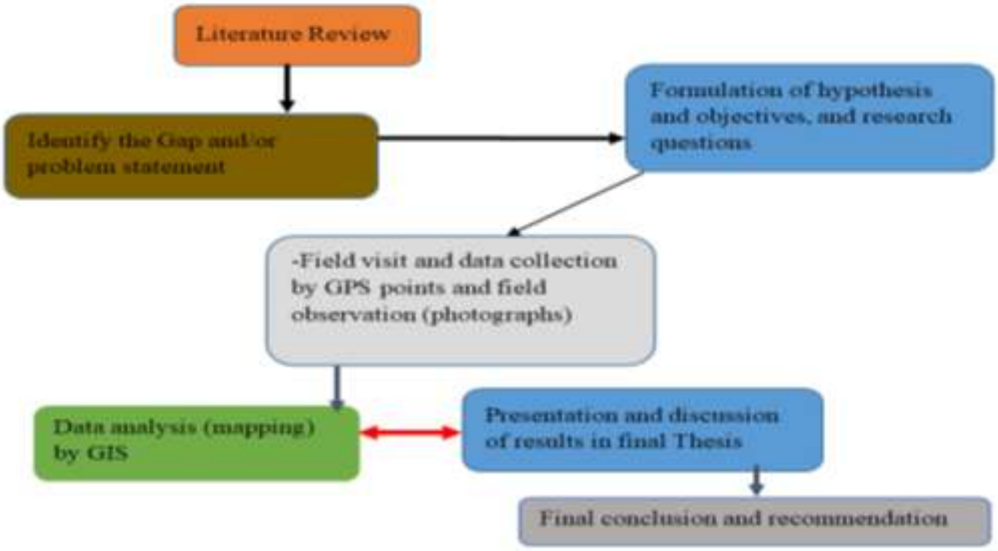

Figure 2: Methodological framework

Source: Author, 2020

III. RESULTS

3.1 Water access situation in old villages and new grouped settlement in Rulindo district

3.1.1 Water accessibility in Nyirangarama and Byimana sites of Bushoki sector

It was found that 97.5% households were within 0–500 meters from a water point implying that fetching water took less than 30 minutes round trip, while 2.5 % were located at more than 500 meters. The water point identified were full functioning, protected, and public (see Figure 3).The same Figure 3 indicated that all households were located at a distance less than 500 meters from public and improved spring water point services coverage, which is in turn, implies that households had access to clean water.

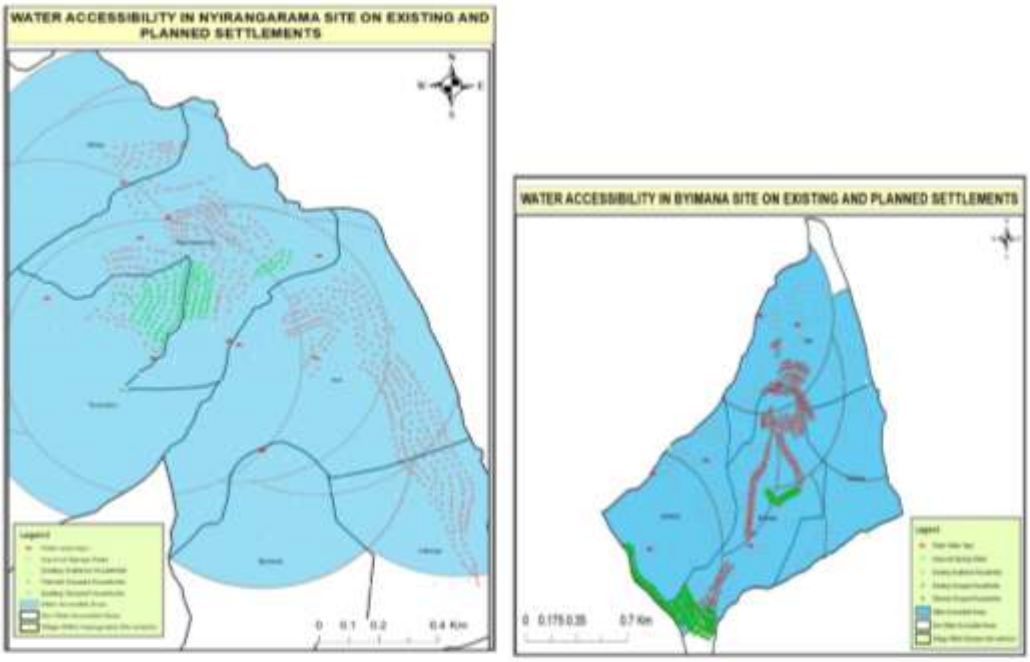

Figure 3: Public and improved spring, water point coverage, accessibility within 500 m in Nyirangarama and Byimana sites

Source: Researcher, 2020

International Journal of Advances in Engineering and Management (IJAEM)
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3.1.2Water accessibility in Rebero site

The results from the survey indicated that there, were 761 dwelling existing grouped settlement and scattered. It was identified that 705 dwelling were situated on distances that allowed more accessibility to water. It was further revealed that 92.6% of both grouped and scattered households were located within 0–500 meters from a water point whereas, 56 dwelling equal to 7.5 % were located at more than 500 meters (See Figure4).

