Integrated Assessment of Socio-economy and Ecosystem Services within and around Kagera Wetland Complexes in Kirehe District

Technical Report

ARCOS Network

February 2021

Integrated Assessment of Socio-economy and Ecosystem Services within and around Kagera Wetland Complexes in Kirehe District: Technical Report

Albertine Rift Conservation Society
Kimihurura, KN 14 Avenue, N$^{o.}$ 47
P.O. Box: 1735 Kigali, Rwanda
www.arcosnetwork.org

Suggested Citation:

ARCOS (2021): Integrated Assessment of Socio-economy and Ecosystem Services within and around Kagera wetland complexes in Kirehe District. Technical Report.

The following persons contributed to the preparation of this report:

Overall supervision and editing: Dr Sam Kanyamibwa

Technical Lead and Report writing: Jean-Paul Kubwimana

Contributors: Yvonne Bigengimana (Ecosystem Services); Jaqueline Ntukamazina (Socio-economy)

Contributors: Janvier Hitimana, Aimable Hategekimana, Noella Queen Bwiza, Diane Uwimpaye

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Introduction

General overview

We are in the face of continuous growth of human population, development trajectories the leading cause of land use change, extraction of natural resources, climate change, and as result, a substantial fraction of wild species is simulated to be at risk of extinction during the 21st century (IPBES, 2019). In Rwanda, the pressure is very much felt on wetland ecosystems and biodiversity that they host. Development trajectories, in addition to agriculture from almost 70% of the country's population tend to encroach wetlands as main sources of water for irrigation, fish production as well as for domestic and industrial processing. The above-mentioned challenges places sectorial approaches to wetland resources management in Rwanda insufficient to meet national and global targets toward poverty alleviation, biodiversity conservation, and food production. An integrated landscape assessment and monitoring approach developed and used by the Albertine Rift Conservation Society (ARCOS) is well suited to provided information on the status of socioeconomic conditions of communities within and around wetlands ecosystems and weighs the pressures they exercise on wetlands' ecosystem services and biodiversity against the benefits they gain from them.

With funding from JRS Biodiversity Foundation, ARCOS and partners is implementing a two-year project termed:" Using *wetland ecological integrity assessment and information management to guide wetland management decisions in Rwanda".* The assessment of socio-economy and ecosystem services within and around Kagera wetland complexes in Kirehe District was conducted with the main objective to inform decision makers as well as the public on the status and socio-economic pressures exerted on wetlands ecosystem services and biodiversity and recommend possible solutions to enhance wise use of Kagera wetland resources.

Methodology

Indicators measured are structured around the State-Pressures-Response framework structuring communication between scientists and end users of environmental information, while it is inappropriate as an analytical tool (Laura at al 2009). The assessment was conducted between September and November 2020 to gather information on how the communities around Kagera wetland complexes in Kirehe District utilize the wetland resources for their socio-economic development, and pressures resulting from the process. The assessment was a critical step toward understanding factors influencing wetland ecological integrity and inform decision makers and stakeholders on possible solutions to bring on ground for wise use of wetland resources. According to UNEP 2008 The Millennium Ecosystem Assessment analyzed 24 ecosystem services – the benefits that people obtain from functioning ecosystems – and found that 15 were in global decline. Humans depend on ecosystem services for many aspects of their well-being (including food, water, health, security and others). The decline in services affects the world's disadvantaged people most strongly, but it also impedes sustainable development globally and, in developing countries, obstructs attainment of the Millennium Development Goals. For

this kind of assessment, we focused on provisional ecosystem services as they are continuously needed for human survival and hence resulting information can guide decision makers for effective management of a given ecosystem/ landscape.

Study sites

The assessment was conducted in Musaza and Kigarama administrative sectors, adjacent to Southern Akagera Wetland Complex as well as Mahama and Mpanga administrative sectors, adjacent to the Eastern Kirehe Wetland Complex.

Targeted respondents

According to Hamed Taherdoost (2017), the sample sizes reflect the number of obtained responses, and not necessarily the number of questionnaires distributed.

The following formula was used to determine the sample size.

$$n = \frac{p\,(100-p)z^2}{E^2}$$

n is the required sample size; p is the percentage occurrence of a state or condition; E is the percentage maximum error required ; z is the value corresponding to level of confidence required

We selected 4 Sectors out of 7 touching on Akagera river, at least 2 villages per Sector. Villages sampled were selected to include areas closer to wetland's natural habitat and those a bit far in the up-hills considered to cover a diversity of respondents toward accessibility and utilization of wetland resources for their socio-economic development. The total number of households surveyed in 340 where 109 were from eastern part of Kirehe wetlands the remaining 231 households were from the southern part of Kirehe toward Rusumo boarder between Rwanda and Tanzania. interview questionnaires and target group discussions were used. The household was chosen as the unit of analysis because it is generally the basic social and economic unit for people at a subsistence level. We have used the household as the unit of analysis to make the data compatible with most other economic datasets, including the national census. We use a structured questionnaire containing both closed and open questions simplified a lot and designed in both English and Kinyarwanda for a smooth communication with communities.

Data analysis

Data entry and statistical analysis was performed using SPSS software, and findings are organized according to the state-pressure-response model. The discussion referred to findings from the National

Institute of Statistics of Rwanda (EICV4,5) as well as global standards for universal access to basic services water and sanitation and food security guidelines.

Status and importance of ecosystem services provided by Kagera wetland ecosystems

According to the Integrated Landscape Assessment and Monitoring framework (Gashakamba, 2018), the main indicators to assess the status of landscape's ecosystem services include (i) land /vegetation cover change, and (ii) the types, quality and quantity of ecosystem services accessed by local community including agricultural products.

Kagera Wetland cover change mapping

To assess the change overtime in wetland cover, we used land cover map under overlay function of spatial analyst tool from ArcMap 10.6, and direct observations on the ground to confirm different classes. We detected a considerable change in wetland cover and use between 2008 and 2018 as shown in the figure below:

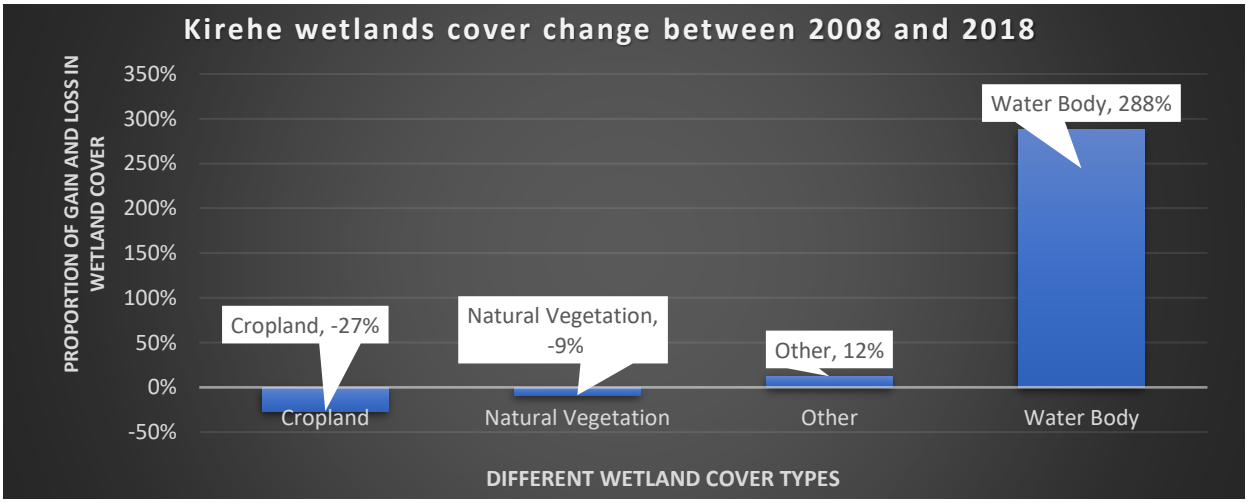


Figure 1: Detected changes in Kirehe wetland cover and use change between 2008 and 2018

