Salinity, pH and Turbidity changes of water in the Negombo lagoon

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ABSTRACT

The Negombo lagoon is a lagoonal estuary, situated in the Gampaha District. It receives surface water runoff mainly from the Dandugam Oya, Ja-ela, Hamilton Canal, and the Dutch Canal. The present study was carried out to identify salinity, pH and turbidity of water in the lagoon during October 2012 and March 2013. Sampling was carried out in 20 locations.The overall average salinity levels of water varied between 15.34ppt and 15.53ppt in the surface and middle layers of the lagoon and 17.23ppt in the bottom layer. pH of water of all three layers fluctuated between 7.68 and 7.75. The highest overall average turbidity of water was 24.99 NTU that was recorded in the bottom layers. Average turbidity levels fluctuated between 10.44 NTU and 12.89 NTU in the surface and middle layers.Spatially, water salinity decreased from the outlet towards the southern periphery of the lagoon due to dilution. However, it was comparatively high in the south west region possibly due to the influx of water from the Hamilton Canal. Water salinity increased from top to bottom of the lagoon due to the density of water. In the northern half of the lagoon, a relatively high pH was observed. However, a considerable relationship of pH could not be identified from surface to bottom layers during the considered period. The turbidity of lagoon water demonstrated an increasing trend from the northern outlet towards the southern fringe. The water in the lagoon appears to be directly influenced by the sediment discharged by Dandugam Oya, Ja-Ela Canal, and Hamilton Canal. Based on the salinity, pH and turbidity of the wate,r the Negombo lagoon can be differentiated into two regions. Overall, the spatial distributions of salinity and pH levels of lagoon water have a negative relationship with turbidity.

Key words: Lagoon water, pH, Salinity, Turbidity

INTRODUCTION

Most coastal lagoons in the world are subject to contamination caused by unsustainable land use in the catchment and surrounding areas. Negombo in Sri Lanka is one of such lagoons that suffer from environmental stress. Anthropogenic activities and the development of urban centres on both sides of the Negombo Lagoon are prominent causes for this stress (Katupotha, 2012). The land's less poor have reclaimed land to construct unauthorized dwellings. This has affected the hydraulic regime of the lagoon causing the problem of increased sedimentation. The establishment of an industrial city in Ekala and a Free Trade Zone in Katunayake may have also had direct and indirect impact on the water quality of the Negombo lagoon (Silva, 1996). In addition, large quantities of solid and liquid waste are being dumped at various locations in the lagoon resulting in pollution problems (Hettiarachchi and Samarawickrama, 2011). As a result,

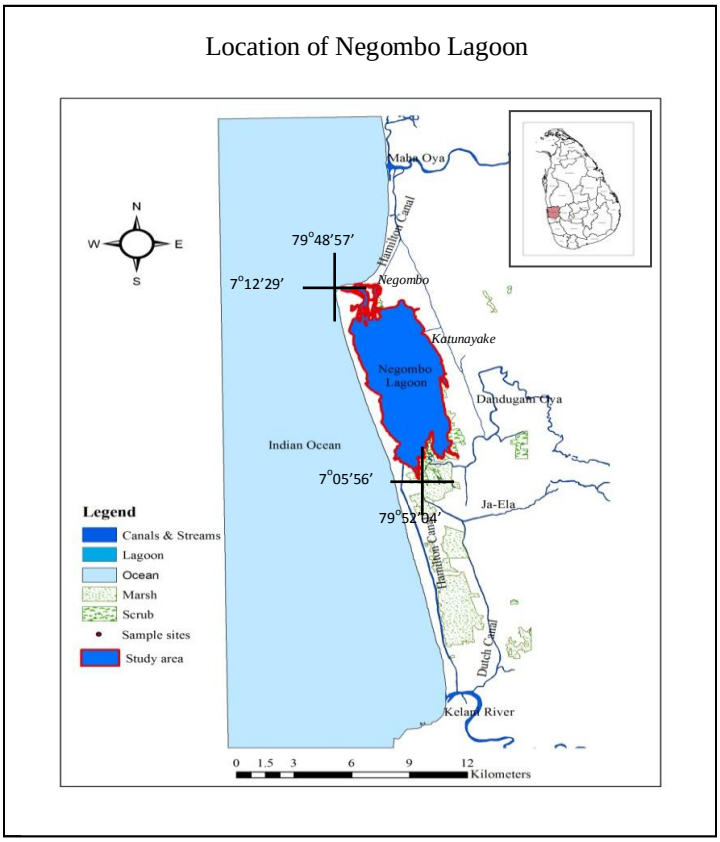
the water quality of the Negombo lagoon has deteriorated over the last few decades. (Wijesekara and Kudahetti, 2011).

