WATER QUALITY VARIATION IN MENIK RIVER IN SRI LANKA AND PEOPLE'S AWARENESS

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ABSTRACT

Menik River in Sri Lanka has already been identified as one of the most polluted rivers in Sri Lanka. This research was conducted to identify the trend of water quality variation in Menik River, to investigate people's awareness, knowledge and attitudes on Menik River pollution and the influential parameters on the deterioration of water quality. Firstly, water quality data for key physio chemical parameters namely pH, Turbidity, Electrical Conductivity (EC), Nitrate and Total Alkalinity from Kataragama water treatment plant intake for the period of 2008 to 2013 was collected and analyzed to identify the trend of water quality variation. Secondly, a questionnaire survey was conducted to investigate the individuals' attitude and awareness about the pollution of Menik River. Finally current status of Menik River water quality was analysed and compared based on water quality data on five different locations along the Menik River. Water quality of Menik River shows significant variation with time. Most of the people in the near vicinity of Menik River are not aware and knowledgeable on the pollution of the river. Water quality of the river is strongly influenced by the different land use practices. Consequently, consideration of differences in land use practices in the catchment when design and implementation of water treatment strategies is of crucial importance.

***Key words*:** water quality, land use, knowledge

1. INTRODUCTION

A growing awareness has been drawn on deterioration of water quality of receiving water bodies such as rivers and lakes as one of the greatest threats on the well-being of humans [1, 5]. The degradation of water quality of receiving water bodies is mainly due to both point sources, which primarily include waste discharges and non-point sources, such as storm water runoff [7, 8]. Despite the fact that most of the rivers are contaminated due to high pollution and intoxication, they persist as an important source of usable water for human consumption. Even though about 71% of the earth's surface is covered by water, the amount of freshwater available is limited and considered as one of the scarcest resources on earth.

In addition, the negative social impacts created due to deterioration of water quality in receiving water bodies eventually leads to increase the treatment cost and time consuming in treatment facilities creating considerable negative impacts on local economy.

Consequently, it is of utmost importance to safeguard the water quality of receiving water bodies through careful monitoring of water quality and by the implementation of required mitigation measures such as Best Management Practices (BMPs). Being a developing country as well as a country with an agricultural based economy, the water quality of receiving water bodies in Sri Lanka is of crucial importance for socio economic development of the country. Sri Lanka inherits around 103 river basins and most of the river plays a vital role in water supply for human consumption. However, Welegedara et al. (2014) comparing the status of water quality in major river basins in Sri Lanka noted that, Menik

River is the most polluted river in Sri Lanka [2].

Menik River serves as a source of drinking water for thousands of people and supports many agricultural and commercial activities. Moreover, the river's ecosystems provide environmental goods and services that are of great value to communities along the river and to the nation.

Therefore, this research study was conducted to identify the trend of water quality variation in Menik River and to investigate people's awareness, knowledge and attitudes on Menik River pollution. The outcomes of the research will be contributed to the implementation of pollution mitigation strategies, water quality monitoring programs and to design of cost and time effective treatment procedures.

2. METHODOLOGY

2.1 SITE DESCRIPTION

Menik River is 114 km long and flows through Southeast Sri Lanka with an estimated terrain of 1m elevation above the level of the sea. It has a catchment area of 1272 km^2 where, the mean annual precipitation is 1496 mm and annual flow is 347 million m^3 [2]. Menik River receives rainfall during the North-east monsoon period from November to January. The data collection of this research project was primarily done by selecting the sites in the vicinity of Menik River in Kataragama. Kataragama is a popular pilgrimage town in the country where large number of pilgrims visits the area daily. However, water quality data measured at Menik River Water Treatment Plant intake at Buttala which is located at around 45 km upstream side of Menik River was also used for the comparison purposes in data analysis of this research project (Figure 1). The selection of Buttala was mainly due to the difference of land use practices compared to Kataragama where Buttala is mainly an agricultural town in which it is the home of the largest Sugar Mill in Sri Lanka.

Figure 1: Site location

The study sites for this research study were selected in the vicinity of Menik River in Kataragama (Figure 1).

