Potential effect assessment of agricultural activities on water quality of rivers in Rwanda: "Case of Muvumba River in Nyagatare District"

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Abstract— *The problem caused by agricultural sector to Water Quality pollution remains a big challenge for Rwanda Government. The general objective of the study was to assess the potential effect of agricultural activities on water quality in Nyagatare District. Specifically, the study assessed agricultural activities in around Muvumba River, examine the level of water quality pollution in Muvumba River, and reveal the relationship between agricultural activities and water quality from Muvumba River. Data collected through interview, and laboratory tests of water samples applied once per month in three points sampling of Muvumba River. The action starting from 19th March 2019 up to 20th March 2020. To determine the correlation between agricultural input and Water Quality data at all selected physic-chemicals parameters, by Linear Regression Model using SPSS statistics with 95% confidence interval. The results indicated that agricultural activities on surrounding of Muvumba River, are presented by the existence of different type of crops, non-protection of anti-erosions, non-wetland margins, the farmers using chemical fertilizers and pesticides, the results revealed also that all selected parameters have not addressed positive relationship or pollution, but many of them did, as per to Rwanda Standards Board guidelines. For sampling point one has taken as baseline because it is upstream of Muvumba river at Nyagatare District, in sampling point 2, the parameters that presented pollution were; turbidity (r=0.193), nitrites (r=0.393), iron(r=0.122), manganese (r=0.008); for the sampling point3: were pH (r=0.319); turbidity (r=0.212); nitrites (r=0.143); nitrates (r=0.618); nitrogen ammonia (r=0.441); Iron(r=0.889); manganese (r=0.269); agricultural activities in surrounding of Muvumba River have significantly contributed to the water quality pollution of Muvumba River, through substances of chemical fertilizers, crop residues, and soil sediments that are transported into the River by erosion. Conclusion of the study that creation of anti-erosions in a surrounding Muvumba River areas, protection of buffer zones, performing vegetation covers, inducing water management bodies at cells level, introducing awareness of farmers how ecosystem functions.*

Keywords— Agricultural activities, Water quality, Water pollution, Muvumba River.

I. INTRODUCTION

The Water its function in ecosystem is to provide the life blood of the community, in the ecosystem makes water a key element for sustaining life as it is fundamental building block that supports biochemistry of all life in the planet (Laurie Brenner, November 15 2019).

In ecosystem Water is very important in lifeblood of the all live in the planet (UNESCO, 2006). It is a basic element for all forms of life for various uses such as drinking, cleaning, as a reproductive medium and as habitat for aquatic organisms and for irrigation purposes (Ninhoskinson, 2011). Water has 70% of the Earth's surface, and 40% of the population in the world, has shortage of Water.

The causes of this water shortage is the absence of freshwater, 95.7% water in the Earth is saltwater, and 2.5 % of water is fresh, while 70% of the freshwater is in the form of ice(Sandi, 2012). The World Health Organization (WHO), quoted by Mmbando J. et al (2007), under 1 % of Water which is able to be used by the different activities of the human. The main sources of the freshwater which is easy to access fund it in Lakes and river, but 25% of the users in the Earth relying on groundwater or deep aquifers for water supplies (Mmbando J. et al 2007). In the world there is no regular to supply freshwater to the users. The areas with the least available Water include most Africa, the Middle East, Asia and Europe.

There is augmentation of famine, hunger and poverty. Population growth is greatest in Low Economic Developed Countries (LEDCs), and this accelerates environmental degradation and poverty. In LEDCs Half of all the populations, do not have safe water to drink. Waterborne diseases kill 25000 people's daily, and about 14 million children under five-year old die each year from illness and hunger (Mmbando J. et al (2007). However, the benefit of safe water for human is highly; generally are main source of water pollution, through outdated farm management activities

The activities of Agriculture, is cited as one of biggest source of water systems deterioration and pollution, (MOSS, 2008). The Agricultural nutrients from farmlands are one of the top running contributors to the poor quality of water. An intensification of agricultural production generally produces an increase of externalities and potential for these by-products to, negatively, affect water quality (Ninhoskinson, 2011). The degradation of water quality by agricultural activities creates hazard life in downstream and requires tuff investments in water analysis and treatment infrastructures (Batchelor, 2000).

The limited areas for agriculture activities is the barrier of adequate distance between farmland and water sources; the result from agricultural product through using varies fertilizers; manure and pesticides and mobile soil particles; each of these groups has serious negative impacts on degradation of both ground and surface water on the site and downstream(Libby, 1990)

II. MATERIALS AND METHODS

2.1 Description of study area

The Muvumba Catchment finds its source in Rwanda on the Mulindi River that is located in the Mountainous and high rainfall central northern part of the country at an altitude of 2030 m.

The Mulindi River flows North over a length of 22.5 km to Uganda onto a flat wetland zone near Kabale from where a complex flow pattern originates that ultimately joins the Muvumba River before it eventually flows back into Rwanda at an altitude of 1 460 m above sea level. The length of the Muvumba River in Rwanda is about 56.3 km. Just south of Nyagatare, the Ngoma River with a number of tributaries contribute their flow to the Muvumba River which flows in a north easterly direction to follow the border between Rwanda and Uganda before finally joining the Akagera River in the North East where the borders of Uganda, Rwanda and Tanzania meet. The final altitude of the Muvumba River is about 1280 meter.

