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Investigation of water quality and prospective issues in Kurunegala Municipal Council area

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Abstract

The prime objective of this study is investigating the existing status of water quality and related health issues, caused by the contaminated water. The results revealed that the pH value of the collected two water samples from the North East Grama Niladari Division (GND) of Kurunegala Municipal Council (KMC) area shows as 6.36 and 6.40, which are below the required standards. Similarly, West GND 5.95 and 6.21, Theliyagonna GND 6.48 and 5.75, North 6.0, Illuppugedara 6.21 and 6.44 and Udawalpola 5.31. Accordingly, the lowest pH value was observed in the Udawalpola GNDs. The EC value of two water samples, taken from west GND reached to 1167$\mu s/cm$ and 1552$\mu s/cm$, which are beyond the standard and undesirable level for consumption. Further samples collected from the North (1073 $\mu s/cm$) and illupugedara (1156 $\mu s/cm$ & 1521 $\mu s/cm$) GNDs recorded unfavorable results in terms of its EC value. This situation creates multifarious health and other issues to the dwellers of KMC area. KMC must understand the necessity of an integrated system to control and manage water quality of the area and to find a sustainable solution.
Key words: water quality, contaminated water, health issues, integrated and stakeholders.

Introduction

Water quality has direct relationship with human health. The dwellers of the Kurunegala Municipal Council (KMC) area face with various health issues, due to the consumption of contaminated water and deficit supply of water. Chemicals from the city area, poor latrine facilities, vehicle services, industries and agricultural chemicals pollute the existing water bodies and spread during the rainy day with runoff water. Moreover, the wastewater discharged in the study area was estimated about 4620m^3/day, of which 29% was discharged from the industries and 68% from households. The Kurunegala General Hospital contributes for 758 m^3/day, which is directly discharged into the Beu Ela canal. In addition, the estimated solid waste disposal in the KMC area is 50MT/day (KMC, 2016). Accumulation of all above

factors caused multifarious diseases to the human health in the study area.

Study area

The dwellers of KMC area have undergone with multiple infection and communicable diseases frequently. This study found that approximately 50% of such diseases are water bone. Hence, this study established its research problem; correlating water quality and human health issues of KMC area. Kurunegala is the capital city of Western Province, which is located within Sri-Lanka 7° 30' N latitude, 80° 23' E longitude. Kurunegala is situated about 94.3 km from Colombo and 42km from Kandy. Kurunegala district covers an area of 4,816 km^2 and out of which 190-200 km^2 are water bodies. The extent of the KMC is 11.34 km2. This consists of 12 GN divisions, along with a total population of approximately 40,000 persons with 5,300 families. The daily floating population is 200,000 persons. KMC areas receives drinking water majorly from Deduru Oya, amounting to 5000-6000m³/day. Approximately, 78% of the dwellers of KMC is drained their waste water in to the Beu Ela and Wan Ela canals (KMC, 2015). Consolidation of all above factors contaminate the waterbodies of the study area, which has become a major cause for increasing trend of human health in the KMC area.

Objective

The prime objective of this study is to assess the existing status of water quality of KMC area and to identify the related health issues, caused by the contaminate water.

Methodology

Pilot survey was carried out to identify the water resources, geology, topography and settlement pattern of the study area and also extended an awareness program among the households and farming community with regard to the research objective. In addition, necessary secondary data, such as population information, statistics of diseased patients, maps and other general information/related literatures were collected from KMC. This has helped to develop a proper sampling scheme and to plan research activities in a productive manner. The primary date were derived through laboratory test and field survey (questionnaire survey, interviews and observations). 12 GN Divisions in the KMC area were considered as strata and selected six samples, following the random sampling techniques. The selected samples are North, North-east, West of Kurunegala, Theliyagonna, Illuppugedara and Udawalpola GNDS, representing total population (KMC). 18 water samples have been collected from the selected sample locations, based on the existing number of water sources (Table-1). The water samples were collected to identify the water quality at each sampling locations. The middle-sized plastic bottles were used to collect sample from tube wells, dug wells, tank and tap line by following random sampling model, which were plotted below Figure-1. Approximately 55% of water samples from dug wells and 44.45% from other water bodies have been selected and tested to investigate the pollution level of drinking water in KMC area. Accordingly, the potential hydrogen (pH) value and electrical conductivity (EC) of each sample have been tested and recorded. The related testing was carried out in the Laboratory of NWSDB-Kurunegala, according to the American Public Health Association, 2016. Hydrochloric acid was used to measure the concentration of pH and