The status of key classes analyzed for wetlands in Kirehe District consist of 1,009.9 ha of crop land 11,340.1 ha of natural vegetation, 144.9 ha of water body making a total of 12,494.9 ha. Along the last 10 years, crop land class lost 27%, while the natural vegetation class lost 9%, and a considerable gain was detected on the water body class that increased up to 288%. Other classes (sand mining and quarry sites) in the wetlands) gained only 12% and this reflects the intactness of wetlands in Kirehe District (Nyandwi at al 2021). The lost 27 % of cropland highly correlates with high gain in water body associated with recurring water because of the ongoing construction of Rusumo hydropower plant, in addition to the outflow of Rweru lake at the upstream due to the diversion of Akagera river's main pathway that occurred between 2014 and 2015, but also heavy rain that hit the region in the last 3 to 5 years which caused more floods.

Types, and importance of ecosystem services accessed by local communities

Ranking the importance of agricultural products for the communities in the landscape

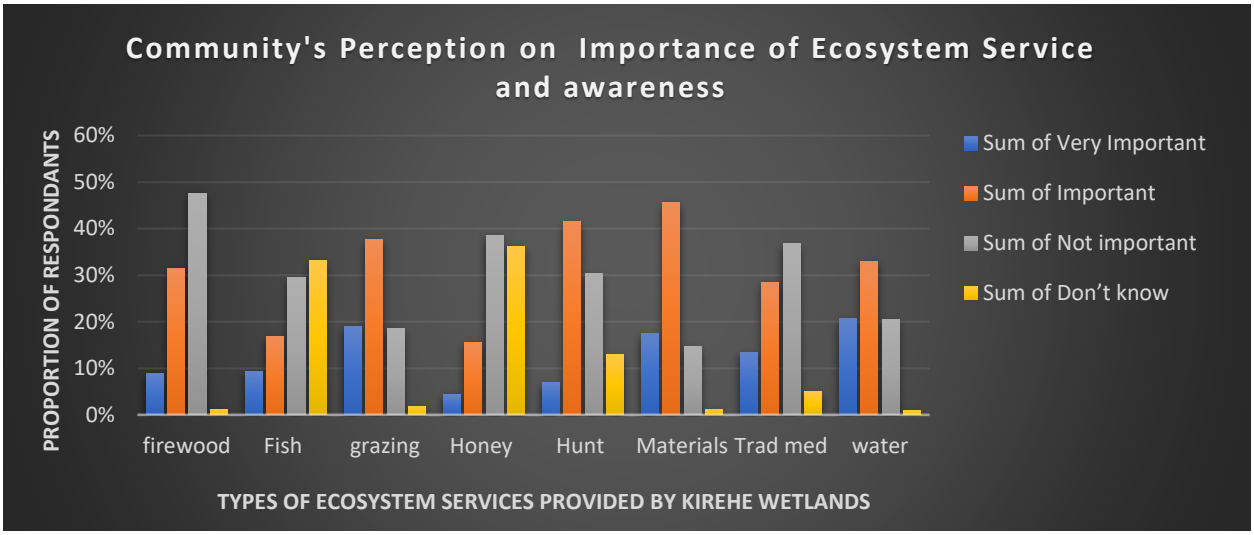


Figure 2: Perception and awareness of local communities on the importance of various ecosystem services

Wetland plant species are used to produce various materials including those used for roofing and production of sleeping mats. More than 65% of respondents ranked them important while 4% do not know their uses. They are also used by farmers uphill for mulching especially for coffee and banana, while bricks makers and households that cannot afford charcoal and because of the scarcity of forest resources in the area, use them in place of firewood.

Photo: Use of papyrus and other Kagera wetland species for mulching in banana and coffee plantations

Photo: Uphill communities harvest wetland plan for different uses including roofing and ceiling their houses

Hunting wild animals especially was ranked important specifically by communities in the eastern part of Kagera wetlands. They added that hunting is still practiced a lot by people from Gisaka area, while fishing was ranked as not important as it is allowed only to members of cooperatives and they are very few in southern part comparatively to the eastern side of the wetland complexes.

Table 1: List of animals hunted and their status on IUCN red list

No	Scientific name	Common name	Vernacular name	IUCN status
1	*Cercopithecus mitis doggetti*	Blue monkey	Inkima	LC
2	*Tragelaphus spekii*	Sitatunga, or Marshbuck	Impongo or Nyirabuhene	LC
3	*Phacochoerus africanus*	Warthog	Ingurube	LC
4	*Papio anubis*	Olive baboon	Inkobe/ Igitera	LC
5			Imbata zo mu mazi	

Water and folder for animals are other ecosystem services ranked by respondents as important (54 and 68% respectively), in addition to the use of wetland plants as traditional medicines. The table below shows plant species used for medicinal purposes.

Table 2: List of plant species used for medicinal purpose and their use

No	Scientific name	Common name	Vernacular name	Medicinal use
1	*Solanum terminale*	struggling shrub/Woody nightshade	Umumanurankuba	Treatment of livestock with complication during gestation period
2	*Rubus rigitus/Rubus pinnatus*		Umukeri	Mixed with umuyobera used to cure livestock with shortage of milk or women with breastfeeding problems

3	*Thunbergia alata*	Black-eyed susan vine	Iganzamwonga	Treats head skin diseases that affect children
4	*Lysimachia ruhmeriana*	Creeping jenny, Moneywort	Umuyobera	Mixed with umuyobera used to cure livestock with shortage of milk or women with breastfeeding problems
5	*Ageratum conyzoides*	Chick weed, Goat weed, White weed, Billy goat	Inkuruba	Treats livestock (goats mainly) with eye problems

According to most of the respondents, when a person is sick, they go to the nearest hospital and they have Health Counselors in villages (known as abajyanama b'ubuzima) who help them regularly. But they cannot keep seating and do nothing when the patient keeps feeling bad. They use traditional medicine, and it works out well.

Most preferred and used crops in the landscape

Respondent listed several crop varieties grown in the study area with dominance of bananas, maize and beans in the southern part while some households still grow sorghum as well. Banana, maize and beans were ranked economically important in the southern Kirehe while sorghum, maize and beans are most preferred in the eastern part in addition to legumes and vegetables and fruits as farmers there can benefit from the small-scale irrigation scheme pumping water from Akagera river.