2.2 DATA COLLECTION

Data collection of this research project was primarily composed of three stages. Firstly, the water quality data obtained at the intake of Menik River Water Treatment Plant at Kataragama for the period from 2008 to 2013 was collected from National Water Supply and Drainage Board in order to understand the trends of water quality variation. The data collected included key physio-chemical and biological water quality parameters namely turbidity, Total Suspended Solid (TSS), pH, Electrical Conductivity (EC), total alkalinity, Nitrate, Phosphate [3].

Secondly, a questionnaire survey was conducted to investigate the individuals' attitude and awareness on the pollution of Menik River choosing four different sites in the vicinity of the river at Kataragama. Sites were selected based on the usage of Menik river water for various purposes such as agricultural, industrial, household and commercial etc. A total of 80 people were interviewed to get their views about the water quality of Menik River. Responders were selected randomly which includes one person over 18 years of age from one dwelling unit and no other specific criteria was followed to select the survey responders. A face to face interview was conducted to gather information as it gave more flexibility to both interviewer and participant.

Questionnaire was composed of both open ended and closed ended questions. In the close ended questions, the respondent was asked to evaluate a list of predetermined responses from which they are to choose their answer. Close ended questions such as period of stay at the area, Health issues and relationship with Menik River were also inquired. In open ended questions, respondents were asked to answer each question in their own words, such as government activity on creating awareness of water pollution, social awareness campaign about Menik river pollution, awareness of environmental laws, willingness to take part in social campaigns, rating on how Menik River gets polluted in each individual's point of view. After the questionnaire survey a free discussion was held to further investigate people's attitudes and awareness on implementation of best management practices.

Thirdly, in order to understand the current status of water quality in Menik River six water samples were collected from each of four different points in the river in November 2014 and then tested for the same set of key physio-chemical parameters described above. The four locations of the river were selected based on the differences in the land use characteristics such as agricultural, industrial, residential and commercial. The samples were collected according to the standard methods and were sent to National Water Supply and Drainage Board laboratory for testing of key physio-chemical water quality parameters (TSS, pH, EC, Nitrate, Phosphate, turbidity). Furthermore, the water quality data obtained at the intake of Menik River Water Treatment Plant in Buttala for the same day was also collected for comparison purposes.

2.3 DATA ANALYSIS

Data analysis was conducted in four stages. Firstly, water quality data obtained at the intake of Menik River Water Treatment Plant at Kataragama for the period from 2008 to 2013 was analyzed. In this analysis due to the rapid fluctuations observed in raw data five month moving average was considered in order to generate an overall understanding on trend of water quality variation of the river during the five years from 2008 to 2013.

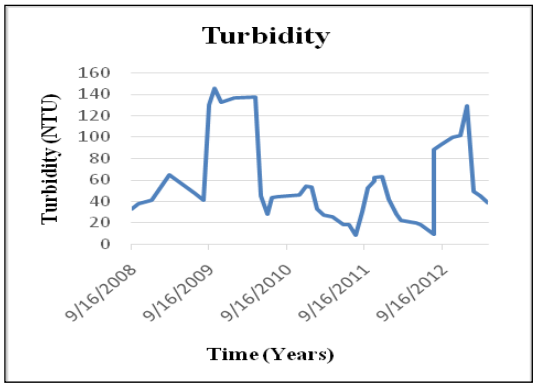
Secondly, data obtained from questionnaire survey was analyzed in order to understand the people's knowledge, awareness and attitude on Menik River pollution.

Thirdly, water quality data obtained from four different catchment areas in November 2014 and water quality data obtained at the intake of Menik River Water Treatment Plant, Buttala for the same time were analyzed to identify the current status of water quality of the Menik River incomparison with Inland river water quality standards and to identify the correlation between key physio-chemical parameters. Due to rapid variations among a site an average out of six samples were considered.

Finally, Kataragama Site water quality data and Buttala water quality data were subjected to principal component analysis (PCA) which is a well-known multivariate data analysis technique [9]. This analysis was conducted in order to identify the correlation between key physio chemical parameters and land use differences.

