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Diversity of Mangrove Species in Kala Oya Estuary in Sri Lanka.

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Abstract : *Mangroves are unique ecosystem distributed among the tropical areas in the world. The study was carried out in Kala Oya estuary in Puttalam lagoon, to identify and assess the distribution pattern of mangrove diversity. Field survey was carried out to collect primary data. Vegetation sampling was performed for 15 quadrants along the periphery of lagoon and estuary. Sample size was 5m ^{x}5m quadrants. Water samples were collected at the sample points for salinity measurements. Shannon - Wiener diversity index was calculated for mangrove diversity. IDW interpolation in Arc GIS 10.1 version and MS Excel 2013 version were used to perform mappings and data anlysis.5 mangrove species identified belonging 4 genera and 4 families in the study area. Rhizophora apiculata, Rhizophora mucronata, Sonneratia alba, Avicennia marina were enumerated true species and Pemphis acidula were the common mangrove associate species that could be seen in Kala Oya estuary. Spatially highest mangrove diversity could be identified in middle areas of the belt. Low diversity could be identified at the proximity of fresh water. Mangrove diversity has been reduced in Kala Oya estuary as a consequence of natural and human interference on mangroves.*

Key words: Diversity, Kala Oya estuary, Mangrove, Spatial distribution

1. Introduction

Since 18th century the flora of Sri Lanka has been studied by many profound botanists. A Dutch botanist Paul Hermann made a collection of plants of Sri Lanka and published it as "Flora Zeylanica" in 1747 [1]. Based on the phytogeographic distributional patterns, 15 significant floristic regions have identified by Ashton *et al* in 1987.The first floristic region is 'coastal and marine belt' which is consist of marine, mangroves, salt marsh, sand dunes and strand vegetation characteristics. The current extent of mangroves in Sri Lanka is around 4000ha -10000ha [2]. Approximately 23 true mangrove species have been identified in Sri Lanka [3]. In Sri Lanka mangroves can be categorized into four groups as very common species, common species, rare species and very rare species. *Avicennia marina, Avicennia officinalis, Excoecaria agallocha* and *Lumnitzera racemose* can be identified as very common species. Common species are *Rhizophora mucronata, Rhizophra apiculate, Bruguiera gymnrrhiza* and *Sonneratia caseolaris*. *Bruguiera cylindrica, Exoecaria indica* and *Sonneratia alba* are among rare species while *Scyphiphora hydrophyllacea, Pemphis acidula* and *Cynometra iripa* can be identified as very rare species [4].

Mangroves are one of the most threatened ecosystems confined only to lagoons and estuaries, located along the narrow belt of the coastal periphery in Sri Lanka. Largest mangrove areas in Sri Lanka are; Puttalam lagoon, Jaffna lagoon and Batticaloa lagoon. As the second largest lagoon in Sri Lanka, Puttalam estuary occupies the largest extent of mangroves in Sri Lanka. The current extent of mangroves in Puttalam estuary has been estimated as 2197 ha approximately including the islets in the lagoon [5]. According to the distinct differences with respect to the net ground productivity of mangroves in Puttalam estuary mangroves species can be broadly categorized into two types as fringing mangroves and riverine mangroves [6]. Riverine mangroves can be seen in Kala Oya and Mi Oya estuaries while fringing mangroves exists along the coast of the lagoon and in islets [6]. 13 true mangrove species and 18 associated mangrove species have been recorded in Puttalam lagoon [5].

Kala Oya located in the dry climate zone in Sri Lanka accounts for 20% of total brackish waters in the country [7]. Dense mangrove forest is located around Kala Oya estuary in the Puttalam Lagoon is the least disturbed mangroves in Sri Lanka [7, 8] which extends over 1200ha [8]. However considerable changes could be identified with the diversion of water from Mahaweli river basin, for irrigation [7]. Due to various consequences mangroves have been degraded in the area. Concerning the ecosystem services of mangroves and the least disturbance level in Kala Oya estuary it is quite important habitat to conserve riverine mangroves for future sustainability. The aim of the

study was to find out the diversity of mangroves in Kala Oya estuary. It is timely important to identify the diversity of mangroves as it is vulnerable for many threats including climate change.

2. Methodology

2.1. Data collection

The study was mainly based on primary data. Sampling for mangrove vegetation followed a belt transect method. Figure 1 shows the study area map. Total of 15 randomly selected samples were located along the costal periphery of the riverine mangrove forest. Vegetation sampling was carried out in each area by using 5m ^{x} 5m quadrants. Species identification was carried out according to the book 'Field guide to common trees and shrubs of Sri Lanka' and observed mangrove species at Kalpitiya and Seacology nurseries. Testing of water was carried out at the same sample sites. Accordingly 15 water samples were collected for testing. Saltiness or dissolved salt content, pH, electric conductivity and temperature of the body of water studied by testing estuarine water as it is an extremely important ecological factor.