Quantity and quality of domestic water used per household per day

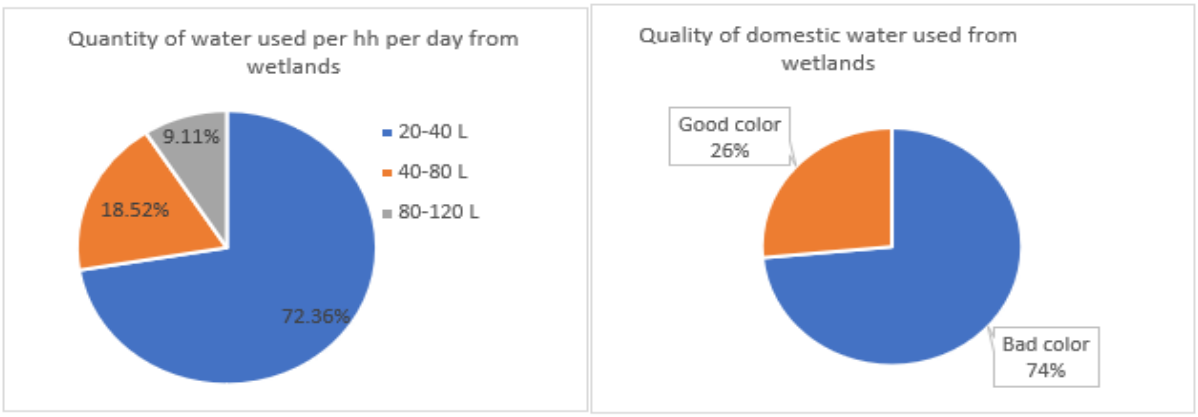


Figure 3: The assessed quality and quantity of domestic water used per household per day

In general, the quality of water used by communities around Kirehe wetlands is not good. 74% reported that water has a bad color and mostly in the side of southern Kirehe within Musaza and Kigarama sectors. However portable water was installed in some villages touching the wetland, but they are not enough. That is why 72.36% use between 20 and 40 litters of water per day (not enough water per household) fetched from the rivers and lakes comparatively to 9.11% that use between 80 and 120 liters of water per

day. It takes between 10 and 20 min to fetch water from the river and lakes comparatively to between 2 to 6 hours spent queuing at the tap water located beyond 3 kms for some villages. Note that Out of 340 interviewees, 51% were female against 49% male. Mostly, the size of household in the community surrounding Kirehe wetland complexes is between 2 and 7 members, and about 10.5% of sampled households have between 8 and 10 members. The average size of households is 4.6 persons. Each family has an average of 1.7 children below 14 years and 0.7 children between 14 and 18 years with 2.2 adults above 18 years, and this shows that the community is dominated by young people of the school age.

Different Sources of water accessible by community around Kirehe wetlands

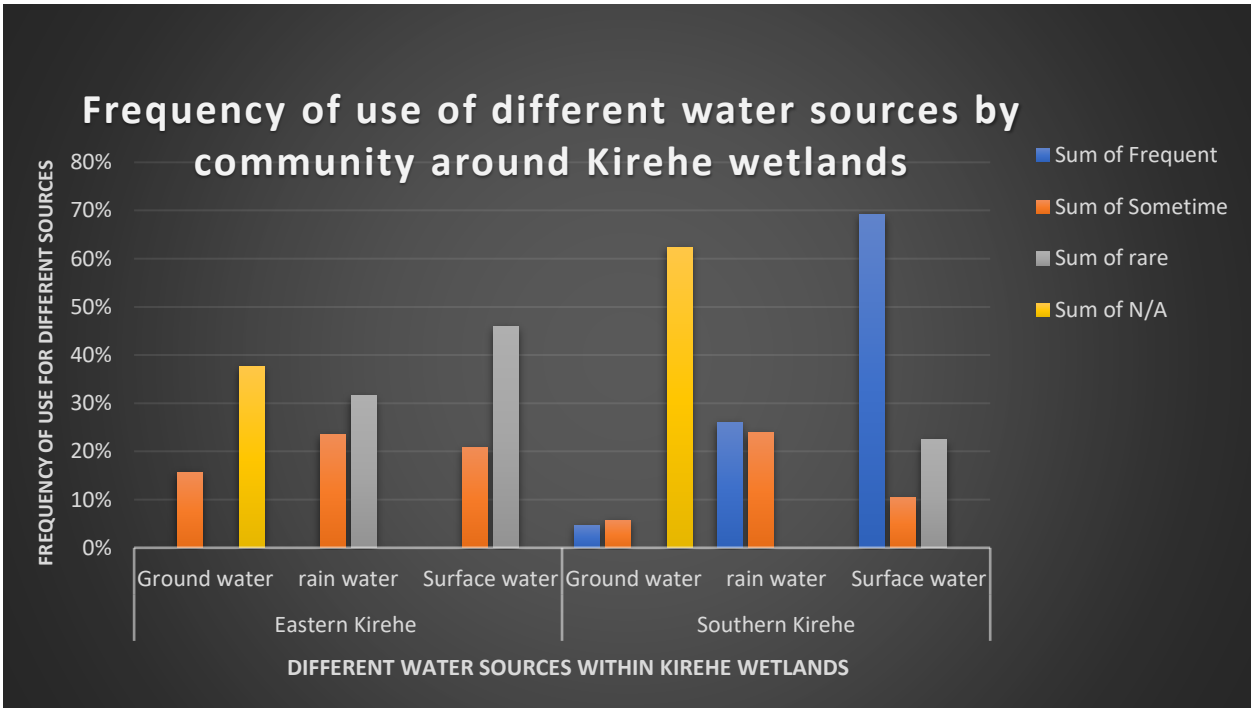


Figure 4: Identified sources of water accessed by communities around Kirehe wetlands

In both sides of the wetland complex, respondents reported unavailability of ground water except some villages of Kigarama sector from which water bores were constructed. Surface water is mostly accessed by communities >70% of respondents from southern Kirehe against 21% of respondents from eastern Kirehe who use the sources sometime. Rain is not predictable in the area and most of community members do not have the capacity to afford rainwater harvesting facilities adequate to store water for a long time. They access rainwater sometime.

Another key indicator to measure the status and use of ecosystem services for socio-economic development purposes, the team considered land holding, house ownership and Equivalized household income as key indicators.

Identified sources of household income

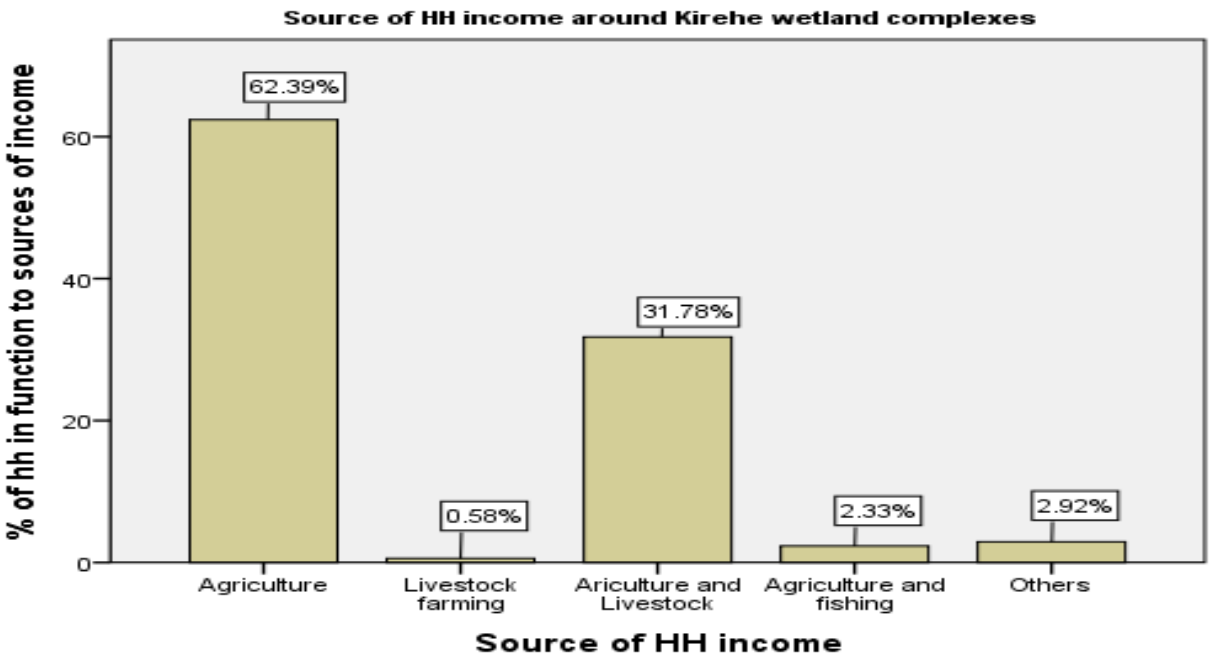


Figure 5: various sources of household income for communities around Kirehe wetland complexes

