ASSESSMENT OF SPATIAL VARIATION IN WATER QUALITY: A CASE STUDY AT MORAGODA ELA, GALLE

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Abstract

In this study the water quality of Moragoda Ela located in the Galle town was analyzed using graphical and statistical analysis of the water quality data at 14 sampling points along the stream. Mean values of COD and BOD_5 were 127.5mg/L and 14.8 mg/L, respectively. Mean values of fecal and total coliforms were 47 and 23471 colonies/100 mL, respectively. BOD_5, COD and the total coliform content exceeded the ambient water quality standards for inland waters in Sri Lanka. The mean fecal coliform value did not satisfy the ambient standards of fecal coliform content for the activities other than irrigations and agricultural needs. Overall the water quality was lower than the demanded quality of water for many activities. The study revealed that the water quality deterioration was attributed to the illegal discharges from a large number of industries, institutions and commercial establishments, high population density and illegal community activities.

Keywords: *Water quality parameters, standards, effluent discharge.*

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1. Introduction[1]

In this study the water quality of Moragoda Ela located in the Galle town was an evaluated using graphical and statistical analysis of the water quality data at 14 sampling points along the stream. Mean values of COD and BOD_5 were 127.5mg/L and 14.8 mg/L, respectively. Mean values of fecal and total coliforms were 47 and 23471 colonies/100 mL, respectively. Prevailing BOD_5, COD and the total coliform content exceed the ambient water quality standards for inland waters in Sri Lanka. The mean fecal coliform value does not satisfy the ambient standards of fecal coliform content for the activities other than irrigations and agricultural needs. Overall the water quality is lower than the demanded quality of water for many activities. The study revealed that the water quality deterioration is attributed ato the illegal discharges from a large number of industries, institutions and commercial establishments, high population density and the illegal community activities.

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2. Methodology

Based on a site survey 14 sampling points (SP1, SP2... SP14) of different potentials for getting polluted were identified. Figure 1 shows the selected sampling points along Moragoda Ela.

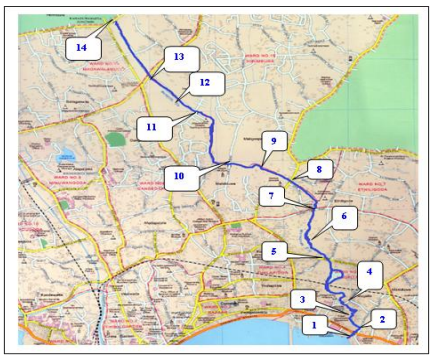

Figure 1 Sampling points {SP1 (at the mouth) ……SP14 (furthest point upstream)}

The following criteria were considered in identifying the sampling points: land usage such as industrial, institutional, commercial, residential and agricultural areas, general hydraulic conditions such as flow patterns, directions and apparent velocities , the locations of sewer outfalls along the stream, sanitary bypasses and the locations of solid waste deposits with a high content of organic silt and matter. Water samples collected from all the sampling points were analysed for several water quality parameters. Statistical and graphical analyses of the values of water quality parameters were used to quantify the extent of pollution of the stream. Principal Component Analysis (PCA) was used to obtain the correlation matrix of all the parameters. The same sampling protocol was used for all the parameters in order to maintain the consistency of sampling and to make all the results accurately comparable

3. Results and Discussion

The ambient water quality standards enacted by Central Environmental Authority (CEA) were obtained from Priyanka *et al*. 2007.The PCA plot in which the angle between two variables is inversely proportional to the correlation coefficient between those variables indicates that all water quality parameters of SP4, SP6, and SP12 are scattered. It implies that those three locations have a relatively similar pattern of water quality variation.

Temperature along the stream lies within a range of 25.9-29.6 ^{0}C. Temperature does not vary significantly along the stream. According to the PCA analysis, Temperature negatively correlates with BOD_5, COD, salinity, alkalinity and pH, while it positively correlates with turbidity. Pradhan et al. (2003) and Das, (2000) showed a positive correlation between temperature and each of turbidity and DO. The electrical conductivity values of first two sampling points which are close to the sea are over twofold higher than those of other locations.