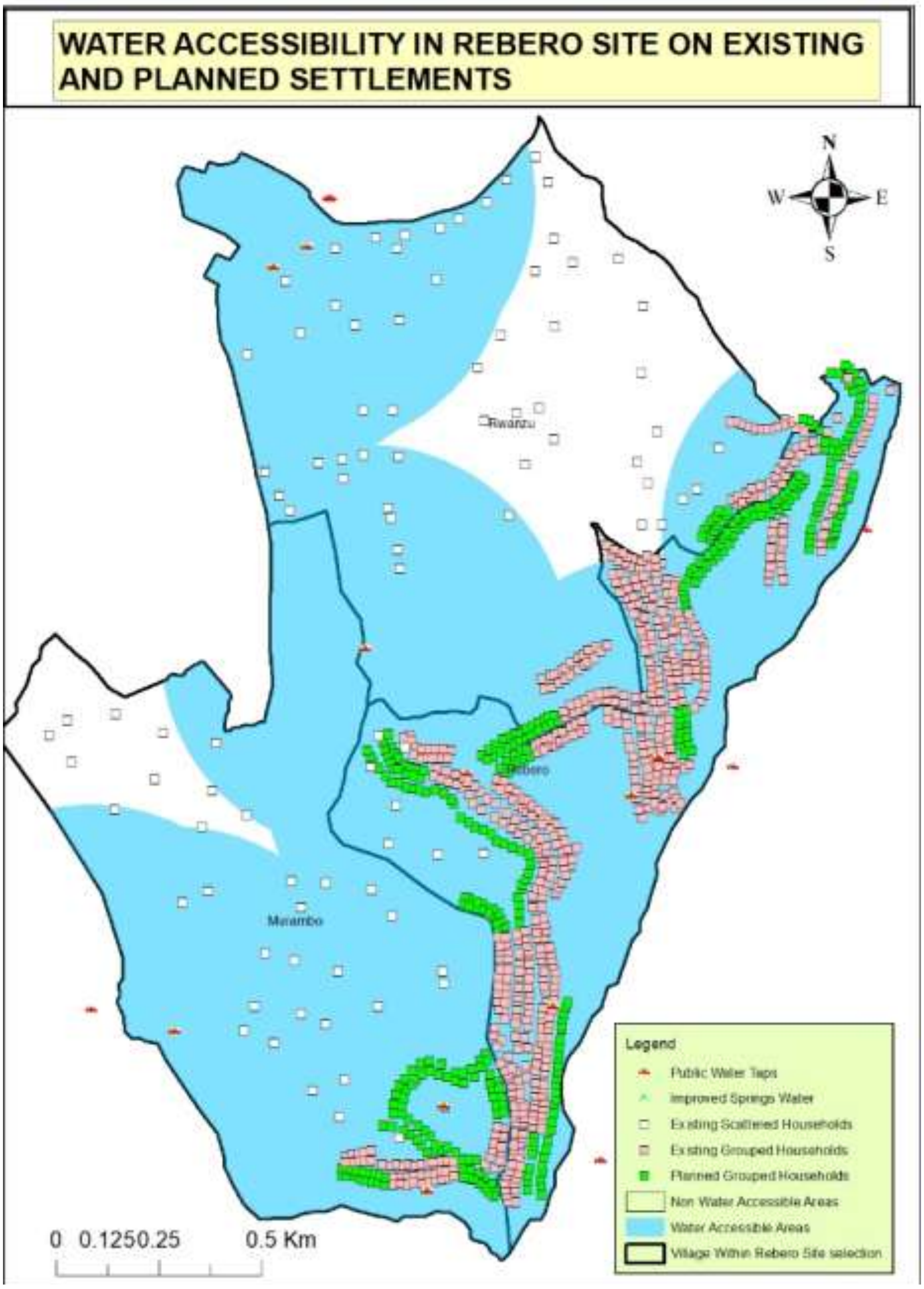

Figure 4: Public and improved spring, water point coverage, accessibility within 500 m in Rebero site. source: Researcher, 2020

International Journal of Advances in Engineering and Management (IJAEM)
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3.1.3Water accessibility in Gitaba village

It was further indicated (Figure 5) that in Gitaba site, the number of households using clean water was 100%, there households' members used water from an improved water source (pipe, protected spring) and could get it within 30 minutes of a round trip.

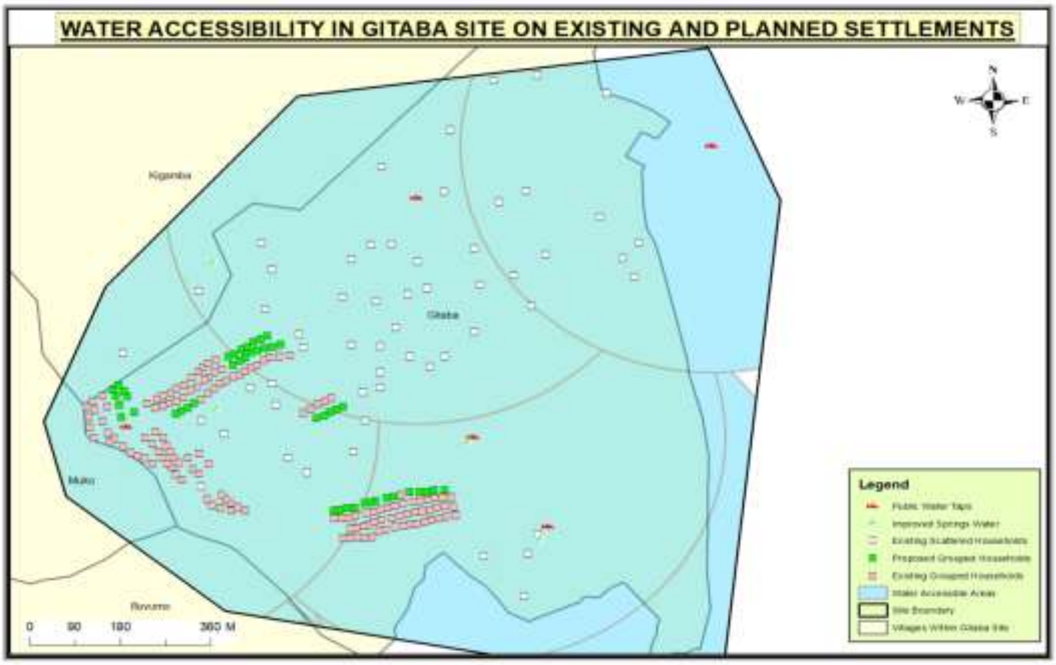

Figure 5: Public and improved spring, water point coverage, accessibility within 500 m in Gitaba site.
Source: Researcher, 2020

3.1.4Water accessibility in Gashinge site

The results in Figure 6showed that in Gashinge site, 97.5% of grouped and scattered households were located within 500 meters from a water point that means that water was accessible, while 2.5 % were located at a distance over 500 meters.

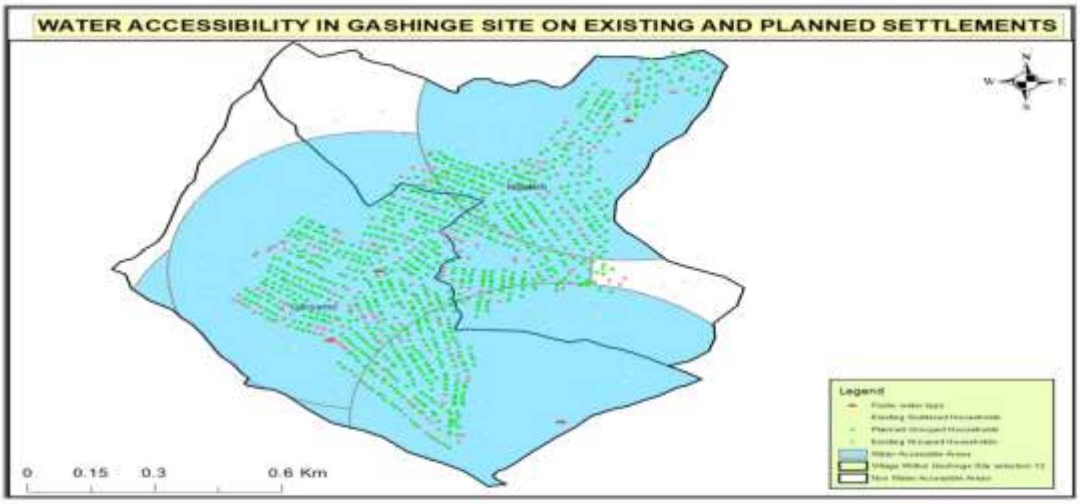

Figure 6: Public and improved spring, water point coverage, accessibility within 500 m in Gashinge site.
Source: Researcher, 2020

3.1.5Water accessibility in Kiziba site

In Kiziba site, using buffer analysis tools households and water points were mapped using ArcGIS software. The distance from each household to the nearest improved spring, public water points was calculated, and for each cluster, the distance of households within 500 m of such a water source was determined the result shown in Figure 7.