Family land holding is expected to correlate with total household income as among 340 assessed households 97.02 % live on agriculture among which 31.78 % combine agriculture with livestock farming and 2.33% combine agriculture with fishing in Akagera wetland. Only 2.92 % depend on other sources such as formal jobs and business

Land and house property ownership

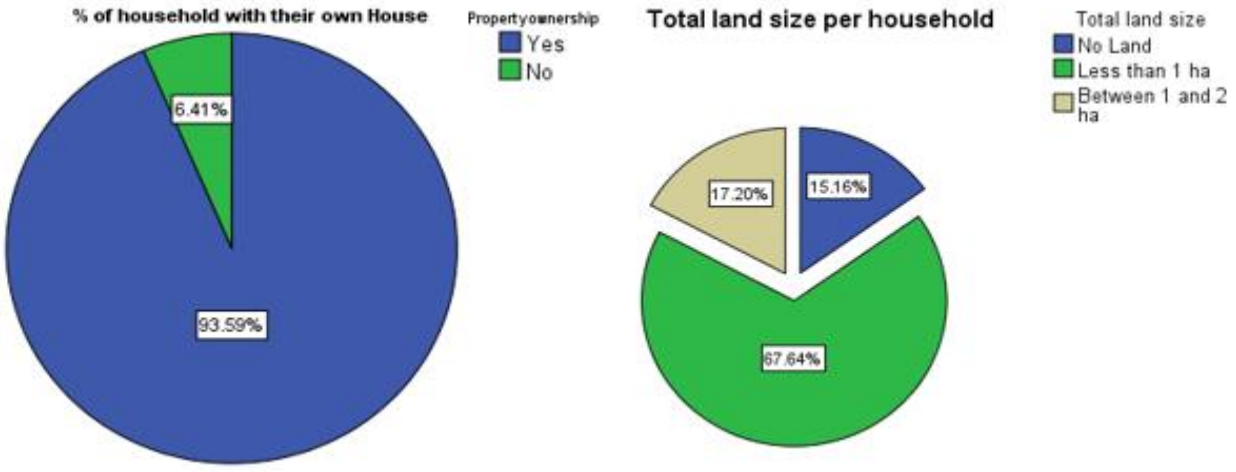


Figure 6: measurement of property ownership as socio-economic indicator

The study shows that 93.59% of the assessed households have their own houses in well-organized village settlements and the majority (67.64%) is the small holder farmers with an average land size of less than 1 ha while 17.2% own between 1 and 2 ha of land, and 15.16% have no land. According to EICV 4, 65% of working individuals above the age of 16 have their main job in agriculture. This clearly shows that the natural resource of land is an important factor in the country's economy, especially in the rural areas, Like the surroundings of Kirehe wetland complexes where agriculture provides main jobs for 97.08% % of the working population.

Measurement of household income as indicator of level of poverty

The total household income was calculated and shows that 68.51% of assessed households earn between 60,000 and 100,000 Rwf per month, 3.79% earn above 100,000 Rwf, while 27.69% earn less than 60,000 Rwf. However, this calculation does not give the real picture of socio-economic development of community living around Kirehe wetland complexes. We could not even base on the income per capita as all members of the households assessed do not earn equally and does not have the same need as others. By that, we simply used the equivalence scales which is "a system of weights, whereby children count as some fraction of an adult, so that effective household size is measured not in numbers of persons, but in numbers of adult *equivalents*. Economies of scale can be allowed for by transforming the number of adult equivalents into "'effective' adult equivalents…" (Deaton 1997: p. 242). As per May *et al.* (1995) and Woolard and Barberton (1998) cited in (Branch at al 2002), the equivalence scale used here assumes that children younger than 15 have half the income generating ability of an adult, and small economies of scale are allowed for in the following equation

$$\text{Adult equivalent income} = \frac{\text{Total household income}}{(\text{number adults} + 0.5\ \text{number children})^{0.9}}$$

The households were ranked according to their adult equivalent income and divided into three categories, ranging from the ultra-poor (Extreme poor) with less than 15,000 Rwf per month actually 18.37%, the medium poor with equivalized household income between 15,000 and 25,000Rwf per month (64.72%), while 16.91% are those with between 25,000 and 35,000 Rwf were ranked as poor (The current exchange rate is 1$= 966 Rwf) ranked as poor as per the principle adopted by World Bank 2005 as revised in 2015). Generally, all assessed households are poor as their purchasing power parity is less that 1.9$ per day set by the World Bank as the global poverty line. Extreme poor household rely only on Agriculture and most of them do not have their own houses (they rent a house on monthly basis) while medium and poor combine agriculture with fisheries and or livestock farming. Most of them have their own houses.

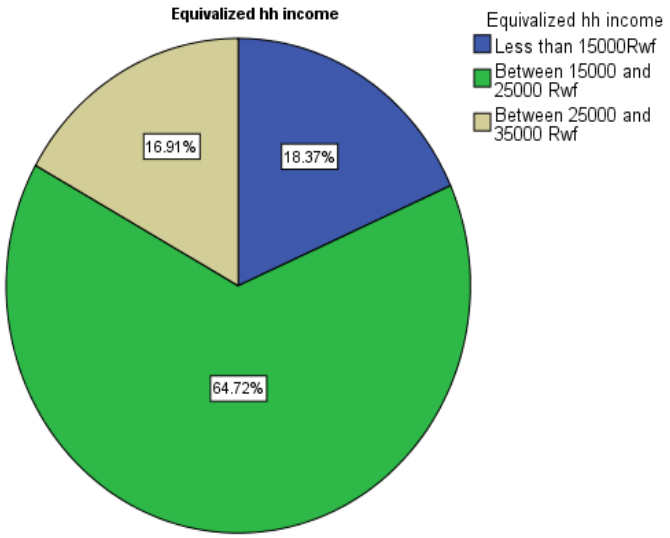


Figure 7: Equivalized household income for communities around Kirehe wetlands

Identified Pressures on ecosystem services, biodiversity, and economic development

Main indicators measured under this study included Education level (segregated by gender and age) of surveyed households, types and severity of hazards caused by climate change, Impact of climate change hazards on agricultural production and human health as well as livelihoods is concerned. To assess the literacy and education levels among husbands and spouse of the surveyed household, interviewee was asked questions to specify whether they can both read and write, read but not write or are unable of any of the two or if they have ever attended school or not.

