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Assessment of the Impacts of Converting Natural Wetlands to Agricultural Farms. Case of Nyabugogo, Kigali City, Rwanda

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Abstract

The assessment of the impacts of converting natural wetlands to agricultural farms in Nyabugogo wetland was the main objective for this research. Considering the efficiency of agricultural activities management, operation and their maintenance in Kigali is essential to reduce the increasing environmental pollution, to raise production and to search for a sustainable method of environmental conservation, this research assesses the pollutant removal efficiency of agriculture such as crops and animal residues in order to enhance the sustainable agriculture development mainly physico-chemical characteristics and some biological characteristics and based on the preliminary assessment and review of existing literature on agriculture management systems for water resources and other environmental conservation concerns in Kigali, the research aims at contributing to the search of an appropriate agriculture management that is more efficient in terms of the increase in productivity, hence contributing to environmental sustainability. Six sampling sites were chosen in Nyabugogo wetland that is Nyabugogo, Karuruma, Kabuye (2 destinations), and Nyacyonga (2 destinations). Nyabugogo and Karuruma in the rural area, and Nyacyonga in the urban area, were chosen for the investigation of fecal coliforms. On the two first locations, Nyabugogo (80 cfu/100ml) and Karuruma (40 cfu/100ml), the study found low but not insignificant results. This is related to the dispersion of habitation in rural areas. Total Dissolved Solid (TDS) ranged from 178.1 mg/l to 179.9 mg/l at Site 1 (dry season) and subsequent test (rainy season) results ranged from 178 to 200 mg/l. The results showed different TDS in different test areas. The TDS was as low as 145.4 mg/l in the surface water of SP4 and as high as 179.9 mg/l in SP1, and in the second survey, the minimum value was 140.3 mg/l and the maximum value was 285 mg/l in SP3. Because the high turbidity levels seen along the river, in the Nyabugogo catchment, erosion protection measures should be implemented, including the use of terraces where there is agricultural activity and tree plantations, particularly at Nyabugogo sites. As a result, the Nyabugogo Riverbanks must be preserved. It would cut down on the quantity of sediment that ends up in waterways.

Keywords

Physico-Chemical Parameters, Water Pollution, Wetland

1. Introduction

Intensive agriculture may hasten the decline of wetlands by raising nutrient and residue concentrations in water bodies. Adjustment and living together of wetland provisioning and controlling capacities can add to food security while further developing dregs and supplement maintenance [1]. Electrical conductivity (EC), temperature, broke down oxygen (DO), and pH all declined as release expanded, absolute nitrogen (TN) and Total phosphorus (TP) didn't. TSS fixations were reliably more prominent downstream of plantation and stretches of vegetable agribusiness downstream of woodland/wetland and fishponds/dam come to [2]. The outcomes for TN and TP were ambiguous, yet it has been proposed that TN and TP fixations developed all through the dry and early wet (and rural) seasons, and afterward were cleaned out during the blustery season, with following diminished focuses toward the finish of the downpours because of weakening. Valley bottoms described by grass/woodland and lakes/repository types had typically certain net yields of supplements and silt, however regions overwhelmed by rural land cover had a net negative yield, bringing about net product [3].

Wetlands play an important role in preventing climate change, providing food and clean water, and protecting us from flooding, among other environmental benefits [4].

Water was kept only in comes with lakes/repositories because of their highlights and the requirement for the executives to hold water for following cultivating exercises. Occasionally, there was a huge connection between net yield and release, with 93%, 60%, and 67 percent of yearly TSS, TP, and TN yields, separately, conveyed during the 115 stormy days, during low stream times, all LULC types showed positive net yields of TSS, TP, and TN (recommending maintenance), however had negative net x yields during high stream periods (proposing send out). There were also significant effects of hillside land use on sediment and nutrient outputs discovered [4].

Cultivation had a significantly lower biomass development (30 g·m^{-2} of every 8 months) than rice (2500 - 4500 g·m^{-2} out of 4 months) and wetland plots (1300 - 1600 g·m^{-2} out of 8 - 11 months) [5]. Higher convergences of TSS, TP, and TN in inflows and outpourings were generally related with human exercises all through the two occasional periods examined (cleaning of water supply trenches, rice plot furrowing, weeding and compost application, and fishpond waste and digging) [6].