2.2. Data analysis

Shannon-Wiener diversity index calculated to find out the diversity of species which is an information theory index under non parametric indices.

$$H = -\sum_{i-l}^{s} Pi \ln(Pi)$$

The value of the H is range from 1 to 5. Higher the value of H higher the diversity and lower the value of H lower the diversity. Abundance of species also presents by the equitability of Shannon index. The equitability (E_H) of Shannon index can be calculated by

$$EH \text{ ¼ } H=Hmax \text{ ¼ } H=ln\ S$$

Shannon's equitability (E_H) can be calculated by, where (E_H) is evenness , H is Shannon 's diversity index and Hmax is the maximum value of H. Value of (E_H) range between 0 to 1. The higher the value of (E_H) indicates the less variation in the community between species.

Arc GIS 10.1 version and Microsoft excel 2013 version were used to perform spatial distribution mappings and data analysis respectively. The results are presented in the form of tables, graphs and spatial maps.

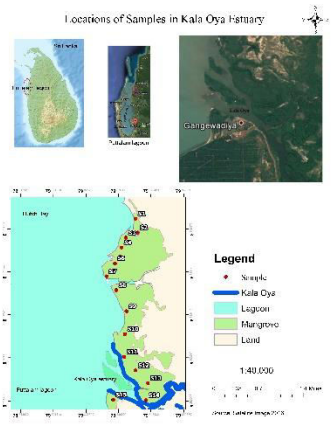

Figure 1. Study area

Source: Designed by the researcher, 2016

3. Results and discussions

3.1. Richness, diversity and abundance of mangrove species

Total of 64 individual mangrove species were enumerated in the area. Figure 2 and table 1 shows the mangrove floristic composition in the study area. 35 species of them belong to true mangrove species while remaining 29 species belong to mangrove associates. Total of 5 mangrove species identified belonging 4 genera and 4 families along coastal periphery of the riverine mangrove forest as shown in figure 3. Four of them are true mangrove species while remaining specie is a mangrove associate.

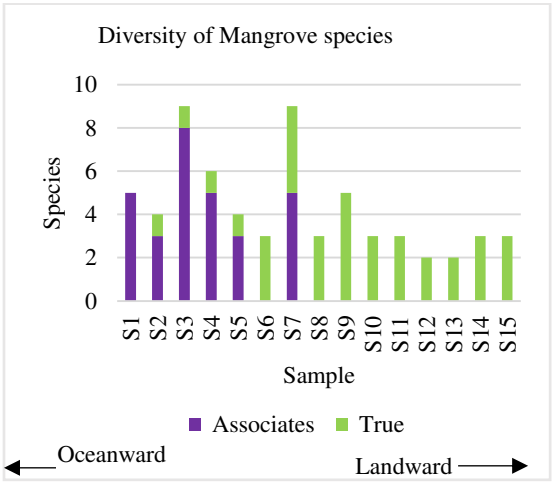

Figure 2. Mangrove species in Kala Oya estuary

Source: field survey, 2016

Table 2 shows the diversity and abundance of mangrove species. Generally diversity of

mangroves ranged from 0 to 1.3 as shown in figure 8.The highest diversity was recorded from sample seven, eight and nine. The identified areas were occupied by different true and associate species including *Rhizophora mucronata, Sonneratia alba, Avicennia marina* and *Pemphis acidula*. The lower diversity of mangrove species could be identified at the proximity of fresh water. Abundance of *Rhizophora apiculata* (Maha Kadol) identified close to the inlet of the lagoon. *Pemphis acidula* was identified as the dominant mangrove associate species in the area. *Pemphis acidula* (Muhudu wara) grows in sandy soils which is categorized as a very rare mangrove species in Sri Lanka. The specie can be used for landscaping as a bonsai tree. *Sonneratia alba* also known as a rare species restricted only to four sample plots. Generally *Sonneratia alba* prefers high saline water. The fruit of *Sonneratia alba* are not edible as the fruit is very tough.