Level of literacy of household leaders and their spouses

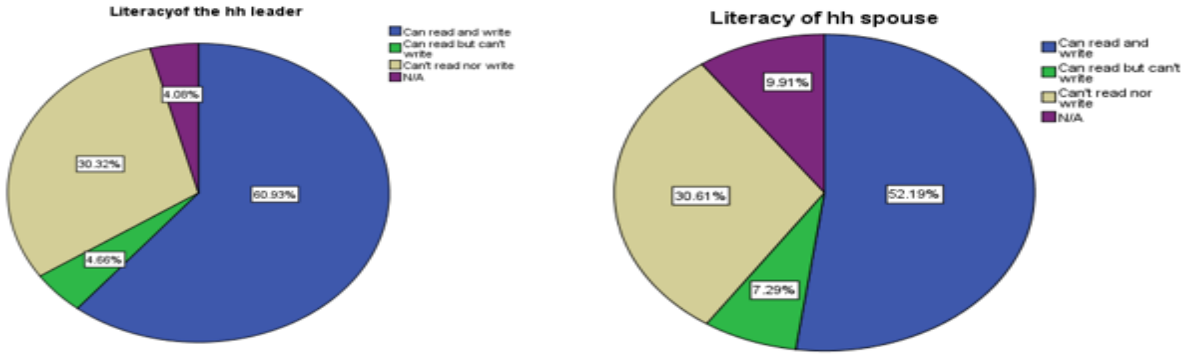


Figure 8: literacy of Household leaders and spouse

Of 340 household sampled, approximately 1/3 of household leaders and 30.61% of their spouse cannot read nor write. 4.08% are widow man while 9.91% is composed of household lead by women. and 4.66% of household leaders against 7.29% of spouse can read but cannot write, and regarding the proportion of people who can read and write, the survey shows that there is a significant different between household leaders and their spouse.

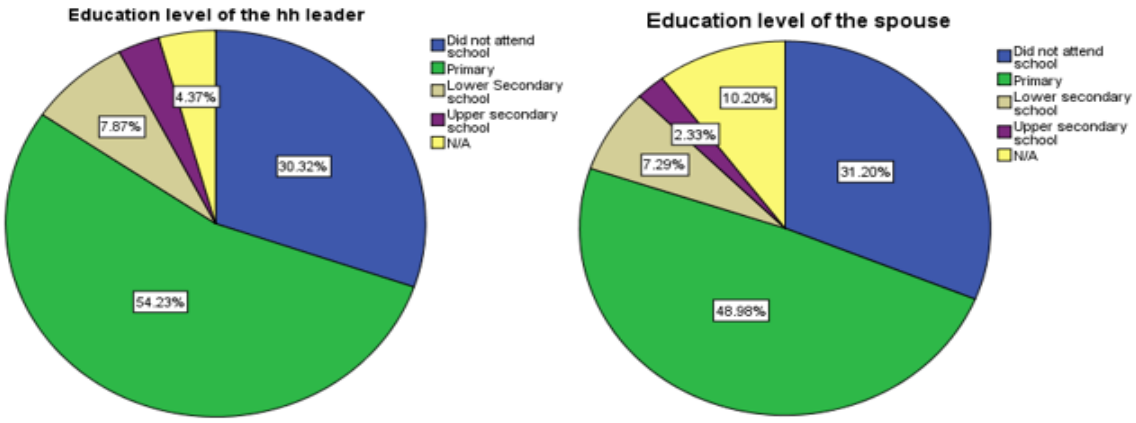


Figure 9: Education level attained by household leaders and their spouse among communities around Kirehe wetland complexes

This study shows that 65.3% of household leaders against 58.6% of spouse in sampled households attended school, with a significant difference at all levels (11.07% of household leaders against 9.5% of spouse at secondary level, and 54.23% against 48.98% of spouse at primary level), with 30.32% and 31.20% respectively did not go to school.

Perception of local communities on climate change over the last 10 years

The pressure is indicated by threats that affect the ecosystem services as well as the Climate Change/Variability and their likely impacts on community livelihoods. As such, communities were asked their perceptions on climate variability and how, this is affecting ecosystem services around Kirehe wetland complexes. The following sections present summaries of the responses from communities on this aspect.

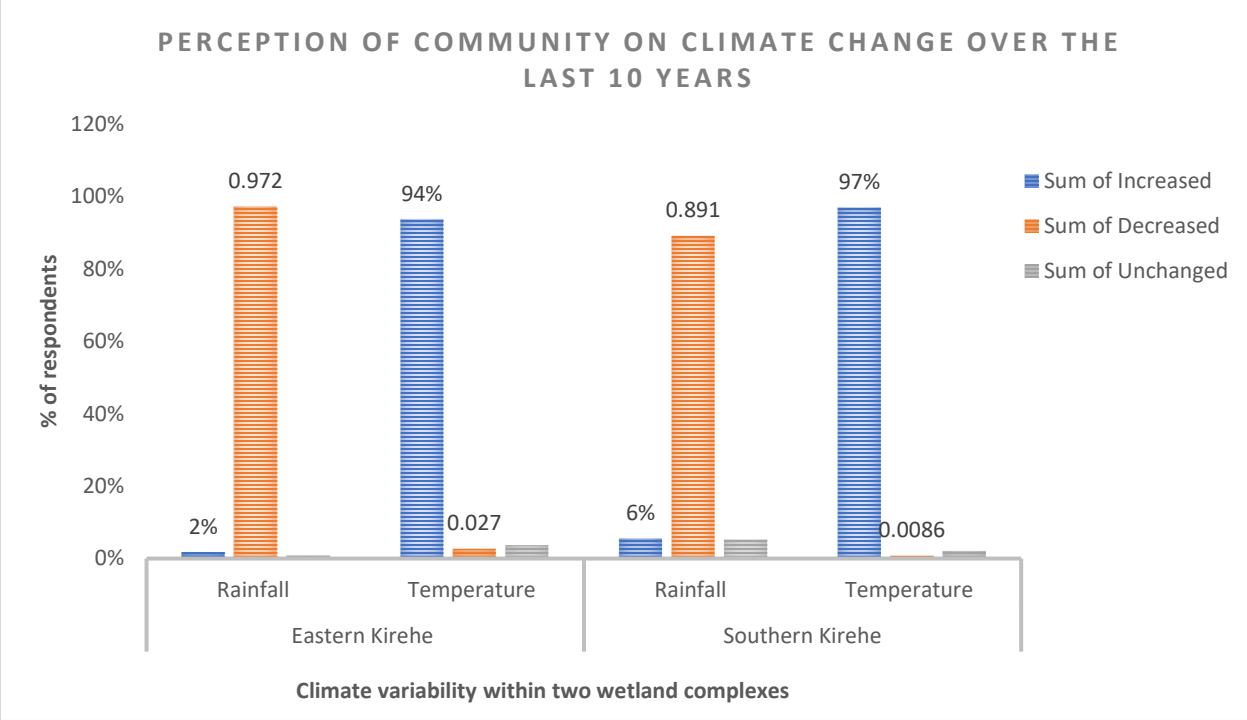


Figure 10: community perception in change of temperature and rainfall

Though the temperature in Kirehe district is relatively higher due to altitudinal influence that may even influence its habitat characteristics 97% of respondents in southern Kirehe against 94% in the eastern Kirehe reported independently that the temperature has increased over the last 10 years, while 89% against 97.2% reported a decrease in rainfall in the same period. They were no longer sure of when to start the agricultural activities in season A as it was still very sunny by November 2020, while they used to start the season A in September and October. Given that the raise in temperature in this case is caused by the sunshine, these findings may partly confirm the increase in dry seasons across the year, which therefore support the idea of decrease in the rainfall seasons within Kirehe wetland complexes.