The results for Total Nitrogen and Total Phosphorus were more mixed, with maxima of concentrations related with land ploughing, weeding, and fertilizer application, as well as fishpond drainage and dredging.

TSS and TN reduced from the inlet to the outflow in wetland plots, due to the absence of disturbances and perhaps additional causes (increased settling/adsorption, nutrient absorption, and denitrification) [7].

Despite increasing fertilizer input in fields, N and P storage in soil dropped (by 4.7 and 1.4 percent, respectively), but rose (by 3.3 and 4.4 percent) in wetlands (3.8 percent and 1 percent). The lower supplement capacity of soil is connected with more noteworthy Nitrogen and Phosphorus ingestion in plots (662 and 270 $mg \cdot m^{-2} \cdot d^{-1}$ of N and P, separately) than in marshlands (339 and 121 $mg \cdot m^{-2} \cdot d^{-1}$ of N and P, individually) and fishponds (7.4 and 4.4 $mg \cdot m^{-2} \cdot d^{-1}$ of N and P). It is critical examining the competent recovering of water, sediments, and nutrients through rotating rice crops in fishpond sediments in order to promote people's livelihoods and economic growth while protecting water quality downstream the agricultural region. Wetlands could be all the more generally incorporated with rice and fish cultivating to go about as silt and supplement supports during basic cultivating times (rice ranch furrowing and weeding, and lake drainage). This could prompt more reasonable agribusiness with less disintegration and lower residue and supplement troubles downstream [7] [8]. The study Assess the impacts of converting natural wetlands to agricultural farms assessed the Nyabugogo wetland located in Kigali city. Six sampling sites were selected that is Nyabugogo bridge, Karuruma bridge upstream, Downstream of Kabuye sugar works (KSW), upstream of Kabuye sugar works, Downstream of Nyacyonga bridge and upstream of Nyacyonga bridge.

Assessment of the impacts of converting natural wetlands to agricultural farms in Nyabugogo included determination of status of several portions of Nyabugogo wetlands and some of their inputs to assess the influent and effluent characteristics. The findings have been compared to national and international guidelines. The research also included consultations to learn more about the city of Kigali's normal agricultural management. The study concluded by recommending improvements to agriculture practices where they are needed to promote long-term viability and environmental preservation.

2. Materials and Method

Study Location

Nyabugogo wetland is located in Kigali city geographically situated at the core of Rwanda with a latitude of 1˚58'S and a longitude of 30˚07'E having a population of more than 1 million (NISR, 2014) and area of 730 km^2 and is arranged close to the geographic focus of the country. The city is based on various slopes, rambling across four edges with valleys in the middle.

The regions are portrayed by two dry seasons (a short dry season: December, January, February and a more extended dry season: June, July, August, September) and two times of downpour (short time of downpour: October, November and (a more drawn out time of downpour: March, April, May). Water is regularly accessible in a lot during water shortage. Sampling was done from August 2021 to January 2022.

In this study, sampling areas were selected conditionally. Nyabugogo bridge were selected as the outlet of all sampling points, Karuruma bridge upstream were selected as the point near Karuruma center where many agriculture activities are carried, Downstream of Kabuye sugar works (KSW) were selected in order to access effects of KSW input in water, upstream of Kabuye sugar works was selected in order to assess the quality of water before meeting with KSW inputs, Downstream of Nyacyonga bridge and upstream of Nyacyonga bridge was selected in order to assess the pollutants caused by Nyacyonga center agricultural activities in Nyacyonga commercial center.

Water was sampled from the sites in three different times monthly in order to ensure consistency of the results. At first the sample was taken in the time when it had rained, another sample was taken at normal conditions when it had not rained and the last sample was taken very early in the morning and the average from the for the samples was determined.

These sites are all located along the same drainage river from downstream to upstream (SP1 to SP6) respectively as shows Figure 1.

