Water Source Management and Water Services in Rwanda: Case of Rulindo and Gicumbi

Towards Sustainable Water Services

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Background & Rationale

Water is a key driver of socio-economic development and contributes to maintaining the integrity of the natural environment. Water sustains lives and economies of countries, and it supports the production of food, energy, transport, sanitation, and other services needed to achieve proper human welfare.

Water resources in Rwanda face growing challenges that range from huge demand arising from the growing population, growing demand for socio-economic use, poor land use practices leading to degradation, and climate change. However, these resources are dearly needed to advance the country's aspirations to become a middle-income country by 2020; and sometimes their growing demand generates into conflicts.

Rwanda has on average an estimated 9.5 billion cubic meters per annum of actual total renewable water and a per capita availability of close to 1,000 cubic meters, according to the country's Water Resources Management Subsector Strategic Plan (MINIRENA, 2011). The use of water resources in Rwanda was estimated at 2.24% in 2012. Based on projected population and water demand in 9 different water catchments, water use is projected to be 58% of available resources. But, two catchments are experiencing deficits since 2014 based on the projections of National Water Resource Master Plan. In general, Rwanda has enough fresh water which can be used. But, efficient use of water resources available was recommended by the National Water Resource Master Plan because some water catchments are stressed, and others will face water deficit based on projected water use by 2040.

In the rural context of Rwanda, the main source of drinking water is from ground water, either natural springs in Northern and Western Provinces or wells in Southern and Eastern Provinces. Water is either fetched directly from wells and springs or piped to communities from springs and wells. As most Rwandan terrain is mountainous, and most people live on top of the mountains, water is pumped on top of the hills and later distributed by gravity though distribution tanks. As mentioned above, water resources support almost all the socio-economic activities in Rwanda. However, over the years, the water resources were degraded due to erosion, pollution from agricultural activities, industrial effluent, and household waste, all leading to reduced water levels and shortages, in addition to contamination. The increased water uses and demand present serious challenges and sometimes result in conflicts.

In Rulindo and Gicumbi districts, Water For People supported the development of district-level Water Resources Management (WRM) Plans in 2016 and 2018, respectively. The WRM Plans were developed to ensure that the two districts have the tools and information they need to make decisions aiming to improve the sustainability of water sources for drinking water and other domestic uses. The Plans enable district leaders and other partners to have a clear picture of available water sources versus demand, water quality and appropriate measures for effective protection, and use of water resources. The Plans estimate that US$30,276,251 for Rulindo District and US$86,537,799 for Gicumbi District are needed to ensure that water sources are protected, water quality is maintained and monitored, and water recharge measures are implemented in all the catchments of water sources that supply systems. These water supply systems in Rulindo are worth over $20 million and serve 243,475 people from 17 sectors; in Gicumbi, water sources supply water to systems worth over $48 million and serve 427,026 people from 21 sectors.

Methodology for Development of WRM Plans

The development of WRM Plans is based on the principles and theories of WRM. The two studies covered the entire Districts of Rulindo and Gicumbi, and the focus was on water demand analysis and water balance. The water demand and balance analysis took into consideration the horizon of 25 years. The two studies were conducted in line with hydrological boundaries at catchment and sub-catchment levels for water sources (springs) and surface water, and data was collected during rain and dry seasons.

WRM Plans were elaborated based on the results of a water resources inventory, delineation of sub-catchments, water demand analysis, water shed characterization, and a water quality assessment.

Stakeholder Analysis

According to the Global Water Partnership (GWP), stakeholder participation is critical to WRM for multiple reasons (GWP, 2017). Fundamentally, it is ethical; water is necessary for people to live, and therefore those that depend on a water resource should have the right to participate in decisions regarding its management. The stakeholder analysis and identification provided the essential information about individuals, groups, and institutions affected by or benefiting from water services provided in the watershed and their various interventions. The stakeholder analysis exercise aim was to answer the key questions below (for Gicumbi as an example):

1. What are the current and future interests of the various stakeholders in the use and management of Gicumbi watersheds? What are their needs and expectations? How do they use services provided by Gicumbi watersheds and what benefits do they derive?
2. What are their past and current power, rights and responsibilities, both formal and informal? What are the networks and institutions of which they are part?
3. What are the social and environmental impacts, both positive and negative, of their past and current exploitation of watershed?
4. How ready and willing are they to participate in and contribute to the management?
5. What are the potential areas of agreement and shared interest, upon which consensus and collaboration can be developed?
6. What human, technical and financial resources are they prepared to contribute to the management process?
7. What is the current volume of water needed per capita/person/day?