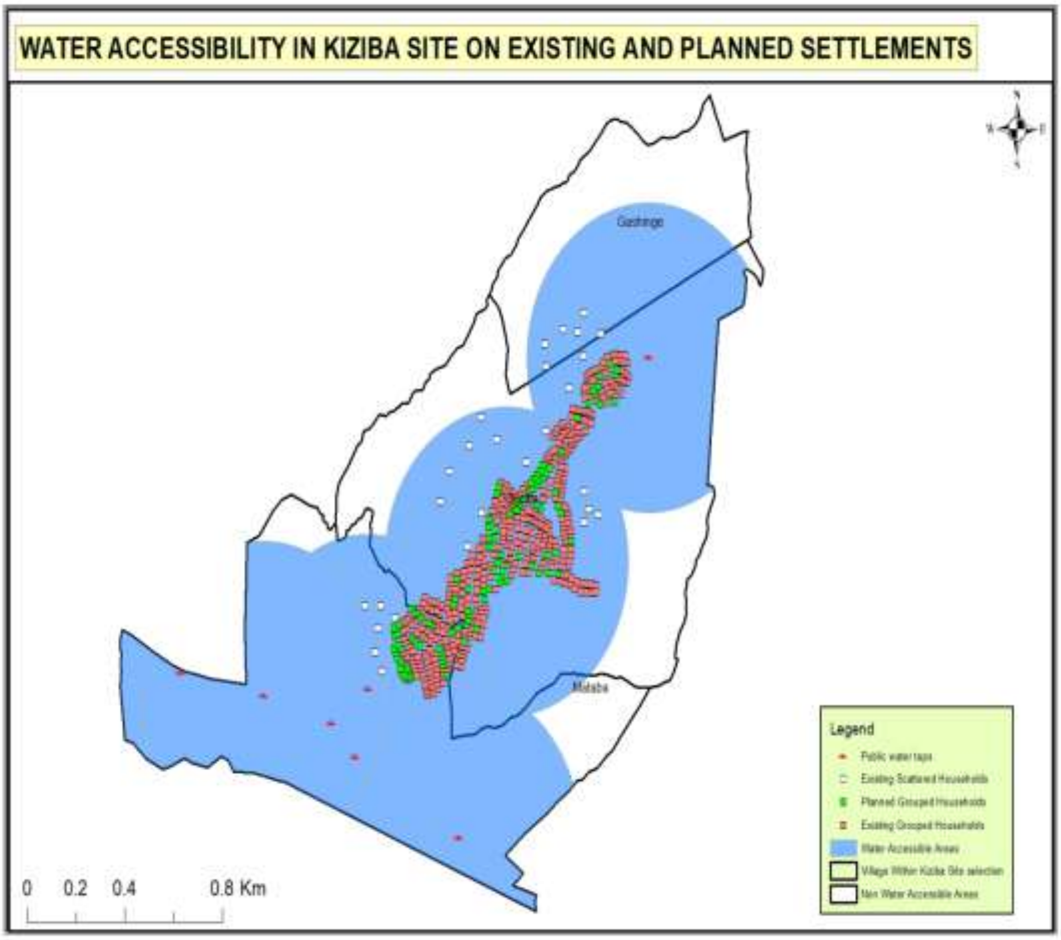

Figure 7: Public and improved spring, water point coverage, accessibility within 500 m in Kiziba site.
Source: Researcher, 2020

3.1.6Water accessibility in Mukarange site

The results in Figure 8 showed that in Mukarange site, selected villages Mukarange, Rwamiko, Kanunga. Here, water accessed for household in Mukarange was 94.0% whereas for the rest 6.0% of households had no access to clean water from the number of dwelling equal to two hundred and thirty-seven (237) fall in the range 500 m distance from water point to dwelling.

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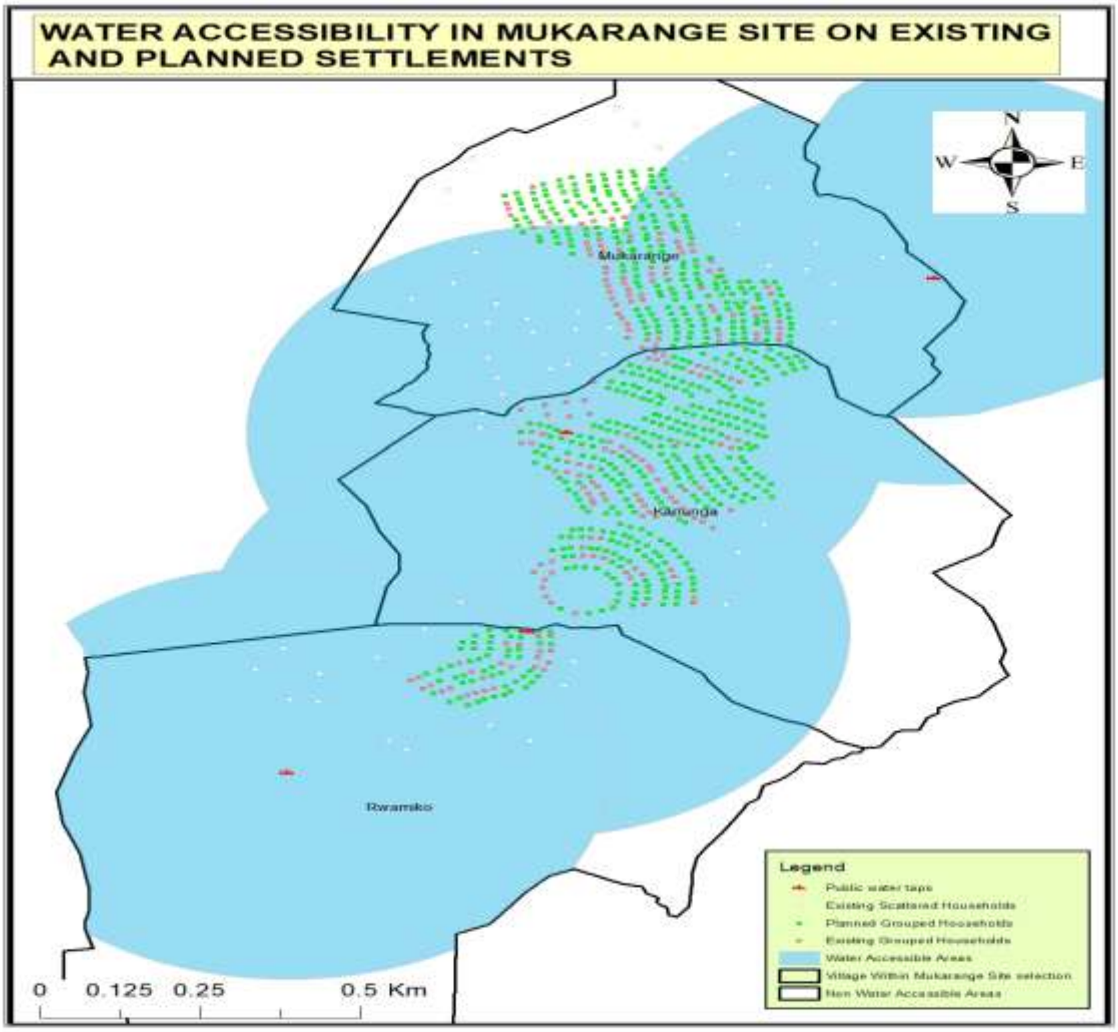

