Journal of Applied Biosciences 162: 16744 - 16753
ISSN 1997-5902

Evaluation of the water quality of sewage treatment plant effluents (SETREP) and its effects on water quality in the Kinyankonge River in Burundi

[redacted]

ABSTRACT

This study has the objective of determining the Physico-chemical parameters of effluents from under-exploited sewage treatment plants (SETREP)to show the quality of these effluents and to evaluate the effect of these effluents flowing into the Kinyankonge River and also to determine the water quality of this River. The quality of effluent from the sewage treatment plant (SETREP) was assessed to determine the effect that may have appeared on pollution using the Kinyankonge River. Effluents and water samples at some strategic and essential points of the River were collected and analysed to show the pH, total dissolved solids (TDS), suspended solids (SS), nitrates, phosphate, biochemical oxygen demand (BOD_5), dissolved oxygen (DO), faecal coliform (FC), and chemical oxygen demand (COD) primarily expending usual approaches. SS, TDS, phosphate, BOD_5, and COD with average values of 192.61, 600.7, 6.29, 139.16, and 279.61 mg/l, respectively, depending on the values mentioned above, effluent from sewage treatment plants (SETREP) was outside the recommended limits set by the Burundian standard for all effluents that could be discharged into the inland waters of the country's Rivers. However, pH (9.42) and nitrate (1.83 mg/l) concentrations were inside the Burundian standard's suggested bounds. In comparison, concentrations of faecal coliforms (42800counts/100 ml) and DO (2.51mg/l) were not definite in the country standard. The difference in water excellence among upstream and downstream bounds was statistically significant ($p < 0.05$) at the sureness level of 96%. The determination of the Physico-chemical parameters was made by the T-test in the laboratory after taking the samples at the three stations (Figure 1) chosen according to the critical and strategic points. The analysis of the data obtained was done by the SPSS software version 18 for windows. It should be noted that the kruskal-wallis ANOVA test was applied to the laboratory to verify the data found. Note that the results found will be used during the monitoring of these effluents by the decision-makers of the country to avoid this kind of effluents either by adopting related laws or rehabilitate the existing under-exploited sewage treatment plants (SETREP) and still build the other sewage treatment plants (SETREP) to protect the rivers, the surrounding population, the biodiversity of the river and also the Lake Tanganyika which is the final receiver of polluted water while it has remarkable

biodiversity worldwide and also is a source of drinking water supply to the economic capital of Burundi. The outcomes recommend that the effluent from sewage treatment plants pollute the river's water, making it unfit for consumption by the surrounding population and its daily use. It is therefore necessary to discourage the release of poor quality effluent into public rivers. The authorities should enforce waste disposal laws to protect people's lives using water from the Kinyankonge River and severely punish anyone who might violate the laws.
Key words: effect; Burundian standards; Kinyankonge River; pollution; effluent of wastewater

INTRODUCTION

Water pollution occurs in rivers, lakes, or groundwater of constituents dangerous to breathing belongings such as biodiversity and the surrounding population. Pollution of the river or stream water by chemicals mixed in effluent and harmful human activities has developed one of the supreme dangerous ecological disabilities of the century (Hart, 2008, Sala *et al*., 2000; Cox *et al*., 2002; Dudgeon *et al*., 2006). Chemical pollution and anthropogenic activities in river waters or streams can be confidential consistent with its sources' environment, so it is point effluence and unsalted effluence. Point effluence contains effluence from a single concerted foundation that can be recognized as an exit tube from a plant or refinery. Undetermined effluence contains effluence from independent sources that cannot be accurately acknowledged, for example, overflow from agronomic activities, septic tanks, or sewage drainage. Under-exploited sewage treatment plants (SETREP) cause effluents that can pollute the waters of the river, the lake, or the Ocean which is the final receiver of pollutants while they are designed to purify wastewater and also limit the inflow of excess organic matter flowing into the rivers to protect the environment (Vindimian,2006). The composition of wastewater varies from time to time due to different treatment plant activities (SETREP). The primary condition of effluent from treatment plants and that it is answerable for growing the excellence and number of artificial mixtures in receipt water physiques (Jimenez and Rose, 2008). The influence of synthetic compounds on water excellence in water body reception changes natural water characteristics such as organic compounds, temperature, pH, and dissolved oxygen (Marsaleka *et al*., 2008). Poor water quality in rivers or lakes disrupts ecological balance. Poor quality makes water polluted and unsuitable for domestic use in communities in all regions, such as rural and urban environments. In addition, it threatens the human lives of people around the river or lake. The Kinyankonge River in Bujumbura, which has become Burundi's economic capital, has not been released from these water effluence problems. The Kinyankonge River comes from Mutakura and runs through the Buterere region, a designated place for the sewage treatment plant (SETREP) and industries of the city in particular and the country in general. On the other hand, the non-functionality of sewage treatment plants (SETREP) currently causes instant effluents in river or lake waters. In this part of the region, the Kinyankonge River has become the primary beneficiary of sewage treatment plant effluents and household water. Therefore, this research's objective was to primarily measure the quality of effluent from the sewage treatment plant (SETREP) connected to the sewer system and its effect on water quality in the Kinyankonge River.