Electrolytes included acids was used for testing EC in water. The collected data was analyzed, using the MS-Office and Excel-2010 software packages.

Results and Discussion

Analysis of water quality

The concentration of pH range in the water within the range of 6.5-8.5 is suitable for drinking purposes (WHO, 2007). The range of pH below 6.5 in the water is acidity and the range above 8.5 is alkalinity, which is not suitable for drinking and could be seen changes in terms of its colour and taste (Clemett, et al., 2007). The EC range, greater than 1000 µs/*cm* is not suitable for consumptions, which are polluted water. The EC range less than 1000 µs/*cm* is acceptable range for drinking (WHO,2004).

Below table-2 examines the actual level (desirable or permissible level) of the samples. The result of collected water samples from dug wells mostly shows as "desirable level" for consumption. Out of 18 samples, the pH value of 10 samples are shown as "desirable level" and 8 samples could be considered as "permissible level". Similarly, 5 samples of EC value show as desirable level and balance 13 samples indicated as permissible level. According to results, pH value has reached to desirable level, whereas EC value reached to permissible level.

However, this study found that the quality of drinking water bodies of KMC area during dry season is reached to low level, due to the contaminations (Table-3). The statistical information shows that the pH and EC value narrowed the gap, compared to the standards and mean value of respective water samples. In addition, some sample location shows that the concentration of pH and EC values have exceeded, when compared with other sample locations. Accordingly, the pH value of 10 samples locations showed the less than 6.5 concentration level in the water. Hence, most of the water bodies in this area are more acidity.

The study revealed that the pH value of the collected water samples from the North East GND shows as 6.36 and 6.40, which are below the required standards. Similarly, West GND 5.947 and 6.161, Theliyagonna GND 6.481 and 5.754, North 5.967, Illuppugedara 6.213 and 6.438 and Udawalpola 5.306. Accordingly, the lowest pH value was observed in the Udawalpola GNDs. The major reasons for this are disposal of solid waste haphazardly and discharge of polluted water to the waterbodies.

It was observed that the northern part of the KMC was spread with runoff of industrial and commercial waste water, which were added up into the waterbodies available in the lowland areas. The paddy cultivation was remarkably cultivated in the north east GND and approximately 78% of farmers use fertilizers and pesticides for farming activities, which are ultimately ended-up with surrounding water bodies. Mostly, dwellers of Theliyagonna GND has poor latrine facilities. Their domestic liquid waste, such septic tank and sewerage pit was constructed very near to the wells, due to limitation of the land area. Similar nature of human activities were observed in the Kurunegala city area, Udawalpola and Illuppugedara GNDs and other GNDs too. Therefore, the water bodies of Kurunegala city, Udawalpola and Illupugedara GNDs have been identified as high concentration rate of EC.

The concentration rate of two water samples taken from west GND of the KMC were 1167$\mu s/cm$ and 1552$\mu s/cm$, which are undesirable for consumptions. Identified reasons behind this are uncleaned drains system and mixing-up of polluted waste water, during the rainy days. Another, two samples collected from Illupugedara were also reached to undesirable level (1156 $\mu s/cm$, 1521 $\mu s/cm$). Low-income communities in Willgodawatta GND has low sanitation facilities. Their septic tanks and sewerage pit are also located closed to the wells. During the night, the dwellers defecate and urinate near the waterbodies, due to unavailability of latrine facilities. According to the Respondents, the children defecate discharge into the open area and most of the time throw their stools into the canal, which will cause water pollution (Agarwal, 2009). The water sample selected from north of KMC recorded its EC concentration rate as 1073 $\mu s/cm$. In this area, the well water had a formation process of mosses and colour different. This has been taken place, after establishing/deepening main water tank in the Kurunegala city.