Focus Group Discussions and Interviews

A consultant used focus group discussions (or meetings) and met with environmental experts from different sectors of the district and community representatives to optimize the limited time for field visits and interviews. The discussion had a gender sensitive basis to ensure capturing the role of women and children in the results obtained.

The meetings helped the team identify, among others, the areas of the district under threat, the types and causes of the problems faced, and efforts and plans already in place. The interviews pointed out some indicators showing possible ongoing trends for appropriation beyond the water supply project timeframe, challenges, and what could be done for improvements.

Flow Measurements

The spring yield was measured in liters per second (l/s). The measurement process involved two persons: one person collecting water with a container of a known volume while the other one was measuring the time needed to fill the container. Three readings were taken during the measurement, and the averages were made and expressed in l/s for each spring.

The mechanical current meter method was used to measure the stream flow of the rivers. This is a standard method used for river flow measurement. The stream channel cross section was divided into numerous vertical subsections. In each subsection, the area was obtained by measuring the width and depth of the subsection, and the water velocity was measured by using the mechanical current meter. Then, the discharge in each subsection was computed by multiplying the subsection area by the measured velocity. The total discharge was then computed by summing the discharge of each subsection.

Water Quality Sampling and Analysis

Water quality parameters were collected and stored in 600ml plastic bottles and placed in a cooler box after sampling to wait for laboratory testing. The parameters analyzed are pH, turbidity, total coliforms, total phosphorous, total nitrogen, iron and manganese. Water quality tests were conducted and analyzed by University of Rwanda laboratories specialized in water quality control. The results from the analysis were compared to Rwanda Standard Board (RSB) and World Health Organization (WHO) standards for drinking water.

Water Demand Analysis and Water Balance

Water use demand was estimated based on the existing data available in the study area, in terms of volume of water per spring/river. The population estimate for the two districts was based on the horizon of 25 years to come. The projected population and water needs were compared to the available water to assess whether the demand would still be met after 25 years. This allowed the team to compare the projected water demand to available water to determine the water balance.

Key Findings of WRM Plans

The Water Resource Master Plans in Rulindo and Gicumbi were limited to water sources currently available, and the water demand analysis was mainly limited to domestic use and industries. The two studies did not consider other future potential water supplies and demands in the two districts, including agriculture, which tends to use a huge amount of water, more than 80% of water use in Rwanda. The purpose was to focus on the sustainability of the sources that currently supply water.

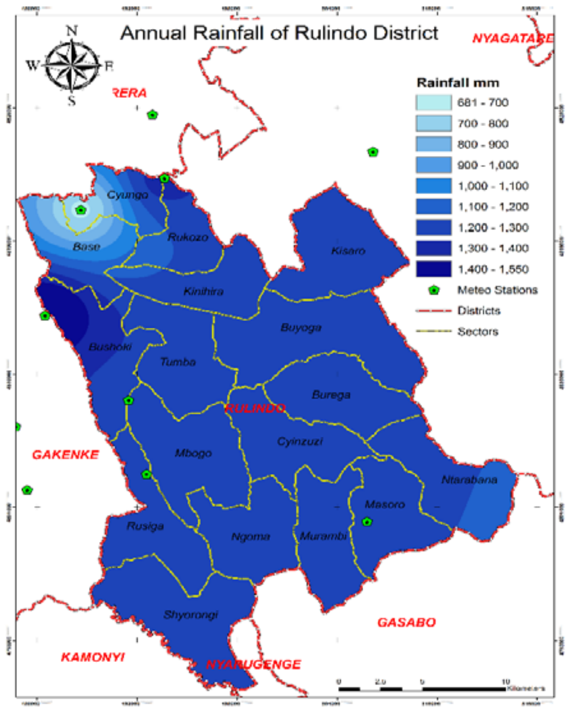
Based on the water demand and balance analysis based on springs, both Rulindo and Gicumbi Districts will face a water deficit over the horizon of 25 years. The study recommends considering alternative sources to ensure that water demand is met by end of 25 years.