MATERIALS AND METHODS

The study area description: Burundi is one of the developing countries in East Africa. The nation is separated into five areas; South, North, West, East, and Central. Burundi comprises two capitals, Gitega, the political capital, and Bujumbura is the economic capital of Burundi. Note that Bujumbura is in western Burundi. It has an equatorial climate with an average temperature of twenty to twenty-five degrees Celsius and an average yearly rainfall of 890 mm. Bujumbura's primary industries are the processing of beverages and organic fertilizers. However, due to its creation as capital, the industrial number has been improved. The town is separated into three parts: industry, housing, and tourism (UN-HABITAT, 2019). The Gihanga, Buterere, and Ngagara part is an elected manufacturing position selected for heavy industries, light industries, and sewage treatment plants. The investigation was accomplished in the Buterere region, compactly populated by heavy manufacturing and sewage treatment plants (SETREP), such as the Buterere peeling plant. The Kinyankonge River flows through the area and originates in the Mutakura district. There are noticeable and notable functional signs that can influence water quantity and consistency in the river. The most observable exercise is the release of effluent from sewage treatment plants (SETREP). While existing industries are dislodging from the city's sewer line to the sewage treatment plant (SETREP) built a long time ago, it is not functioning at present. In addition, Savonor and Siphar discharge their effluents into the Kinyankonge River (see Figure 1) at the Tanganyika Lake, rich in Africa and an essential water source for economic capital Burundi. It should be noted that sampling station three (S3) is at the point chosen before the river's discharge point into Tanganyika Lake.