However, lowest level of pH and high concentration rate of EC were observed in the KMC area. Statistical analysis revealed that the quality of the water bodies are below the standards and not recommended for drinking as it is.

Human health issues

Human health issues have also been analyzed, following the quantitative and qualitative approach; for which the collected data from sample locations were utilized. Health issues (volume) have been differed-location wise, according to its distance from the waterbodies and also due to its physical features and quality of water of the area. Accordingly the dwellers, those who are living closed to the waterbodies are frequently affected with health related issues, due to the direct link with the waterbodies of the KMC area. Based on the information received from Public Health Midwives and Public Health Inspector, more susceptible and vulnerable groups are children, living around the water bodies. This has been evidenced from the statistical information, derived from the study.

Accordingly, more than 67% of children (including newborn babies) suffer from various illnesses (total children population in KMC-25,000) (KMC, 2015). The increasing rate of waterborne diseases, skin rashes, infection diseases, allergies and stomach problems, diarrhea, whooping cough, and fever are some of the dominant health effects, identified among the children in the KMC. According to the Respondents, the 83% answered that the drinking water is not up to the required standard and they use them, since there are no any other options.

According to the World Health Organization (WHO, 2007); the waterborne diseases was estimated as 3.6% of the total DALY (disability-adjusted life year), causing about 1.5 million human deaths annually. Approximately, 11 million children are happened to die before reaching their fifth birthday annually. This is approximately 30, 000 children per day. Another 300 million children suffer from illnesses caused by multifarious reasons, including scarcity of clean water.

Diarrhea

Diarrheal disease is the second leading cause of death among the children under five years, killing around 525,000 children every year (WHO, 2011). Diarrhea can leave the body

without the water and salts, which are necessary for life survival and loss of such combination, will dehydrate the body, causing deaths. KMC area is considered as risk zone for diarrhea. Particularly 8-10% of diarrhea cases recorded in April and August of 2015, due to the heavy rainfall.

Typhoid

Typhoid fever is highly contagious, passing the bacteria out of their body with stools urine. If someone else eats food or drinks water that has been contaminated with such stools and urine, they can also become an infected with the bacteria and develop typhoid fever (WHO, 2011). Diarrhea. The decentralization of such bacteria with runoff water together with urine, sewerage water and untreated wastewater causes the disease of typhoid. In 2015, 18,2% of people have been affected with typhoid in KMC area, which was increased up to 25% during the month of April/May-2015.

Hepatitis-A

Hepatitis-A is a liver disease caused by the hepatitis-A virus. The faucal-oral route primarily spreads the virus, when an uninfected (and unvaccinated) person consumes food or water that is contaminated by an infected person. The disease is also closely associated with unsafe water, food, inadequate sanitation and poor personal hygiene. Further, the polluted sediments in the water bodies, which is unseen dust mixed with pure water, directly affect digestive system of human being and lead to multifarious health issue in the stomach. It can subsequently form hepatitis-A.

In 2015, 11% of the people in KMC area were affected with hepatitis-A. High percentage (18.91%) was recorded in February and May-2015, due to the heavy summer resulted depositions of sediments in the waterbodies.

Malaria

Malaria is a fever, spread by the *Anopheles* female mosquitos; which are commonly grown in the surrounded waterbodies in KMC area. This fever depress the man's health and being heedlessly lead to death. The study revealed that the 14% of people were affected by Malaria in the year 2015. Approximately 10% of people have been affected in July-2015.