Figure 8: Public and improved spring, water point coverage, accessibility within 500 m in Mukarange site.

Source: Researcher, 2020

3.1.7Water accessibility in Kisigiro site

As illustrated in Figure 9, it was noted that 100 percent household in Kisigiro site used water from an improved source (pipe, improved spring) and get it within 30 min round trip and short distance, which is about 500 meter within regarding to all 208 household occupied from selected village.

International Journal of Advances in Engineering and Management (IJAEM)
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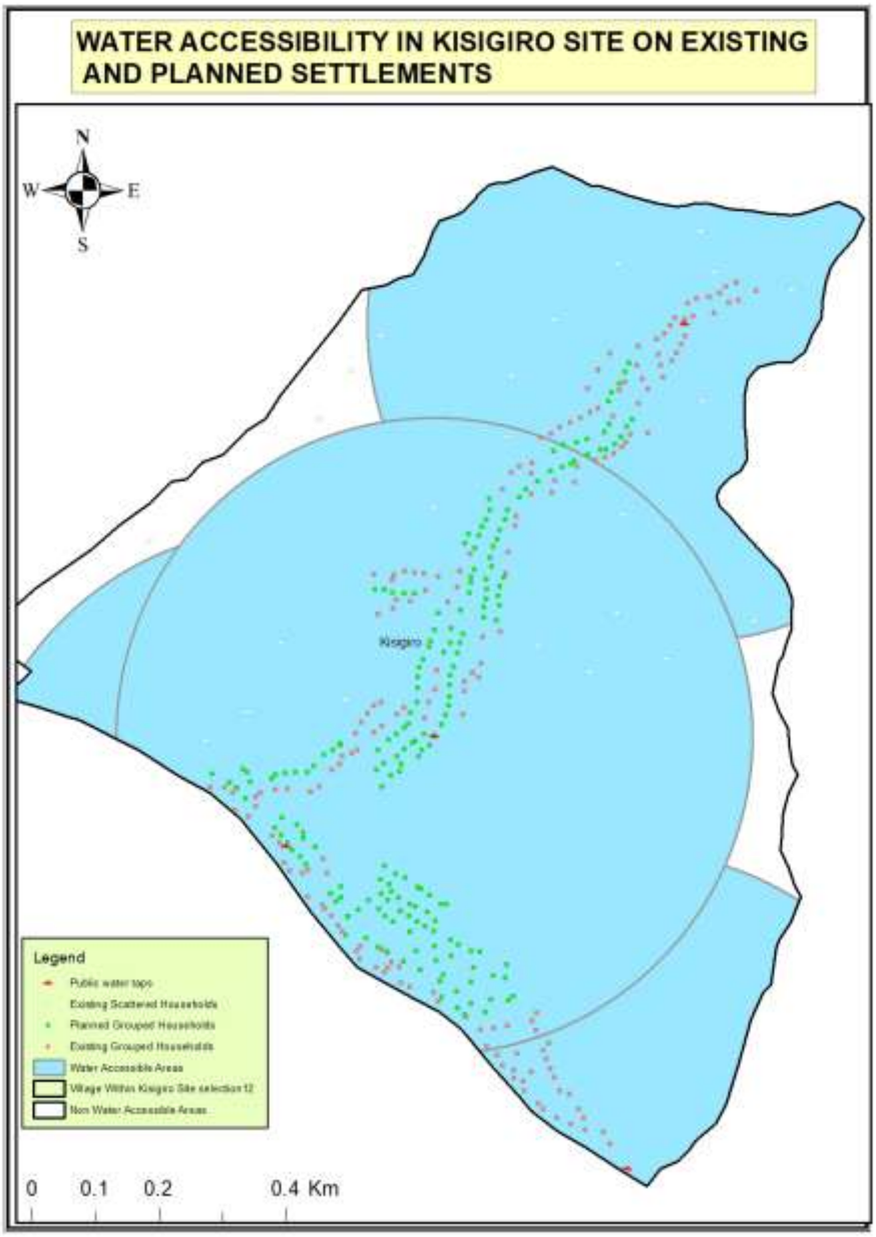

Figure 9: Public and improved spring, water point coverage, accessibility within 500 m in Kisigiro site.
Source: Researcher, 2020

3.1.8Water accessibility in Gitagata site

The survey results in Figure 10 revealed that 100 percent household, which is equal to 130 dwelling in Gitagata site.