3. RESULTS AND DISCUSSION

The results of the data analysis of five months moving average obtained for the water quality parameters namely TSS, pH, EC, Nitrate, Phosphate, turbidity are shown in Figure 2.



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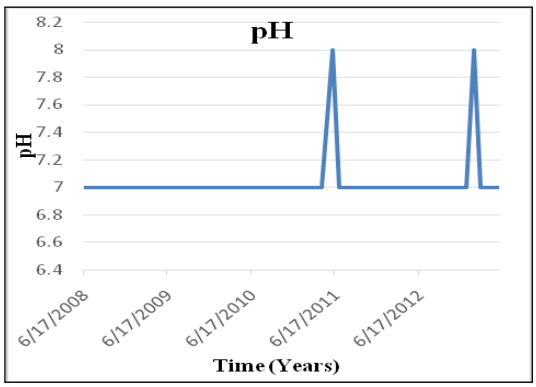

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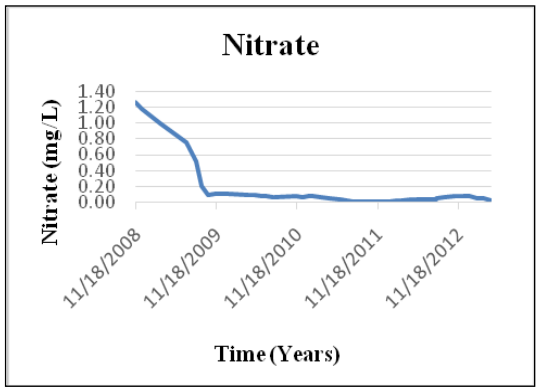

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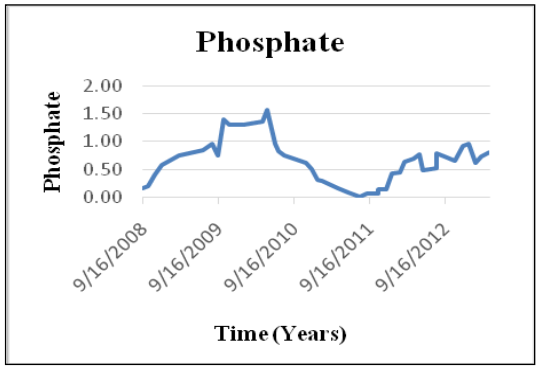

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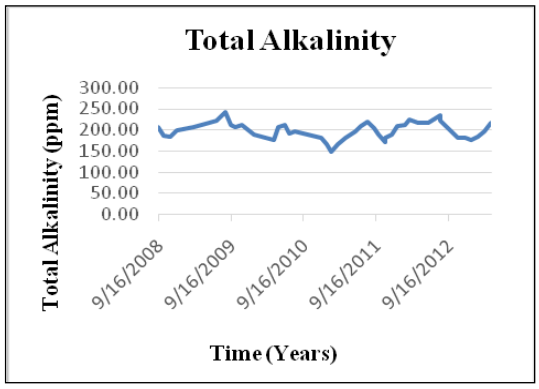

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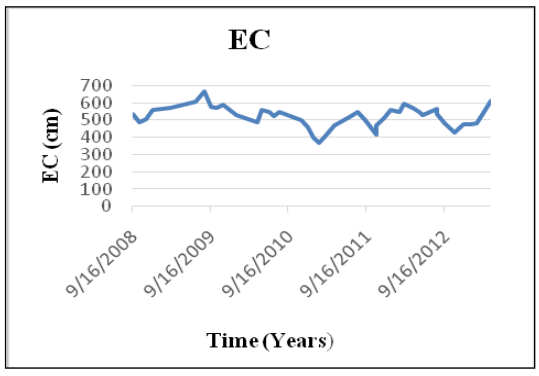