Dengue fever

Dengue is also a highly vulnerable fever, spread by the *Aedes egypti* and *Aedes Albopictus* mosquitoes; which are commonly grown in the surrounded waterbodies in KMC area. The common symptoms are appearance of red spots on the body, eyes redness, continuous fever, joint pain *etc*. it was observed that the 27% of people were affected by dengue fever. The 14.9% was recorded in January, despite several remedial measures extended by KMC. Mostly, the rapid increased and proliferation of vectors, leading to high records of dengue cases are generally taken place soon after the high rainfalls in the area.

Leptospirosis

Leptospirosis is a bacterial disease that affects humans and animals. It is caused by bacteria of the genus Leptospira. Without treatment, Leptospirosis can lead to kidney damage, liver failure, respiratory distress, and even death. The microorganisms such bacteria pollute the waterbodies and develop the Leptospirosis in the area. This study ascertained that the farmers are mostly affected by Leptospirosis, due to the usage of

fertilizers, pesticides and pollute water. It was recorded that the 14% of people were affected in the KMC area and highest percentage was recorded in 18.42% in March, due to the usage of polluted canal water with the high chemicals mix for paddy cultivation. The fish verities and other organisms have also been affected and died in the agricultural lands due to the untreated canal water and usage agricultural chemicals.

Impacts on aquatic organisms and agriculture

Similar to human health, the poor quality of water has a negative impact on aquatic organisms and agricultural activities. The high concentration of EC formulates algae in the waterbodies, which obstruct the smooth flow of water and exhibits the ambiguous characters. The sunlight and rays are prevented, infiltrating into the waterbodies; which will directly affect the aquatic organisms. This study found that the Farmers of North east and west of Kurunegala city and Udawalpola GND use cannel water for agricultural activities. In addition, a few farmers use ancient dug-well water for agricultural activities, are also polluted by means of various sources, which directly affect the yield of crops and human health.

During the interview, the 73% of dwellers said that the usage of cannel and dug-well water for agriculture causes negative impact in terms of its yield. Indeed, the canal water carries various pollutants, which will proliferate insects and will have a negative impact foe plant/ crop growth.

Conclusion and recommendations

KMC faces multiple obstructions in maintaining waterbodies available in its purview. The major causes for this issue is insufficient support extended by all stakeholders, including general public. The polluted/untreated water discharge into the waterbodies, disposal of solid waste and chemical usage are major factors that have contributed for lower grading water quality of the area. Similar to the agricultural land, this situation has adversely affected to the human health too. It is the fact that lowered water quality will have linear relationship with dwellers health status, but this study made a reasonable effort to assess the existing situation of water quality of the area and its effects to the human health. This study will facilitate decision makers and KMC to take remedial measures, according to the Geography of the area, i.e. priority can be given to high occurrence area of health issues.

This study derived the different results in testing water samples in the context of its pH and EC values; which are deviated from required standards. This has shown the polluted level of existing waterbodies of KMC area and not up to the standards for consumptions. Usage of such water will causes various health difficulties; such as malaria, dengue, Diarrhea, typhoid, hepatitis-A and leptospirosis as specified above. They have been identified in the study area. Similarly, microbes and aquatic organisms available in the waterbodies have affected agricultural activities of the area.

KMC, Department of irrigation and all other stakeholders has great responsibilities in discharging their duties to overcome this situation. This study suggested to implement productive and viable measures to collect entire solid waste discharged in the area and to stop all untreated and chemical wastewater mix-up in to waterbodies and also required to prepare a Management plan addressing identified issue in accordance with existing

municipal council, environmental and water management/irrigation laws. Until such time, all stakeholders must be educated and aware on this crisis situation and should called for participating management activities to overcome this adverse situation to human health and agricultural activities. Respective law implementing Authorizes must be more instrumental in implementing laws against the all-illegal activities. KMC must understand the necessity of integrate effort to control and manage water quality of the area in sustainable manner.