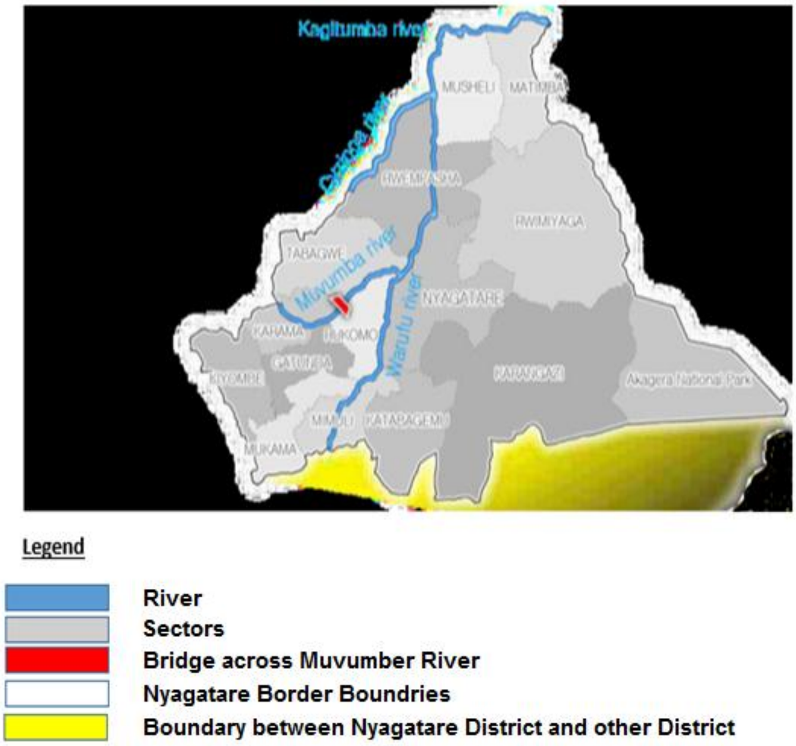

FIGURE 1: Description of study area

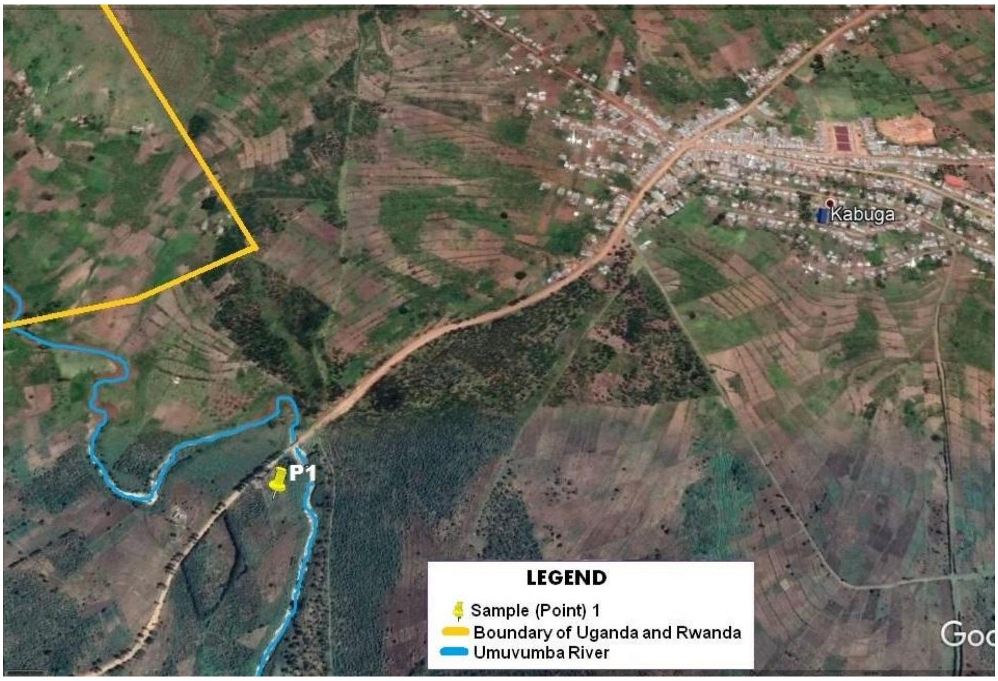

FIGURE 2: Location of sampling point 1in Muvumba River
Ref.: Google Map

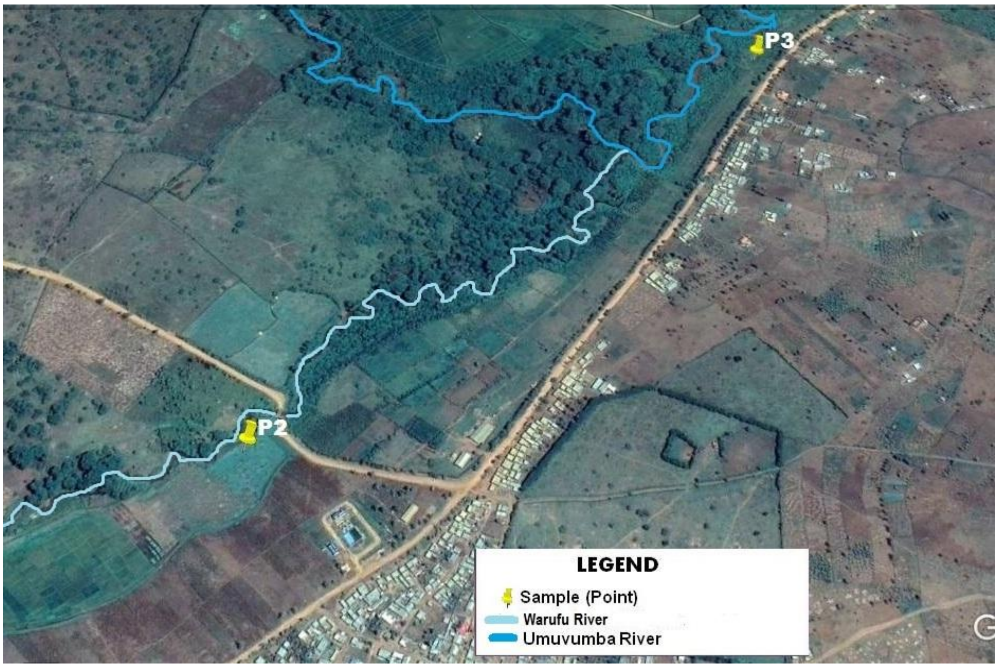

FIGURE 3: Location of sampling point 2 and 3 in Muvumba River

2.2 Research design

Research design is considered as a master plan specifying the accurate methods and procedures for collecting and analysing the required data. Hence, this study used qualitative and quantitative methods. In regard to qualitative method, the researcher conduct face to face interview to the farmers' cooperatives operating at MUVUMBA Marshland and surrounding areas and also use telephone interview to the different farmers 'around tributaries of the Muvumba River. Furthermore, an interview was conducted to the Officer in charge of agriculture in Nyagatare District; and the researcher's own observation was needed for supplementary information. In terms of quantitative method, the researcher has selected three sampling points basing on upstream; main tributary and downstream of Muvumba River and one of tributaries flow to Muvumba in Nyagatare District characterized by agricultural plantations. Furthermore, Linear Regression Model using SPSS statistics with 95% confidence interval was used to demonstrate the correlation between agricultural activities and the degradation of water quality level from Muvumba River.

2.3 Study population

The population, under this study, was composed of all cooperatives performing agricultural activities in Muvumba marshland and surrounding areas, whom the total number are 13 cooperatives; namely CODERVAM; MP8 Rice Growers COPERATIVE; COPRORIKA; COPRIMU; CORVNY; AGROVENTURE Ltd; these cooperatives are firming rice, and Cooperatives maize farming are KABOKU; KOHIIKA; COTEBARU; CODEPCUM; COPAMA; TWUNGUBUMWE; and AMIZERO IWACU; and there are also 1 big individuals farmer which are firming tomatoes around MUVUMBA River; using fertilizers; the total population are 14 farmers.

2.4 Source of data

The study involved the use of primary data and secondary data. Primary data were collected through interview, observation, and laboratory tests of raw water from Muvumba River. Secondary data from literature review such as books and official reports, and websites.

2.4.1 Interview

A formal interview was conducted to the farmer's leaders and Agronomist of Nyagatare District, in order to get information from the respondents, and to ensure of other agricultural features in the area of the study; in order to have accuracy data also the researcher did his own observation on field for different times, in dry and rainy seasons of 2019 and 2020, in order to ensure himself the agricultural features in Muvumba marshlands and surrounding areas.

2.4.2 Laboratory tests of water from Muvumba River

2.4.2.1 Water sampling