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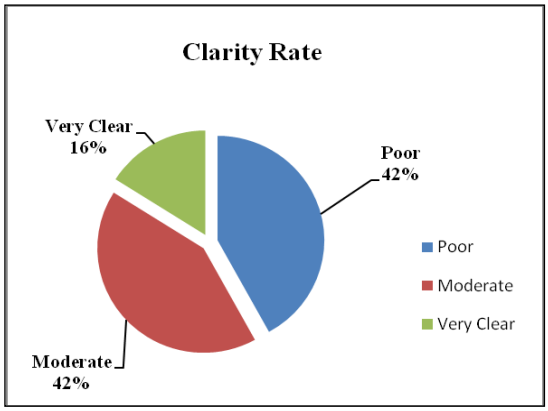
Figure 2: Variation of Water quality for five years

As can be seen in Figure 2, turbidity, phosphate, EC and alkalinity shows a significant variation over the period. Furthermore, Nitrate level shows a rapid drop and pH remains almost uniform with very little fluctuation. This indicates the need for continuous monitoring of river water quality and hence the design of treatment procedures accordingly rather than limiting into conventional treatment procedures.

Figure 3 shows the outcomes of the data analysis of the questionnaire survey. According to Figure 3.a to3.d most of the people are satisfied with the Menik River water quality and they do not consider it to be the most polluted river in Sri Lanka even though they agreed that there is a change in the color and the river is polluted to a considerable state.



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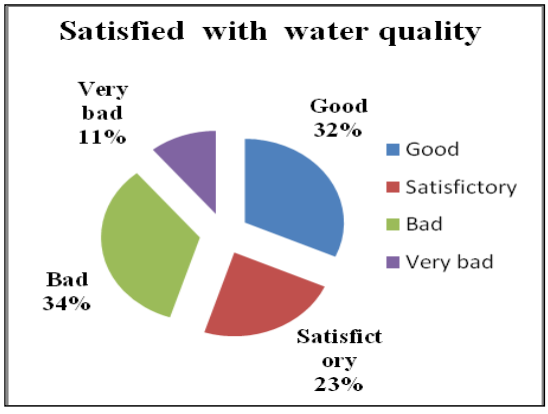

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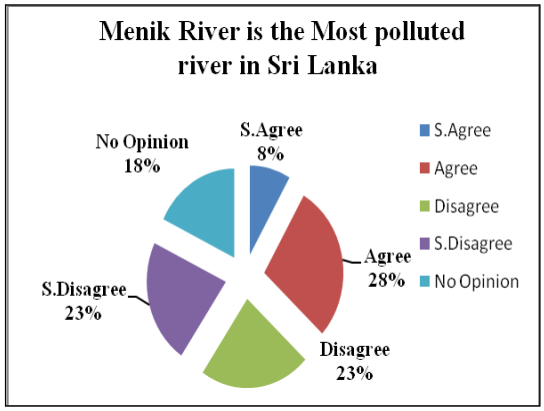

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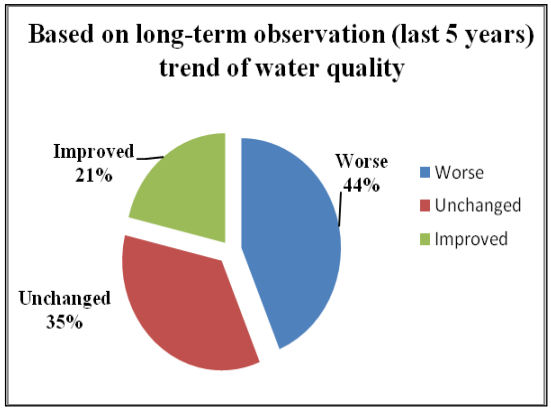

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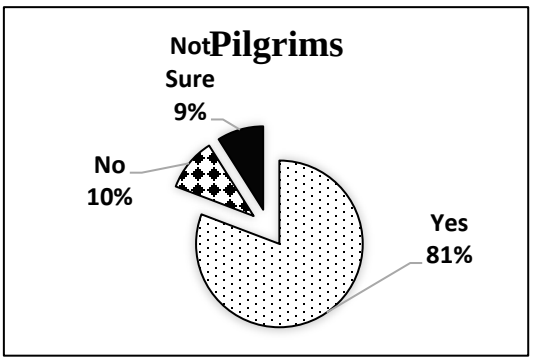
Figure 3: Peoples view on Menik River and its water quality

Note- in Figure 3(c) S.Agree refers to Strongly Agree and S.Disagree refers to Strongly Disagree.