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Appendices

Table-1: Sampling Scheme

GND	Locations	Tot. Samples	Tube well	Dug well	Tank	Tap line
831	North	4	-	1	3	-
834	North East	2	-	2	-	-
836	Theliyagonna	3	1	1	-	1
837	West	3	1	2	-	-
838	Illuppugedara	3	-	2	-	1
842	Udawalpola	3	1	2	-	-

Source: Field Survey, 2015

Table-2: Source of water samples

GND	Locations	Total number of water samples: 18			
		Hydrogen ions (pH)		Electrical Conductivity (EC)	
		MDL	MPL	MDL	MPL
831	North	1 (W)	3 (Ta)	1 (W)	3 (Ta)
834	North east	2 (W)	-	-	2 (W)
836	Theliyagonna	2 (W, T)	1 (Tw)	-	3 (TW, W, T)
837	West	2 (W, Tw)	1 (W)	2 (W, Tw)	1 (W)
838	Illuppugedara	2 (T, W)	1 (W)	2 (W)	1 (T)
842	Udawalpola	1 (W)	2 (W, Tw)	-	3 (W, Tw)

Source: Field Study, 2015
Keys: MDL –Maximum desirable level, MPL – Maximum permissible level, W-Well, T-Tap line, Tw-Tube well and Ta-Tank.

Table-3: Statistical analysis of selected water samples in dry season-2015

GND	Locations	Source of samples	pH Standard: 6,5 – 8.5	EC Standard:1000> $\mu s/cm$
831	North	Tank s. no: 1 Tank s. no: 2 Tank s. no: 3 Well	6.911 7.056 6.763 5.967	223 236 247 1073
834	North East	Well s. no: 1 Well s. no: 2	6.362 6.409	768 857
836	Theliyagonna	Tube well Well Tap line	6.957 6.481 5.754	924 608 912
837	West	Well s. no: 1 Well s. no: 2 Tube well	6.947 5.947 6.161	744 1167 1552
838	Illuppugedara	Tap line Well s. no: 1 Well s. no: 2	6.213 7.154 6.438	107 1156 1521