Many gaps remain in the understanding of water resources in estuaries in Sri Lanka due to the lack of data and accurate information. The magnitude of salinity intrusion in the Negombo lagoon could not be assessed for a long period since appropriate data was not available (Silva, 1996). The lack of knowledge and information creates many issues for conservation management activities, preparation of development plans, awareness programs, restoration strategies and forecasting. Long-term observations and the collection and analysis of primary data will be useful to understand the existing situation and pressures on the lagoon environment and issues related to water resources. Surface water research requires systematic investigation (Wijesekara, 2010). The variability of salinity, pH, and turbidity is unique in estuarine lagoons. Hence the objective of this study is to estimate the long-term variation in water quality in the Negombo lagoon with respect to salinity, pH, and turbidity.

STUDY AREA

The study was conducted in the Negombo lagoon that is located in the Gampaha district (79^0 48' 57"- 79^0 52' 4"E and 7^0 5' 56" - 7^0 12' 29"N). Sampling was conducted from October 2012 to March 2013. The Negombo lagoon is a highly dynamic estuarine ecosystem that links to tides and river flow. The lagoon is part of an unique hydrological system that includes the Muthurawajawela marsh, Attanagalu Oya, Hamilton Canal, Dutch Canal and the adjacent coastal belt. The lagoon is about 3200 ha and is connected to the Indian Ocean by narrow canals to the north near Negombo town (Environmental profile, 1991). Tidal waves from the ocean side flow into the lagoon twice a day resulting in changes in the salinity of water (Conservation management plan, 1994). Fresh water enters from the southern end of the lagoon through the Dandugam Oya, Ja-Ela (Attanagalu Oya) and several streams from Muthurajawela marsh (Environmental profile, 1991, Hettiarachchi and Samarawickrama, 2011) (Figure-01).