Figure 4 is based on the questionnaire, where interviewers were asked to identify the major pollutant of Menik River.

As can be seen in Figure 4, more than 80% of the people think that Menik River is polluted mostly due to pilgrims. And it is most probably because pilgrims are bathing in the river as it has made a tradition to clean themselves from the river and then walk forth to the holy place and also throwing food wastes or garbage's to the river. Furthermore, more than 50% agree that garbage dumping, sewerage discharge to the river are also as major pollutants to the river.



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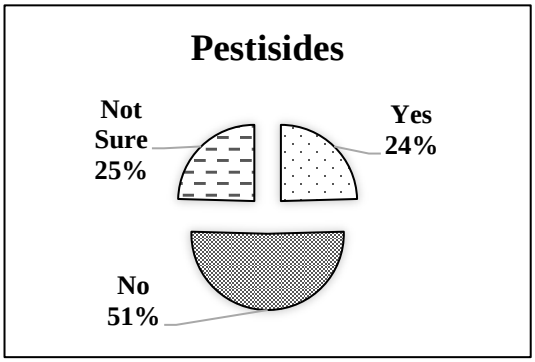

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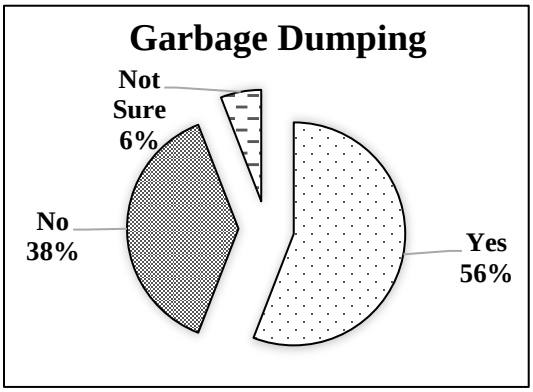

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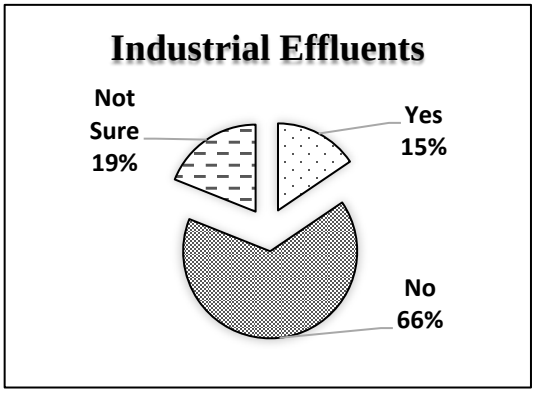

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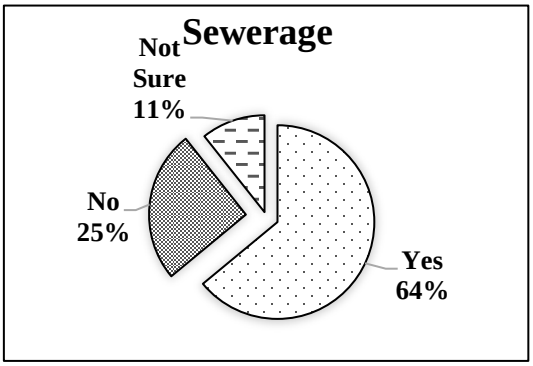

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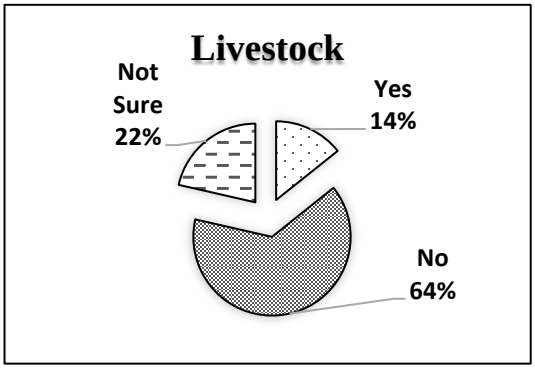