842	Uda walp ola	Well s. no: 1 Well s. no: 2 Tube well	6.866 5.306 7.176	362 208 797

Source: Field Survey, 2015

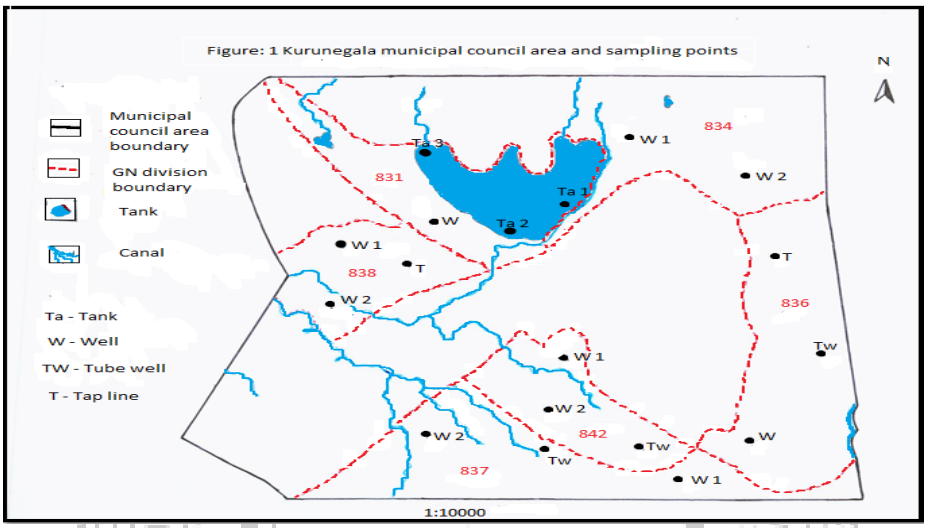


Figure-1: Sample plots
Source: Prepared, based on KMC profile 2015

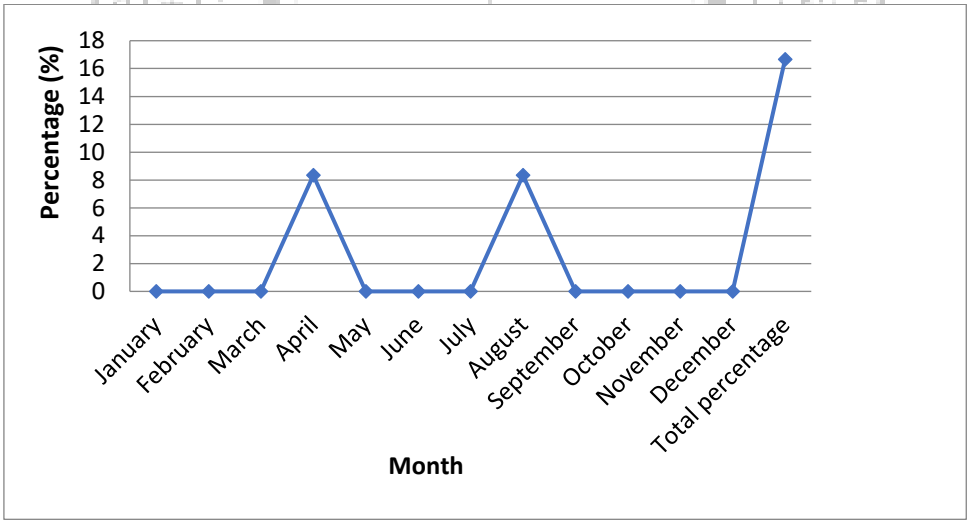


Figure-2: Diarrhea cases in KMC area- 2015

Source: KMC-2015