The water samples were collected one time per month from Muvumba River in every sampling point, for a period of 12 months starting from 19th March 2019 up to 20th March 2020. Subsequently, twelve sampling campaigns were conducted during that period for the three sampling points in the Muvumba River. Samples were collected and stored in appropriate equipment, which are cleaned, and rinsed with distilled water before use. Samples were put in good condition in order to preserve it during transportation to the laboratory for analysis; and keep it in favorable temperature of 3^0c to 4^oc, to avoid any external contamination, when preparing the laboratory for analyze, the different selected physico-chemical parameters.

2.4.2.2 Laboratory analysis

Water samples from the Muvumba River, were collected and analyzed in Laboratory of WASAC Ltd at Nyagatare Water Treatment Plants; Samples were analyzed using standards manual for testing water and wastewater (APHA, 2005). The physico-chemical parameters analyzed and laboratory method used were pH, turbidity, nitrites, nitrates, ammonia nitrogen, phosphates, iron, and manganese.

2.5 Data analysis procedure

Bailey (1982), data analysis consists of running various statistical tests on the data often by hand computation or by desk calculator. For this study, the collected data was processed, analyzed and managed using editing, tabulation, and graphics in order to provide clear and understandable data. The Linear Regression Model using SPSS statistics with 95% confidence interval was used to find out the correlation coefficient (r) between agricultural activities inputs and the data from laboratory tests of physico-chemical parameters for water samples taken in Muvumba River. Hence the results from laboratory and had positive correlation with agrochemicals data were compared to the Rwanda Standards Board (RSB) guidelines in order to analyse the level of water pollution from agricultural practices in Muvumba.

III. RESULTS AND DISCUSSIONS

3.1 Assessment of agricultural practices in Bishya wetland and surrounding areas

3.1.1 Opinion of interviewees

Basing to the information from all interviewees (100%) has agriculture activities of Maize, Tomatoes and rice as agriculture production performed in Muvumba Marshland, and surrounding areas. This situation shows that agricultural productions are different crops with various fertilizers and pesticides to increase their production capacity and reduce poverty.

The totality of interviewees; (100%) have regularly use fertilizers; 71.42% of interviewed frequently use NPK17*17*17; and 7.14 interviewed used NPK 10-8-10; and 100% used UREA as fertilizer and DAP; also pesticide like Benlate; Beam; cypermethrin 40% ; Tricyclazodale 75%; Bifurthrin; 40%), and fungicide; 60. This situation confirms that agricultural activities in Muvumba Marshland and surrounding areas characterized by the use of different chemical fertilizers and pesticides as agricultural inputs.

3.1.2 The author's own observation

The Author observation, on field for different times, in dry and rainy seasons 2019 and 2020, realized that agricultural features around Muvumba River are composed of non-protection anti-erosions, existence of different types of rocks and soils, the use of chemical fertilizers, absence of wetland margins. This improper management of Muvumba River remains a major challenge, despite the efforts made by the Government of Rwanda at improving wetlands management over the years.