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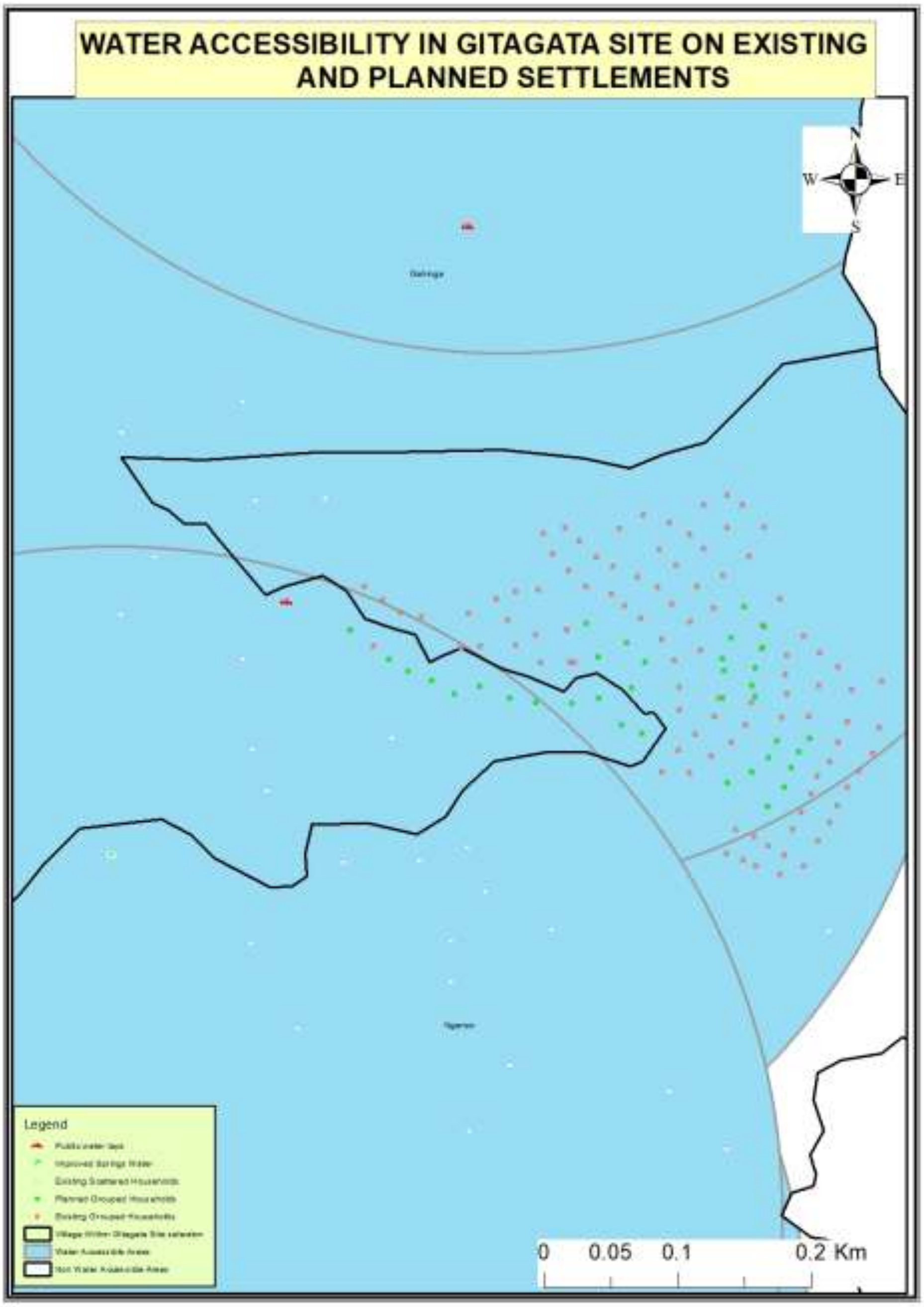

Figure 10: Public and improved spring, water point coverage, accessibility within 500 m in Gitagata site.
Source: Researcher, 2020

3.1.9Water accessibility in Gatete site

The results in Figure 11revealed that 92 % of households in Gatete site were located at a distance less than 500 m that implies that water accessibility while 8% were collected the water farther 500 m.

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 8 Aug 2021, pp: 1612-1627 www.ijaem.net ISSN: 2395-5252

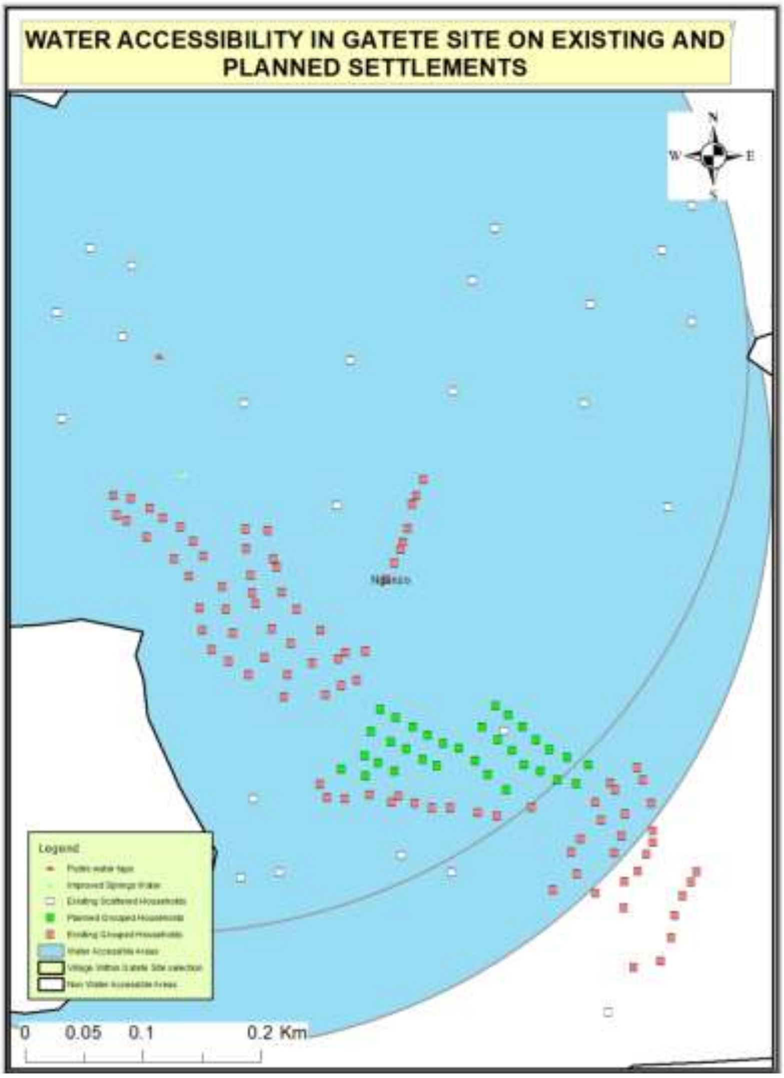

Figure 11: Public and improved spring, water point coverage, accessibility within 500 m in Gatete site.
Source: Researcher, 2020

3.1.10Water availability in Burehe site

The analysis in Figure 12indicated that households located at a distance of less than 500 meter to the water point were 100 %. Therefore, households are able to fetch and use clean water from an improved source (pipe, improved spring) and get it within 30 min round trip.