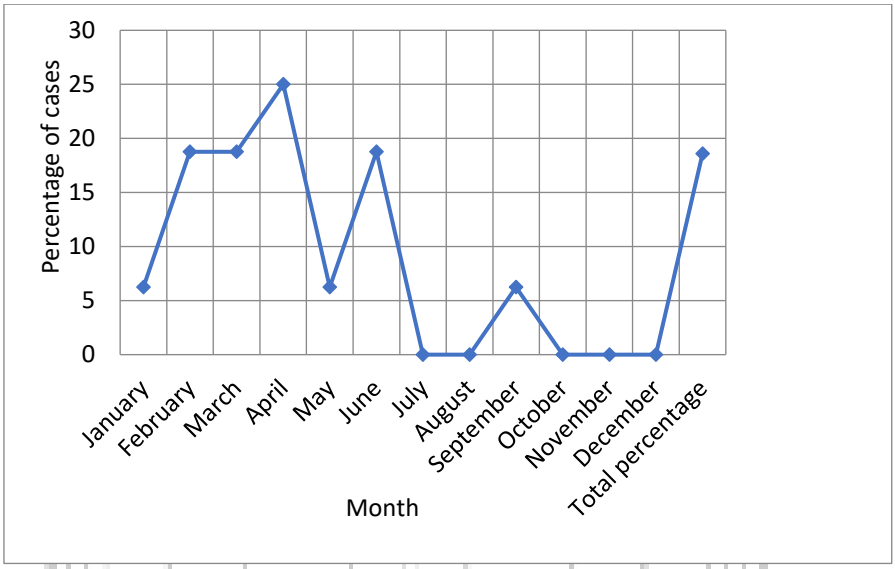


Figure-3: Reported typhoid cases in KMC area-2015
Source: KMC, 2015

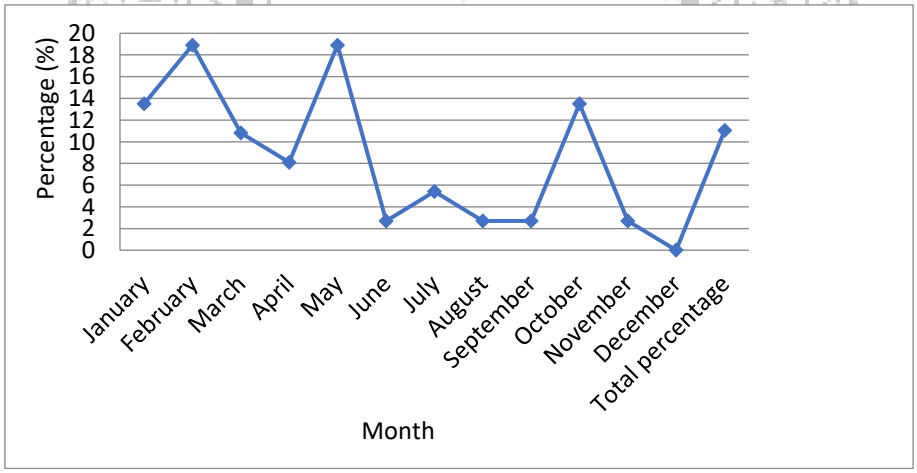


Figure-4: Hepatitis-A reported in KMC-2015
Source: KMC, 2015

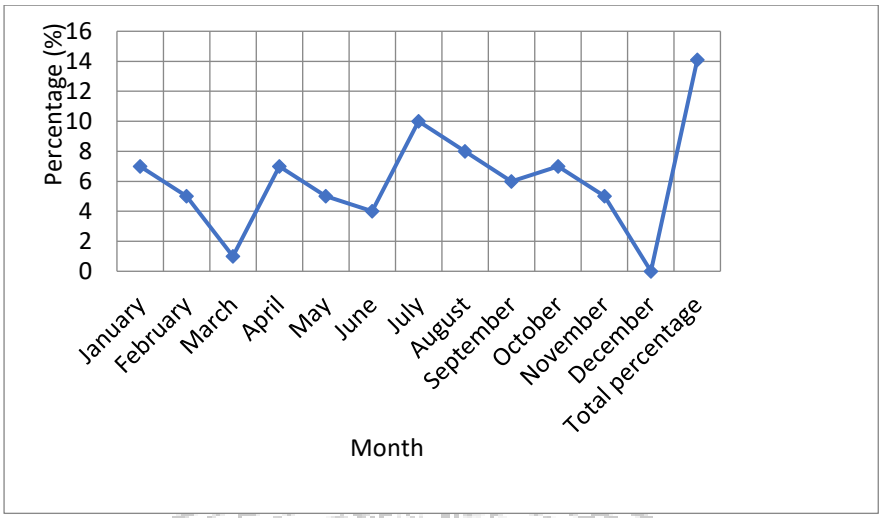


Figure-5: Malaria fever reported in KMC area-2015
Source: KMC, 2015

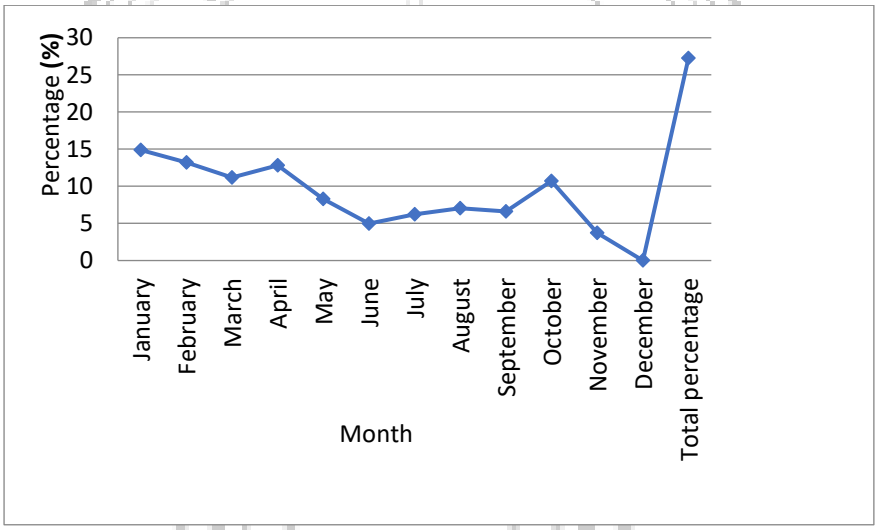