3.2 Laboratory tests of water samples

3.2.1 The sampling points

They are three water-sampling points selected focusing on upstream of Muvumba River; entrances Warufu River as tributary flow to the river, and downstream where agriculture activities concentrated than other areas around Muvumba River; mainly the plantation characterized to these areas are Rice; Maize and tomatoes. Therefore, the upstream of Muvumba River, is the first sampling point where is backing to Rwanda in Nyagatare District from Uganda country, and was considered as water quality parameters baseline, and second is Warufu River which is small River flow into Muvumba river; and the third one is downstream of Muvumba River; all around the long of River characterized agriculture activities of different crops with different Farmers; the plastic bottles well cleaned used to collect water sampled, transported in cooler-box to laboratory for analysis; except the parameters like pH, which are measured on the field.

According to (.FAO, 2014) Agricultural pressures on water quality come from cropping and livestock systems and aquaculture, which have all expanded and intensified to meet increasing food demand related to population growth and changes in dietary patterns; therefore, researcher was chosen those sampling points in order to analyse the level of water quality pollution due to the agricultural activities of Muvumba River in Nyagatare District.

3.2.2 Presentation of the results of physico-chemical parameters from laboratory tests.

This section presents findings from laboratory analysis and then presents the graphical analysis of data. In order to interpret and be able to draw understandable conclusions on the research, the linear regression model has conducted. From the 19th March 2019 up to 20 March 2020, water samples from Muvumba River, have been taken and brought to laboratory for the analysis. Below we present the average results of different physico-chemical parameters for each sampling point.

TABLE 1
AVERAGE RESULTS OF DIFFERENT PHYSICO-CHEMICAL PARAMETERS FOR EACH SAMPLING POINT

Sampling points	P1	P2	P3	RSB standards
	N=12	N=12	N=12	
pH	7.5 ± 0.25	6.5 ± 0.50	5.8 ± 0.25	**5.5-9.5**
Turbidity(NTU)	424.56± 150	731.43 ± 120	970.32 ±100	**-**
Nitrites (mg\L)	0.45 ± 0.07	0.52 ± 0.12	0.82±0.11	**0.9**
Nitrates (mg\L)	34.13 ± 0.60	38.22 ± 0.07	39.13 ± 2.02	**45**
Ammonia Nitrogen (mg\L)	0.32± 0.12	0.35 ± 0.08	0.45± 0.14	**0.5**
Phosphate (mg\L)	3.09 ± 0.06	3.22± 0.10	3.95± 0.13	**2.2**
Iron (mg\L)	2.53 ± 0.32	3.50± 0.43	4.82 ± 0.40	**0.3**
Manganese (mg\L)	0.373 ± 0.05	0.405 ±0.25	0.635 ± 0.43	**0.1**

Water quality parameters described in the table 1, have been selected on regarding of the types of fertilizers applied by farmers in their agricultural activities around Muvumbe River. Moreover, the table indicates the average results and standard deviation of the physico-chemical parameters for each sampling point in Muvumba River. It also indicates the RSB standards and different others to compare with these average results and then to demonstrate the level of pollution.

3.2.2.1 Results from PH laboratory test

The pH is an important parameter in water, as it can indicate whether organisms or substances can exist in water for any value of the pH and thus Ph in water measures to indicate the amount of hydrogen (acid ion) in the Water.

Figure 4 illustrates the average values of pH in three sampling points.

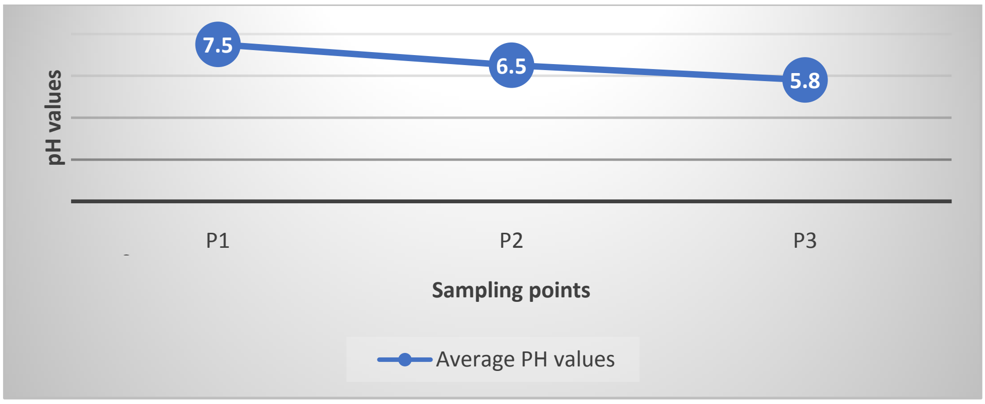

FIGURE 4: Average pH values according to sampling points in Muvumba River.

The figure 4 indicates that the pH in sampling point 3 was changed and tend to be acidic than other sampling points with average pH value of 5.80, this indicate that along of Muvumba River there is a change of pH, according of (Talling, 2010); Naturally occurring fresh waters have a pH range between 6.5 and 8.5; for that reason, sampling point 3, it was indicated lower pH which is under 6.5; and considering the minimum limit of 5.5 fixed by RSB; there is change of pH in water from Muvumba River.

3.2.2.2 Results from Turbidity laboratory test

The average values of water parameters from laboratory results as presented in table 1 showed that turbidity is high in all sampling points ranging from 424.56NTU and 970.31 NTU. These average turbidity values overtake accepted limits of RSB that is fixed at 25NTU.

