EFFECT OF URBANIZATION ON TEMPORAL AND SPATIAL VARIATION OF DISSOLVED OXYGEN CONCENTRATION IN A NATURAL STREAM: A CASE STUDU IN MEDA-ELA CANAL, KANDY, SRI LANKA

G. M. P. Kumara[1], A. C. S. Perera[1], I. P. S. K. Pelpitiya[1], M. M. J. G. C. N. Jayasiri[1], M. D. D. Perera[1], N. G. R. Saumyarathna[1], G. W. R. W. M. R. M. W. K. Kirinde[1], U. R. M. H. D. Rathnayake[1], R. P. S. P Chandrasiri[1], D. M. N Diyawadana[1], N. D. K. Dayawansa[2]and M. I. M. Mowjood[2]

[1]Postgraduate Institute of Agriculture, University of Peradeniya, Sri Lanka. Email: chathup87@gmail.com
[2]Department of Agricultural Engineering, Faculty of Agriculture, University of Peradeniya, Sri Lanka

ABSTRACT

Meda-Ela is a natural water stream which starts from Kandy Lake, runs across the city and merges with the Mahaweli River. Over the years waste water generated by industries, garages, laundry community, hospital, bus stand and residences in the catchment of Meda-Ela has been released to the stream depleting its natural beauty and making it a waste channel. High rate of urbanization in the recent years has worsened the situation. The objectives of this studyto investigate the temporal and special variation of the Dissolved Oxygen (DO) concentration along the Meda-Ela canal and determine land use change in Meda-Ela watershed during the past 50 years in each tributary. Water samples were obtained in the morning and afternoon at eleven different sampling points along the stream line starting from the Kandy Lake to the outlet of the canal in orderto estimate DO concentration. The results were compared with the past DO concentration data of the same sampling points in years of 2010, 2012, and 2013. Arc GIS 10.2 version was used to map the land use change in Meda-Ela watershed and sub watershed in 1972, 1980, 1992, 2003 and 2014. The reduction of DO is increasing and the points where DO concentrations decrease are situated in highly urban areas such as, Goodshed bus stand, hospital, prison and the central market. The runoff from the tributaries has contributed to increase the DO concentration at some crucial points but recently the contribution from tributaries has also decreased. The land use dynamics of the tributaries of Meda-Ela play a major role in its DO concentration and the streams health, unplanned and improper urbanization in the tributaries and Meda-Ela catchment will convert this natural stream to a waste water canal. Therefore a well-planned and managed urbanization is recommended for the protection of this urban stream.

Key words: Meda-Ela, Urbanization, Tributaries Contribution and re-aeration

1. INTRODUCTION

Meda-Ela is a natural water stream which originates from the spillover sluice of the Kandy Lake located at the center of Kandy. Meda-Ela runs across the Kandy city to its southern boundary over a length of about 6 km covering a catchment area of about 14.68 km^2 and drains into the Mahaweli River(Abeygunawardena et al., 2011). Population increase and rapid urbanization in recent times has resulted in a marked increase in settling of large number of residential houses, shops and commercial establishments and small scale industries in the catchment area of the Meda-Ela (Mowjood et al., 2011). Waste water generated from all these establishments are released into Meda-Ela stream, these discharges have an effect on Dissolved oxygen concentration (DO) along the Meda-Ela creating septic conditions (Perera, et al., 2013). The objectives of this study to investigate the temporal and special variation of the Dissolved Oxygen (DO) concentration along the Meda-Ela canal and determine land use change in Meda-Ela watershed during the past 50 years in each tributary and to investigate the temporal and spatial variation of the Dissolved Oxygen (DO) concentration along the Meda-Ela canal during last 4 years due to urbanization.