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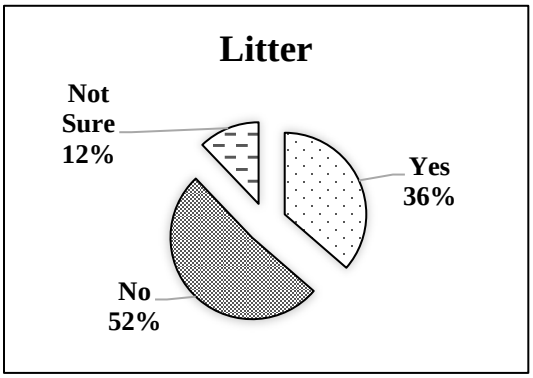

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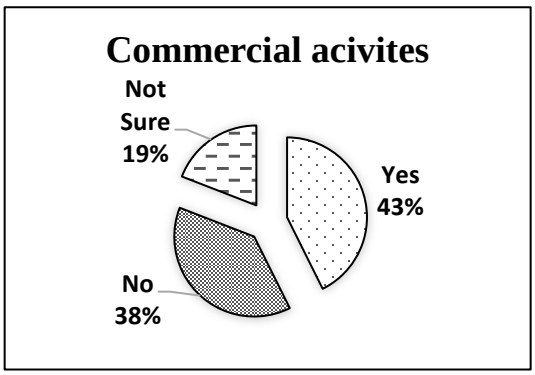

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Figure 4: Different pollutants on people's response

As can be seen in Figure 5, more than 60 % of the people use the Menik River water directly for bathing and washing.

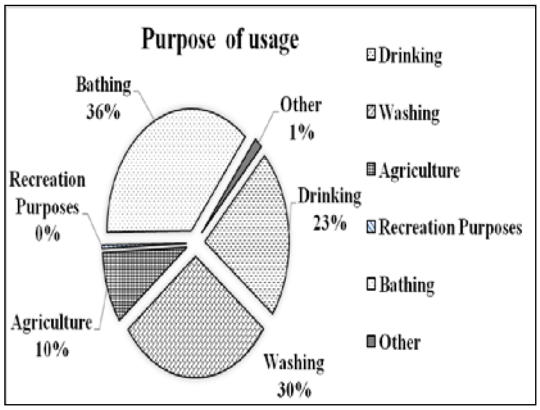


Figure 5: Purpose of using Menik River water

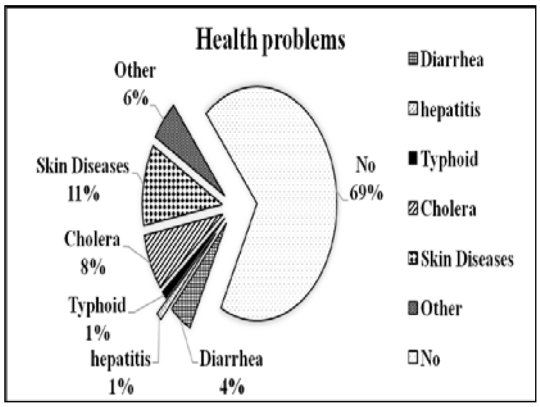
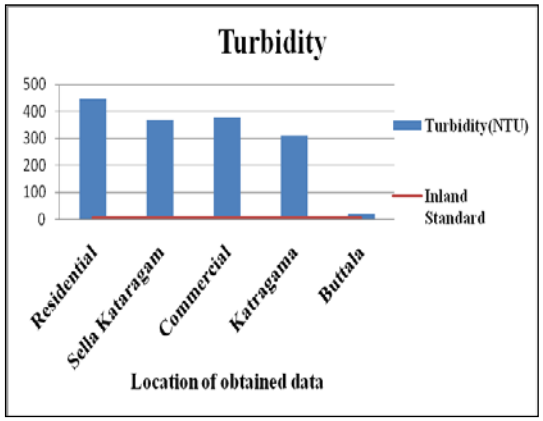


Figure 6: Health problem related to Menik River usage

Figure 6 shows the percentage of responses made for the question based on the experience about water borne diseases. As can be seen in Figure 6, majority of the respondent had no idea on different types of water borne diseases questioned in the questioner. However, out of the respondents who had an idea on health issues majority has experienced with skin disease which is followed by Cholera. Figure 7 shows the variability of key physio chemical water quality parameters between the four sites investigated at Kataragama, residential area, commercial area, Sella Kataragama and intake at Buttala. Table 1 shows the comparison made with recommended inland water quality standards in Sri Lanka.