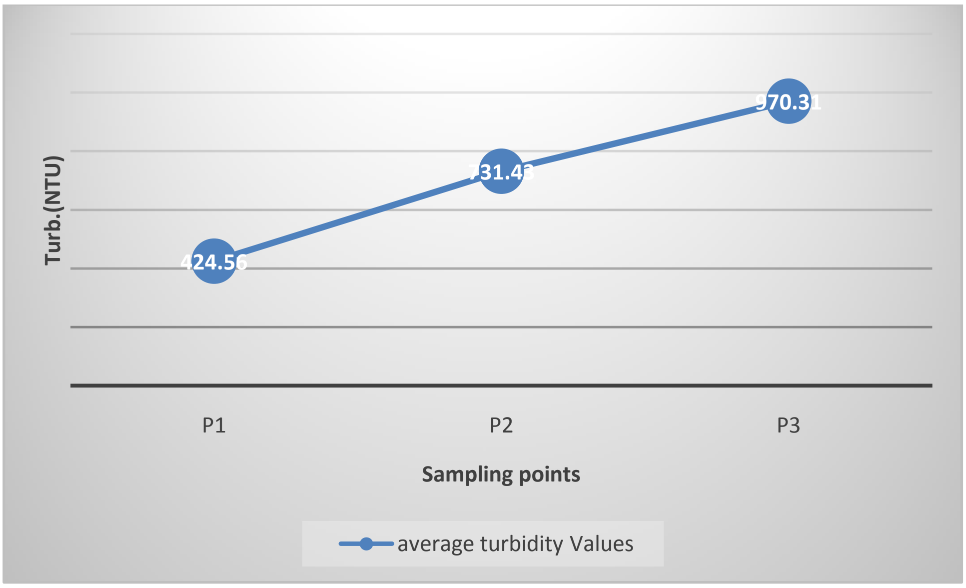

FIGURE 5: Average turbidity values according to sampling points in Muvumba River

From the figure 5, it is observable that in sampling point P3 located in downstream area, level was very high comparing point1 and point2; this situation means that in all sampling points, suspended particles, the presence of organic and colloidal materials from agricultural runoff and soil sediments contribute towards high turbidity values, especially in rainy season; according to Thirupathaiah, 2012. Turbidity can provide shelter for opportunistic microorganisms and pathogens in water and also Turbidity of water has an influence on other parameters such as color and even chemical parameters which affect water quality.

3.2.2.3 Results from Nitrites laboratory test

Nitrites is the one among parameters that have been analysed; the laboratory tests for Nitrites have shown that average concentration of nitrites varies from 0.45 mg/l to 0.87mg/l. These all-mean values are increase along the Muvumba River where agricultural activities are characterized even if the concentration of nitrites is under limit of the RSB guideline, which is 0.05mg/l.

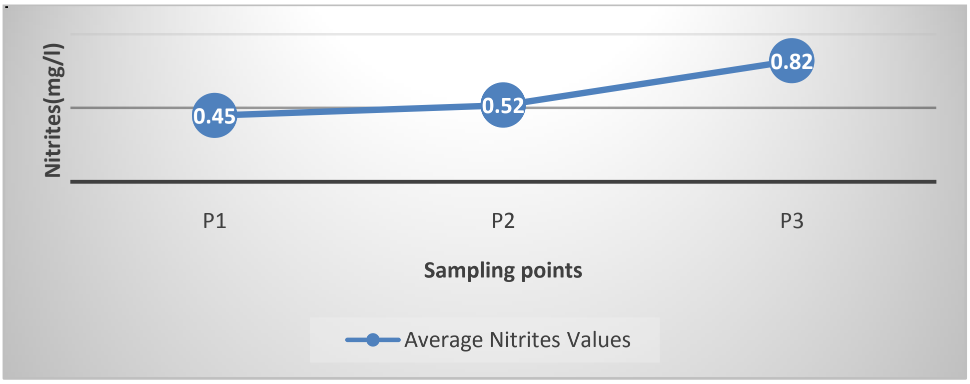

FIGURE 6: Average of nitrites concentration according to sampling points in chosen

The figure 6 shows that the average nitrites levels was high in all sampling points and more increased in sampling point3 (P3); comparatively to other points. According to the limit accepted RSB which is 0.05mg/L; and according to the Canadian guidelines for aquatic water quality has an upper limit for nitrite of 0.06 mg/L; while nitrite in much more toxic to aquatic life than nitrates, nitrite tend to convert quickly to nitrate.

This situation showed that agricultural activities performed in surroundings of Muvumba River; produce substances containing high quantity of nitrites; therefore the water from Muvumba river has been accumulated high quantity of nitrites from agricultural input, according to the required of nitrite level in water.

3.2.2.4 Results from Nitrates laboratory test

Nitrates have been selected among parameters to be analysed as they can contribute in water pollution of the River since they are much more abundant in intensive agricultural runoff. From the laboratory tests, nitrates have shown that the average concentration of nitrates varies from 34, 13 mg/l to 39,13 mg/l in all sampling points. However, all mean concentration levels were within the RSB standards of 45 mg/l.

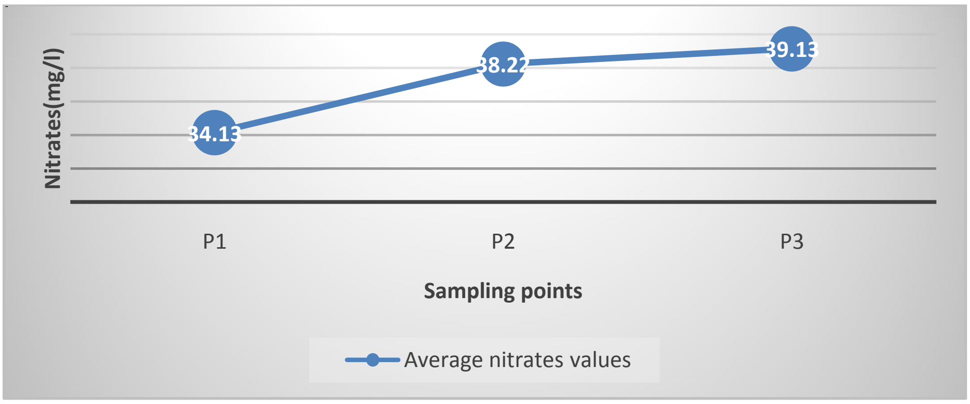

FIGURE 7: Average of nitrate concentration according to sampling points.