Figure-01: Location of Negombo lagoon

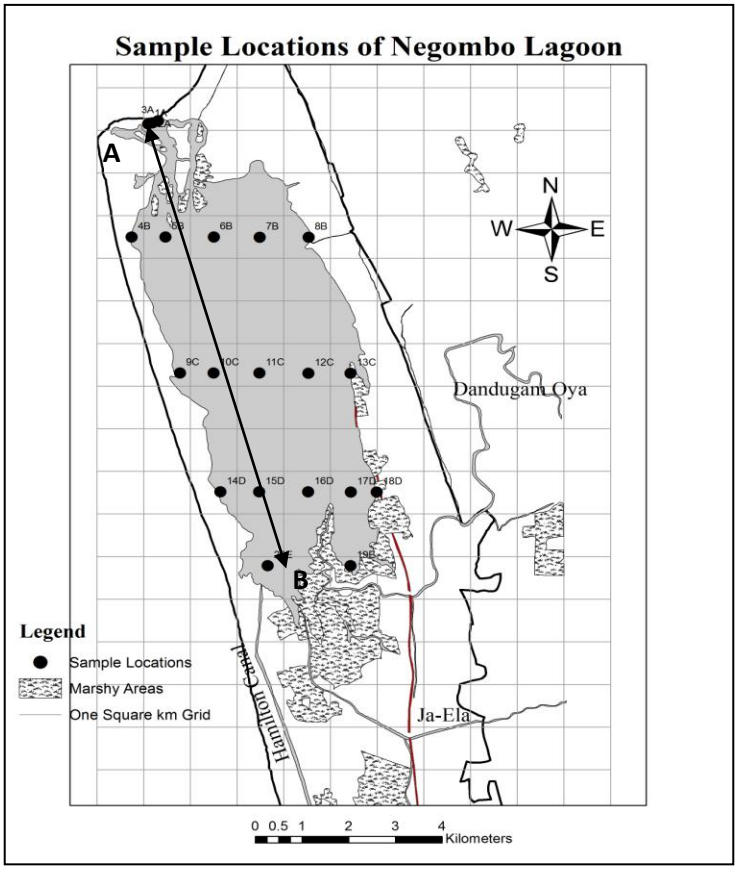


The lagoon has international significance for biodiversity and is a safe haven for migratory birds. Nevertheless, it is surrounded by already developed areas that have abiotic structures and dense settlements. It is threatened further by an excess of ongoing development activities in its immediate surroundings (Environmental profile, 1991). An increasing population, illegal encroachment, over exploitation of marine and brackish fisheries resources, and accompanying land use/cover changes are placing enormous pressure on the lagoon and its surrounding lands.

METHODOLOGY

A 1(one) km^2 grid map was superimposed on the study area to demarcate the locations of sample sites. Water sampling was carried out in three transects with a total of 20 sampling sites. The gap between each transect is about 3 km and that between sampling sites was 1 km (Figure-2).

Figure-2: Locations for water sampling in the Negombo lagoon



Absolute locations of the sample sites were identified using Global Positioning Systems (GPS). *In situ* field-testing of salinity, pH, and turbidity were carried out at monthly intervals during October 2012 and March 2013. Testing of water was carried out of surface, middle, and bottom water layers in each location. A portable YSI -63 Multi-Parameter was used to check salinity and pH measurements while turbidity was measured in Nephelometric Turbidity Units (NTU), using a 2100P Turbidity meter. Data analysis was carried out using the ArcGIS (version 9.3) software package along with Microsoft Excel analytical tools. The interpolation technique in ArcGIS was performed to prepare distribution maps. Results are presented in the form of graphs and maps.

RESULTS

Salinity

Overall average salinity levels of surface and middle layers of the lagoon water varied between 15.34 ppt and 15.53 ppt and was 17.23 ppt in the bottom layer (Table-01).

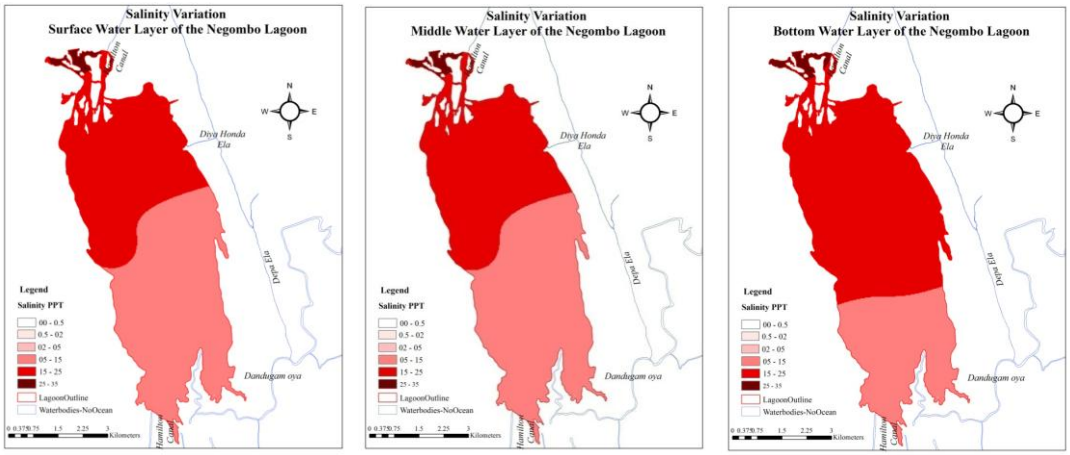
Table-01: Average levels of salinity, pH, and turbidity in Negombo Lagoon

Water layer	Salinity (ppt)	pH	Turbidity (NTU)
Surface	15.34	7.68	10.44
Middle	15.53	7.75	12.89
Bottom	17.23	7.72	24.99

Thus, the water can be considered to be brackish, rather than coastal water or inland water. Salinity levels were greater in the bottom-of-the-lagoon water column owing to density of the water. Spatially, the highest salinity readings were recorded in the first transect that are located at the outlet of the lagoon where averages fluctuated between 26.48 ppt and 26.60ppt. Salinity decreased in the last transect at the southernmost end where average salinity levels fluctuated between 5.833 ppt and 9.613ppt. This may be attributed to that fact that the Dandugam and Ja-Ela Oyas discharge freshwater into the Lagoon at this end (Figure-03, Figure-02, and Figure-06).

