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Assessment of Efficiency of Water Quality Management along Mzinga River

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Authors' contributions

This work was carried out in collaboration between all authors. Authors DBM and GFM designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors GFM and MLM managed the analyses of the study. Authors DBM and MLM managed the literature searches. All authors read and approved the final manuscript.

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Short Research Article

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ABSTRACT

Water is considered as fundamental to development due to its contribution to economic growth and human welfare. If there is no good management of human activities such as agriculture, domestic, car washing, industrial wastes, water sources might be polluted. This study has been designed to assess the efficiency of water quality management along Mzinga river. Specifically, the study assessed (i) the current status of water quality from Mzinga river base on physical, chemical and biological parameters, (ii) the compliance of communities with water resources management needs and (iii) the implementation of the aspects of Tanzania National water policy for water quality management. Laboratory Analysis of water samples, Questionnaires, Structured Interview Guide as well as Physical observation were used to collect Primary data. Secondary data were collected

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from the National Bureau of Statistics (NBS) and different reports on the website. Data were analyzed using both quantitative and qualitative methods. The measured results showed that Mzinga River pollution has increased based on physical, chemical and biological parameters compared to the measured status of the year 2014 and vary from one station to another according to activities carried on that area. Example pH at Mbangukwalu was (5.90), Darajani (5.85) and Msikitini (5.80) which is too acidic compared to that recommended by Tanzania Bureau of Standard(TBS) 6.5-8.5 but that of Videte station was 6.40 which is within the range. These values differ from that measured 2014 which ranges from 6.09-7.05 and are within the TBS standard, the reason for these variations was due to different activities practiced carried in these areas. Moreover, the overall measured status of heavy metal at the river is lower than that of the year 2010 as result of Karibu Textile Mills industry being closed. The result shows that, even though there is an existence of water quality framework, water quality at Mzinga River has deteriorated. Furthermore, the study shows that the compliance of communities with water resources management needs is weak. This study recommended that there should be shifting of people's settlements and human activities such as Farming activities and Car washing along the river in order to comply with water resources management Act.

Keywords: Assessment, efficiency; water quality; resources management; Nzinga river; communities compliance; Tanzania National Water Policy.

1. INTRODUCTION

1.1 Introduction to Water Quality Management

Large parts of the developing countries suffer serious water deficits due to the issue of water quality management [1,2]. Water sources pollution which caused by disposal of solid waste, discharge of untreated or inadequately treated wastewater, lack of standard sanitary facilities and poor hygienic practices [3]. Degraded water quality cannot be used for any activities such industrial and course a net loss of water resources [4] and cause serious diseases like cholera, which leads to the lost human who are the manpower of the nation [5]. In Tanzania quality of water sources degraded by different human activities carried along the river, example water quality in Mzinga river, Msimbazi river, Mpiji river and Kizinga [6]. The important tool used to control pollution of water sources is Water quality management [4]. Elements of management may include control of pollution, use an abstraction of water, and land use. Management activities are determined by natural water quantity and quality, the uses of water in natural and socio-economic systems and prospects for the future. The objective of water quality management is to control the discharge of pollutants so that water quality is not degraded to an unaccepted level [7]. In water quality management the pollutants are measured, prediction of the impact of pollutants, determination of the background water quality which would be present without human intervention, and decide the levels accepted for intended use of water are done [8]. Management implies policy development, planning, allocation of scarce resources, implementation of policy and the operation of communities, agencies and utilities [9]. Water quality management differs from one country to another according to the framework of the country. This study has been designed to assess the efficiency of water quality management along Mzinga river, Tanzania

1.2 Water quality management strategy in Tanzania

In Tanzania, water quality management is under the ministry responsible for water which has existed for many years .the ministry enacted the first laws to manage water quality in 1973 [10]. The legal and institutional frameworks for management of water quality in water resources in Tanzania have been restructured by recent initiative like the National Water Policy (2002) [11,12]. Tanzania's National Strategy for Growth and Reduction of Poverty (MKUKUTA) is an institutional framework which is a very important driver for improving water quality management as a reduction of poverty and improved quality. At the national level, the Environmental Management Act is the key legal initiative for improving the management of water resources [13]. Also, there are numbers of legal frameworks at the national, regional and international level for water quality management. At the National level, the Environmental Management Act (EMA-2004) and the Water Resources Management Act (WRMA-2009) are the key legal initiatives for improving water quality management. They charge maximum fines of Tsh 50 million [14]. Water resources Management act of 2009 part II describes that every person residing in Mainland Tanzania shall have a stake and a duty to safeguard and protect water resources and to inform the relevant authority of any activity and phenomenon that may affect the quantity and quality of the water resources significantly [15]. The water quality management has been described by the Tanzania National Water policy which is "safe clean water for all people" [16]. This policy has been governed by several aspects which are systematic water quality monitoring and assessment procedures to establish the status of water resource quality that is to detect problems at an early stage and to permit their time management and remediation, conjunctive and comprehensive management of quality and quantity of water resources. Application of the "polluter pays" principle along with other legal and administrative tools, development and enforcement of standards for in-stream flows, industrial effluents and other waste discharge to meet environmental objectives, practical and cost-effective water quality and pollution control. The general objective of this policy is to maintain or improve the quality of Tanzania's water resources and the specific objectives are to increase community access to clean, safe water [14].

1.3 Tanzania National Water Policy

Water quality management in Tanzania is described by National water policy [17]. The policy is "safe clean water for all people" [16]. This policy stipulates that a water quality management and pollution control is needed to protect the beneficial uses of the nation's surface and ground waters from pollution and degradation. This policy has been governed by several aspects for its successful implementation which are: Systematic water quality monitoring and assessment procedures to establish the status of water resource quality that is to detect problems at an early stage and to permit their timely management and remediation, Conjunctive and comprehensive management of quality and quantity of water resources, Application of the "polluter pays" principle along with other legal and administrative tools ,Development and enforcement of standards for in-stream flows, industrial effluents and other waste discharge to meet environment objectives, Practical and cost effective water quality and pollution control monitoring programs (including networks) and Raising public awareness of the importance of protecting water resources from pollution and degradation.The general objective of this policy is to maintain or improve the quality of Tanzania's water resources and the specific objectives are to increase community access to clean and safe water (Hawkins). The nine basins water boards in Tanzania under Ministry of Water and Irrigation are responsible for the implementation of National water Policy [16].

1.4 Basins Water Boards and Their Offices

Basin Water Boards (BWB) is executive bodies with mandates to execute and promote integrated water resources planning and use [10]. Thus, in order to manage the quality of water, basin water boards have to regulate the way human systems operate in generating, abating and disposing of waste products through pollution control, prevention of sediments build-up and the degradation of wetlands and the imposition and collection of fees and charges [18]. This is in connection with WRMA-2009 and EMA-2004 regulations which are supporting the National Water Policy. Tanzania has nine administrative units corresponding to the nine major river or lake basins which are; Pangani River Basin Water Board, Wami Ruvu Basin Water Board, Rufiji River Basin Water Board, Ruvuma and Southern coast Basin Water Board, Lake Nyasa Basin Water Board, Internal Drainage Basin Water Board, Lake Rukwa Basin Water Board, Lake Tanganyika Basin Water Board,Lake Victoria Basin Water Board

1.5 Wami/Ruvu Basin Water Board

Wami /Ruvu Basin Water Board was established in July 2002 under Water Act No. 42 of 1974 of water Utilization (Control and Regulations) with its amendments No. 10 of 1981. But the former Act has been repealed with recently Water Resources Management Act No. 11 of 2009 [15]. The Wami/ Ruvu Basin is located in the eastern part of Tanzania and has a catchment area of 66,294 km^2. The basin has two major rivers of Wami and Ruvu with an approximate area of 43,742 km^2 and 17,789 km^2 respectively and it has coastal rivers located to the Eastern part of the basin flowing into the Indian Ocean, most of which are located in Dar es Salaam region. Those which are located in Dar es Salaam are Msimbazi river, Kizinga River, Mpiji River and Mzinga River.