2. METHODOLOGY

Water samples were obtained in the morning and afternoon (9^{th} May 2010, 2013, 2014 and 24^{th} May 2012) at eleven different sampling points along the stream line starting from the Kandy Lake to the outlet of the canal to estimate DO concentration. Following table 1 and figure 1 show Sampling points (1, 2, 3, etc.) and distance to those points from Kandy Lake along the Meda-Ela. Wrinkler titration method was used to determine DO concentration in each samples and the results were compared with the past DO concentration data of the same sampling points in

years of 2010, 2012, and 2013. Arc GIS 10.2 version software was used to map the land use change in Meda-Ela watershed and each tributary during 1972, 1980, 1992, 2003 and 2014.

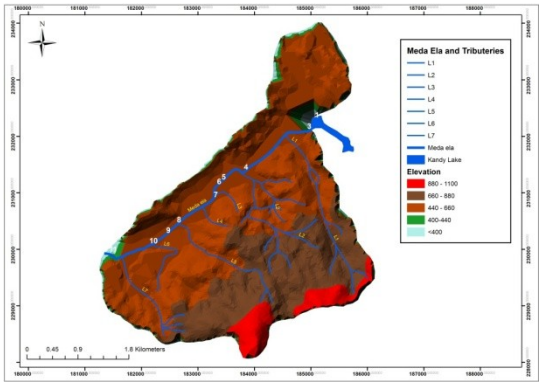

Figure 1: Sampling points along the Meda-Ela watershed

Table 1: Sampling points and distance

Sampling points	Distance from Lake	Sampling points	Distance from Lake
Kandy Lake	0	7. Near to the Fire Brigade	2000
Beginning of the Spill	90	8. Near Royal Moll	4350
End of the Spill	110	9. Near Court Complex	4680
Ground after Kandy Hospital	1600	10. New Lawyers Complex	4920
Before the Hospital treatment plant	1700	11. Outlet of the Canal	5620
After the Hospital treatment plant	1750		