From the figure 7, it is noticed that concentration of Nitrates vary at high level, since the difference in average values is high. The sampling point P3 presents a high concentration level of 39, 13 mg/l; this point is in downstream of Muvumba River, where performed more agricultural activities.

3.2.2.5 Results from Ammonia nitrogen laboratory test

The ammonia nitrogen in water body comes from different sources but in our research, we focused the ammonia nitrogen that comes from fertilizers that are used in surrounding of Muvumba River.

According to the Keven Mc Kague, "environmental impacts of nitrogen use in agricultural'' stated that the concentration of ammonium in the soil is generally quite low (1mg/kg), because it is quickly converted to nitrate under condition that are favourable for mineralization, and the high rates of an ammonium fertilizer or high rate of manure are applied; Occasionally, heavy rainfall washes this concentrated ammonium from the field into surface water.

This contains high level of ammonia nitrogen that has a negative impact on water quality.

Laboratory results have shown an average concentration level of ammonia nitrogen ranging between 0.32mg/l and 0.45mg/l for all sampling points. These all-average values were an upper limits accepted by RSB of 0.05 mg/l.

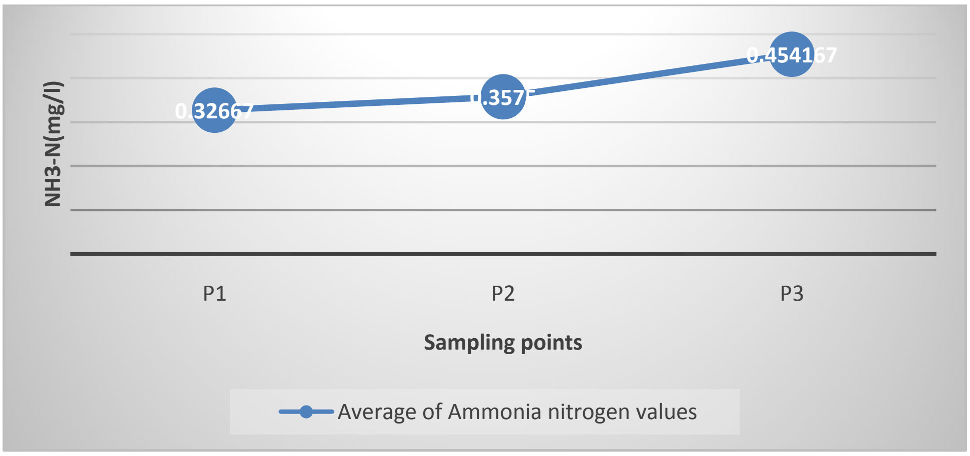

FIGURE 8: Average of ammonia nitrogen values according to sampling points selected.

The figure 8, indicates that the concentration of ammonia nitrogen was on high in all sampling points but more increased in sampling point 3, which located in downstream of Muvumba River, where the agricultural activities is performed much therefore laboratory tests for ammonia nitrogen (NH_3-N) shown that the mean values did overtake RSB guideline which is 0.05mg/l, the trend situation was indicated that there is high concentration of ammonia nitrogen in water from Muvumba river through agricultural activities done in surrounding of River.

3.2.2.6 Results from Phosphates laboratory test

The phosphates were other parameters chosen to be analysed in this research, phosphates from agricultural runoff contribute to the deterioration of water quality in Muvumba River. Laboratory tests for phosphates have shown phosphates concentration level varying between 3.09 mg/l and 3.95 mg/l in all sampling points. These average values present pollution cases of water quality of Muvumba River, since they are all above accepted limit of RSB, which is 3mg/l.

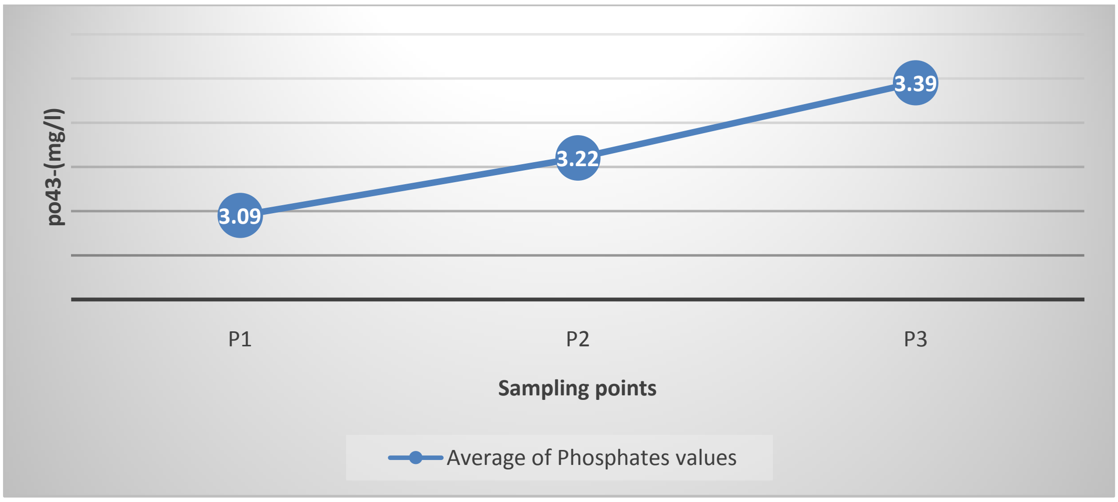

FIGURE 9: Average of phosphate concentration according to sampling points selected

The analysis from the figure 9 shows that there is high concentration levels in P2 and P3 corresponding to 3,09mg/l and 3,39mg/l respectively, comparatively to poin1 which is upstream of Muvumba River at Nyagatare District.