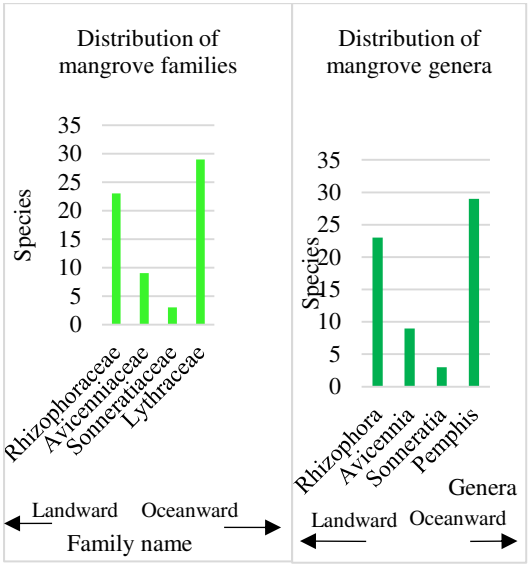

Figure 3. Distribution of mangrove species, family and genera

Source: Field survey, 2016

Table 1. Mangrove species recorded in Kala Oya estuary

No	Species	True/Associate	Genera	Family
1	*Sonneratia alba*	True	Sonneratia	Sonneratiaceae
2	*Rhizophora mucronata*	True	Rhizophora	Rhizophoraceae
3	*Pemphis acidula*	Associate	Pemphis	Lythraceae
4	*Avicennia marina*	True	Avicennia	Avicenniaceae
5	*Rhizophora apiculata*	True	Rhizophora	Rhizophoraceae

Source: Field survey, 2016

Rare species; *Sonneratia alba* and *Pemphis acidula* will be vulnerable for extinction from the area due to the encroachment of *Rhizophora mucronata*. Therefore nearest localities can be identified as critical areas for mangroves. Concerning the distributional pattern of mangroves as shown in figure 2, abundance of mangrove associates could be seen towards the ocean while true mangrove species dominant close to the landward fresh water area.

Table 2. Diversity and abundance of mangroves in Kala Oya estuary

Sample no:	Diversity	Abundance
S1	0	0
S2	0.56233	0.81127
S3	0.34883	0.50325
S4	0.45056	0.65002
S5	0.56233	0.81127
S6	0.34657	0.50000
S7	0.84410	0.76833
S8	1.09861	1
S9	0.67301	0.97095
S10	0	0
S11	0	0
S12	0	0
S13	0	0
S14	0	0
S15	0	0

Source: Field survey, 2016

3.2. Salinity, pH, Ec and temperature across mangrove diversity

The average salinity level of the lagoon water is 24.24ppt (parts per trillion). The highest salinity value recorded as 29.6 ppt where sample 8 existed. The lowest salinity value reported as 11.1ppt where sample 13 located as in the figure 4.

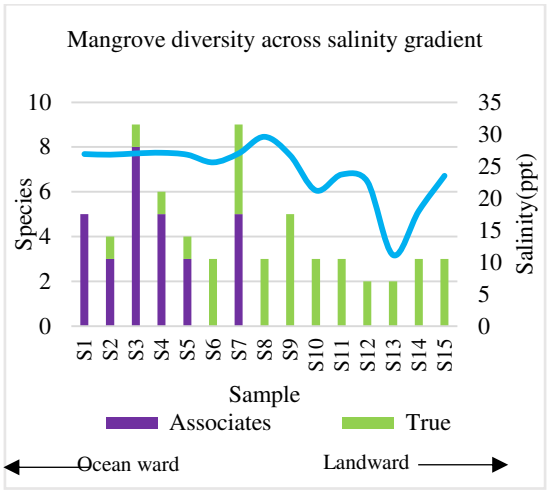

Figure 4. Salinity (ppt) level of Kala Oya estuarine water

Source: Field survey, 2016

The average pH value of the water body recorded as 7.52933.Lowest pH value recorded where the diversity of mangrove species are moderate as shown in figure 5 and 8. The pH value significantly increased along the low diversity of mangrove species from sample 8 to 15. Figure 6 shows the average electric conductivity (Ec) recorded as 31.60667 ms while the average temperature of the collected water samples recorded as 28. 64 ° C.

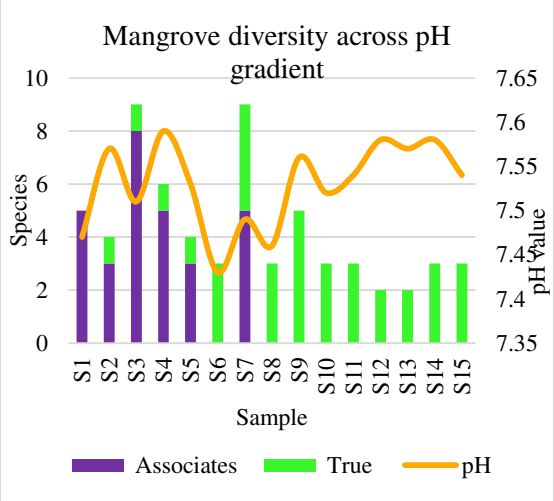

Figure 5.pH values of Kala Oya estuarine water

Source: Field survey, 2016

The temperature dramatically increase from sample 5 to 8 where spatially highest diversity of mangrove species could be identified as in the figure 7 and 8.