The highest salinity values were recorded in October 2012 while the lowest values were recorded in November 2012 during the study period. These results reveal that salinity levels are negatively correlated with precipitation (Figure-7). Furthermore, Silva, (1996) in his research on water quality in the Negombo lagoon, demonstrated that the annual variation of salinity reached a maximum during March-April and a minimum during May-June and November-December.

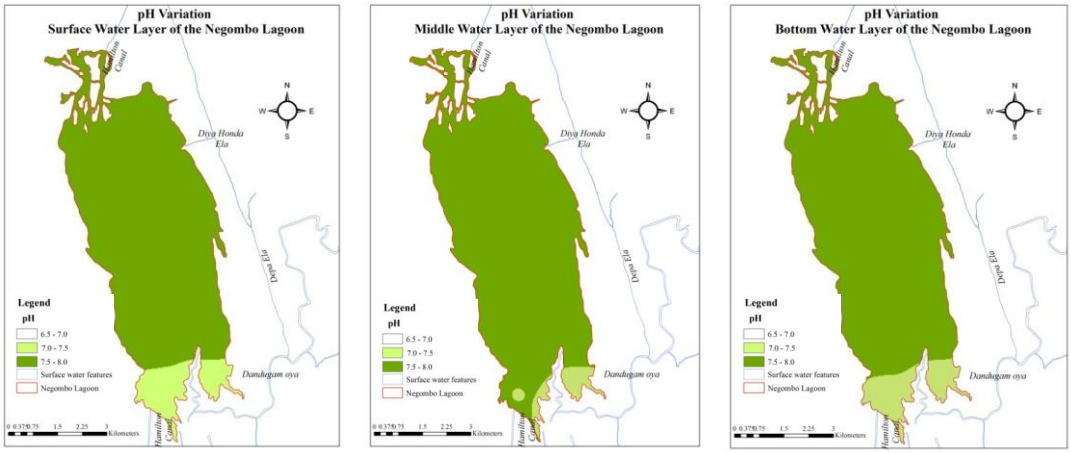
Figure-03: Average salinity variation in the Negombo Lagoon during October 2012 to March 2013



pH

Average pH levels of all three water layers of the lagoon fluctuated and remained between 7.68 and7.75 (Table-01). The highest pH values were recorded in the outlet area (at its northern tip) that varied between 7.84 and 7.99. Conversely, pH levels demonstrated a decreasing trend at the southern end of the lagoon where pH values fluctuated between 7.18 and 7.5 (Figure-04 and Figure-06). A significant relationship or changing pattern of pH between surface, middle, and bottom layers of the water could not to be identified; however, in November 2012 the pH levels were relatively low.

Figure-04: Average pH variation of Negombo lagoon during October 2012 to March 2013



Turbidity

Turbidity is a parameter that can indicate the presence of sediment in surface waters. The highest overall average turbidity of 24.99 NTU was recorded in the bottom water layer while overall average turbidity levels of surface and middle water layers varied between 10.44 NTU and 12.89 NTU (Table-01). Turbidity levels increased at the bottom layer due to suspended sediments settling on the lagoon bed. Turbidity values were low at the northern outlet and comparatively higher towards the southern end of the lagoon (Figure-05 and Figure-06). The variation in turbidity in the waters in the Negombo lagoon could be influenced by the suspended sediments transported by the influx of surface water from the Dandugam and Attanugallu Oyas (Environmental profile, 1991). Turbidity levels in the eastern end of the lagoon are influenced by soil erosion caused due to development activities (Figure-05 and Figure-09).