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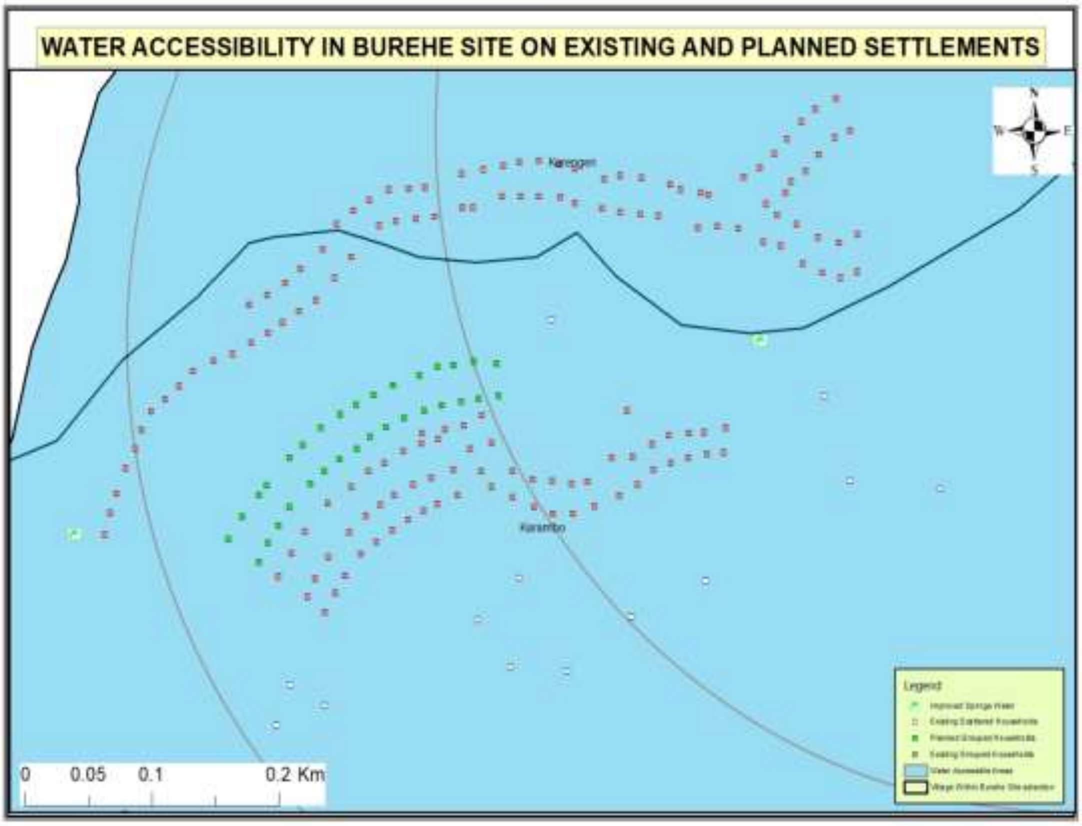

Figure 12: Public and improved spring, water point coverage, accessibility within 500 m in Burehe site.
Source: Researcher,2020

3.1.11Water accessibility in Gihinga site

The result from the survey and calculation in Figure 13showed that almost 97 percent of the households in Gihinga site were able to reach sources of water point because they were at a distance of less than 500 meters while only 3 percent reached water points located at distance great than to 500 meters.

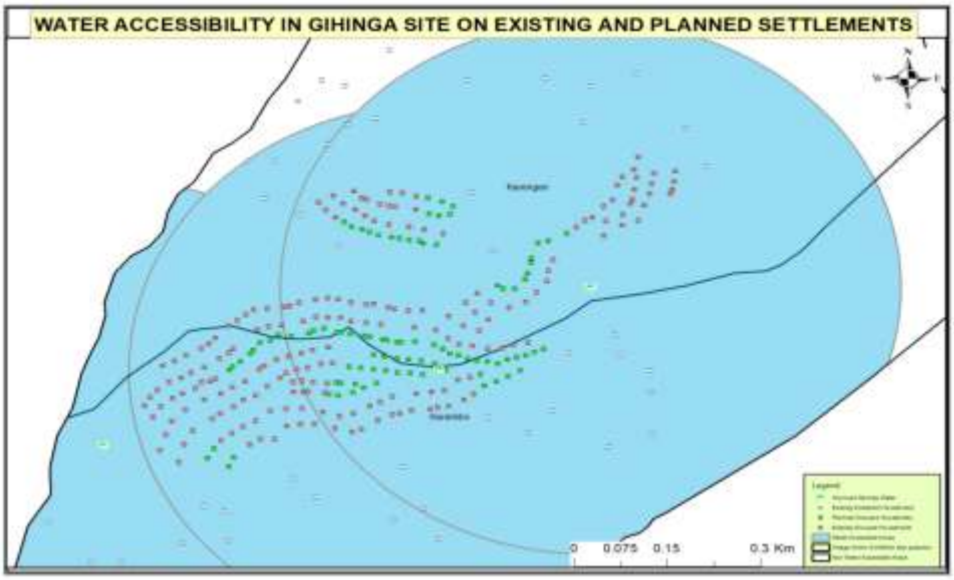

Figure 13: Public and improved spring, water point coverage, accessibility within 500 m in Gihinga site.
Source: Researcher, 2020

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 8 Aug 2021, pp: 1612-1627 www.ijaem.net ISSN: 2395-5252

3.1.12Water accessibility in Nyantabo site

The results in Figure 14 indicated that 99.5 % of households in Nyantabo site were located at a distance less than 500 m while 0.5 % were collected the water farther 500 m.