Specific Findings: Case of Rulindo

The annual rainfall in Rulindo is good and ranges between 651mm to 1,550mm. A big part of Rulindo has annual rainfall above 1,200mm. Map 1 illustrates rainfall patterns in Rulindo. The analysis of the water quality revealed that iron (Fe) concentration in both rainy and dry seasons is in the recommended range of RSB and WHO limits.

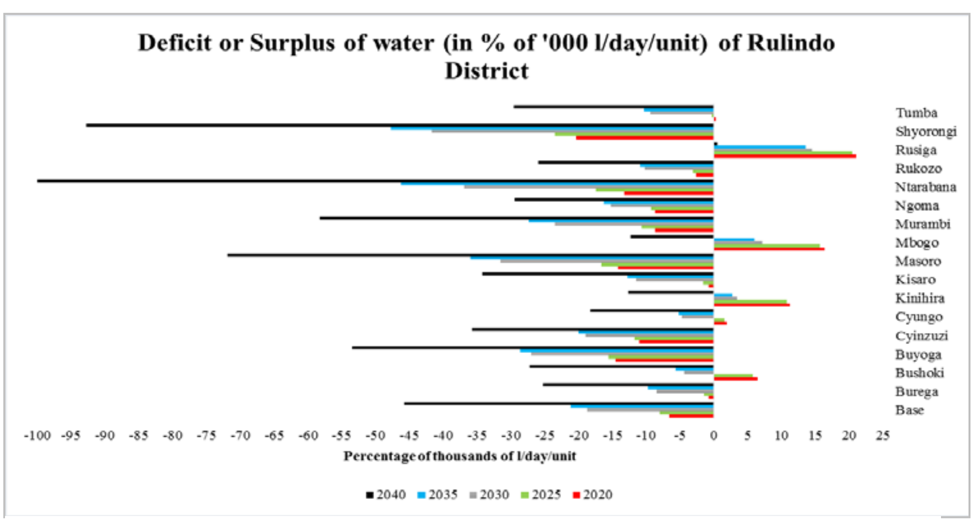
The study revealed that sources are prone to contamination and fecal coliforms. It was also revealed that the number of fecal coliforms increases in rainy seasons and drops in dry seasons. The increased concentration of fecal coliforms during the rainy season should be associated with the ground water contamination by the pit latrines in the area and the runoff of water in the water catchment, which in many places is not well protected and/or captured.

The measured concentration of total nitrogen and total phosphorous indicates a general increasing concentration in rainy season. It should be noted that the latter two parameters could serve as baseline concentrations that should be checked at least every two or three years. This is to ensure that that significant increases in nitrogen and phosphorous compounds are not occurring due to fertilizer or manure spill.



Map 1: Annual Rainfall for Rulindo

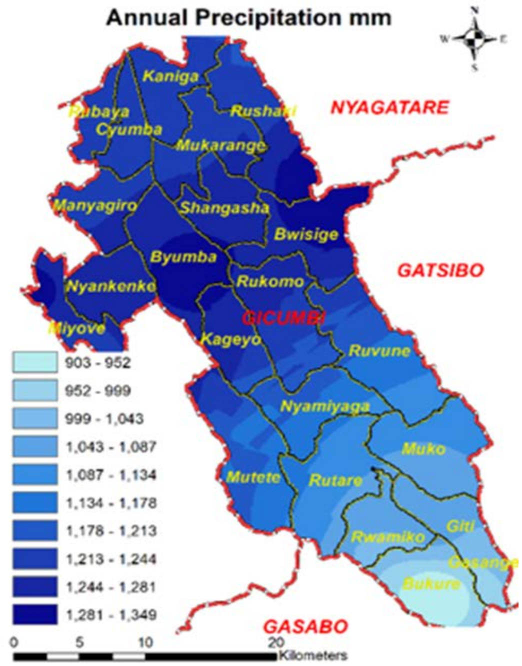
In addition to the above findings, the study revealed that water demand is higher than water production from sources, and water from sources is not enough to meet the demand over the 25-year horizon. If the district continues to rely on water from springs, water demand will not be met, and water service will not be sustainable. Graph 1 illustrates findings from the water demand and balance analysis for each sector of Rulindo District. The water demand and balance analysis were based on daily use with quantities expressed in liters/unit. The deficit and surplus of water were calculated as the difference of water available (from existing spring sources) and water demand. The major driver of the water deficit was observed to be population growth. The sectors of Shyorongi, Ntarabana, Masoro, Cyinzuzi, Tumba, and Murambi were observed to face water deficits soon. These sectors have a high population and many planned activities that will need water in the near future, based on the Rulindo District Master Plan.