Types and severity of Diseases identified within Kagera wetlands' catchment

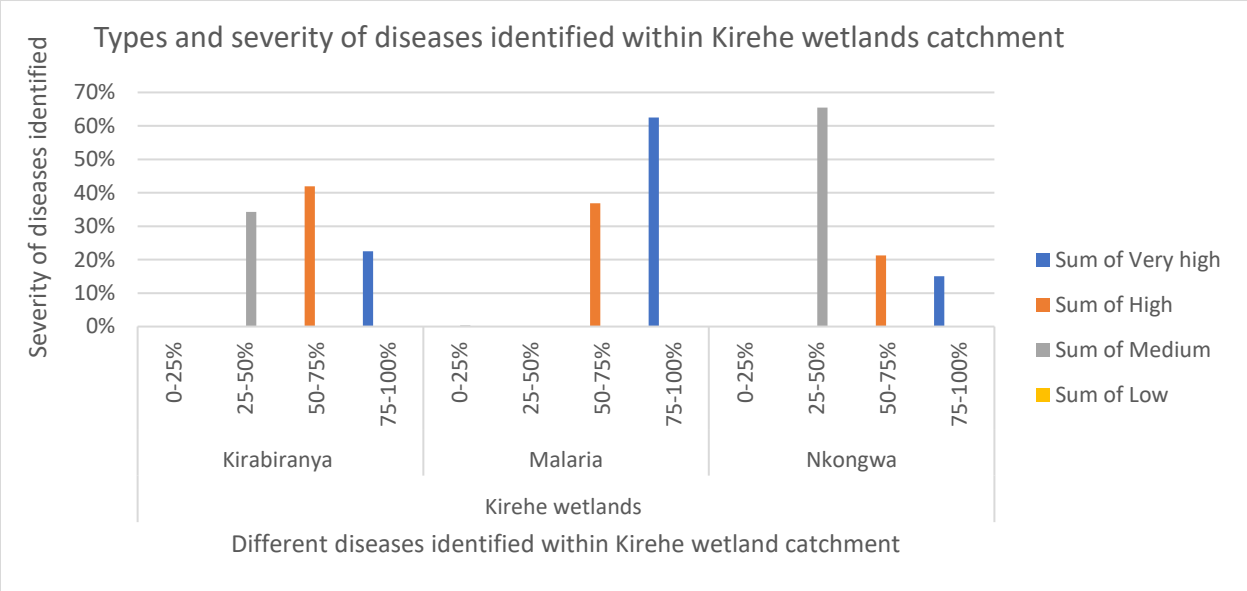


Figure 11: types and severity of diseases reported by communities

The method of scoring the severity of the identified disease based on the proximity to the sources and transmission mode as well as climate conditions favorable for the development of the disease, and four levels from low to very high were considered. Malaria was ranked as high (100% of respondents confirmed), Maize stalk borer (Nkongwa) which affects maize and sorghum reported as medium (66%), because they can spray insecticides to control their spreading even if about 34 % reported it as a high threat. Banana Xanthomonas Wilt (BXW)/Banana Bacterial Wilt known as Kirabiranya y'urutoki that affect banana (64%) was reported as a high threat as well

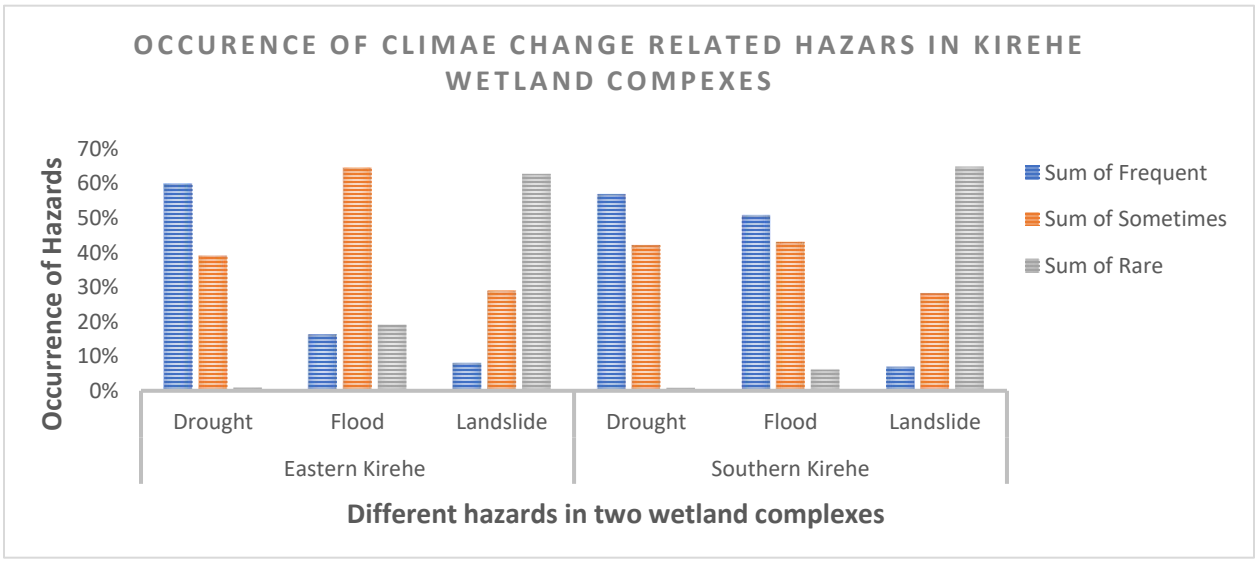


Figure 12: Perception of communities on occurrence of hazards within Kirehe wetlands

The results show that flood occurrence in southern Kirehe wetlands is high during these last 10 years (only 5 % of respondents reported it to be rare comparatively to 20% of respondents in the eastern Kirehe wetlands). The landslides are very rare in both catchments while drought is very frequent within the entire catchment.

