Assessment of Heterogeneity of Soil and Water Characteristics of Kala Oya Estuary from River Mouth to River Fall

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Abstract

Assessment of the heterogeneity of soil and water quality characteristics from river mouth to river fall of Kala Oya estuary on North-Western coast of Sri Lanka for a period of four months from March to June 2017 was carried out. The objective is to determine the primary soil characteristics including Total Organic Matter Content (TOC), Moisture content, Soil pH while water quality characteristics such as pH, Dissolved oxygen, temperature and electrical conductivity in three locations at three different distances [river mouth (0m), mid estuary (691m), river fall (1880m)]. Although there is no significant difference in TOC in 3 sites ($p<0.05$, one way ANOVA). Slight variations were recorded with the highest value of (2.76±0.27) at river mouth. According to Principal Component Analysis (PCA), river mouth was indicated with higher bulk density, soil pH, and electrical conductivity whereas the higher organic content and moisture content were characterized by the mid of the estuary. Thus there were variation in the physico-chemical parameters in water and soil across the river mouth to river fall in Kala Oya estuary.

Keywords: heterogeneity, physio-chemical parameters, Kala Oya estuary

Introduction

An estuary is very rich in biological production exhibits heterogeneous nature (Silva, Jennerjahn and Ittekkot, 2005). Largest and least disturbed riverine mangroves in Kala oya estuary exhibits floral species zonation (Amarasinghe and Perera, 2017). As physico-chemical factors of soil and water influence on the flora and fauna composition on an ecosystem (Atwell et al., 2013) such information is required in planned restorations and conservation of an ecosystem. So the present study was carried out with objective to determine primary soil and water characteristics at three different distances [river mouth (0m), mid estuary (691m), river fall (1880m)]. Detailed hydrological studies and physico-chemical investigations of soil and water in different seasons could assist in detailed mapping of Kala Oya estuary.

Literature review

Kala oya estuary is a bay estuary which borders the Wilpattu National park on the north-western coast of Sri Lanka and are kept minimal destructive human intervention. It supports the largest and least disturbed riverine mangrove ecosystem in Sri Lanka (Central Environmental Authority (CEA), 2006). A large amount of freshwater received from trans-basin Mahaweli river diversion scheme is controlled by the water-holding ability of the tank system within the Kala Oya basin (Amarasinghe and Perera, 2017). The tidal flood which impacts the soil characteristics include abiotic factors such as salinity, redox potential/oxygenation, and physical and chemical properties of water (Wan, Wan and Hedgepeth, 2015) that control species zonation of mangroves (Saha and Choudhury, 1995). Switching water tables towards surface, increased the volume of freshwater in Kala Oya reduced salinity in estuarine water. As a result the freshwater aquatic flora species increased (Atwell *et al.*, 2013). Although there was a salinity gradient observed in estuary generally because of the high freshwater supply but this gradient could vary from evaporation, winds and tidal mixing (Atwell *et al.*, 2013).

Methodology

Table 3: Basic information about the study sites at Kala Oya estuary

Site	Location	Distance
1	$8^0$17' .752' N; $79^0$50' .034' E	0m
2	$8^0$17' 14.0" N; $79^0$50' 44.0" E	691m
3	$8^0$16' 37.5" N; $79^0$50' 44.0" E	1880m

The study was carried out in three locations at different distances [river mouth (0m), mid estuary (691m), river fall (1880m)] in Kala Oya estuary. Data were collected from March to June 2017. In each sites three stands were selected. In order to gather data on soil and water quality characteristics, randomly selected places in the forest (1 Km distances from each site) were considered. By using the soil corer soil sample were collected up to 15 cm depth. In each stands six samples were collected randomly for soil and water analysis. Samples were labelled and preserved at 4^0c for lab analysis. The water quality parameters pH, dissolved oxygen, electrical conductivity, temperature were measured in-situ using pre-calibrated multiparameter (EUTECH: CyberScan PCD 650)

Soil pH, temperature of the soil were measured in the field using FieldScout Soilstik pH meter while carbon content, moisture content, bulk density were measured in the laboratory using standard. Soil moisture content was analysed through oven dry method where soil samples were kept at 105^0c for 24 hours until constant weight gained. The bulk density of soil was determined by core method described by McKenzie. The carbon content was measured using the standard method proposed by Walkley and Black (1934). Chromic acid wet oxidation method, where organic carbon in the soil sample was oxidized by 1 N potassium dichromate solution ($K_2Cr_2O_7$) in concentrated sulfuric acid.

The statistical analysis was done using MINITAB 14 statistical software package. The physico-chemical parameters of soil and water were analyzed using one-way ANOVA test. Principal component Analysis (PCA) was performed to study the categorization of three different sites.

Results

The table.2 summarizes the physiochemical characteristics obtained in this research. Soil pH, soil temperature, bulk density shows significant variation each site.