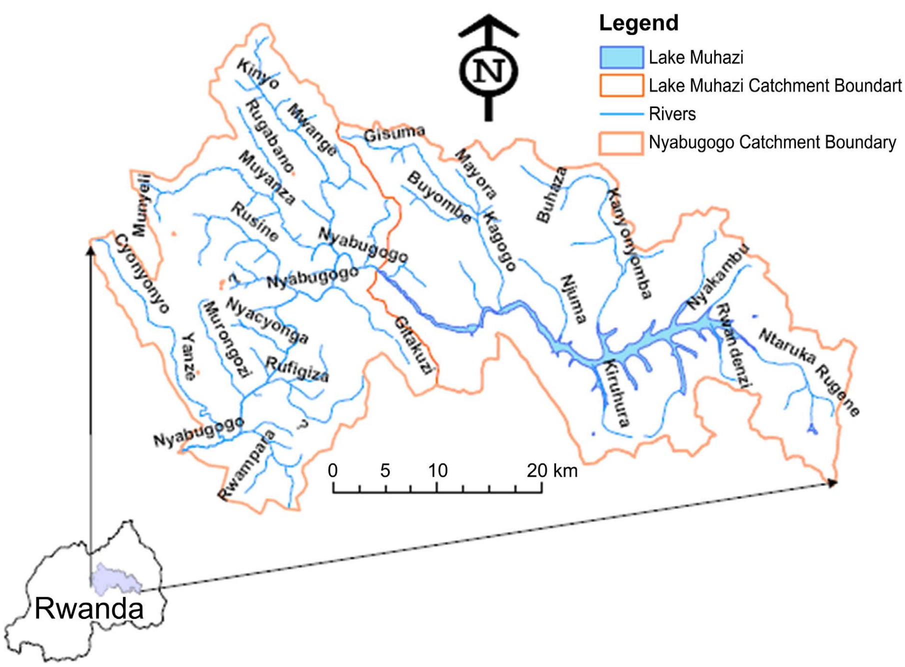

Figure 1. Administrative map of Kigali city.

3. Results and Discussion

3.1. Physico-Chemical Results

Organic and inorganic compounds are dissolved and suspended in water. Natural waters contain a wide range of physico-chemical features, and ecosystems freshwater which has developed response to differences [9]. Ecological networks, which have developed certain conditions, that may be extremely sensitive to chemical introduction into the environment also to alter fast when substance concentrations vary [10].

Water quality standards and what we think about contamination, then again, are resolved by what is in the water, yet in addition by what the water is utilized for (e.g., drinking water, water for bathing etc.). In a contaminated water body, one or more pollutants have accumulated to the point where they are potentially dangerous to organisms that reside in the water body, as well as animals and humans who drink the water [11].

Physico-Chemical Results Interpretation

The pH in all regions went from 7.1 to 7.8 **Table 1**. It meets the target value for a fairly liquid base pH and is well within the range of surface water. The temperature rose from 21.1˚C to 22.7˚C. Dissolved solids in full-scale wastewater increased from 145.4 mg/L for SP4 to 179.9 mg/L for SP1. This is due to the low level of dumping remaining in the wetlands of the area. Turbidity is basically more pronounced at 96.5 NTU downstream than at 70 NTU upstream. This is due to the accumulation of large amounts of suspended particles downstream. This is ultimately the result of the dumping of large amounts of waste downstream (SP1).

The pH of SP1 was 7.3 in the rainy season is the lowest of the relative majority of targets due to the low convergence of particle H^+. The temperature in this example is 21.7˚C lower than in the previous example because the time of this survey was during the stormy season. The highest TDS content is 285 mg/l at

Table 1. Physio-chemical characteristics of surface water during dry.

ID/avg Results	pH	To ©	TDS (mg/l)	Conduc (μs/cm)	Turb (NTU)	Hardn
SP1	7.6	21.8	179.9	560	98	114
SP2	7.3	22.4	286	555	14.6	162
SP3	7.8	21.6	149.3	288	93	89
SP4	7.8	22.7	145.4	295	96.5	93
SP5	7.5	22.1	154	311	90	100.5
SP6	7.1	21.7	176.8	412	70	84
RSB Standards	5 - 9	>3	≤1500	≤1200	30	80
WHO	5 - 9	>3	≤1500	≤1200	30	80

T: TDS; Turb: turbidity; Hardn: hardness; Cond: conductivity (mg/L$CaCO_3$).