1.6 Compliance of Communities with Water Resources Management in Tanzania

Water Resources Management Act No.11 (2009), Part II section 7 describes that every person residing in Mainland Tanzania shall have a stake and duty to comply with water resources management needs. Thus, they should protect the water resources by not polluting them and to inform the relevant authority of any activity and phenomenon that may affect the quantity and quality of water resources significantly.

2. MATERIALS AND METHODOLOGY

2.1 Study Area

2.1.1 Location

Mzinga River is located in southern part of Dar es Salaam crossing Charambe ward, in the southern part is nearby Mbagala Rangi Tatu, the eastern part of Mbagala kuu and western part of Tandika. Mzinga river falls under Wami/Ruvu river basin, and approximately 18 km stretch of this river flows from west to east in the center of the city and serves as a source of water for agricultural and domestic activities. It is from Mbande forest and consists of sand sediments. The rivers flow to the north-east direction to the Indian Ocean. The climate of Mzinga sub-catchment has tropical characteristics of moist savannahs, with a dry season of 3-5 months. Usually, there are two rainy seasons (March-May) with monthly average rainfall of 150-300 mm, and the short rainy season (October-December), with monthly average rainfall ranging from 75-100 mm. Generally, it has a humid climate with average monthly temperatures that vary from 26°C in August to 35°C in December and January. The average monthly temperature ranges from a maximum of 31.5°C-32.1°C to a minimum of 18.1°C-18.6°C. Relative humidity reaches 100% on almost every night of the year and rarely drops below 55% during the day [19].

2.1.2 Current land use

Mzinga river is characterized by variety land uses. The main land use in the area is the human settlement with a great majority of the population living in unplanned and informal settlements. Other land uses include Agriculture

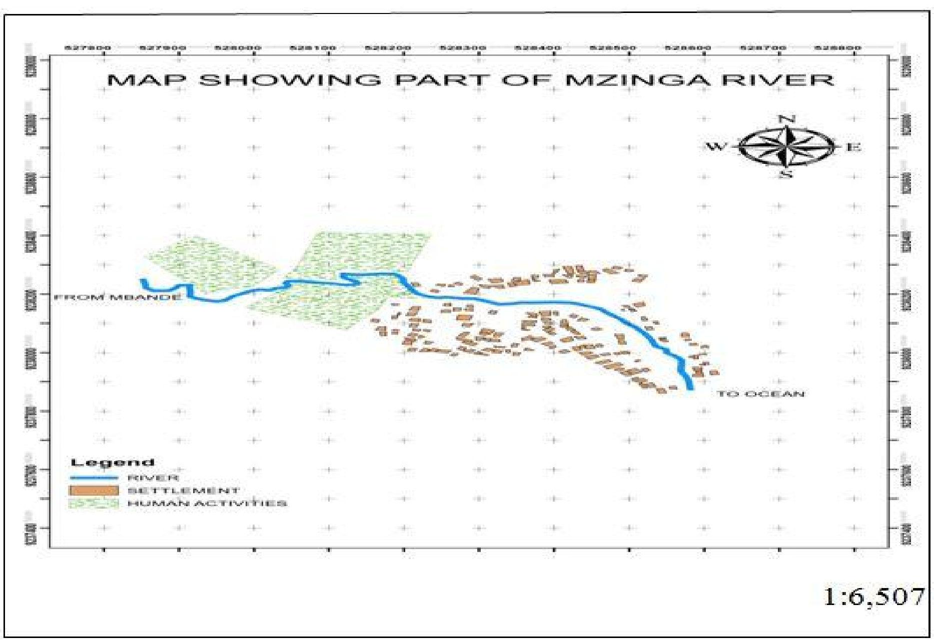

Fig. 1. The map of the study area

activities for green vegetables such as amaranths, Chinese, cabbage, pumpkins and potatoes' leaves. Also, paddy (rice), leguminous crops, watermelon and maize are practiced within and along the river basin. The stream is a major supply of water for irrigation, particularly during the dry season. Other activities include livestock keeping, car wash, sand mining, recreational and small business.

Plate 1. Human settlement and agriculture activities along Mzinga river

Plate 2. Recreational activities along the Mzinga river

2.2 Sampling Methods and Procedures

2.2.1 Procedures

2.2.1.1 Positioning of sampling points

Five sampling points in the mainstream of Mzinga river were selected for water quality analysis. One point named (Point 1) was located in the upstream of the river, two points (Points 2 and 3) were located in the middle stream of the river and the rest points were in the downstream of the Mzinga river (Fig. 2). Points were selected basing activities carried in that area, most critical and dominant sections with agricultural activities, car washing, swimming and washing activities.

2.2.2 Water samples collection

Water samples were collected in the clean plastics bottles then placed in a cool box in order to maintain their quality. Samples were collected according to activities practiced along the river, example sample at point 2 and 3 were collected at a place where mining and agricultural activities were practiced, sample at point 1 was taken where human settlement is was high and sample at point 4-5 were taken at downstream where car washing, agriculture, livestock high settlement and solid waste disposal activities were practiced. Two Samples were taken at each point immediately before entering to the point and after leaving the point for a period of one month.

2.3 Laboratory Analysis

After sampling the samples were collected and taken to the Ardhi University laboratory for analysis. A spectrophotometer was used to measure turbidity, ammonia, phosphorus, color and chemical oxygen demand, pH and conductivity were measured by using Electronic pH meter and Deluxe conductivity meter respectively. Dissolved oxygen was measured using oxygen electrodes. Plate count agar was used to determine the values of total coliform thereafter Potassium. Lead, cadmium and chromium were measured using Atomic Absorption Spectrophotometer (AAS) also Salinity and temperature were measured by using Electrode meter. Lastly, BOD was analyzed by incubating sample for 5 days at 20°C and initial and final dissolved oxygen measured.

2.4 Questionnaire Method

Data on the current status of compliance of communities with water resources management needs along the river and on the implementation of the aspects of the Tanzania National Water Policy for water quality management were collected using questionnaires in the household. The household's samples were selected by probability sampling using systematic random sampling method whereby after every five households, the sample was selected. The households were picked in relation to where water samples were collected. The sample size of the study was based on the total number of households which is 342,221 households and was calculated using the following formula (Equation 1). The equation 1 is from [20].

$$n = \frac{N}{1 + N(\alpha)^2} \quad (1)$$

Where n = sample size, N = total number of households, α = margin of error set at 7%.
By using the above Equation, the sample size calculated was:

$$\text{Sample Size (n)} = \frac{342,221}{1 + 342,221\,(0.07)^2}$$
$$\approx 200 \text{ Households}$$

The study sample size is approximately to 200 Households.

2.4.1 Interview guide

Data on the implementation of aspects of the Tanzania National Water Policy for water quality management were collected using Structured Interview Guide Method. The structured questions addressed to staff of Ministry of Water (Wami/Ruvu Basin Water Board) who deal with the implementation of relevant aspects of the Tanzania National Water Policy [17] were interviewed and the information, opinions or beliefs were collected and recorded.