Graph 1: Water Balance for Rulindo

Specific Findings: Case of Gicumbi

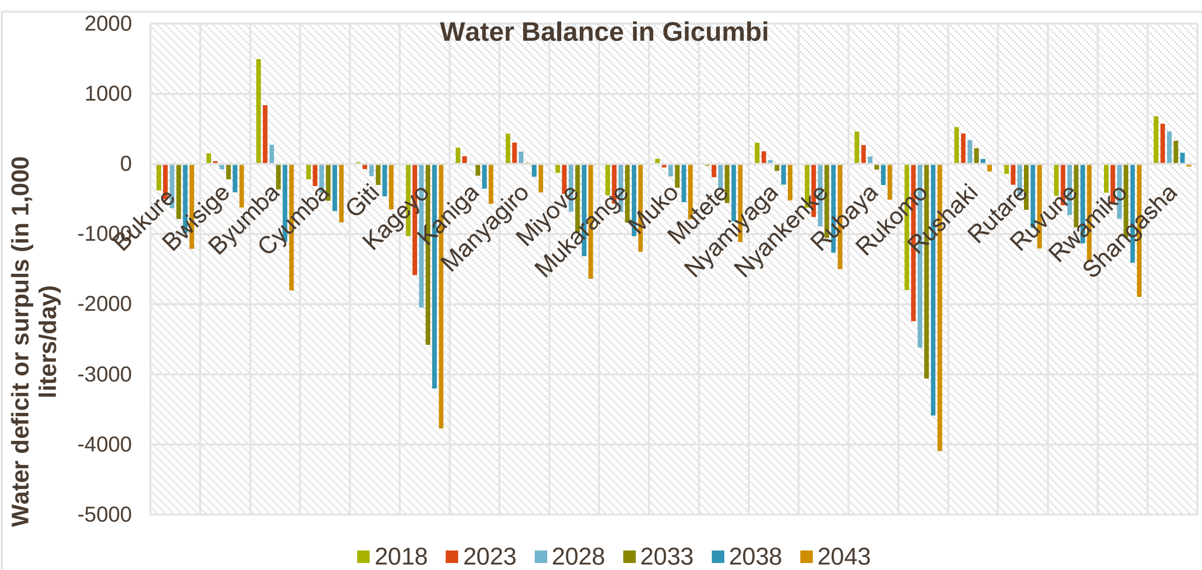
The annual rainfall variation in Gicumbi, based on the Rwanda Meteorological Agency (RMA) database, ranges approximately between 903mm to 1,349mm. The water quality analysis revealed the main issues as pH, total nitrogen, total phosphorus and total coliforms.



Map 2: Annual Rainfall for Gicumbi

The potential hydrogen (pH) analysis revealed that water in Gicumbi is acidic, and pH is below the RSB and WHO standards for drinking water in both dry and rainy seasons. There is a need to install pH regulators on water systems. The total nitrogen and phosphorous were observed in samples taken, an indication that farming is affecting water sources in Gicumbi. This shows that agricultural practices in catchment areas of water sources will affect water services. As observed in Rulindo, the number of total coliforms increases in the rainy season compared to the dry season. This was an indication that water is contaminated with pit latrines or any other form of open defecation in the catchment areas of water sources.

Similar to Rulindo, the water demand analysis showed that the water demand is higher than water supply. The water demand was estimated based on population growth scenarios and water consumption rate projection. The District of Gicumbi needs to find alternative sources to supply enough water in the next 25 years instead of relying on natural springs.