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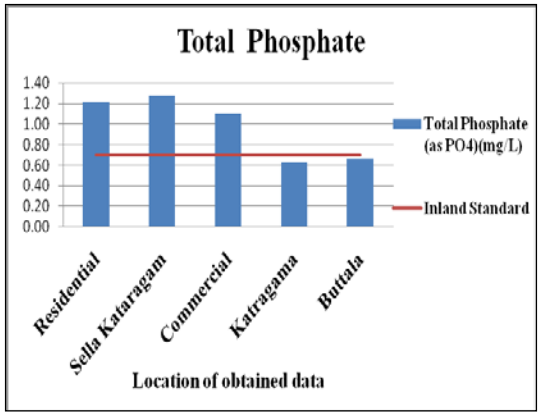

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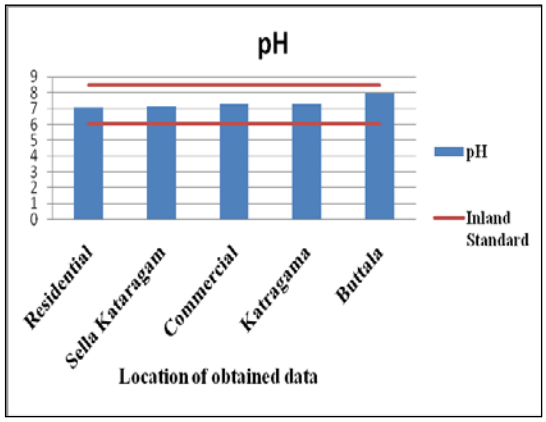

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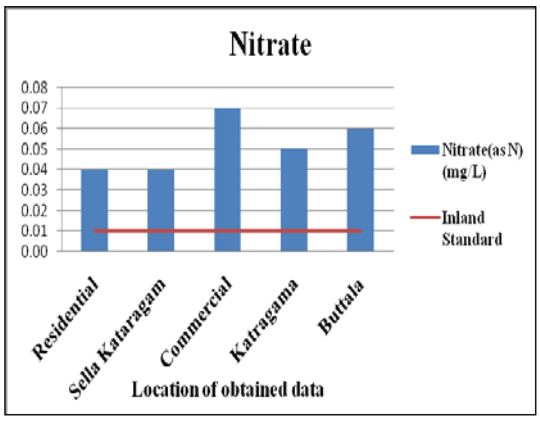

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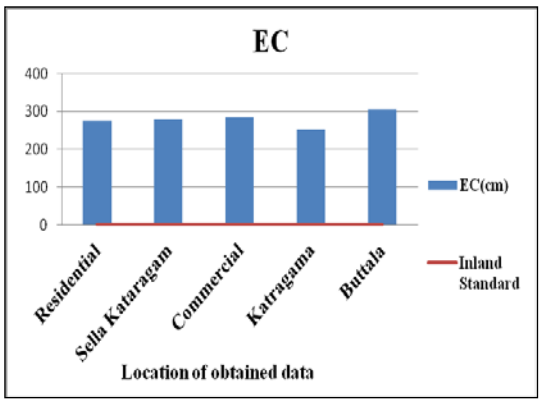

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Figure 7: Water sample parameters obtained from 5 different sites and tested from National Water Supply and Drainage Board

Table 1: Comparison of Inland Standard drinking water parameters with obtained average data.