2.5 Data Analysis

Data analyses carried out by using both qualitative and quantitative method.

2.5.1 Qualitative analysis

The qualitative analysis included the compliance of communities with water resources management needs and the implementation of the aspects of Tanzania National Water Policy.

2.5.2 Quantitative analysis

The quantitative analysis involved the data from laboratory analysis of sampled water for the current status based on physical, chemical and biological parameters of water quality of Mzinga River. Thereafter, the findings were compared with the WHO and TBS standards for confirmation and also compared with previous findings.

3. RESULTS

3.1 Current Status of Water Quality of Mzinga River

According to laboratory analysis, the status of water quality at Mzinga river obtained and results shown as following:

3.1.1 Conductivity

The conductivity of water along Mzinga River was measured in Laboratory. The findings are presented in Fig. 3.

Fig. 3: The study shows the results of Conductivity of water at Mzinga River ranges from 450 µS/cm to 540 µS/cm. The lowest value of 450 µS/cm was measured at the sampling point 2, middle stream (Mbangukwalu), whereas the highest Conductivity of 540 µS/cm was measured at Msikitini (Downstream). The highest Conductivity at Downstream was because wastes from various sources were mixed. These values of Conductivity were above the permissible limits of TBS which is 3 µS/cm.

3.1.2 Potentiality of hydrogen (pH)

The pH was measured along Mzinga River and the findings are shown in Fig. 4.

Fig. 4, shows different values of pH that ranges from 5.80 to 6.86. Low pH value was measured at Msikitini (Downstream) and the highest value was measured at Kiforongo (Upstream). The highest pH of water indicates the acidic nature of water even although it is within the range of TBS. The lowest pH indicates that water of the river is too acidic as it is under the range. This means that all pH values along the river area were acidic in nature. The pH of the study area was too acidic because of the activities conducted in those areas such as Agricultural activities and car washing. These pH values were too acidic compared to the pH values of the year 2014 which were done by (Saria, 2014). This shows the activities that caused pollution has been increased.

3.1.3 Temperature

In the study, area temperature was analyzed along the sub river and the findings are presented in Table 1.

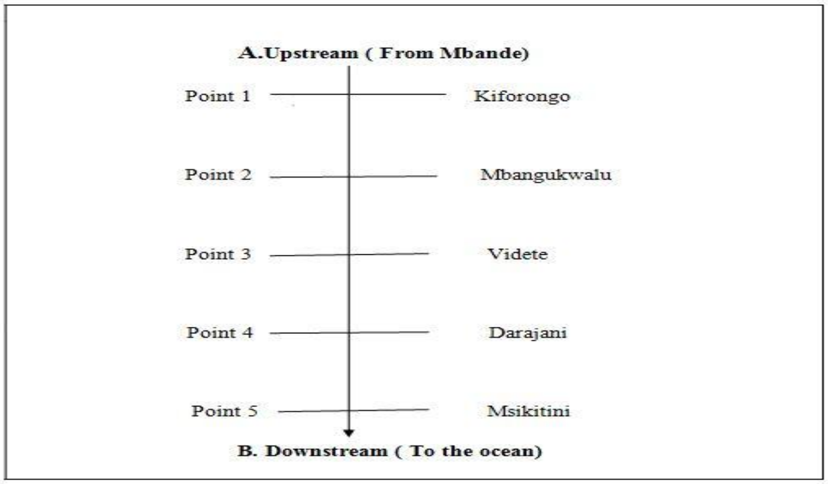

Fig. 2. The outline of Mzinga river main sampling points

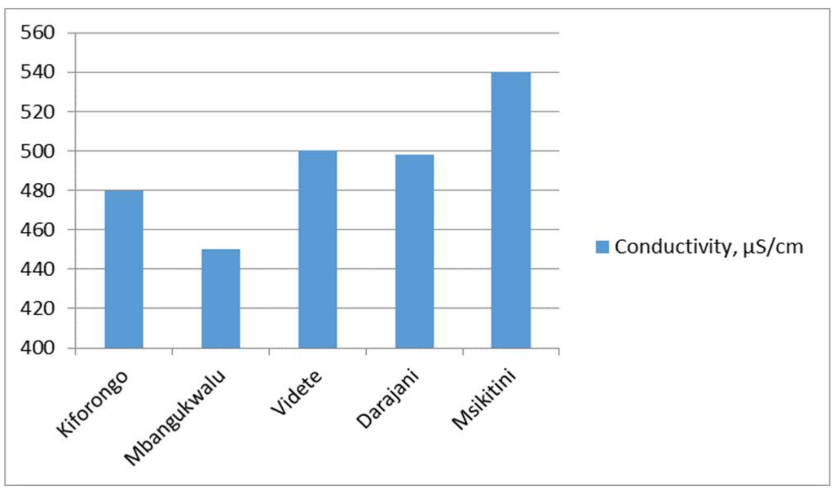

Fig. 3. Mzinga river's water conductivity

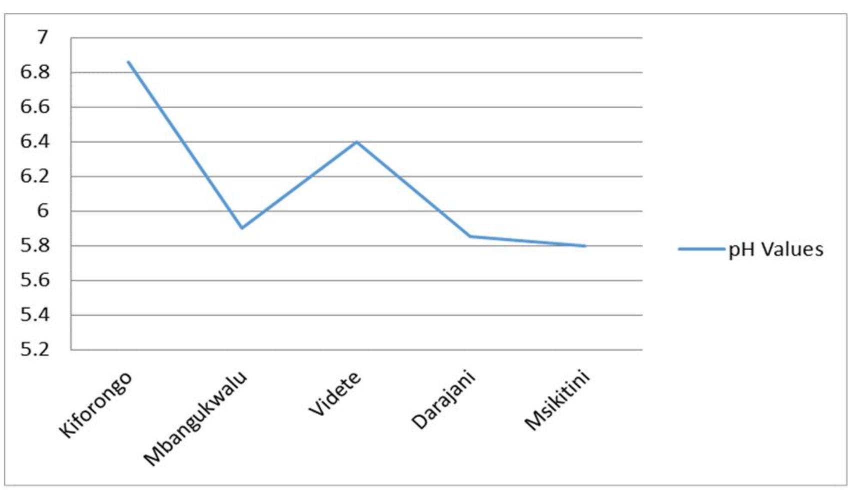

Fig. 4. pH values of water sample from Mzinga river.

Table 1. Temperature of Mzinga river

Sampling points	Temperature (ºC)
Kiforongo	24.4
Mbangukwalu	25.7
Videte	25.9
Darajani	26
Msikitini	25.4

Table 1 shows the level of temperature at the study area was low at upstream with 24.4ºC comparing to the temperature recorded in other sampling points such as Mbangukwalu with 25.7ºC, Videte which had 25.9ºC, Darajani with 26ºC and Msikitini with 25.4ºC. The increase in temperature was due to the car washing activities carried in this area, where its wastewater discharge to the river without any treatment.

3.1.4 Turbidity

The study examined the turbidity of the water in the area of study. The research findings are presented in Fig. 5.

Fig. 5 shows that turbidity of water along the sub-catchment fluctuates from 56 NTU to 310 NTU sampling points such as Kiforongo had 56 NTU, Videte had 220 NTU, Darajani had 107 NTU and Msikitini had 121 NTU. The highest values of 310 NTU were recorded at Mbangukwalu and it was attributed to farms activities carried surrounding this area and the presence of larger slaughterhouse which discharges wastes into Mzinga River. The turbidity levels from other points were within standards while the turbidity levels at Mbangukwalu (310NTU) exceeded the TBS, which recommends 300 NTU.