Graph 2: Water Balance for Gicumbi

As shown in Graph 2, under a conservative scenario (for water consumption rate), nearly half of all sectors are non-water deficit, with a modest surplus. Under the same scenario in 20 years, Shangasha and Rushaki will be the only non-water deficit sectors, while in 10 years Byumba, Manyagiro and Rubaya will still be non-water-deficit. The sectors of Cyumba, Ruvune, Rwamiko, and Giti are particularly deficient in water supply considering the number of springs available and discharge of those springs. For instance, Cyumba and Ruvune Sectors have water sources with a total discharge of less than 5 liters per second.

Proposed Improvement in WRM

Protection of Catchment and Springs

The WRM Plans recommend catchment management plans and spring protection techniques. Catchment management plans were created for all delineated spring recharge catchments. The status of each visited spring and action needed for its protection were also assessed and proposed. The Plans also propose key actions for sustainable spring protection, protection of the recharge catchment, and water conservation measures such as agroforestry, terracing, cut-off drains and trenches, forest plantation, and the rehabilitation of natural forest.

Institutional Framework

Based on the provisions of water law, WRM Plans recommend that Water Users Associations should be established and operationalized to manage each water source or, where possible, two or more water sources. Those Water Users Associations will be supervised by WRM committees at sector level and district level where they are operational. Otherwise, this supervisory role will be played by local authorities from cell to district level.

Stakeholder Engagement

It is evident that water is a central resource supporting human activities and ecosystems, and it is required for different purposes. Hence, there is the need for integrated WRM, which should be participatory, technically, and scientifically informed.

Both districts (Rulindo and Gicumbi) should begin the process of stakeholder participation in formulating a strategy for WRM. Stakeholder participation should involve those who are affected by, and thus have an interest in, water resources. Stakeholders can be individuals, organizations, or groups. Stakeholder engagement in both districts should consider:

- Various levels of public-sector agencies in the water sector
- Private-sector organizations and companies with water interests
- Environmental and professional NGOs
- Representatives of people likely to be affected by water resources

Conclusion & Lessons Learned

The WRM Plans in Rulindo and Gicumbi revealed that water sources are not enough to supply water in communities, health centers, and schools. In addition, water quality is lacking because water sources are polluted and need treatment before water is supplied for domestic use. The main sources of contamination in both districts are human activities. The two studies recommended protections of source catchment areas and springs.

To ensure that both districts will have sustainable water service in the 25 year horizon, it was recommended to conduct a specific study on increasing water production options.

The studies revealed that pH is below 6, which shows that the soil in both districts is acid. It is recommended to install pH regulators for all proposed water systems to ensure that water supplied is meeting the drinking water standards.

Based on the two WRM Plans developed for Rulindo and Gicumbi, the followings lessons were learned:

Insufficient water from sources: In both Rulindo and Gicumbi Districts, water from springs is not enough to meet the demand. It was found necessary to consider other alternative sources to ensure sustainable water services in both Rulindo and Gicumbi. WRM Plans showed the real picture of available water. This inspired the districts and partners to consider the study on alternative sources and recommended treatment of water surfaces to increase water production and meet demand. The district understands the need for this additional capital investment now, which provides time to identify future funding sources.

Rainfall: Both districts (Rulindo and Gicumbi) have enough annual rainfall, and groundwater recharge is assured. Both districts have the potential of a good aquifer, and additional groundwater abstraction might be a reliable source to meet future water demand.

Water quality: The studies conducted for WRM Plans show that human activities are the main factors affecting water quality in both districts. The two districts should put in place a mechanism for water quality control to ensure that water supplied to communities is safe.

Stakeholder engagement: Stakeholder analysis is a tool to help understand stakeholder dynamics and evaluate initiatives proposed to protect water sources and preserve water quality. The two districts should develop a plan for engaging all stakeholders and ensure that Water Users Associations are established and sustained.

Investment in protection of sources: The two studies showed that the protection of water catchment is too expensive. But, it is imperative to invest in catchment protection of the sources because they supply water to water systems that serve 243,475 people in Rulindo and 427,026 people in Gicumbi. If catchment sources are not protected, the sources may dry out and water quality will deteriorate overtime this will impact water services in both districts.

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