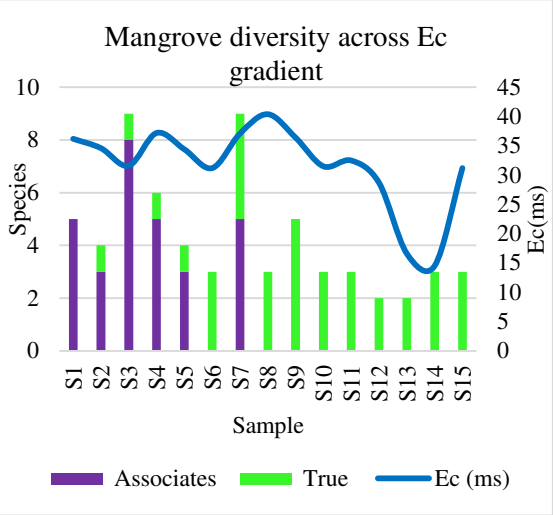

Figure 6. Ec values of Kala Oya estuarine water

Source: Field survey, 2016

Figure 7 shows significant lower temperature level among first five sample plots where mangrove associates enumerated highly. The area consisted of dramatic increase of temperature could be identified as a mangrove diversity hotspot in Kala Oya estuary.

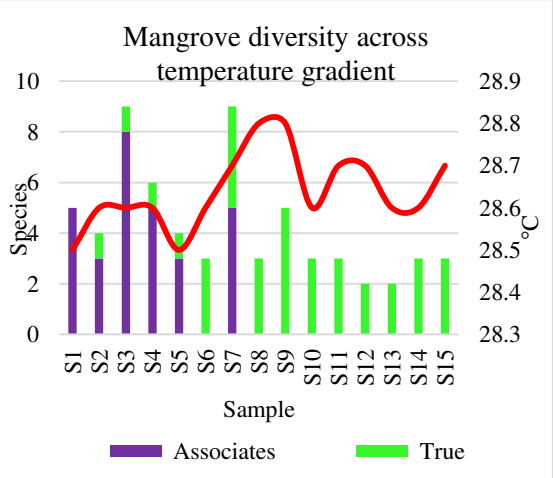

Figure 7. Temperature of Kala Oya estuarine water

Source: Field survey, 2016

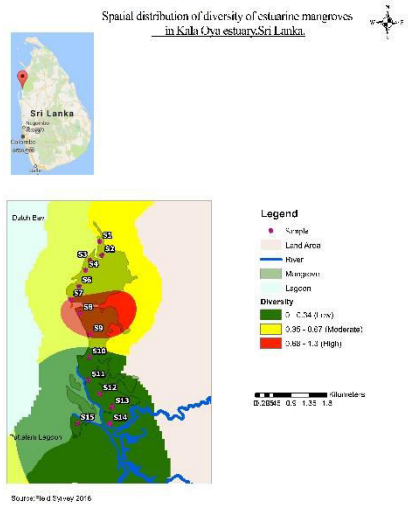

Figure 8. Spatial distribution of mangrove diversity

Source: Field survey, 2016

4. Conclusion

True mangrove species significantly established in the intertidal zones or at the proximity of fresh water where the inlet of the lagoon; Kala Oya could be identified. The investigated area is well nourished with sediments and supply perfect salinity levels for each species. Salinity tolerable species were well survived in the area. Due to the sedimentation mudflat surfaces are being created in the area which influenced for the significant distribution of mangrove associates. The distribution of *Rhizophora apiculata* quite easily identified around the inlet of the lagoon. Rare and very rare mangrove species are distributed in the upper and middle section of the estuary. The diversity of mangroves have been reduced close to the estuarine mouth. Around the estuarine mouth human disturbances have been increased than the past. Large sediment patches (small islands) are used as ad hoc landing sites of fishermen (Field visit 2016). Fresh water influx have been reduced due to climate change, as a result the salinity level fluctuate frequently. Mangroves as sensitive salinity tolerable species which have the vulnerability due to climate changes. As a diversity hotspot of mangroves and as an ecological niche, Kala Oya estuary have to be conserved for future generation as mangroves have the potential to reduce the impacts of global warming as perfect carbon sinkers. The spatial differences of mangrove diversity in Kala Oya indicate as in the figure 8, the necessity of immediate conservation measures for protection of the area.

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