SP2 due to the deposition of many excellent solids in this region of the stream. The turbidity is 182.7 in the rainy season and 182.7 in the dry season Table 2. This is because the survey was conducted during the rainy season and a large amount of precipitation was released into the stream. The range exceeds the 30 limits proposed by both RSB and WHO.

pH estimations

The pH of the effluent is considered an important limitation as it affects the physical, complex and natural climate. Strong and anti-acidic pH causes erosion of sewer and plumbing materials (Manahan, 1993). The SP1 dry season surface water test shows that the rainy season pH lifts from 7.4 to 8.4 and the pH value is 7.1 to 7.8, which is the value specified by the WHO and RSB for ocean water with a pH value of 5.0 to 9.0... And this value probably doesn't affect life at sea as shows Figure 2. At SP1, the pH is 7.6 in the dry season and 8.4 in the rainy season, which is higher than the estimated target. The results of Hydrogen potential (pH) all went above 7 which shows the basicity of the region and this resulted from the increase of human activities nearby this wetland that is located in the nearest vicinity of Kigali City.

Table 2. Physicochemical parameters of surface water in the rainy season (Sample 2).

ID/avg Results	pH	To ©	TDS (mg/l)	Conduc (μs/cm)	Turb (NTU)	Hardn
SP1	8.4	21.7	178.1	552	95	120
SP2	7.4	21.5	285	560	15.3	166
SP3	8.1	21.6	152.1	290	95	81
SP4	8.0	22.8	140.3	292	97	97
SP5	7.6	22.5	160	290	91	101.2
SP6	7.5	21.5	181.1	440	90	85
RSB Standards	5 - 9	≤25	≤1500	≤1200	30	80
WHO	5 - 9	≤25	≤1500	≤1200	30	80

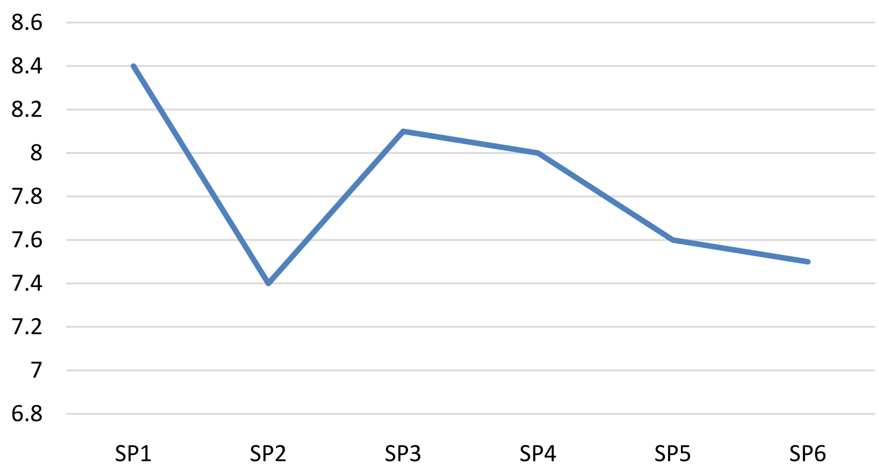

Figure 2. pH value graph illustration.

Surface water temperature

During present research the temperature range was between 21.6˚C at SP3 and 22.7˚C at SP4. The most negligible worth of temperature is found at SP3 (2 1.7˚C), and the most raised regard is at SP4 (22.7) and this is required from the time (dry season) the water was trying **Figure 3**.

At KSW, the most decreased regard was 22.1˚C at SP3 and the most significant worth was 22.5˚C. This investigating was assessed in blustery season [12]. High temperature slants toward the breakdown of regular carbon by small scale natural elements which produce normal acids thusly making of such destructive cuts down the pH [7].

3.2. Chemical Concentration Characteristics of Nyabugogo Marshland

The chemical concentration characteristics of surface water in Nyabugogo stream was one of the study's goals. Water samples were taken at six (6) locations along the stream, including SP1, SP2, SP3, SP4, SP5, and SP6. To determine the concentration of heavy metal, titration was utilized, and the results were obtained using spectrophotometer equipment [13] [14]. The findings revealed that wastewater dumping directly from residences, car parks, garages, and industry contaminated the water with significant concentrations of potassium, calcium, chloride, and sulphates.