Impact of climate change related hazard on communities' livelihoods and health

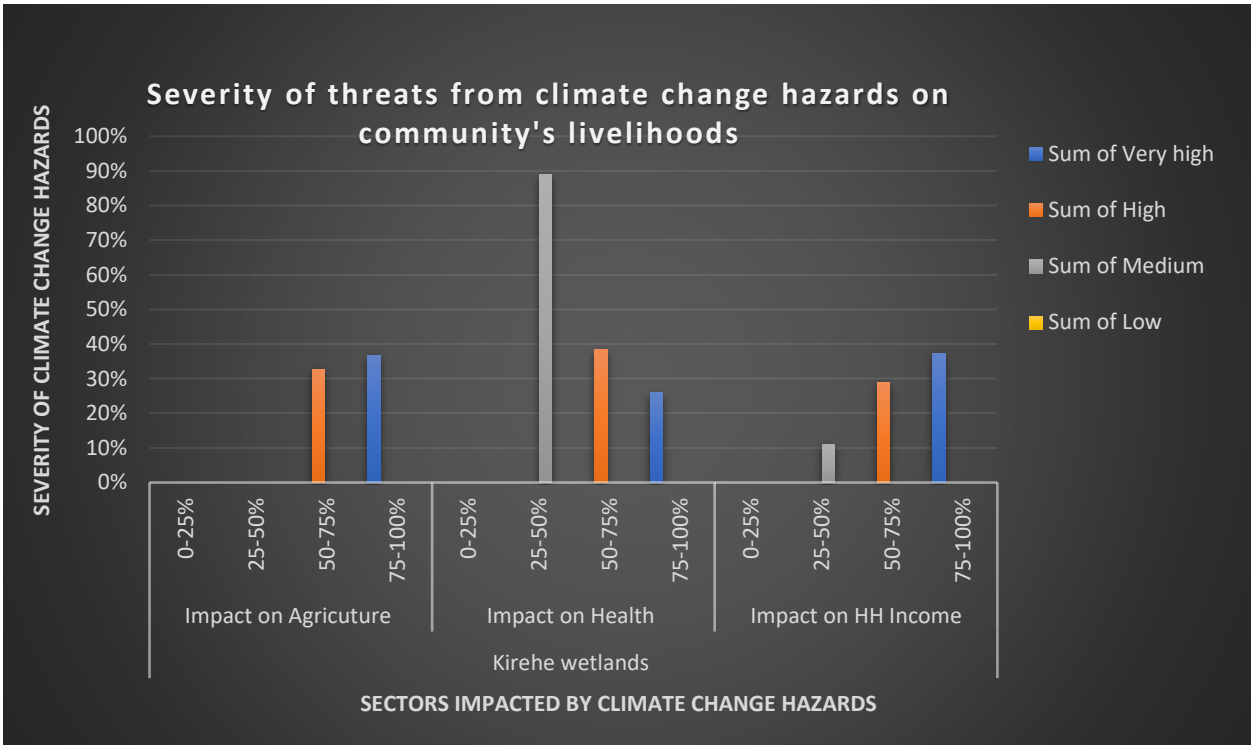


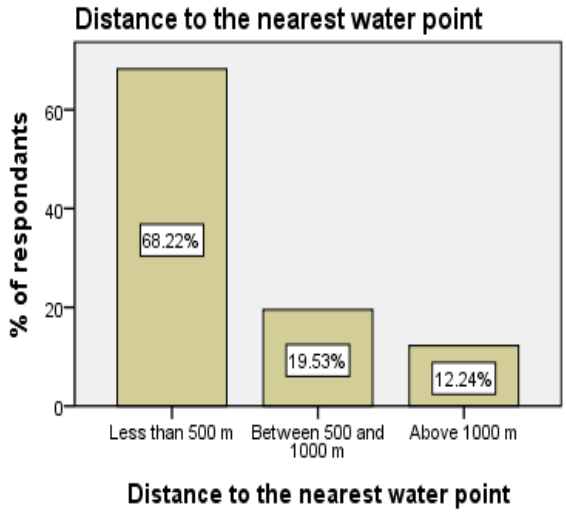
Figure 13: severity of hazards on community's livelihoods and health

most of respondents perceived the impact of climate change hazards on health as medium as till today, both drought and floods did not directly claim lives. About 40% of respondents associated the severity of malaria with climate change hazards especially the prolonged drought that follow severe floods that occur sometimes. The negative impact on household income is very high as most of communities rely on agriculture as the main sources of income. However, they reported impact on infrastructure and education as medium.

On-ground and planed solutions enhance wetland management

Various indicators were assessed to measure the level of interventions in place to address the pressures to Ecosystem services and biodiversity. Among other indicators, accessibility, and quality of socio services (water points, health centers, schools) as well as good sanitation practices at household level were assessed. In addition, a map showing potential sites for conservation and development projects was produced by the GIS technical team.

Measurement of distance to the nearest water point

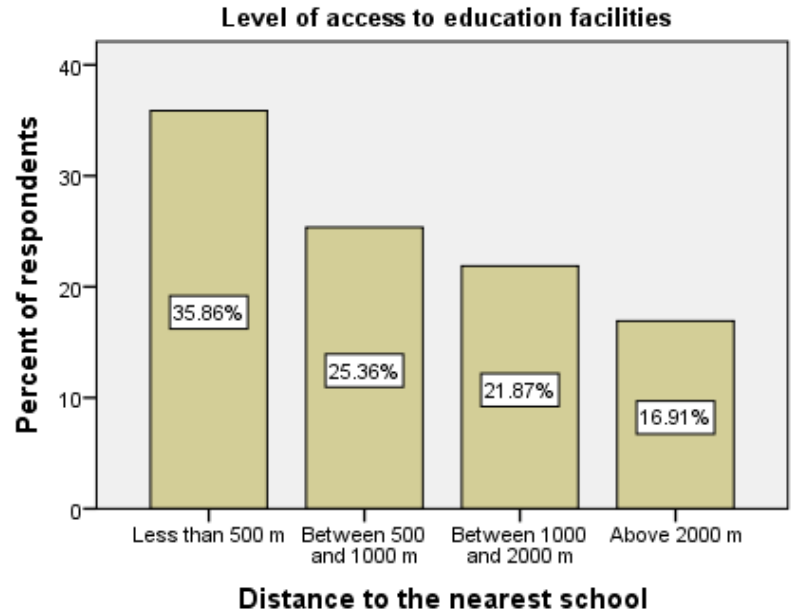


In terms of response, the study looked at the level of access to water and other services such as education and health care. Regarding water accessibility, about 1/3 of sampled households have no access to clean water as they travel more than 500m and the situation is very worse for almost 12.24% that travel above 1000 m to reach the nearest water point. Queuing time was also very warring in some villages as 13.12% must wait for more than 4 hours to get clean water. This pushes them to rely much on water from ponds and rivers in the wetland where 48.69 % reported to use pond water without any treatment, 0.58% apply chemical treatment and 0.58% filters pond water before drinking.

Figure 14: Distance to the nearest water point

The common challenge they reported was that they cannot afford water filters and they used to find sylon on the market but currently it cannot be accessed in the local market. In addition, most of household surveyed reported the difficult to get firewood that they can use for boiling water and lack of alternative cooking energy. The EICV 4 reported that Eastern Province (Kirehe District included) has the lowest percentage of households using improved drinking water source (81%) comparatively to other provinces

Accessibility to education facilities



Looking at the accessibility of education facilities like schools, only 16.91% of household surveyed walk more than 2000 m to reach the nearest school. Otherwise, the Government and local leaders have invested efforts to build new schools and reduce the distance walked by students to reach schools.