3.1.5 Dissolved oxygen (DO)

In the study area DO was measured and the finding are as presented in Fig. 6.

Fig. 6. shows the DO findings for various sampling points along Mzinga River. The DO for the study area ranges from 0.00 Mg/l to 7.8 Mg/l. The sample upstream (Kiforongo) shown to have the highest value of DO 7.8 Mg/l. The DO values upstream had the highest DO comparing to other sampling points. Sampling points such as Mbangukwalu and Msikitini had the lowest DO of 0.00Mg/l compared to sampling points of Videte recorded the DO of 0.46Mg/l while Darajani recorded the DO of 1.21.mg/l. There is a variation of DO in the sampling points.

3.1.6 Biochemical oxygen demand (BOD)

The study analyzed Biochemical Oxygen Demand (BOD) from the water samples taken along the Mzinga River and findings are presented in Fig. 7.

The study findings presented in Fig. 7 shows BOD values of the study area ranges from 37 mg/l to 128 mg/l. The lowest BOD of 37 mg/l was recorded at the point upstream, followed by Mbangukwalu which recorded BOD of 48 mg/l. Videte recorded the BOD of 90 mg/l and Msikitini had 97 mg/l. Darajani BOD was

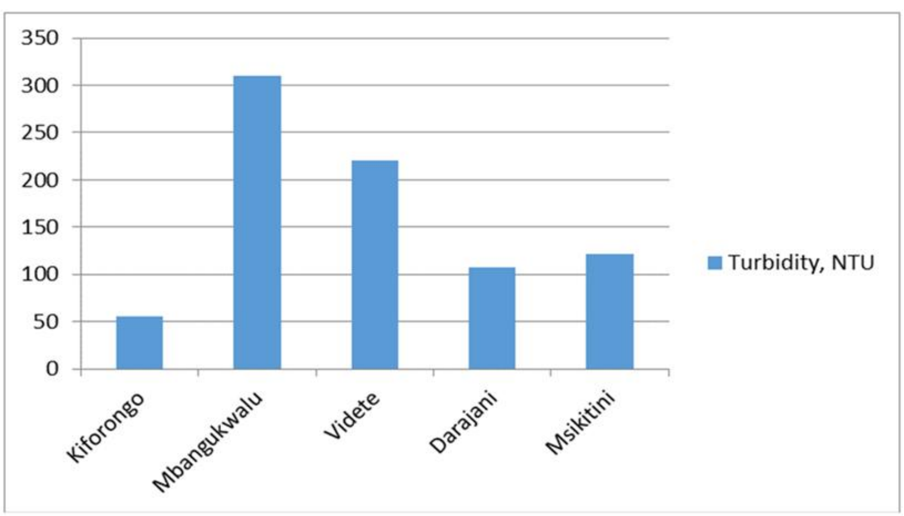

Fig. 5. Turbidity of water sample at Mzinga river

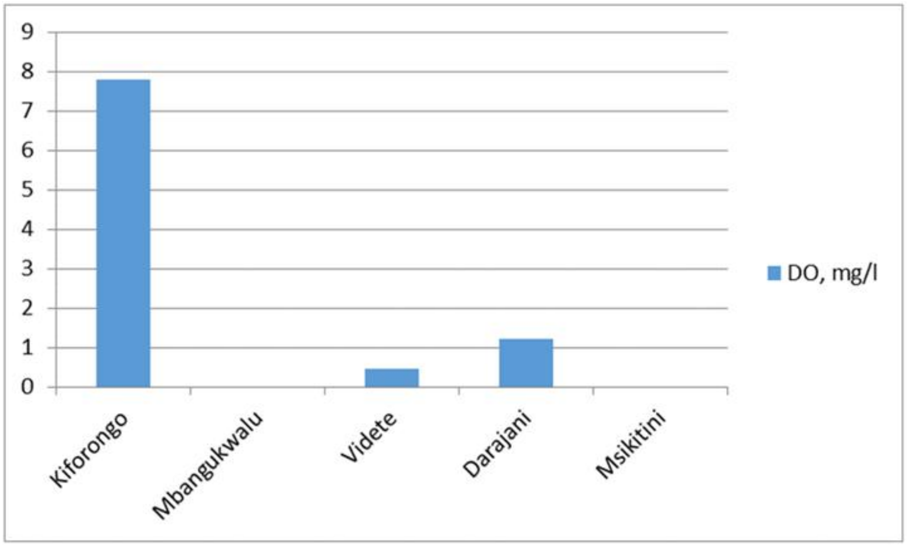

Fig. 6. Measured dissolved oxygen for water at Mzinga river

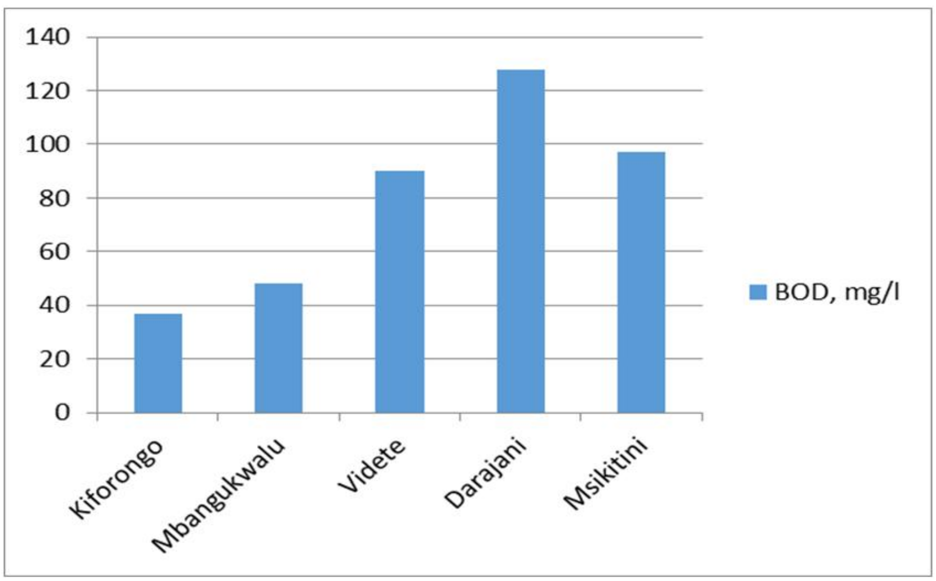

Fig. 7. Measured biochemical oxygen demand (BOD) for water at Mzinga river

128 mg/l and it was the highest. The highest BOD at Darajani was linked to the car washing activities and domestic activities that discharge wastes into the river. Both sampling points were exceeding that of TBS which is 30 mg/l.

3.1.7 Chemical oxygen demand (COD)

The study analyzed the COD of water sampled along Mzinga River. The results are presented in Fig. 8.

Fig. 8. presents the COD from the various sampling points. The COD values range from 40.08 mg/l to 320 mg/l. The lowest COD was recorded at upstream with COD of 40.08 mg/l whereas the highest COD was recorded at Darajani with the COD of 320 mg/l. The highest value of COD (320 mg/l) at Darajani was linked to the discharge of raw wastes from the Car washing and domestic practices. All the sampling points with exceptional of upstream point (Kiforongo) had exceeded the TBS recommended limit which is 60 mg/l.