Table 4: The variation of mean ± standard error of mean (SEM) of physico-chemical parameters of water and soil

Parameters	Site 1	Site 2	Site 3
Soil pH	5.98 ± 0.10^{ab}	6.19 ± 0.15^{a}	5.67 ± 0.14^{b}
Soil temperature	29.56 ± 0.18^{a}	28.42 ± 0.17^{b}	28.92 ± 0.19^{b}
Organic matter content	1.85 ± 0.34^{a}	2.33 ± 0.34^{a}	2.76 ± 0.27^{a}
Moisture content	44.75 ± 5.10^{a}	57.95 ± 4.77^{a}	55.55 ± 3.65^{a}
Bulk density(g/cm$^{3)}$	1.12 ± 0.12^{a}	0.62 ± 0.13^{b}	0.64 ± 0.06^{b}
Water temperature	21.72 ± 3.74^{a}	29.92 ± 0.23^{a}	21.11 ± 3.18^{a}
Water pH	4.53 ± 0.78^{a}	6.36 ± 0.06^{a}	4.64 ± 0.70^{a}
Electrical conductivity	35.95 ± 6.21^{a}	31.23 ± 0.56^{a}	38.30 ± 7.16^{a}
DO	2.80 ± 0.55^{b}	5.65 ± 0.22^{a}	4.02 ± 0.66^{ab}

For each parameter, mean values indicated by different superscript letters at each row are significantly different from each other ($p<0.05$)

Table 5: Summary of the Eigen values, Eigen vectors and PCA scores of 3 sites based on physico-chemical parameters in the study area

Eigen analysis of the Correlation Matrix					
Eigenvalue	7.4849	3.5151			
Proportion	0.680	0.320			
Cumulative	0.680	1.000			
Eigenvectors (Coefficient in the linear combinations of variables making up PC's)					
Variable	**PC1**	**PC2**	**PC3**	**PC4**	**PC5**
Soil pH	0.273	-0.354	-0.173	0.290	0.207
Soil Temperature	-0.320	-0.257	-0.157	0.353	0.215
Organic matter content	0.044	0.529	0.286	0.414	-0.416
Salinity (ppt)	0.333	-0.219	0.030	0.027	-0.299
Moisture	0.257	0.379	-0.053	0.026	0.622
Bulk density (g/cm3)	-0.221	-0.425	0.163	0.017	-0.322
Water temperature	0.362	-0.079	0.014	-0.404	-0.135
Water pH	0.365	-0.017	-0.068	0.631	-0.114
Electrical conductivity	-0.334	0.216	-0.782	0.046	-0.236
DO	0.343	0.184	-0.357	-0.230	-0.266
Salinity	-0.318	0.262	0.298	-0.042	-0.007

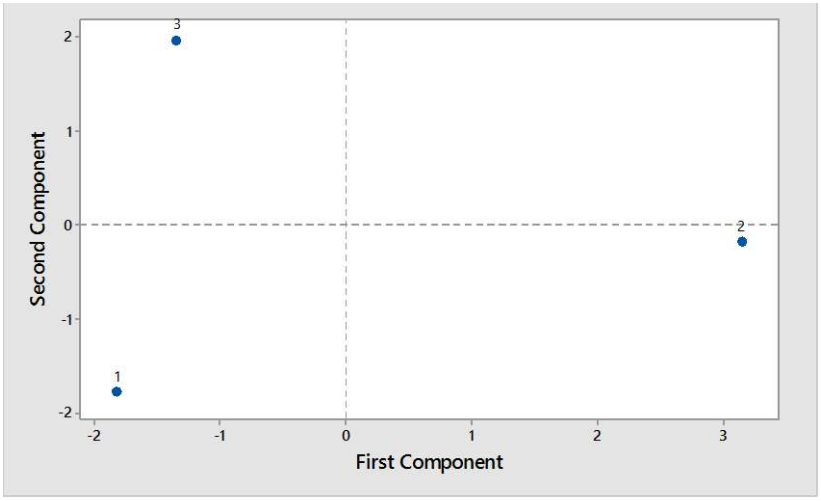

Figure 3: Ordination of the study sites of PC1 and PC2 scores of Principle component analysis based on physic-chemical parameters in the study area

The results of the principal component analysis based on the physical and chemical parameters of soil and water in the three different sites is given in Figure 1. The eigenvalues of the first two principal components, eigenvectors of the water quality parameters and the principal component scores for the study sites are given in Table 3.0. Two principal components displaying a cumulative variance of 100% were obtained after applying PCA on soil and water parameters (Table 5). According to the results of the PCA on soil and water quality parameters, the Site1 (River mouth) was characterized by higher bulk density, soil pH, and electrical conductivity. The site 2 (Mid

estuary) was characterized by high organic matter content and moisture content (Table 5, Figure 3)

Discussion

The study initially revealed that there was a variation in physico-chemical characteristics in this estuarine area. The results of this study indicated that organic content shows significant difference in relation to distance from river mouth ($p<0.05$). Among the distance from the river mouth TOC was low (1.85 ± 0.34) near river mouth possibly due to frequent wash off from tides and floods in that area. This contribution varies under different climatic and environmental conditions. Perera, Sumanadasa and Amarasinghe, (2012), reported the species wise contribution of carbon retention function in some mangrove areas in Sri Lanka

Grand mean of bulk density was 0.792g/cm3 with the different three sites. River mouth shows highest bulk density ($p<0.05$) when compared with mid estuary and river fall. This may be justified by the thumb rule that organic matter content and bulk density were irreversibly related with loose, well aggregated, porous soils which were rich in organic matter resulted in low bulk density.

Conclusion

There were variations in DO and soil parameters such as soil pH, Soil temperature, and bulk density in between the three locations studied. Hence, the characteristic of soil and water varies dependant to the distance and influence of tidal action.

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