Parameter	**Highest desirable limit**	**Average of 5 sites**
pH	6.0-8.5	7.34
Electrical conductivity (EC) at 25^0C µs/cm	0.7	279.34
Total Phosphate (as PO_4)(mg/L)	0.7	0.98
Turbidity(NTU)	5.0	303
Nitrate(as N) (mg/L)	0.01	0.05

As can be seen in Table 1, the average values of the parameters are higher than the highest allowable limit for inland drinking water quality standard. As can be seen in Table 1, turbidity and EC limit are significantly higher than the allowable limit, where as pH level is staying within the limit and nitrate and total phosphate values are also above the tolerance limit [6]. The turbidity in collected data sites are seen to be 60% more than the allowable limit. This indicates that the inadequacy and ineffectiveness of conventional water treatment facilities.

As can be seen in Figure 7 there is a considerable variation between Kataragama sites and Buttala for majority of the parameters. Most importantly, the turbidity at Buttala is significantly low compared to Kattaragama sites. This can be attributed to the difference in land use practices. Most importantly, solids build-up and hence the wash-off to Menik River could be much higher at Kataragama due to frequent vehicular activity. Furthermore, total phosphate concentration is considerably larger at Kataragama compared to Buttalla whereas Nitrate shows an opposite trend. Moreover, Buttala shows the highest values for both pH and EC. These differences can also be attributed to the difference land use practices. This indicates the importance of design of effective treatment procedures considering the land use variations rather stick into one conventional procedure for all the plants. It can be noted that the average values of the Nitrate, total phosphate, EC and turbidity are lesser than the standard data tolerance limits but pH level is just touching the maximum tolerance limit [6].

Figure 8 shows the PCA bi-plot obtained for the data collected at Kataragama and Buttala sites.

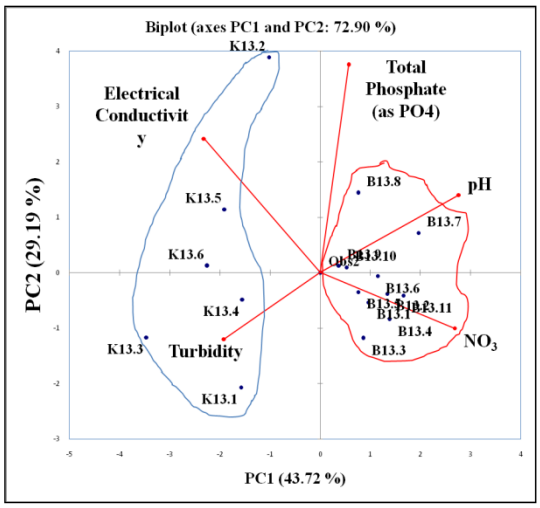

Figure 8: PCA bi-plot for Butttala and Kataragama sites

As can be seen in Figure 8, Kataragama and Buttala data are grouped in to two clusters. Most importantly, loadings of both Nitrate and Phosphate clearly discriminate the Buttala Site from Kataragama. This clearly indicates difference in the water quality in these areas and hence the influence of different land use practices on water quality as discussed above. In this context, consideration of non-point source pollution discharges such as storm water runoff is of vital importance in the implementation of BMPs to safeguard the water quality of the river. As can be seen in Figure 8, none of the variables show strong correlation. This indicates that these parameters should be considered as key indicators of water quality in the design of cost and time effective water quality monitoring programs.

4. CONCLUSION

Water quality of Menik River shows significant variation with time. Most of the people in the near vicinity of Menik River do not aware and not knowledgeable on the pollution of the river. This highlights the need for conducting regular awareness programs and cleanup activities in the catchment area through regional work groups and regulatory authorities. Furthermore, special control on the activities of pilgrims is of utmost importance to minimize the pollution caused by pilgrims. In this context, provision of only specific points along the river for their activities such as bathing and washing can be suggested. Research clearly indicates the influence of different land use practices on river water quality. This highlights the significance of consideration of differences in land use practices in the catchment when design and implementation of water treatment strategies. Moreover, results reveal the inadequacy and ineffectiveness of conventional water treatment facilities significantly in the context for Turbidity and EC treatment. Furthermore, in order to mitigate the water quality deterioration in the river due to different land use practices implementation of BMPs targeting the non-point source discharge such as storm water runoff can be strongly recommended.

5. ACKNOWLEDGEMENT

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