3.1.8 Salinity

The study analyzed the salinity of the river water. The level of salinity found in Mzinga River water varies from 0.01 to 0.1. The findings are presented in Fig. 9.

Fig. 9. shows the values of salinity along Mzinga River. These values exceeded the limit of TBS which is 0.00Mg/l for river water. These values linked to the human activities such as agricultural activities with the use of fertilizers and also discharge of sewage from domestic homes.

3.1.9 Ammonia (NH_3)

The results indicate that the concentration of Ammonia ranges from 4.21 mg/l to 7.18 mg/l (Fig. 10). These concentrations were above the Tanzania Standards (2 mg/l). The higher levels of Ammonia in Mzinga river was due to the application of fertilizers (CAN, NPK, UREA) in growing green vegetables by peasant within the river course and the discharge of sewage from domestic homes. The Ammonia findings from the study were higher than that of 2014, which ranges from 4.50 Mg/l to 6.50 Mg/l.

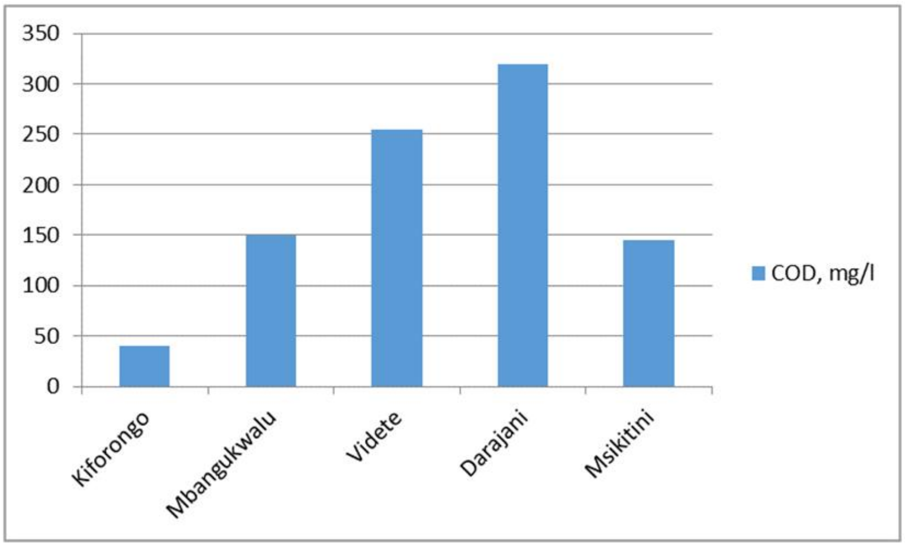

Fig. 8. measured Chemical Oxygen Demand (COD)for water from Mzinga river

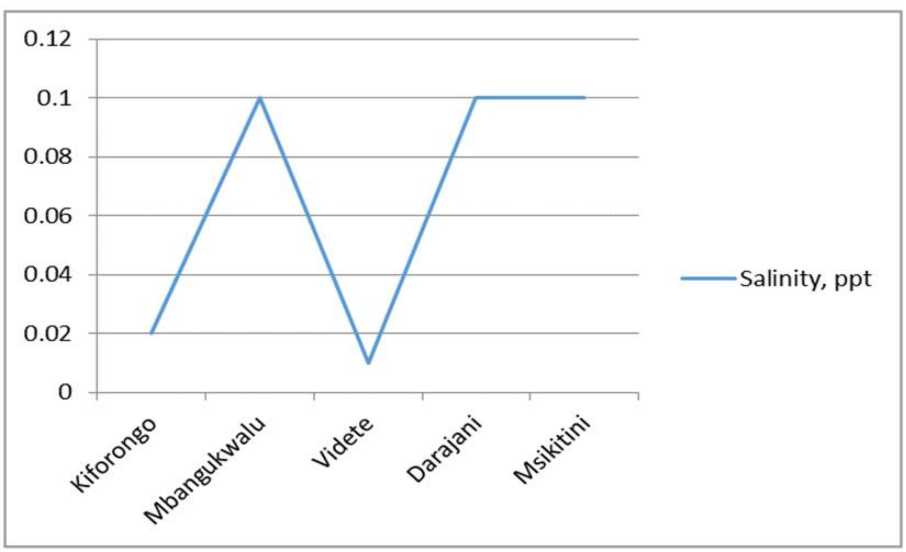

Fig. 9. Measured salinity of water from Mzinga river

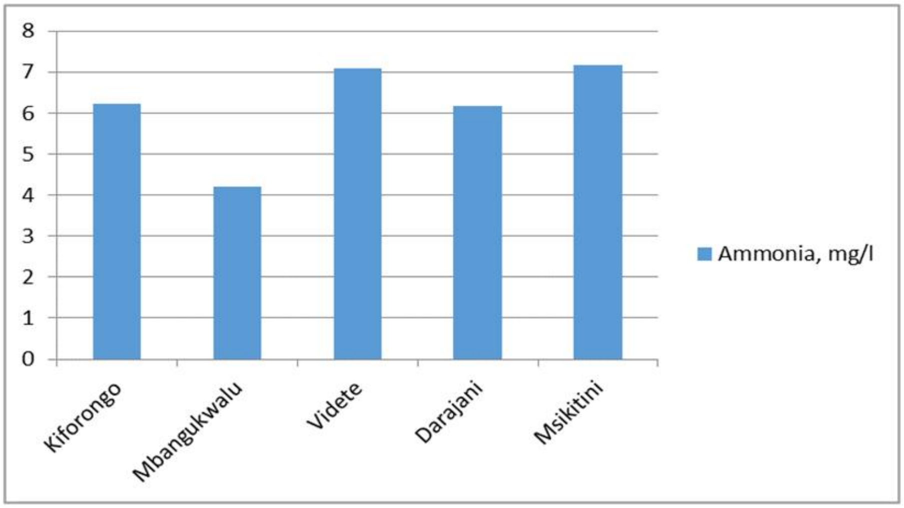

Fig. 10. Measured concentration of ammonia of water sample from Mzinga river

3.1.10 Fecal coliform

The results show that fecal coliform ranges from 5 to 150 counts/ 100ml (Fig. 11) which are above the TBS limits (5 to 50 counts/100 ml). This indicates that Mzinga River is highly contaminated by fecal matter this is due to discharging of wastewater from sanitary without treatment. Also, the study results were higher compared with the previous research of which were 2.78 to 120.36 counts/100 ml [21].

3.1.11 Phosphorus

In Fig. 12 show that Concentration of Phosphorus of Mzinga River was found to range 4.35 mg/l to 8.85 mg/l. The concentrations of Kiforongo and Videte were within TBS permissible limits while the remaining sampling points were exceeding the limit (6 mg/l). The elevated concentrations of phosphorus in middle and downstream of the river was due to the fertilizers (Organic manure and Synthetic fertilizers (NPK)) used by peasants in growing crops within and along the river course.

3.1.12 Color

Fig. 13. shows the results of Color of water along Mzinga River which ranges from 386 mgPt/l to 470 mgPt/l. These values were above the permissible limit of TBS which was 300 mgPt/l.

3.1.13 Potassium

Fig. 14 shows that the examined concentration of potassium in water along Mzinga River ranges from 3.963 mg/l to 4.85 mg/l .These concentrations are above the TBS limit which is 2 mg/l. These higher levels of Potassium (K) along Mzinga River were due to the application of fertilizers (NPK) in growing crops by peasants within the river course which consists of large amount of Potassium.