Turbidity in water is caused by suspended matter such as clay, silt, and organic matter and by plankton and other microscopic organisms that interfere with the passage of light through the water Turbidity is closely related to total suspended solids (TSS), but also includes plankton and other

organisms. Figure 2 shows the variation of turbidity and TSS along the stream. Except three sampling locations (SP4, SP6 and SP7) there is the same variation pattern between turbidity and TSS. Hence turbidity can be used as a surrogate parameter for TSS analysis for Moragoda Ela.Samples was collected from SP3 and SP6 after a heavy rainfall. However the high rainfall has not affected much on the turbidity of the stream because there are sampling points with more turbidity than those two locations. The solid content in a stream largely depends on how frequently the water body gets affected by soil erosion and floods, and the amount of receiving decayed plants and animals. SP4 and SP13 have significant lower values of solids compared to the other sampling points. This is probably due to the fact that gabions have been placed in the stream banks and the area has a good vegetation cover

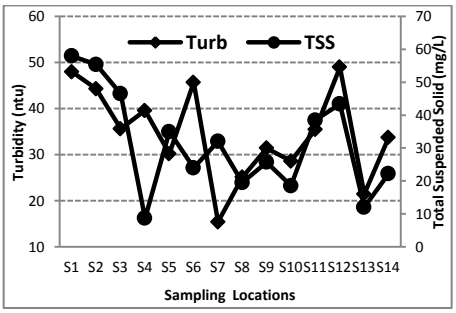

Figure 2 Variation of Turbidity and Total Suspended Solids

pH changes within 6.5-8.3 along the stream and it does not show a significant variation with the type of surrounding area. Alkalinity level lies within 90-365 mg/L. The highest value of pH is 8.30. Water with a pH of less than 4.8 or greater than 9.2 can be harmful to aquatic life, and alkalinity of 100-200 mg/L will sufficiently stabilize the pH in a stream (Mitchel, M.,2003). The alkalinity value of Moragoda Ela lies within this range and then scaling or corrosion potential of water is low. The drinking water standard for pH and the range of pH demanded by irrigation water lies within 6- 8.5. Significantly high values of alkalinity were observed throughout the investigation period at sampling point1 and 2. Das and Pandey (1978) stated that high alkalinity indicates pollution.

The permissible concentration of chloride for drinking water with simple treatment is 200mg/L and that for agricultural irrigation is 100mg/L (Priyanka *et al*. 2007). Hence the water in the reaches from SP6 to SP14 is suitable for agricultural irrigation in terms of chloride concentration (Figure 3).Sulphates of Moragoda Ela vary between 160-970mg/L (Figure 3). The maximum standard value of sulphate in drinking water with simple treatment is 250mg/L and for agricultural irrigation is 1000mg/L (Priyanka *et al*. 2007).The high sulphate concentration at the upstream of Moragoda Ela may be due to the discharge of detergent-laden sanitary water directly into the stream by the surrounding residential areas.

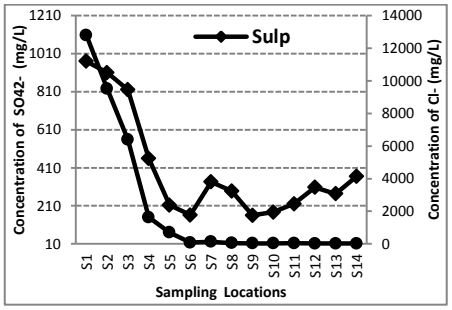

Figure 3 Variations of SO_4^{2-} and Cl^-

Minimum DO range that should be in a water body for its water to be used for domestic purposes, recreation and wildlife propagation is 2 mg/L (David H. Liu. et. al., 1997). BOD_5 is often used to evaluate the biodegradable fraction, and COD is the total organic pollution load of waters contaminated by reductive pollutants. As shown in Figure 4, DO concentration varies from 8.55 mg/L to 3.49 mg/L.SP7 experienced the lowest DO concentration. The same sampling location has the second highest BOD_5 concentration (Figure 5). Hence the low DO level may be attributed to the illegal discharge of slaughter house wastewater which is rich in biodegradable organic matter and suspended solids.