3.2.2.7 Results from Iron laboratory test

Laboratory tests for iron have shown that the concentration level of iron in River varies between 2.53mg/l and 4,82mg/l in all sampling points. These average values are highly surpassed the limits accepted by RSB that stands at 0.3 mg/l.

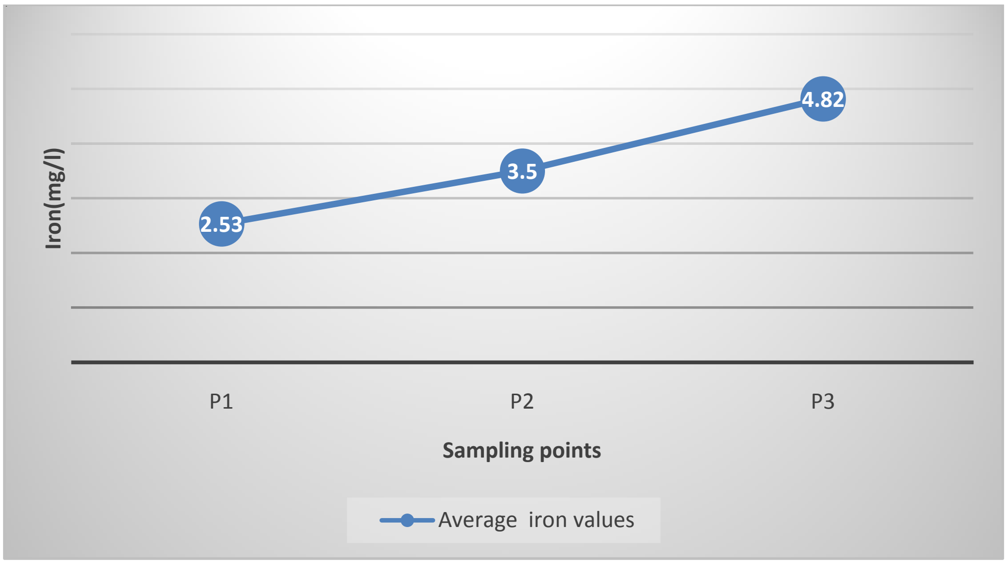

FIGURE 10: Average of iron concentration according to sampling selected sampling points in Muvumba River.

From the figure 10, the concentration of iron is higher in all sampling points but in sampling points P2 and P3 situated near the crops plantation tomatoes, maize, rice, and located in downstream of tributary (Warufu River) and Muvumba River.

Therefore the concentration of Iron in water from Muvumba River is high than guidelines from WHO and RSB limit; and confirming deterioration of water quality from Muvumba River.

3.2.2.8 Results from Manganese laboratory test

Laboratory tests for manganese have shown that the concentration level of manganese in Muvumba River; varies from 0.37 mg/l to 0.63 mg/l in all sampling points. These average values exceeded the limit of RSB standing at 0.1 mg/l.

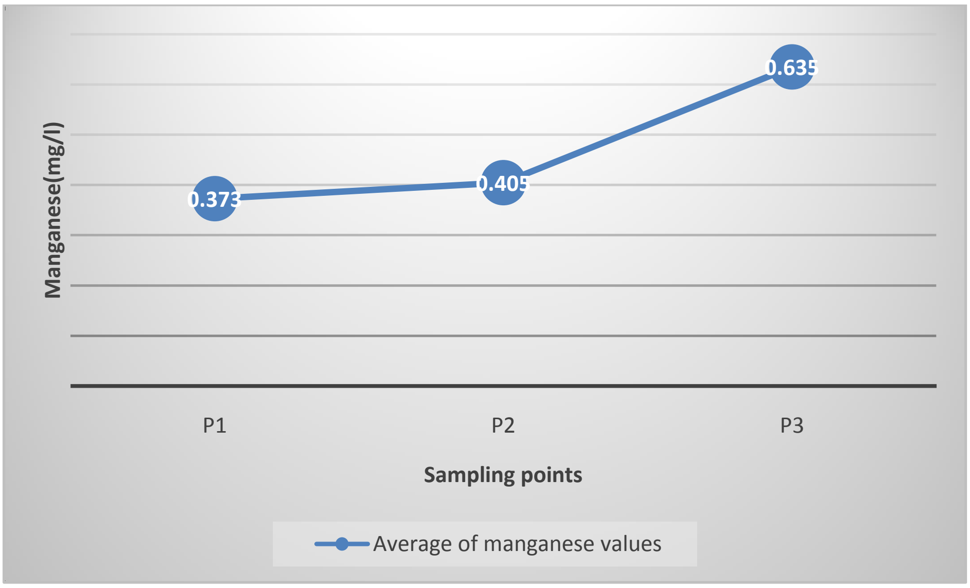

FIGURE 11: Average of manganese concentration according to sampling points selected.

The figure 11 indicates that the concentration of manganese is highly increasing in along of Muvumba River. This situation means that Muvumba River accommodates the sediments of manganese that are highly soluble in water and their concentration manifest itself during the dry season than rainy season.

3.3 Correlation between agricultural practices and water quality from Muvumba River

3.3.1 Demonstration of coefficient of correlation using Linear Regression Model

In order to demonstrate the correlation between agricultural inputs and water quality from Muvumba River, a Linear Regression Model using SPSS confidence interval of 95% was adopted. The following table shows results of coefficient of correlation between these two variables.