Figure 15: Distance to the nearest school

Location of existing and potential sites for irrigation

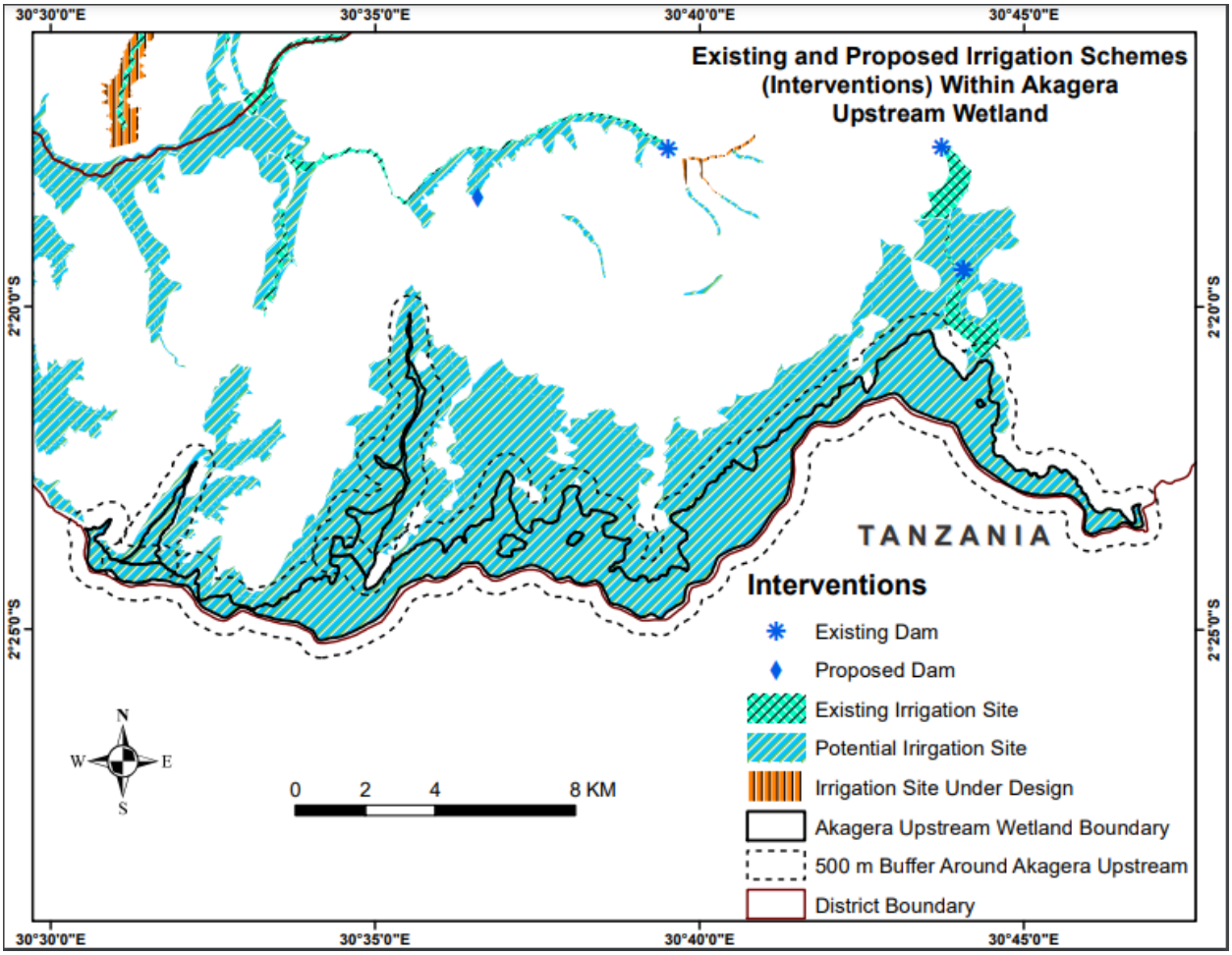


Figure 16: Map showing the potential sites for irrigation using water from Akagera wetlands

To reduce the vulnerability to climate change related hazards in kirehe wetland catchments, The Ministry of Agriculture supported Kirehe District to establish and operationalize dams especially in Kigarama and Nyamugali sectors which help farmers to benefit from irrigation system. The map shows some uphill sites irrigated sites and proposes more potential sites for dam installation. It shows also new potential sites for irrigation around the wetland but proposes in addition to the buffer zone predicted by the environmental law (50m from the wetland) an additional area of 500 m within the catchment in which eco-agricultural practices can be implemented when financial resources allow to enhance connectivity of the wetland system, benefit biodiversity conservation, and improve communities livelihoods.

Conclusion and recommendations

The Integrated Assessment of Socio-economy and Ecosystem Services within and around Kagera wetland complexes in Kirehe District is part of the project funded by JRS biodiversity Foundation with the objective to avail information on the status and threats to biodiversity and ecosystem services within and around Kagera wetland complexes in Kirehe District. The study was conducted by ARCOS. The findings show the importance of wetlands in Kirehe district in terms of valuable ecosystem services and economic resources it provides to the surrounding community in from agriculture, fisheries, health (medicinal plants) food production and hunting but also water availability that help them fight against poverty. However, the report shows also different pressure exerted on wetlands where drought and floods are the main threats followed by waterborne diseases like Malaria, followed by sand mining and overharvesting of wetland plants mainly papyrus sp and hunting of some animal especially in the eastern part of the wetland complex. The report also shows a big change in wetland use and cover change between 2008 and 2018 mainly related to climate change hazards and demographic pressures. These led to the following recommendations:

- Looking at the trend in change of wetland cover use and change over the last 10 years, it is very important for Kirehe District to have in place a wetland management plan to ensure sustainable management of the wetland resources in the future.
- The economic status of community living closer to the wetlands shows that most of them are poor and have limited access to clean water for domestic use especially in areas within Mahama and Mpanga sectors. They use water from the wetland and untreated because of luck of means for treating water. Initiatives to supply clean water should be oriented in these areas and more importantly, the use of hill side irrigation requires scale up in all sectors touching the wetland complex.

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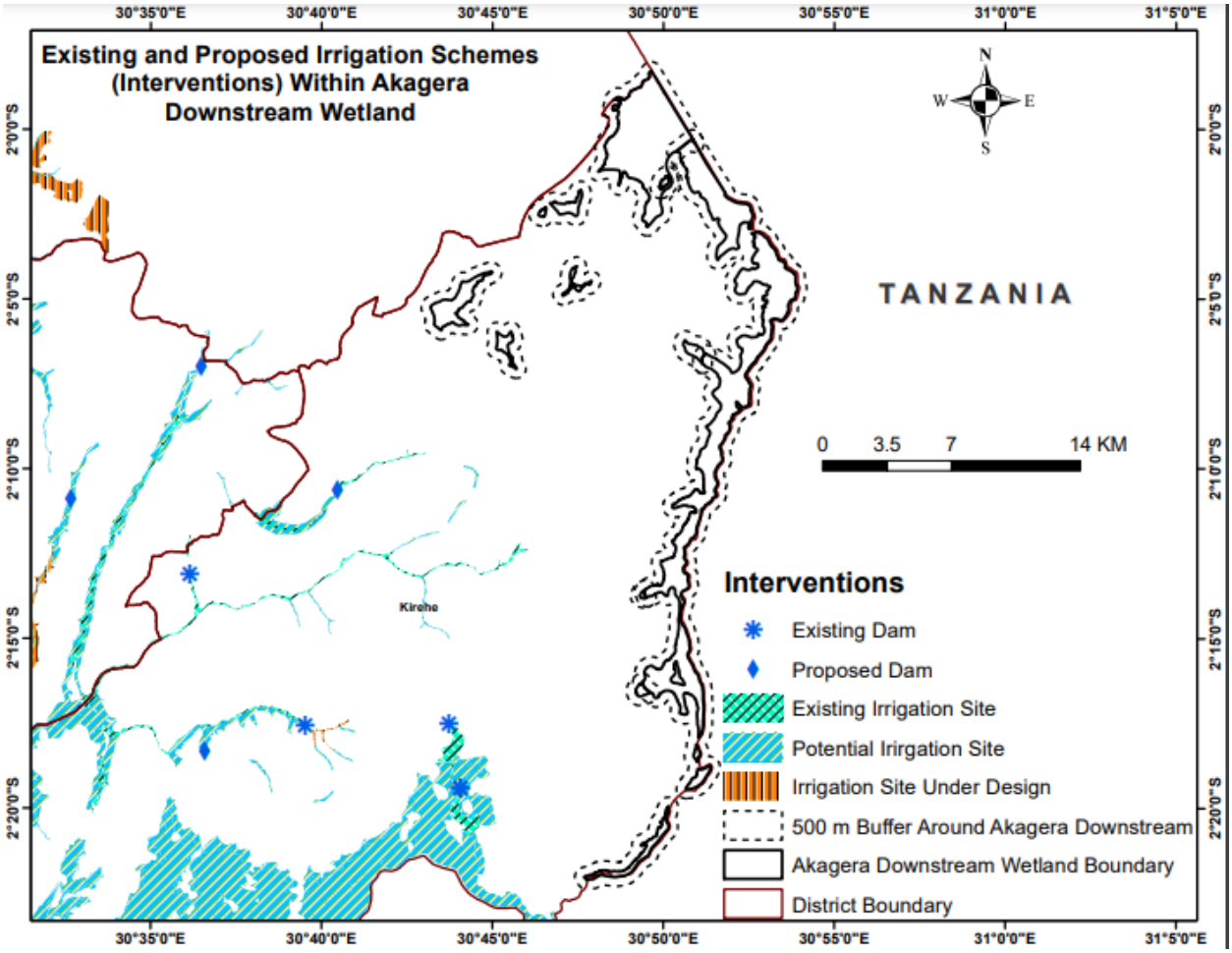
Annexes

Annex 1: Location of potential sites for green activities in Eastern Kirehe



Annex 2: Photos showing ecosystem services use

Photo: Harvesting wetland plants for folders of cows and goats and making sleeping mats