During the sample analysis the most un-worth centralization of chlorides in the surface water was 20.5 ± 0.7 mg/L at SP5 while the most raised regard obsession was 77.11 ± 6.9 mg/L. Differentiating these characteristics and the acceptable farthest reaches of surface water of 2 mg/I and 6.0 mg/I by WHO and REMA independently, they give off an impression of being over quite far and subsequently there are ramifications for the climate [15].

Sulfate in surface water is harming to the sewerage system as it will overall go through oxidation and decline changes due to the presence and nonattendance

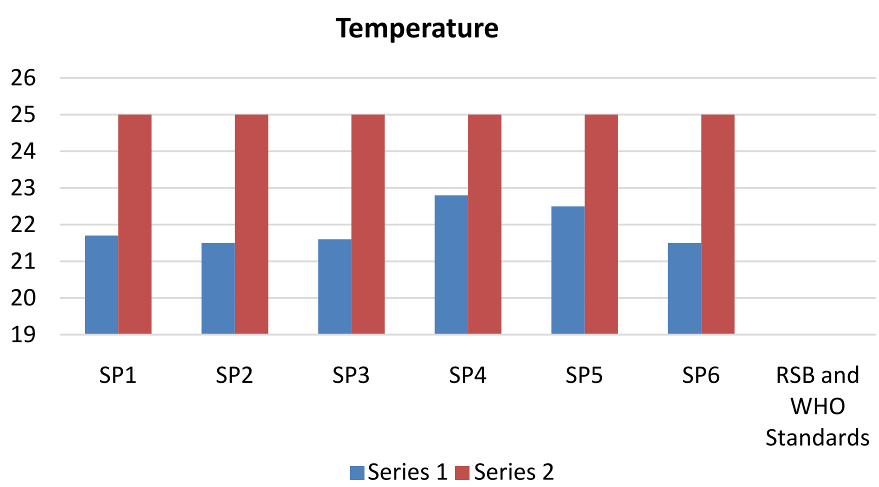

Figure 3. Temperature measured data.

of oxygen [16] [17]. During this audit sulfate obsession regard was low 59 ± 1 mg/I at SP5 and was high 174 mg/I at SP2 [9] [16] Differentiating these results and the good furthest reaches of surface water < 500 mg/I and <500 mg [18] by WHO and RSB exclusively, the results shows being at quite far.

4. Conclusion and Recommendation

The surrounding farming site's activities, as well as the sites' locations within wooded areas, contributed a substantial amount of organic carbon to the river. Organic matter is likely to have influenced other water quality indicators. Due to the need for oxygen during the degradation of the materials, dissolved oxygen decreased with larger organic carbon loadings. Particulate matter levels rose in tandem with organic carbon levels. Due to the increased quantity of particles and ions in the water, there were also higher levels of conductivity ([19], p. 22). This could be the result of road salt being washed into the water body by runoff from nearby roads, especially about inhabited areas [20]. The Water Quality Index clearly showed that measures such as turbidity and conductivity among others had high quality rating values, implying that surface water quality was not impacted significantly. pH and total phosphorus had a considerable impact as well, but not as much as the first four parameters [21]. However, protection measures shall be applied in order to keep the agricultural field from harming the wetland. Because most of the pollution in peri-urban areas is caused by agricultural fertilizers, it is advised that the city administration monitor and control the usage of these products and report any difficulties to a higher level [4] [22] [23]. Conducting controlled research is a last recommendation. The goal of this controlled study is to segregate the compost before it is dumped into the Nyabugogo River in Kigali as well as periodic monitoring. As a result of this separation, the individual doing the study may be able to better understand the waste components [9]. The concern is that these investigations would take a long time and be expensive. However, there is still unpredictability in surface water quality, necessitating more research into this area in order to improve our understanding of the Nyabugogo wetland.

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Conflicts of Interest

The authors of this article declare that there are no conflicts of interest regarding the publication of this paper.

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