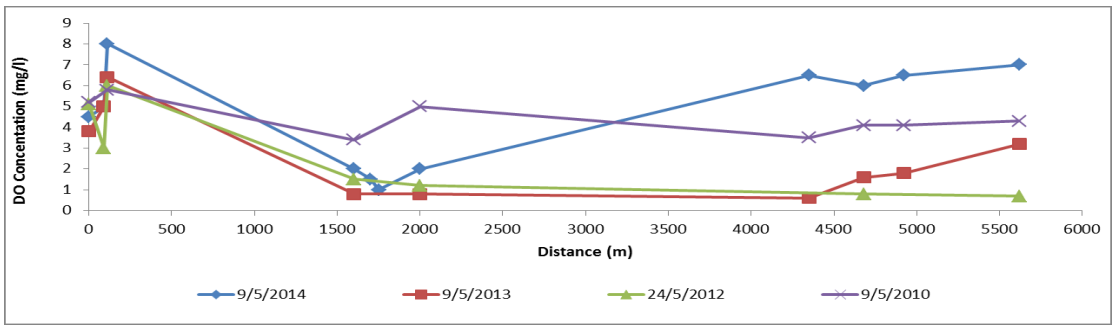

Figure 2: DO variation along Meda-Ela in Morning

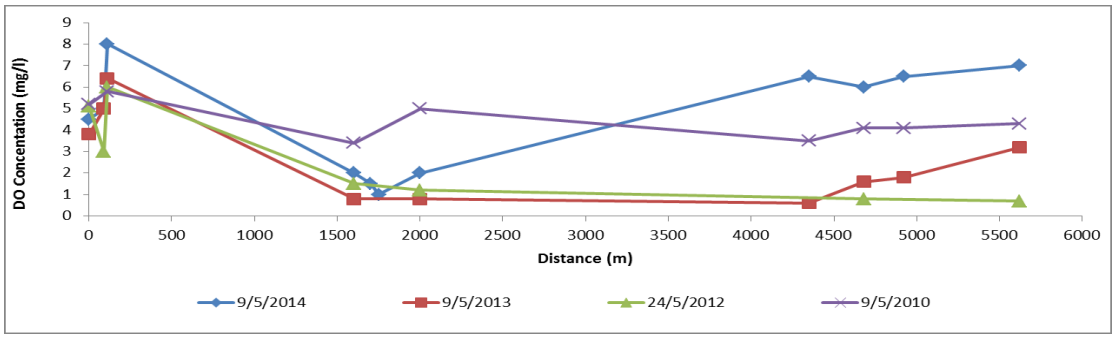

Figure 3: DO variation along Meda-Ela in evening

3. RESULTS AND DISCUSSION

As shown in figure 2, at Kandy Lake, the DO level was fairly intact for aquatic life, and the DO level rise high at sampling points 2 to 3 which are located just before the spill and after the spill, respectively. This could be due to water getting aerated with more oxygen dissolved after the spill at point 3, thus the DO concentration in sampling point 3 has reached to saturated DO value. There was a sharp drop in the DO concentration at sampling points from 3 to 4 and sampling point's 4 – 6 which acts as a septic zone, since no DO for aquatic life.

Tributary 2 (2T) is the biggest sub watershed in the Meda-Ela watershed and it have highest drainage density than other sub watershed (Kumara et al., 2014). According to the figure 4, 2T sub watershed suddenly urbanized during past 10 year period and it is the highly urbanized sub watershed in the Meda-Ela watershed.

Kandy hospital, laboratories, small industries, service station, clinical centers and high number of residences can observe in 2T sub watershed area.

The outlets of the 2T sub watershed and surface flow coming from Bus stand, Market, railway station locates in between sampling point 4-7and those samples recorded lowest DO concentration. The waste water generates form those places release to those natural and manmade canals and finally involved to reduce DO concentration in Meda-Ela.

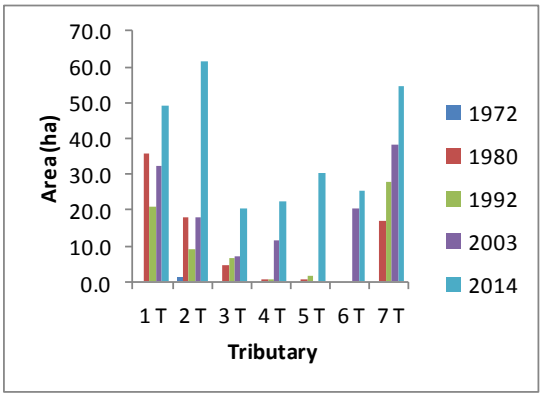

Figure 4: Urbanized area in each tributary during past 50 years

From points 8 – 11 the stream is slowly recovering its natural DO concentration and recovering from the pollution. This is due to re-aeration process and the contribution of tributary water which coming from high elevation area in the Meda-Ela watershed.

RF contributions to increase DO in Meda-Ela check with RF data during the month of May in each year. According to RF data in Figure 5, only 2014 sampling date evening experienced 6 mm RF and it involved to increase DO concentration in evening part. But in 2010, before two days to sample collection, watershed received more than 25 mm RF.

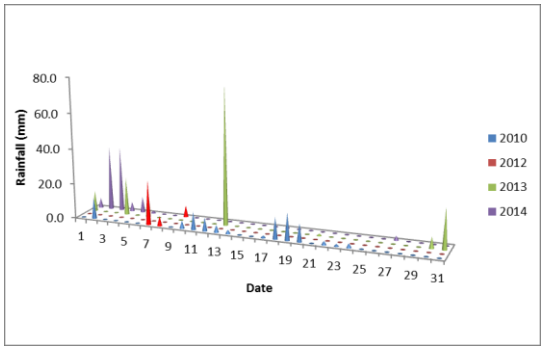

Figure 5: Rainfall distribution during month of May in MedaEla watershed

(Source: Kings Pavilion rainfall station, Kandy)
Due to that runoff water and base flow of those tributaries increasing DO concentration in Meda-Ela during that period than other three years. In2012 May month have zero RF and almost all the points recorded less DO concentration compare with other years.