Individual estuaries often exhibit highly variable dimensions that depend on land use and management practices (Wood 1997). Further, Madduma Bandara *et al.*(1987) state that as a result of depositional processes, the total area occupied by the lagoon had decreased. Excessive siltation has taken place in the Negombo lagoon resulting in the loss of about 25% of its surface area during the last three decades (Hettiarachchi and Samarawickrama, 2011) The sedimentation rate in the lagoon appears to be about 1.5mm/y (Environmental profile, 1991). Heavy sediment loading into the lagoon was apparent and it will exacerbate the siltation of the lagoon bed (Silva, 1996).

Figure-05: Average turbidity variation of Negombo lagoon during October 2012 to March 2013

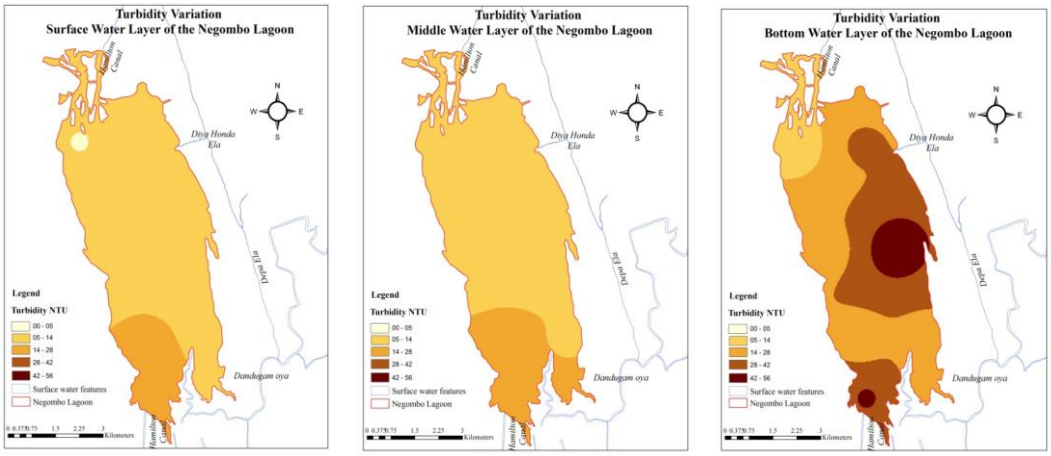
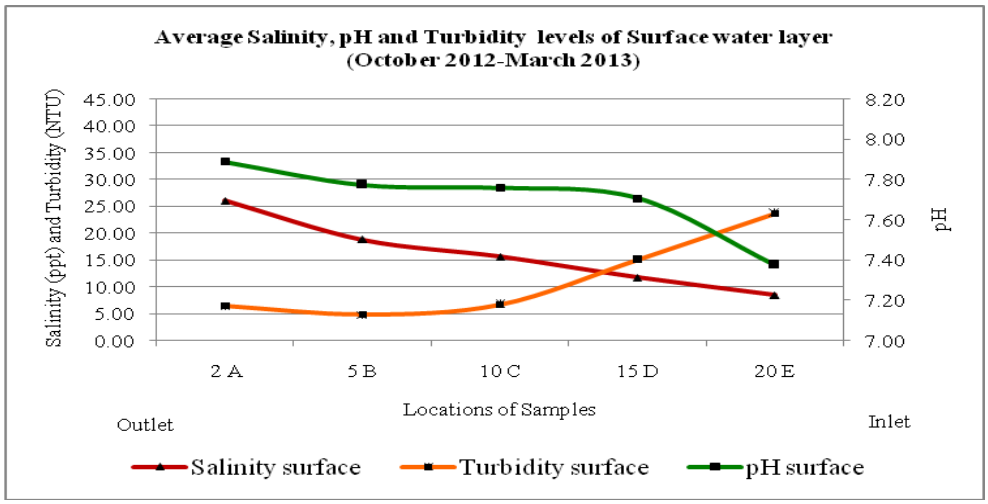
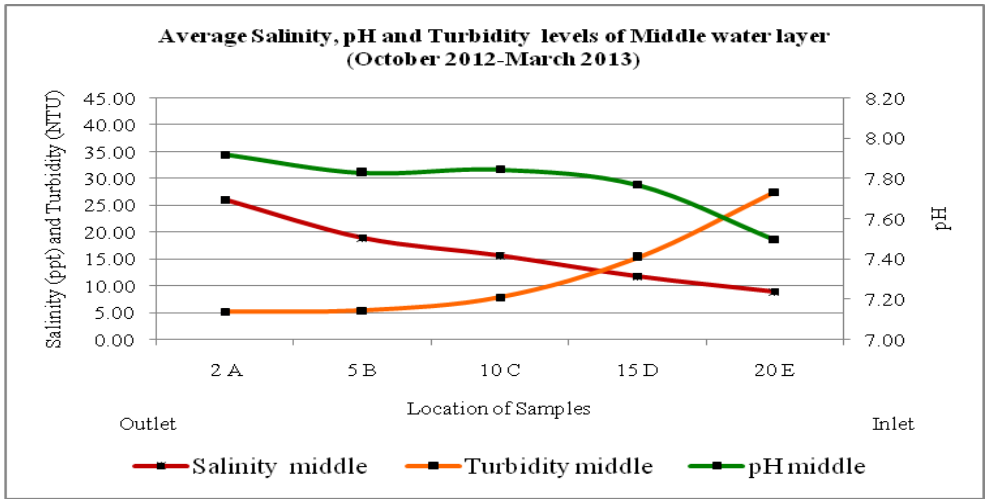