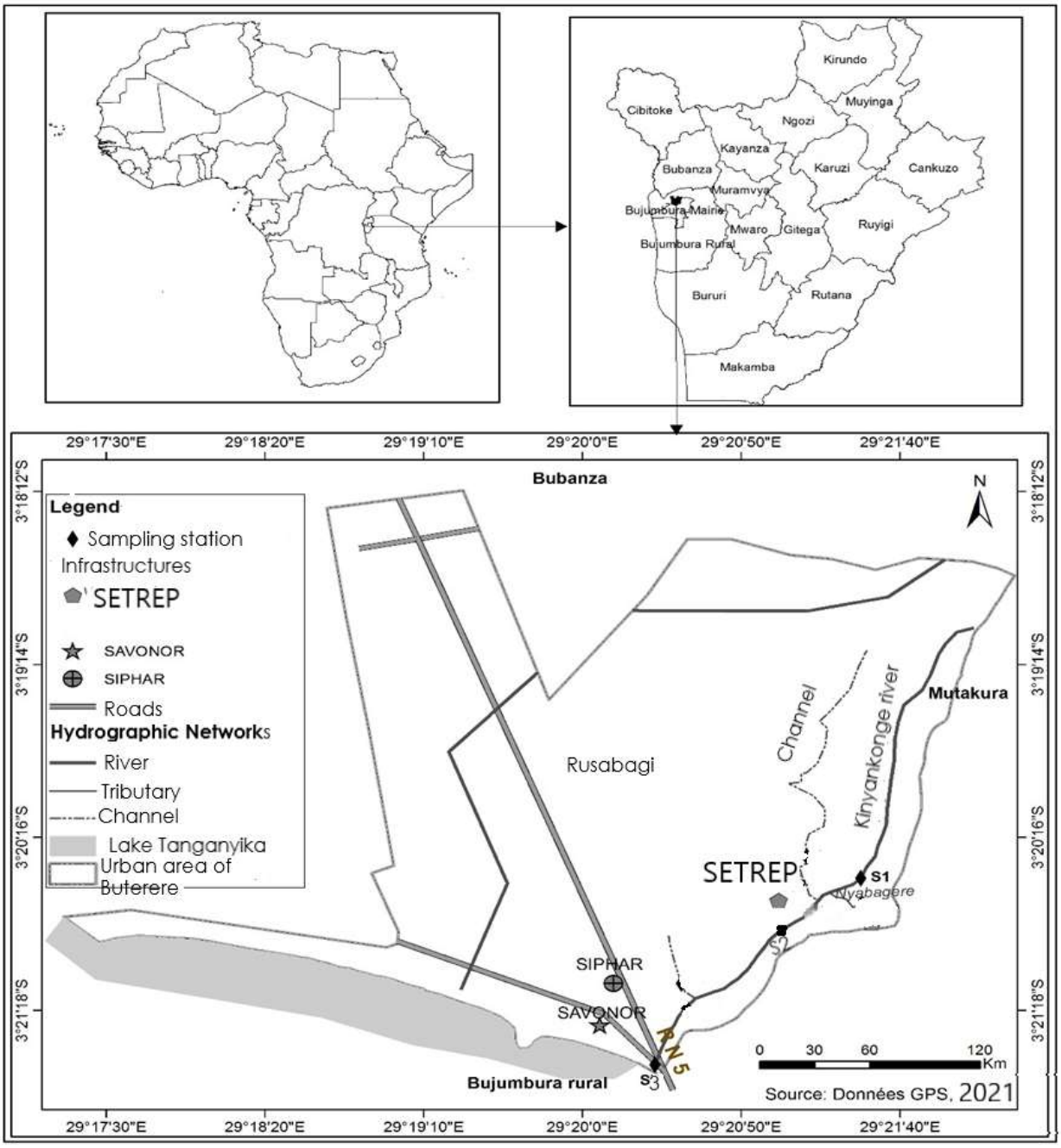

Figure 1: Maps of the study area

Sample collection and analysis: The samples were composed of the Kinyankonge River's water upstream and downstream of the effluent release point and sewage treatment plants' effluents (SETREP). Sampling was done during the dry season period, precisely in July once a week for three whole weeks. The only pollutants overflowing into the Kinyankonge River from the water treatment plant in all connected societies were forsaken into the river by quantities of waste from economic capital Burundi through the sampling performed for this description. Each day of sampling, three samples were composed precisely at each selected sampling point and materialized upstream, downstream, and with sewage treatment plant (SETREP) effluents. Nine samples were collected without going elsewhere (3 upstream, three downstream, and three sewage treatment plant effluents). All samples collected at 3 station points were collected from carefully washed glass flasks and were carefully capped. Each flask was cleaned with a suitable sample before the last collection of the desired sample. Samples were located in a cooler to keep the samples carefully and transported directly to the laboratory for further examination. Samples from this study were thoroughly analysed for SS, pH, TDS, nitrates, phosphate, DO, COD, BOD_5, and FC using exactly the usual approaches of the American Public Health Association's standard series of water and wastewater analysis methods (APHA).,1995). The investigation was completed precisely in triplicate.

Statistical analysis: This investigation, which was executed and composed by computational work, was statistically examined via SPSS tools. The study's 96 per cent sureness test was deliberate by looking at spatial alterations in water excellence with upstream and downstream parameters expending version 18 of the SPSS for Windows to measure wastewater effluent's influence. After a thorough analysis, the data was cleaned and standard using SPSS software to improve its quality and reliability. Note that the kruskal-wallis ANOVA test has been used again to be sure and also to determine the real results which can be used by the government to protect the biodiversity of this river particularly and Lake Tanganyika in general.

DISCUSSION AND RESULTS

Briefly, the results were presented following overall tables. Where appropriate, effluent results were compiled in parallel and following worldwide effluent requirements (GER, 2007) and Burundi's typical acceptance limits for manufacturing effluents released into domestic waters (MBS, 2013). Manufacturing effluents reduced the pH of water from 7.65 (upstream) to 8.09 (downstream) and slightly enlarged the suspended solids (SS) from 29.58mg/l (upstream) to 144.5mg/l (downstream). Action plant effluents have enlarged total dissolved solids (TDS) in river water (430.05mg/l upstream and reduced to 331.96mg/l downstream).Relief of sewage treatment plant effluents with a phosphate level of 4.62mg/l enlarged phosphate levels from 1.36 mg/l upstream to 3.19mg/l downstream. High levels of phosphorus and other nutrients pose a difficulty in eutrophication in rivers, channelling softened oxygen levels in waterways (Osibanjo *et al*.,2011). Imaginable sources of phosphate could contain the usage of phosphoric acid and phosphate salts as manufacturing resources. Furthermore, phosphate's intensive use based on detergents for laundry purposes in families or manufacturing could be an additional probable foundation (Osibanjo *et al* .,2011).