3.1. Land use Change and Urbanization Rate in the Meda-Ela Watershed

Figure 6 show the land use in Meda-Ela watershed during past 50 years. According to that clearly can observe, land extend of urban areas is drastically increasing. Meda-Ela is the natural and lowest elevation area in Meda-Ela watershed involved to drain all water coming from direct surface flow area and sub watersheds. According to figure 7 the rapid urbanization rate recorded during past decade in all 7 tributaries. Then waste water and foreign materials release to those water bodies tremendously increase and ultimate result is decreasing DO concentration temporally and spatially along the Meda-Ela. During the past 4 year the DO concentration gradually decrease year by year without the effect of RF where the main reason is uncontrolled urbanization and the reduction of water flow through the Meda-Ela and

7 tributaries. Very recently observed two major tributaries (3T, 4T) were dry out due to land use change in each tributary sub watersheds.

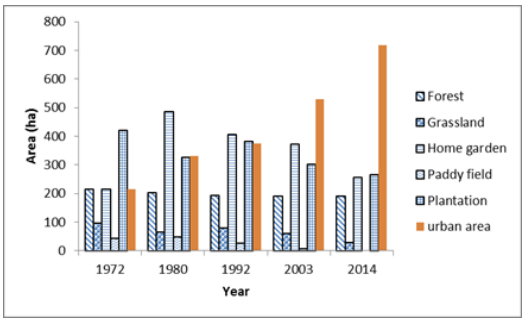

Figure 6: Land use change in Meda-Ela watershed

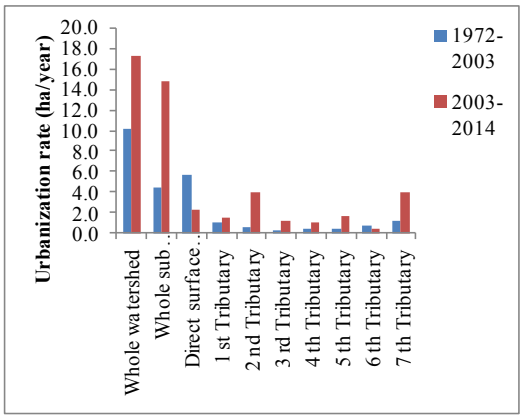

Figure 7: Urbanization rate in Meda-Ela watershed during past 50 years

4. CONCLUSION

DO concentration in Meda-Ela spatially and temporally varied due to land use change, urbanization and RF. Land use changes and rapid urbanization closer to sub watershed and direct surface flow areas mainly involve in spatial variation and RF contribution involve in temporal variation of DO concentration in Meda-Ela watershed. Rapid urbanization and anthropogenic activities along the Meda-Ela and tributaries drastically reduce its natural beauty and converting it to waste water canal rather than natural drainage during past decade.

RFEFERENCES

[1] A. W. G. N. Abeygunawardena, N. D. K. Dayawansa., and S. Pathmarajah, "*Socioeconomic Implications of Water Pollution in an Urban Environment: A Case Study in Meda-Ela Catchment in Kandy Sri Lanka*", *Tropical Agric. Res*. 22(4): 374-383, 2011.

[2] G. M. P. Kumara, A. C. S. Perera, I. P. S. K. Pelpitiya, N. D. K. Dayawansa, and M. I. M. Mowjood, "*Dynamics of urbanization and its impact on hydrology: A case study of Meda-Ela urban stream in Kandy, Sri Lanka*", 5th International conference on sustainable built environment 2014, Kandy, Sri lanka. ICSBE/14/247,pp 82-88, 2014.

[3] M. I. M. Mowjood, "*Why is Meda-Ela so murky?*", A case study. Illustrative Cases for Teaching IWRM. A compendium of ten illustrative cases from South Asia, SaciWaters, pp 8 -13, 2011

[4] A. C. S. Perera, I. P. S. K. Pelpitiya, M. I. M. Mowjood, and K. B. S. N. Jinadasa, "*Dissolved oxygen dynamics in a stream that flows through a city*", A case study in MedaEla in Kandy, Proceeding of the 4th international conference on structural engineering and construction management, Kandy, Sri Lanka.Pp 22-30, 2013.