Figure-06: Spatial variation (AB cross-section in figure-02) of average salinity, pH, and turbidity in Negombo lagoon.





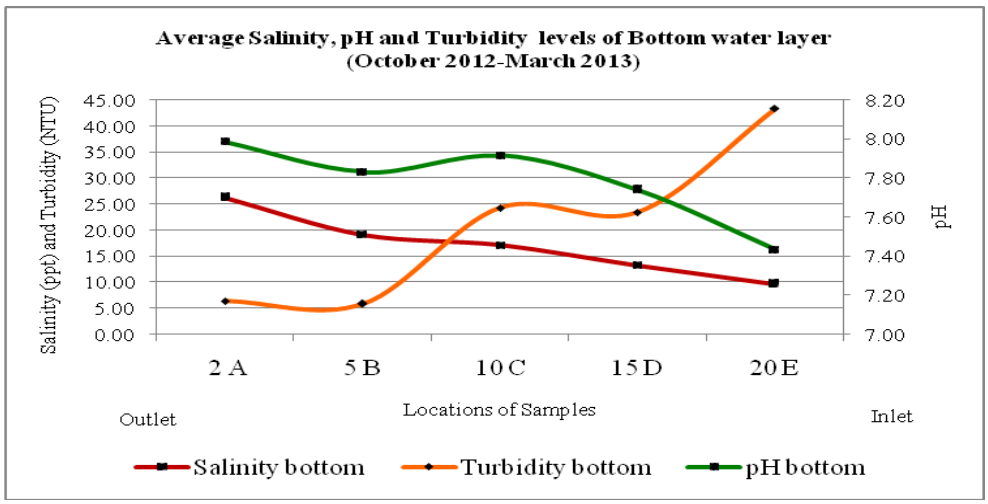


Figure-07: Spatial and monthly variation of salinity in Negombo lagoon along AB cross-section in figure-02

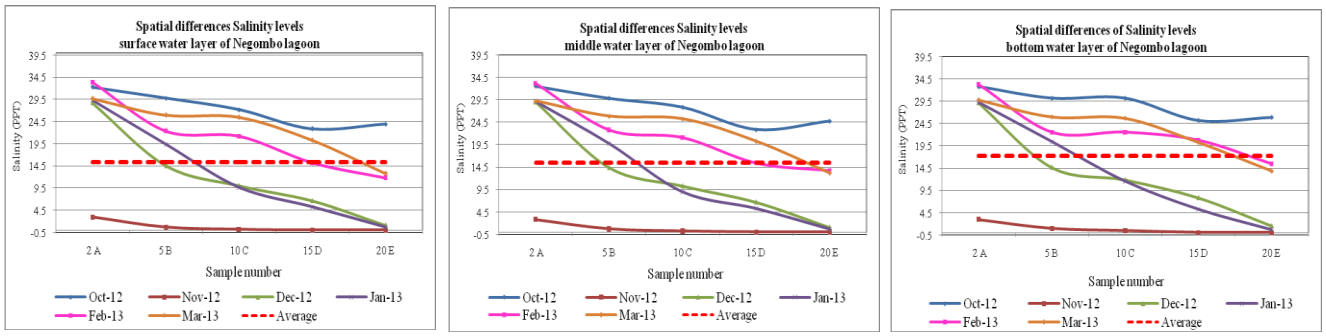


Figure-08: Spatial and monthly variation of pH in Negombo lagoon along AB cross-section in figure-2