The attention of nitrogen in the sewage treatment effluents studied ranged from 0.67 to 1.88 mg/l, which influenced the river water's nitrate level. The presence of such high concentrations suggests that bottlers use

nitrogen-rich materials. In this case, nitrate would have complete control over the excessive intake of nutrients in the water. Still, harmful algal blooms and nitrogen determination would occur under favourable conditions such as high phosphate levels and alkaline conditions. Algal blooms harm humans by producing toxins or biomass that can imitate fish, thereby regulating the broader communities' diet. The impact of the analysed sewage treatment plant pollutants on dissolved oxygen (DO) satisfied was significant at a confidence level of 96 percent, according to probabilistic analysis of the study t-test using SPSS software. Because the effluent studied had exceptionally high COD values (139.16mg/l) and COD (279.61mg/l), high organic compounds were required. The effluents from the sewage treatment plants studied increased oxygen-demanding oxidative damage in the river water, likely to result in oxygen exhaustion, as exemplified by the low concentrations of DO (see Table 1) below found in the river's downstream section. The water volume in the Kinyankonge River was insufficient to dilute the effluents of the sewage treatment plants studied. Still, it had a significant impact on dissolved oxygen levels. By altering aquatic animals' breathing, low oxygen demand (DO) values can harm their growth.

Table 1 : Parameters verified and levels recorded (Mean ± SD)

Parameters	**Samples sources and location**		
	Kinyankonge river Upstream	**Sewage treatment plant effluents**	**Kinyankonge River Downstream**
pH-Value	7.65 ±0.25	9.42± 0.27	8.09 ± 0.48
S S (mg/l)	29.58± 13.2	192.61 ± 47.0	144.5 ± 58.1
T D S (mg/l)	430.05 ± 83.8	600.7 ± 92.4	331.96 ± 75.6
P O_4^{3-} (mg/l)	1.36 ± 0.33	6.29 ± 2.15	3.19 ± 1.83
N O_3^- (mg/l)	1.16 ± 0.36	1.83 ± 0.91	1.44 ± 0.68
D O (mg/l)	6.28 ± 2.15	2.51 ± 1.23	1.96 ± 0.70
B O D_5 (mg/l)	21.94 ± 11.1	139.16 ± 31.6	78.61 ± 29.1
C O D (mg/l)	42.94 ± 24.2	279.61 ± 63.8	155.5± 54.2
F C (counts/100 ml)	592 ± 132	42800 ± 32559	9687 ± 6524

National effluents with very high faecal coliforms 42,800 counts /100 ml significantly increased faecal coliforms in water from 592 to 9,687 colonies per 100 ml. The Kinyankonge River upstream recorded an increased number of bottom coliforms (592counts /100ml). This water category of this river studied near urban residential areas could contribute to poor health conditions in the surrounding population. There is an informal settlement somewhere before the upstream sampling point of surface water of Kinyankonge River. The true potential of environmental damage caused by solid waste cannot be used to analyse the impact of the effluent studied from the sewage treatment plant (SETREP) because existing pollution is part of the current baseline data of the sampling point found upstream. The other, impromptu installation (kumase) appears exactly after the sampling point appears downstream. Faecal contamination in the river studied would cause diarrhoea problems to the surrounding population and other diseases if the water treatment procedure were not put in place to make the water consumable. For example, the water must be

boiled before drinking it. The Burundian standard established to compare (BS: 538) with that of effluents marked in (Table 2) discloses that the excellence of the effluent studied from the sewage treatment plant (SETREP) is an unacceptable standard nationally or internationally, as most parameters have manifested themselves outside the recommended range. Briefly, this requires that effluent outside the acceptable standard should not be released into public waters or the general environment. The corresponding measures set up the comparison between the existing parameters upstream and downstream (Table 3) shows quite apparent variations. The revelation of these measurements to the statistical investigation of the t-test sample via the SPSS authorizes that the differences are statistically weighty ($p < 0.05$) at a 96% self-confidence level for nearly all parameters, except for SS, pH, and nitrates. This confirms the overview of contaminants into the Kinyankonge River by effluent from sewage treatment plants (SETREP). These sewage plant effluents (SETREP) have suggestively changed the water's excellence through the Kinyankonge River by influencing its physical, chemical, and biological imperative, plummeting the ease with which the populace can use the river, and effectively endangering the lives of river users. What is very dangerous at this moment is that the surrounding water handlers are not even conscious of the various dangers in life to which they are exposed using water of this category existing in the Kinyankonge River.