TABLE 2
COEFFICIENT OF CORRELATION BETWEEN AGRICULTURAL INPUTS AND WATER QUALITY FROM MUVUMBA RIVER

Parameters	P3 r	P2 r
	N=12	N=12
PH	0.319	-0.058
Turbidity(NTU)	0.212	0.193
Nitrites (mg\L)	0.143	0.393
Nitrates (mg\L)	0.618	-0.356
Ammonia Nitrogen (mg\L)	0.441	-0.430
Phosphate (mg\L)	-0.785	-0.139
Iron (mg\L)	0.859	0.122
Manganese (mg\L)	0.269	0.008

3.3.2 Correlation between agricultural inputs and water pollution from Muvumba River

The relationship between agricultural inputs and water quality parameters demonstrated trough Linear Regression Model using SPSS with confidence interval of 95% considering both data from agricultural inputs used by farmers in their respective farm crops as summarized in Table 3, and laboratory results of water samples as indicated in Table 1.

TABLE 3
SUMMARY OF AGRICULTURAL ACTIVITIES IN SURROUNDING OF MUVUMBA RIVER

Sampling point Selected	Location	Types of Crops	Agricultural inputs	The total Quantity (kg) for each type of fertilizers and pesticides	Total quantity of fertilizers and pesticides for sampling points
P1	Upstream of	N/A	N/A	N/A	N/A
P2	Tributary	Maize Tomatoes Rice	NPK 17*17*17	310800	**553,152**
			NPK 10*8*10	5250	
			urea	149400	
			Beam	86481	
			Benlate	279	
			Fungicide	21	
			insecticide	21	
			Chloropyriphos-ethyl	900	
P3	Downstream of River Of River	Rice	NPK 17*17*17	439,875	**625,949**
			Urea	183000	
			Chloropyriphos-ethyl	294	
			Beam	1050	
			Benlate	1430	
		Maize	Tricyclozole 75%	300	

In subsection 3.3: we have demonstrated the coefficient of correlation between agricultural inputs and water quality; however all parameters that showed positive relationship were not indicating pollution basing on Rwanda Standard Board limit. Therefore, in this section, we highlight the relationship between agricultural inputs and water quality with emphasis on water parameters presenting pollution levels comparing to limits set up by Rwanda Standard Board and compared to the sampling P1 which is water quality baseline.

The Linear Regression Model results indicated that agricultural inputs had positive relationship with turbidity (r=0.193), nitrites (r=0.393), Iron (r=0.122), Manganese (r=0.008, in sampling point P2. This situation highlights pollution of water in sampling point P2, which is cause by use of different fertilizers and pesticides falling into the River from stream passing through maize, rice and tomatoes farms crops.

Results showed also that agricultural activities had positive relationship with pH (r=0.319), turbidity (r=0.212), nitrites (r =0.143), nitrates (r=0.618, ammonia nitrogen (r=0.441, Iron (r=0.859), manganese (r=0.269, in sampling point P3. This situation highlights pollution of water in sampling point P3, which attributed to the use of different fertilizers and pesticides falling into the River from stream passing through maize and rice farm crops.

Considering the farms activities characterized around Muvumba River and different types of fertilizers and pesticide applied to increase production; accommodates the most abundant sediments from agricultural activities containing iron and manganese that are highly soluble in water and contribute to the river pollution. It also highlights that absence of anti-erosion and ineffective drainage of Muvumba River; contribute to degradation of Water Quality

IV. CONCLUSION

The agricultural activities around Muvumba River and quality of water, used SPSS to determine the correlation between them; the result have indicated that there was positive relationship between these variables in sampling points, P2 and P3 compared to P1which is considering as water quality baseline in Muvumba river, and Rwanda Standard Board limit,. Talks about this relationship, all parameters have not presented pollution, but some of them did according to the positive correlation and Rwanda Standard Board guidelines. The parameters which had positive relationship for the sampling point two (P2) are turbidity (r=0.193), Nitrites (r=0.393), Iron (r=0.122), Manganese (r=0.008, and sampling point P3, the parameters that indicated positive relationship between agricultural input and result from water quality. parameters, were pH (r =0.319), turbidity (r=0.212), nitrites (r=143), nitrates (r=0.618; nitrogen ammonia (r=0.441; iron (0.859); manganese (r=269.

Briefly, agricultural activities in surroundings of Muvumba River, where characterized different crops, unprotected of anti-erosion structures, inefficient management of Muvumba marshland margins (buffer zones), utilized of chemical fertilizers and pesticides, and appearance of different types of rocks and soils. All these have contributed to pollution of water in Muvumba River.

The result demonstrated by the coefficient of correlation between agricultural inputs and water quality parameters such as pH; turbidity, nitrites, nitrates, Iron, manganese; nitrogen ammonia presented positive relationship between them; therefore, the research hypothesis confirmed that the agricultural activities have affected the pollution of water quality of Muvumba river. For sustainable wetland management the researcher suggested the following:

- Creation the protection anti-erosions in surrounding Muvumba river areas.
- To make a buffer zone land use in marshland of Muvumba river, through sensitizing local community and educating people using croplands surrounding Muvumba river in a way respecting Marshland margins (buffer zone) and have minimum knowledge the causes of water pollution. referring to the law on wetland protection applicable in Rwanda,
- To sensitize population the way to manage the agricultural wastes for protecting water to be polluted.
- To advise the district planers to consider long-term development matters, in order to sustain economic development of district; agricultural policy should not only be focused on the increase food production but also considering water quality stability.
- To consider environmental protection during the activities of agriculture and avoid the activities which can contribute to the pollution of water quality from the resource.
- To create the activities anti-erosion in order to maintain rainwater.

- Collaborate with district agronomist in order to take action of farming in order to be conformity of laws governing the use of land.
- To prepare agricultural activities which is not degrading the soil and the water quality.
- To mix organic manure with industries fertilizers in order to reduce induced by chemicals fertilizer and increase crop productivity.
- Create clubs for environmental protection in order to educate mass population about it.

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