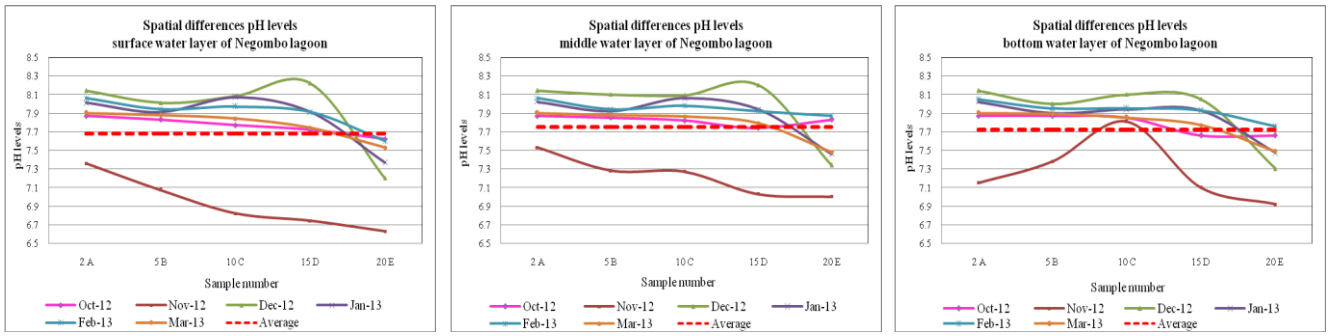
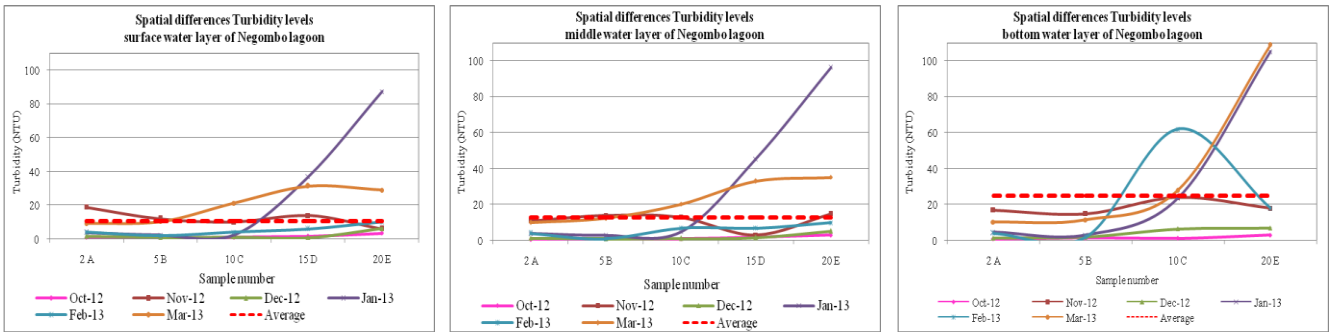


Figure-09: Spatial and monthly variation of turbidity in Negombo lagoon along AB cross-section in figure-02



CONCLUSION

The Negombo lagoon is subject to the intense fluctuation of salinity levels due to the inflow patterns of surface waters that in turn vary with seasonal precipitation and evaporation.

The turbidity of lagoon water is highly sensitive to surface run off and land use changes of the surrounding area. A negative relationship can be established between the salinity and pH of water with turbidity levels in the lagoon.

The salinity levels of the lagoon water are higher at the surface and decrease at the bottom of the lagoon owing to the density of the water. Conversely, turbidity levels of the lagoon water are higher at the bottom and decrease towards the surface water layers due to settling of suspended sediments.

RECOMMENDATION

Long-term monitoring of water quality parameters is necessary to assess changes, and to differentiate impacts related to human activities and natural processes.

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