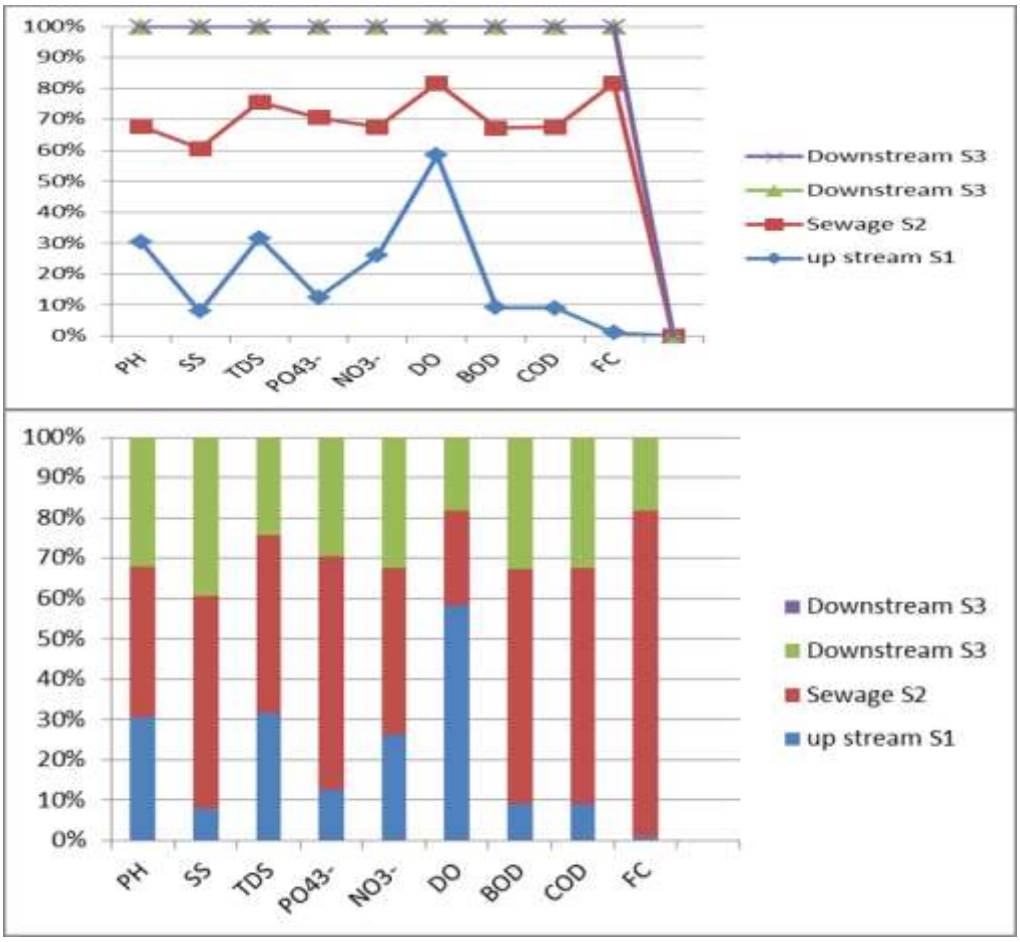

Figure 2: Presentation of results graphically (Mean ± SD) by 2 ways

Table 2: Assessment of local and global principles with the effluent results

Parameter	Sewage treatment effluents	Burundi standard (BS 539:2014)a	IWA(GER)$_b$
pH	9.420	6.5–9.0	6.0-9.0
S S (mg/l)	192.61	330	NS
T D S (mg/l)	600.7	500	NS
P O_4^{3-}(mg/l)	6.29	0.15	NS
N O_3^- (mg/l)	1.83	50	NS
D O (mg/l)	2.51	NS	NS
B O D (mg/l)	139.16	20	30
C O D (mg/l)	279.61	60	NS
F C (counts /100 ml)	42800	NS	NS