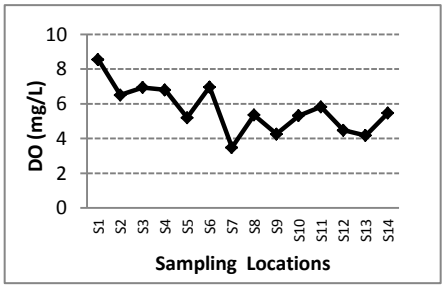

Figure 4 Variation of Dissolved Oxygen concentration

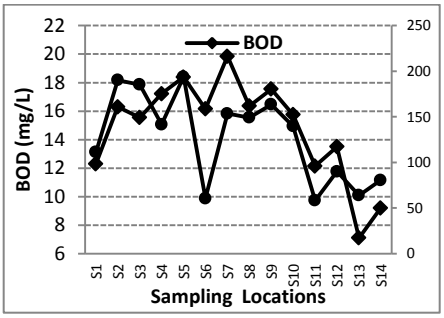

Figure 5: Variation of BOD_5 and COD

The COD and BOD_5 values of all sampling points except few are higher than the critical values which are 10 mg/L for BOD_5 and 20 mg/L for COD. Therefore the degree of pollution of this stream is high when compared with the permissible concentrations in a stream. Mean value of COD and BOD_5 are 127.5mg/L and 14.8mg/L, respectively. Prevailing BOD_5 and COD in Moragoda Ela exceed the ambient water quality standard for inland waters in Sri Lanka. According to Figure 5, COD concentration varies from 193.84 mg/L to 58.38 mg/L.

SP2 shows the highest BOD_5 and COD values. This point is at a bend of the river. It can reasonably be argued that this may be due to the accumulation of organic suspended solids at the bend. Both BOD_5 and COD are in a trend of decreasing toward the upstream. The lower COD value at SP14 implies that the illegal discharges from the cement industry may not have caused much effect on the increase of organic load into the stream. SP8 which is close to the pulp and paper industry has relatively high BOD_5 and COD values compared to the

locations of its upstream area. The pulp and paper industry discharges wastewater rich in COD and deficient in BOD_5. Therefore there may be another source of biodegradable organic matter at that point such as the discharge of domestic sewage. High values of COD due to accumulation of domestic sewage were reported by Mohan et al. (2007) ranging between 88 - 535 mg/L. Sharma and Gupta (2004) also found that the municipal waste water is responsible for maximum organic pollution, resulting in an increased BOD_5. There is an inverse relation between DO and oxygen utilization in terms of BOD_5 and COD. BOD gives a complete picture of the nature and extent of pollution and about the water quality (Kumar and Sharma, 2002).

4 Conclusions

It can be concluded that the water quality of Moragoda Ela was lower than the demanded quality of water that is used for domestic purposes, bathing and recreational activities. The degree of pollution decreased along the river from downstream to upstream. Different segments of Moragoda Ela have got polluted to different degrees. The level of pollution was highly dependent on the parameter of concern. Especially first three sampling locations which were near the sea experienced most of water quality parameters exceeding the demanded quality of water that is used for many activities. Those 3 locations possesed elevated values for chloride and sulphate concentrations, conductivity, salinity, alkalinity and hardness. Turbidity can be used as a surrogate parameter for TSS analysis for Moragoda Ela because there was a good correlation between the two parameters except at three sampling locations.The stream receives a high organic loading from the surrounding industries and residential and commercial establishments.

This may be the major source of pollution in the stream.The poor implementation of rules and regulations on wastewater discharge and less contribution by the government to maintain and clean those water bodies may also contribute to the existing pollution.

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