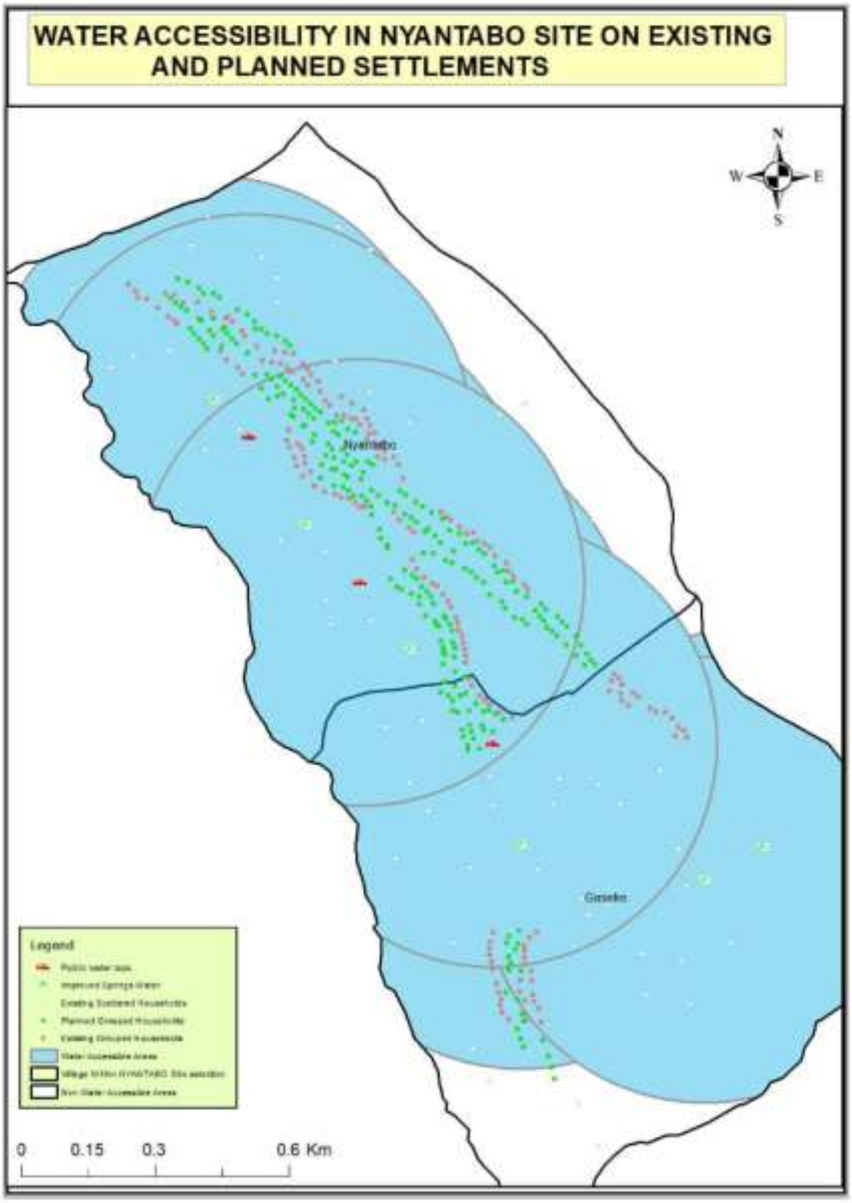

Figure 14:Public and improved spring, water point coverage, accessibility within 500 m in Nyantabo site.
Source: Researcher,2020

3.1.13Water accessibility in Rugarama site

Thus, results in Figure 15 revealed that 91.2 % of households in Rugarama site were located at a distance less than 500 m while 8.8 % were collected the water farther 500 m.

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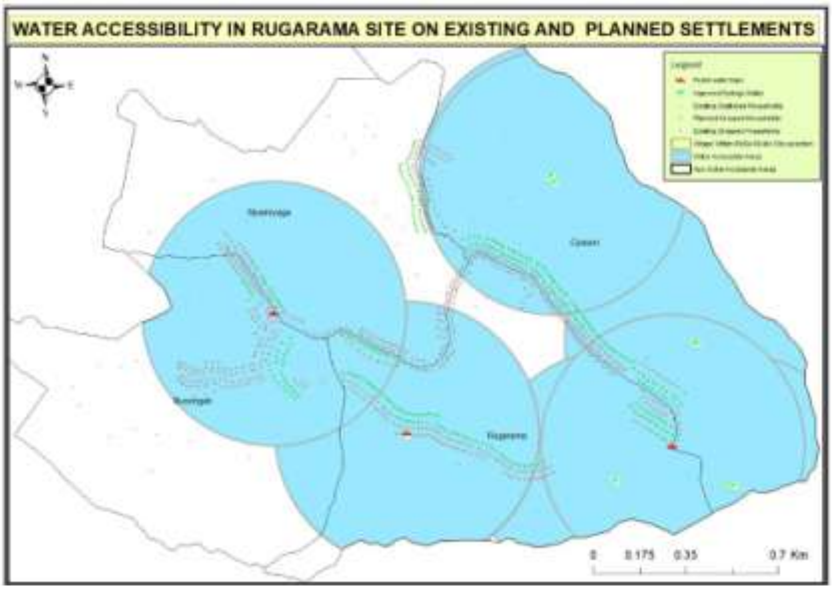

Figure 15:Public and improved spring, water point coverage, accessibility within 500 m in Rugarama site.Source: Researcher, 2020

3.1.14Water accessibility in Kamazi site

Resultsin Figure 16 revealed that 81.5 % of households in Kamazi site were located at a distance less than 500 m while 18.5 % were collected the water farther 500 m.

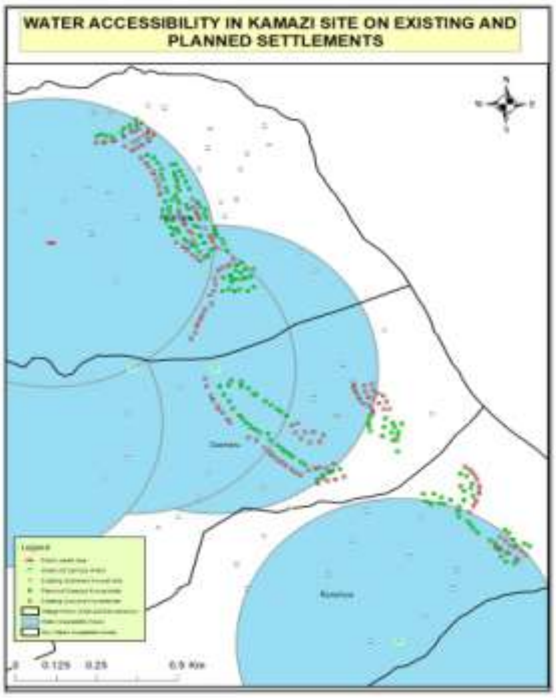

Figure 16: Public and improved spring, water point coverage, accessibility within 500 m in Kamazi siteSource: Researcher, 2020

3.1.15Water accessibility in Gitwa site

In Gitwa site it was noticed that (see Figure 17) there were, selected from the villages Rusumo, Kibanda. Here, water accessed for household in Gitwa was 98.0% whereas for the rest 2.0% of households had no access to clean water.