Table 3: Spatial dissimilarity in water quality

Parameters	t-test value ($p < 0.05$)	Remarks
S S	0.372	Not Significant
T D S	0.003	Significant
P $O_4$3-	0.000	Significant
N O3−	0.410	Not Significant
D O	0.012	Significant
B O D	0.00	Significant
C O D	0.003	Significant
F C	0.00	Significant

This water for National purposes

Legend:

NS: Not Specified Yet a BS 539: National Effluents – National Acceptance limits for discharged into inlandShallow Waters b IWA (GER): International Water Association – Global Effluent Requirements SETREP: Sewage Treatment Plant, (S.S) =Suspended Solids, (TDS) =Total Dissolved Solids, (COD) =Chemical Oxygen Demand, (BOD) =Biochemical Oxygen Demand, (DO) =Dissolved Oxygen (FC) =Faecal Coliforms, (WRA) =Water Resources Act

In Burundi's national territory, the release of untreated effluent or processed effluent from a treatment plant or industry directly into river waters is prohibited; this decision is close to Malawi's (WRA., 1969). The Water Resources Authority is answerable for nursing agreements with nationwide water rules to certify that municipal water users follow the Water Resources Act (WRA). Furthermore, existing regulations inspire industries to release their effluent into the city's sewer line for transportation to the sewage treatment plants (SETREP). The treatment plant's effluent monitoring committee is in place despite the discharge of untreated effluents into the Kinyankonge River, demonstrating that the treatment plant is currently inoperable. It should be noted that before being discharged into water resources, the municipal assembly treats the effluent collected (LGA, 1982). As a

result, it is unclear whether the Burundi Municipal Assembly of Economic Capital of Burundi (Bujumbura) and other monitoring bodies, like the Water Resources Office, know the current direct releases. According to (Chaonamwene *et al.*,2009), the Bujumbura Municipal Assembly has laboratories that are not well equipped, so only the WRB can monitor the water supply through the Central Water Laboratories, resulting in incomplete monitoring following the law in place; this observation is similar to that of Malawi. Because of a lack of resources, these effluents' monitoring activity of all types is expected to be continuous and regular (monthly). However, it is done on an ad hoc basis (Chaonamwene *et al.*,2009). The government's failure to enforce effluent disposal regulations effectively has a significant negative impact on the Kinyankonge River's water quality, which has implications for downstream livelihoods.

CONCLUSION AND RECOMMENDATION

The quality of effluent water from sewage treatment plants (SETREP) and Kinyankonge River water was evaluated, and it was exposed that the effluent discharged by SETREP into the Kinyankonge River is of improper class both nationwide and globally, since most of the parameters verified are below the limits suggested by Burundian and worldwide standards. TDS, PO_4^{3-}, DO, BOD, COD, and CF amounts ranged slightly ($p<0.05$) between upstream and downstream water at a confidence level of 96 percent, indicating that sewage treatment plant effluents cause gross waste. It is therefore proposed that the Municipal Assembly of Burundi's Economic Capital (Bujumbura) and the Office of Water Resources be more proactive and aggressive in regulating and applying stringent effluent discharge regulations to ensure minimum contamination in Burundian rivers while also protecting the human lives of those who use the Kinyankonge River's waters and also protect the biodiversity of the Kinyankonge river particularly and the Lake Tanganyika which is the final receptor of pollution come from to the kinyankonge river. Note that the innovation has been made for the couple which has been used, for geting the real results and then show the actual situation of this river.

- We recommend that the country's authorities build the sewage treatment plants and connect all wastewater to carry this water as well as rehabilitate existing sewage treatment plants (SETREP) to reduce the remarkable effluent in today's day.
- Put in place the right technique to reuse the wastewater routed as fertilizer to fertilize the fields as in other countries
- Put in place laws and regulations to combat this kind of effluent as well as the monitoring mechanism
- Because of these effluents exceeding national and international limits that is unfavorable to the aquatic animals of this river, we recommend to the decision-makers to protect this river to make clean these waters to be favourable to the biodiversity of this river as well as those of Lake Tanganyika even without forgetting the surrounding population using these waters daily.

CONFLICT OF INTERESTS

The authors of this article state that there is no conflict of interest for this publication**.**

ACKNOWLEDGE

The authors thank and will remember always the contribution of the members of the National laboratory of hydraulics Research.

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