3.1.14 Total coliform

Fig. 15: shows that Total coliform ranges from 18 to 500 counts/100ml. This level is above the TBS limit which is 5 to 50 counts/100 ml. Also, these results were higher compared to the previous research done by Saria which was 14.17 to 486 counts/100 ml.

3.1.15 Heavy metals

The study also analyzed the heavy metals as part of the pollutants being discharged by along Mzinga River. Pb, Cd and Cr were selected as heavy metals for the study. The concentration of measured metallic effluents that were analyzed is shown in Table 2.

3.2 Compliance of Communities with Water Resources Management Needs

The study examined the compliance of communities with water resources management. Needs along Mzinga River. Different aspects of observed river water quality changes and its causes/sources were assessed qualitatively.

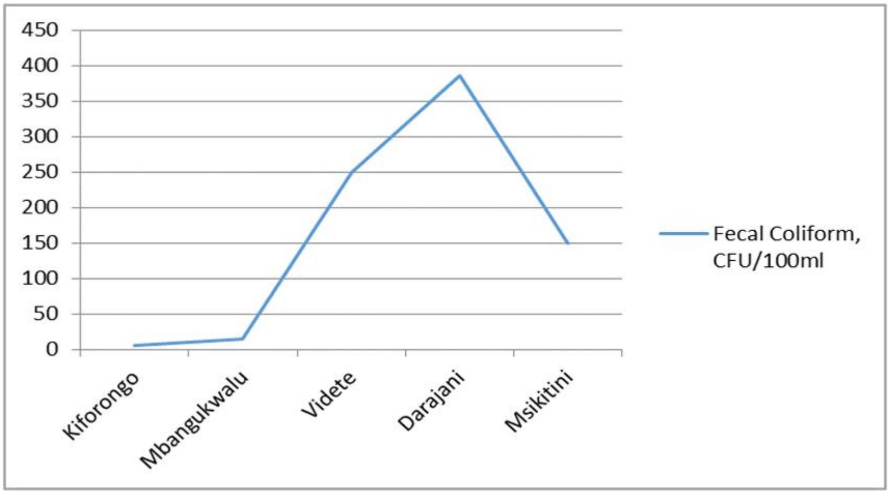

Fig. 11. Measured fecal coliform of water sample from Mzinga river

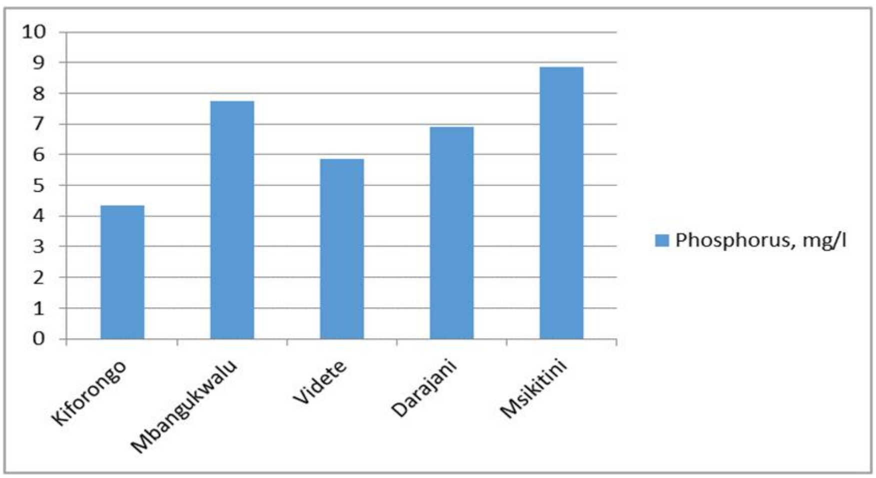

Fig. 12. Measured phosphorus concentration of water sample from Mzinga river

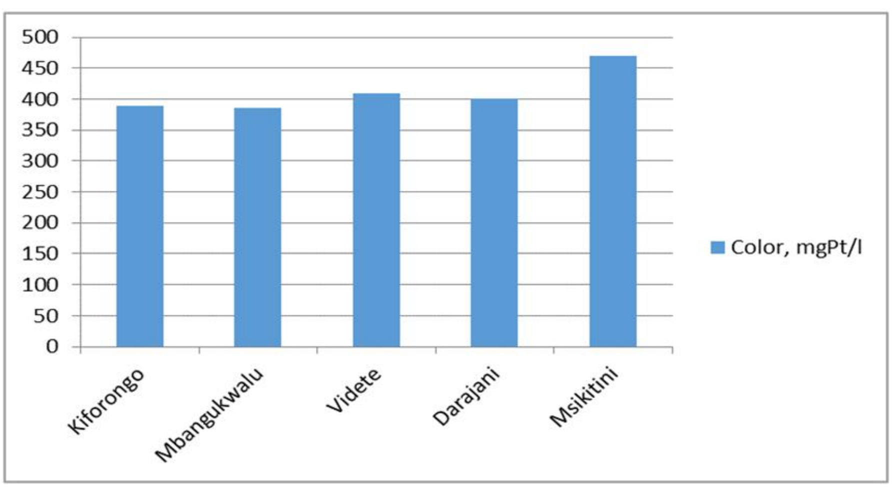

Fig. 13. Measured color of sample of water from Mzinga River

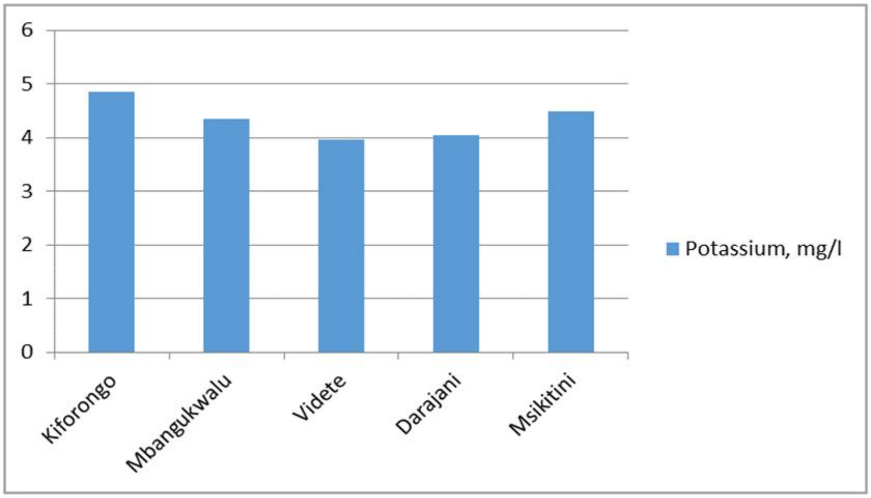

Fig. 14. Measured concentration of potassium of water sampled at Mzinga river

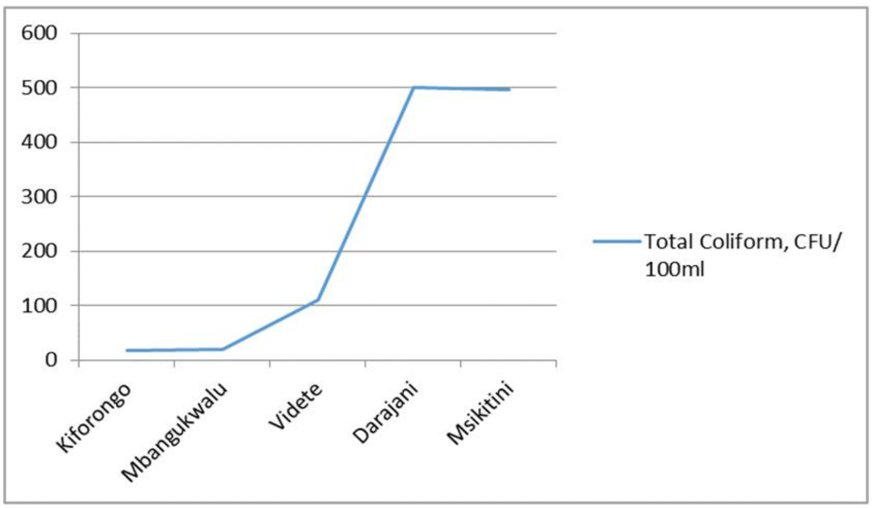

Fig. 15. Measured total coliform of water from Mzinga river

Table 2. Heavy metals concentration along Mzinga river

Sampling points	Pb (mg/l)	Cd (mg/l)	Cr (mg/l)
Kiforongo	0.01	0.01	0.09
Mbangukwalu	0.106	0.04	0.156
Videte	0.126	0.09	0.165
Darajani	0.06	0.02	0.193
Msikitini	0.11	0.014	0.156

3.2.1 Discharge of domestic wastes and sewages into Mzinga river

Table 3 shows the results of 200 respondents on the waste and sewage disposal at Mzinga River.

Table 3 is a cross-tabulation of the discharge of domestic wastes and sewage into Mzinga River. 150 respondents out of 200 respondents (75%) they discharge wastes and sewage into river direct without treatment. The respondents explained the reasons for disposal sewerage to river are: lack of standard sanitary, Lack of designated places for waste disposals and inadequate waste waters infrastructures.

3.2.2 Farming activities within/along Mzinga river

Respondents were asked if they had been practiced any farming activities within/along Mzinga river and for how long they had been practiced it. The findings are presented in Table 4.

Table 3. Discharge of domestic wastes and sewage

Discharge of domestic wastes and sewage		
Yes	**No**	**Total**
150	50	200

Table 4. Farming activities within/along the river

Farming activities within/along river		
Yes	**No**	**Total**
130	70	200

From Table 4, the study findings show that 130 respondents reported that they practice farming activities within and along the river while 70 respondents reported that they do not practice farming activities within and along the river. In this activities, 52% respondents were using synthetic fertilizers (CAN, NPK, UREA) and pesticides (Mancozeb, Acephate, Permethrin) in growing their crops (Green vegetables), followed by 36% of people who were using organic manures.

3.2.3 Cars washing activities practices along the Mzinga river

Fig. 16 study shows that 99 percent of the respondent's practices car washing activities along the river and they are not aware as it has the effect to pollution of river water.

3.2.4 People awareness on pollution of Mzinga river's

The findings revealed that large percent (60%) of people were not aware of river pollution problem (Fig. 17). Among of the people who were not aware were those who were practicing agricultural activities within the river course and used fertilizers in growing vegetables.

3.3 Implementation of the Aspects of Tanzania National Water Policy on Water Quality Management

Interviews conducted with three key informants from Wami/Ruvu Basin Water Board within the Ministry of Water and Irrigation who responsible in the implementation of the aspects of Tanzania National Water Policy on water quality management. The findings are as discussed below:

3.3.1 Wami/Ruvu basin water board

It was observed that the WRBWB is the major body to enclosure the management of water quality along Mzinga River and other rivers within the basin.

3.3.2 Ways to protect Mzinga River from human activities along the river

According to question addressed to WRBWB staff, it observed that the main challenge that faces the Ministry of Water and Irrigation is lack of allocation of areas for specified uses due to land ownership status.