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Volume 3, Issue 8 Aug 2021, pp: 1612-1627 www.ijaem.net ISSN: 2395-5252

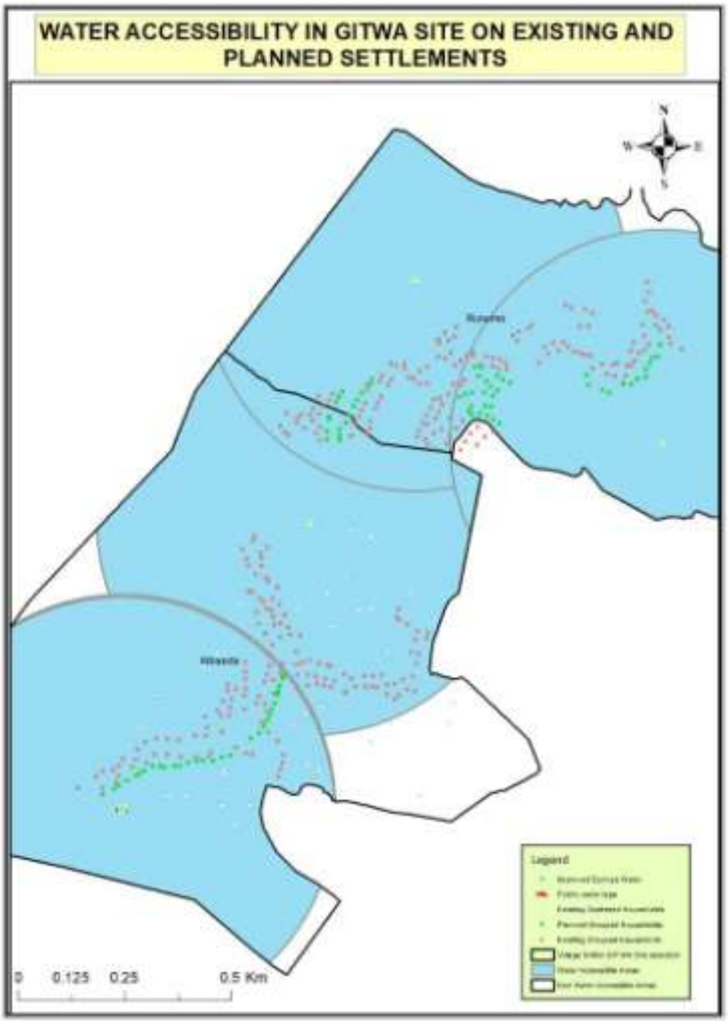

Figure 17: Public and improved spring, water point coverage, accessibility within 500 m in Gitwa site.
Source: Researcher, 2020

IV. DISCUSSION

The present study was concerned with mapping water distribution and accessibility in grouped settlements of Rulindo district, Northern Province of Rwanda.It focused on the selected villages within the four sectors Bushoki, Burega, Cyungo and Kisaro. The results revealed that most people from Rulindo shifted from scattered to grouped human settlement and indicated that there were people who were still living in scattered settlements.

According to the Land Use Planning Law that governs the planning of land use and development in Rwanda, it is stated as a fundamental principle that it must “prioritize higher density, multi-family residential settlements either located in an urban or rural area”. Moreover, according to the land use “must focus on integrated land uses like residential, commercial…in settlement areas in which people live and work to minimize physical distances” (Ngoga, 1995).

The phenomenon of resettlement was also implemented in the past by other African countries. The similar example was villagization in Ethiopia which was implemented to introduce social and economic change through a socialist agrarian transformation which also included mechanization and cooperativisation (Pankhurst, A., 1992: 77). The phenomenon was backed by the Ethiopian constitution which stated the following: "The state shall encourage the scattered rural population to aggregate in order to change their backward living conditions and enable them to lead a better social life" (Jansson, Harris and Penrose 1990: 113). Villagization was intended to improve agricultural production, to facilitate the delivery of services such as health and education to populations which were difficult to reach in their scattered homesteads, and to improve the land use of the peasants (Kelkil, 1998).

The cornerstone of any healthy population is access to safe drinking water. Water contributes much to health. Good health is the essence of development. The importance of adequate water supply and sanitation services as drivers for social and economic development, poverty reduction and public health is also fully acknowledged in Rwanda's flagship policy documents and national goals. Water contributes to health directly within households through food and nutrition, and indirectly as a means of maintaining a healthy, diverse environment. The right to water was defined as "Everyone's right to have access to sufficient, safe, acceptable and physically accessible and affordable water for personal and domestic uses". Safe drinking water is a relative term, varying with country and international organizations' specific quality standards and guidelines (Dinka, 2018).

The findings (see Figure 3 to Figure 18) from of this study revealed that most of the surveyed sites had water accessibility rate which was higher than 80% on average. This is in line with the NST1 keys strategic interventions about the water accessibility, which stipulates that water accessibility will be scaled up from 85 % (Estimates 2017) to 100% by 2024 (GoR, 2017). It also indicates that there is still much to be done to increase water accessibility to the desired level.

According to Patunru (2015), improved water sources do provide some degree of additional protection over unimproved sources, despite the fact that microbial quality cannot be guaranteed (Shaheed et al., 2014). Demand for water will continue to increase, and it has been estimated that by 2030 nearly half of the population will live in areas of high-water stress, which will result in the displacement of populations. While water scarcity is likely to limit opportunities for economic growth and the creation of decent jobs in rural areas, the increased demand for water in areas with reduced water availability or high competition for water calls for an increased diversification of water sources, such as low yielding wells and springs, rainwater or storm water harvesting, urban runoff, and wastewater recycling. This not only has the potential, through technological development, to create jobs in the operation and maintenance of treatment plants to reclaim water, but it enables new forms of small-scale intensive uses of water such as the cultivation of highly profitable crops in small plots (WWAP,2019).

V. CONCLUSION

The present study was concerned with mapping water distribution in Rulindo district in the Northern Province of Rwanda. There are abundant water resources which could be explored to ensure access to water among its residents. Nevertheless, the existing distribution systems in some cases, do not reach those in need. Therefore, the present thesis was aimed to map water distribution and access in grouped and non-grouped settlements of Rulindo district. Both primary and secondary datasets were employed. The study identified different types of water distribution systems in 16 sites of the selected villages within the four sectors purposively selected sectors because they implemented resettlement programs. These include Bushoki, Burega, Cyungo and Kisaro sector. The results were maps that revealed that most people from Rulindo shifted from scattered to grouped human settlement. However, it was also revealed that there were people who were still living in scattered settlements. The majority of households from selected site in the four sectors of Rulindo namely Bushoki, Burega, Cyungo and Kisaro were located within 0–500 meters from a water point whereas in general less than 10% were located at more than 500 meters. The study further revealed that the percentage of scattered households existing in many of the selected sites will continue to decrease because convenient access to safe water will be one of the incentives (i.e., pull factors) for people to move to grouped settlements. The study recommends that incentives should drive the resettlement programs implemented in Rwanda. The study further recommends that further research on water accessibility is needed, and that it should focus on issues such as water availability and quality of water in different settings.

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