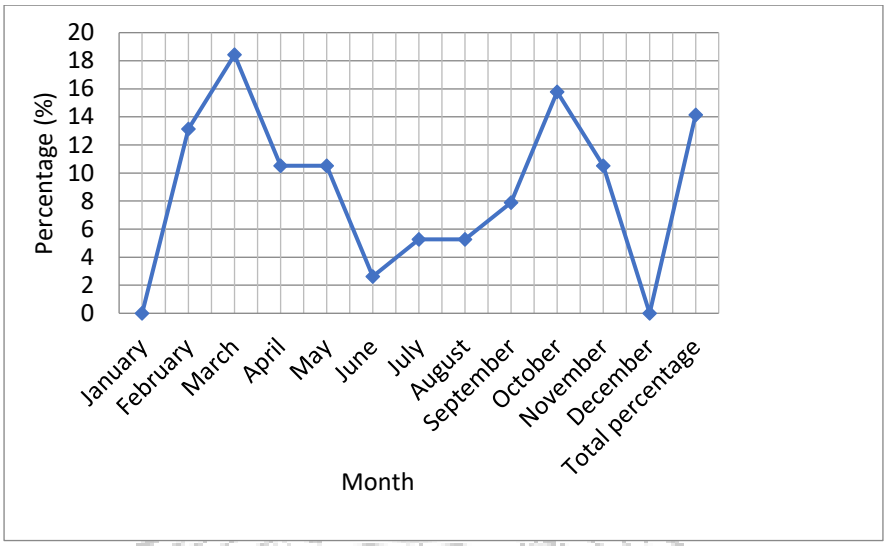


Figure-6: Dengue fever recorded in KMC area-2015
Source: KMC, 2015



Figurer-7: Leptospirosis in KMC area-2015
Source: KMC, 2015

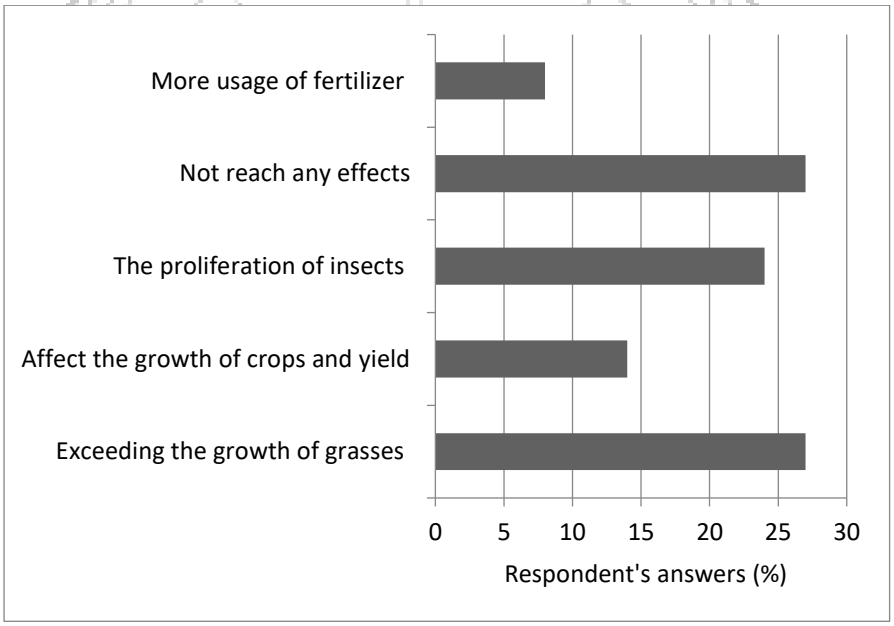


Figure-8: The water quality and its impacts on aquatic organisms and agriculture
Source: Field survey, 2015.