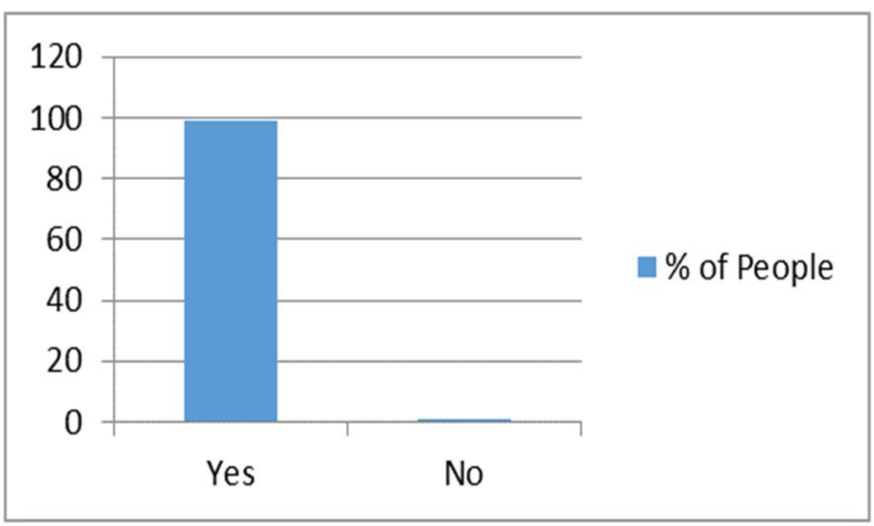

Fig. 16. Car washing activities practices along Mzinga river

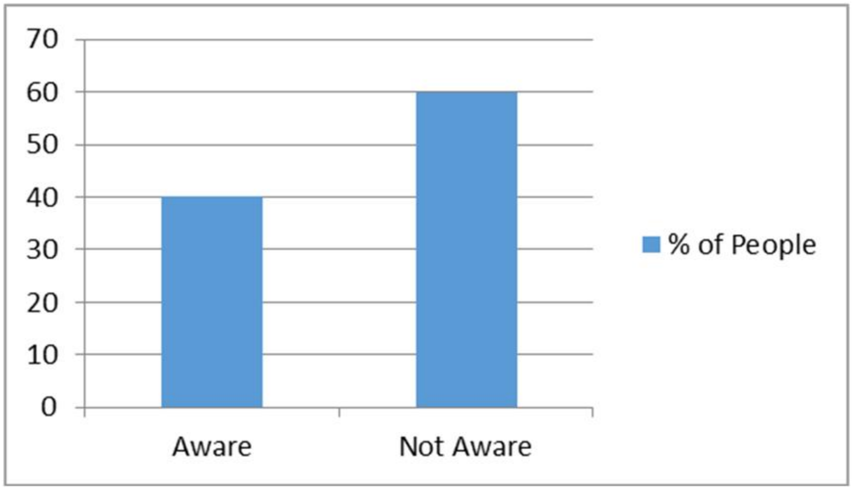

Fig. 17. River pollution awareness

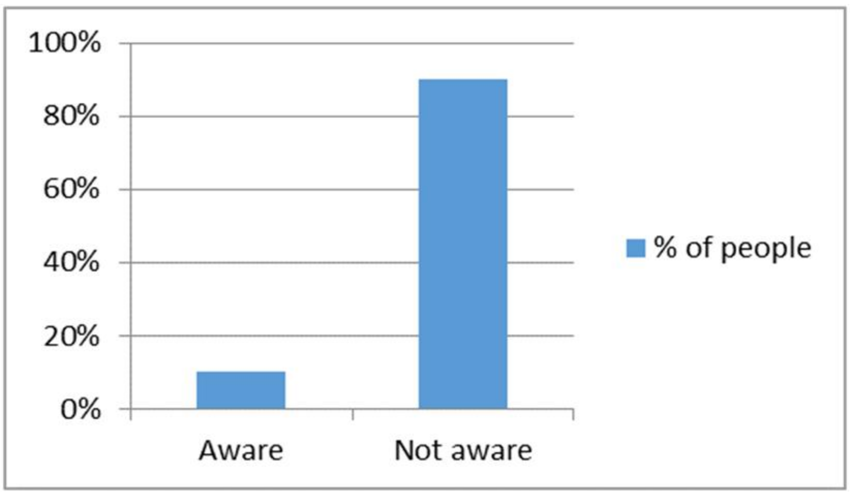

Fig. 18. Water policy awareness

3.3.3 National water policy on water quality management

It observed that,due to insufficient funds, the aspects such as systematic water quality monitoring and assessment procedures to establish the status of water resource quality that is to detect problems at an early stage and to permit their timely management and remediation, also conjunctive and comprehensive management of quality and quantity of water resources, and practical and cost-effective water quality and pollution control monitoring programs (including networks) were hardly implemented.Some of the parameters do not have Tanzania standard like Dissolved Oxygen which made it difficult to implement the aspect of development and enforcement of standards for in-stream flows, industrial effluents and other waste discharge to meet environmental objectives. "Polluter pays" principle along with other legal and administrative tools faces the challenge of laxity in enforcement. The challenge has brought forth the huge weakness of the ministry. Such weakness is thus National Environmental Management Council (NEMC) has the legal power to take legal actions against those who discharge wastes into the river. The Ministry of Water and Irrigation is passively involved since legal measures can only be taken by NEMC, also, due to lack of coordination and shared management responsibilities among the sectors of government (Central government and local government) and lack of support from the communities has made it impossible to implement the aspect of raising public awareness of the importance of protecting water resources from pollution and degradation, Based on findings, it was observed that there is a poor implementation of aspects of Tanzania National Water Policy due to different challenges which face the implementation. Also, WRBWB affirmed the implementation of aspects of Tanzania National Water Policy would reduce the pollution into Mzinga river

3.3.4 Awareness of households with water act/ law

It was found that large percent (90%) of people along Mzinga River are not aware of water act/law which deals with pollution control. Thus, they have never been told by local government leader to stop polluting the river nor attended any seminar or education awareness on water quality management and pollution control.

4. DISCUSSION

The current status based on physical, chemical and biological parameters of water quality of Mzinga River was found to be higher compared to the status of the year 2014 and to some points exceeding the Tanzania Bureau of Standards (TBS). Also, the status of heavy metals was found to be lower compared to that of a study conducted in 2010 due to the absence of the KTM industry even through some point it seems has level exceed that of TBS. It observed that even though there id framework for good water quality but river Mzinga river still deteriorated. The study shows that pollution at Mzinga river increased as compared to study conducted in 2014.Also, the status of heavy metal was lower than of the year 2010 due to the absence of the industry (KTM) which was closed., although at some points it was exceeding the TBS standards hence the presence of heavy pollution. pH was very low than the accepted TBS limit of 6.5 to 8.5 at Mbangukwalu which recorded 5.90, Videte had 6.40, Darajani had 5.85 and Msikitini had 5.80 compared to pH of the year 2014 which ranged from 6.09 to 7.05. Conductivity was exceeding the accepted TBS limit of 3 µS/cm at Kiforongo which had 480 µS/cm, Mbangukwalu had 450 µS/cm, Videte had 500 µS/cm, Darajani had 498 µS/cm and Msikitini had 540 µS/cm. Turbidity was exceeding the acceptable TBS limits of 300 NTU at a point like Mbangukwalu with 310 NTU. Points of Mbangukwalu and Msikitini had the DO of 0.00 mg/l followed by Videte which had o.46 mg/l, Darajani had 1.21 mg/l and Kiforongo had 7.80 mg/l. BOD exceeded the TBS acceptable limit of 30 mg/l at Kiforongo which had 37 mg/l, Mbangukwalu had 48 mg/l, Videte had 90 mg/l, Darajani had 128 mg/l and Msikitini which had 97 mg/l. COD was exceeding the acceptable limit of 60 mg/l at points like Mbangukwalu which had 150.27 mg/l, Videte had 254.55 mg/l, Darajani had 320 mg/l and Msikitini which had 145 mg/l. Salinity was exceeding the acceptable limit of 0.00 ppt at points like Kiforongo which recorded 0.02 ppt, Mbangukwalu had 0.1 ppt, Videte had 0.01 ppt, Darajani had 0.1 ppt and Msikitini had 0.1 ppt. Ammonia was exceeding the acceptable limit of 2 mg/l at points like Kiforongo which had 6.23 mg/l, Mbangukwalu had 4.21 mg/l, Videte had 7.09 mg/l, Darajani had 6.18 mg/l and Msikitini had 7.18 mg/l. Also, the current ammonia was exceeding the status of ammonia in the year 2014 which ranged from 4.50 mg/l to 6.50 mg/l. Total coliform was exceeding the acceptable limit of 5 counts/ 100 ml to 50 counts/ 100 ml at points like Videte which had 110 counts/ 100 ml, Darajani had 500 counts/ 100ml and Msikitini had 496 counts/ 100ml. Also, Fecal coliform exceeded the acceptable limit of 5 counts/ 100 ml to 50 counts/100ml at points like Videte which recorded 250 counts/ 100 ml, Darajani had 386 counts/ 100 ml and Msikitini which had 150 counts/ 100 ml. Phosphorus exceeded the acceptable limit of 6 mg/l at points like Mbangukwalu which had 7.75 mg/l, Darajani had 6.90 mg/l and Msikitini had 8.85 mg/l. Potassium was exceeding the acceptable limit of 2 mg/l at points like Kiforongo which had 4.850 mg/l, Mbangukwalu had 4.352 mg/l, Videte had 3.963 mg/l, Darajani had 4.037 mg/l and Msikitini had 4.49 mg/l. Also, the color was exceeding the acceptable limit of 300 mgPt/l at points like Kiforongo which had 389 mgPt/l, Mbangukwalu had 386 mgPt/l, Videte had 410 mgPt/l, Darajani had 401 mgPt/l and Msikitini had 470 mgPt/l. Heavy metals like Lead exceeded the acceptable limit of 0.1 mg/l at points like Mbangukwalu which had 0.106 mg/l, Videte had 0.126 and Msikitini had 0.11 mg/l. These values were less than those of the year 2010 which was 1.75 mg/l. Furthermore, the compliance of communities with water resources management needs was found to be low, then study concluded that the compliance of communities with water resources management needs was weak. It was found that the communities were not conserving the river water as they were practicing their activities.

5. CONCLUSION

The current status of Nzinga river is deteriorated compare to that of 2014 even though there is framework for good water quality. Furthermore, the compliance of communities with water resources management needs was found to be low, then study concluded that the compliance of communities with water resources management needs was weak. The communities were not conserving the river water as they were practicing their activities. The study also concluded that the implementation of aspects of Tanzania National Water policy for water quality management was poorly as water quality of Mzinga River is still poor. This is due to the laxity in the law enforcement, lack of enough finance and lack of coordination and shared management responsibilities among the sectors in government to implement the aspects of Tanzania National water policy. Based on the study findings, enhancement of sustainable water quality management should be done. The budget should be priories on the implementation of the aspect of National policy. Also, the Ministry of Water and Irrigation enforce laws of water quality management.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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