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EVALUATION OF SHORELINE SEDIMENT QUALITY FOR THE DELINEATION OF SITES FOR MANGROVE AFFORESTATION ALONG THE COASTAL AND INLAND AQUATIC ENVIRONMENTS OF MALAPPURAM DISTRICT, KERALA, INDIA.

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ABSTRACT

Mangroves are ecologically important tropical forests that are one among the most threatened habitat in the World. In addition to many of the anthropogenic threats, mangroves are also threatened by the impact of global climate change. Both water and sediment characteristics are known to influence the growth and development of different mangrove species. The primary objective of this study was to demarcate ideal sites that uphold adequate growth requirements for mangrove afforestation along the coastal and inland aquatic environments of Malappuram district, Kerala, India, in terms of assessing selected sediment quality parameters.

Collection of sediment samples were carried out from38 sites representing 4 habitats during Pre-monsoon, Monsoon and Post-monsoon seasons. Physico-chemical characteristics of the collected samples were analyzed following standard procedures (Trivedi et al,1987).

Out of the 38sites studied, results of the analysis of various parameters of sediment samples indicated that, seasonal changes in parameters like pH, Electrical conductivity, Salinity, Chloride, soil moisture, organic carbon and texture were found to be influential on the growth of mangroves. Sites already having mangrove population limited to 11 in numbers, wherein optimum values for all the parameters were noticed irrespective of seasons. Comparison of the present results with earlier standardized optimum growth requirements of selected mangrove species has revealed the possibilities of afforestation practices along the study area in all the season of the year.

The overall study revealed that mangrove species such as *Bruguiera gymnoriza, Avicennia marina, Sonneratia apellata, Sonneratia caseolaris, Rhizhophora mucronata, Avicennia officinalis, Vitis vitigenia, Deris trifoliate, Cerbera odollam, Premna seratifolia* were suitable for afforestation along selected sampling stations. Species such as *Rhizhophora apiculata, Kandelia kandel and Acrostichum aureum* were not suitable for the afforestation in any of the sites under study.

Key *words: Coastal environment, Sediment, Mangroves, Afforestation.*

INTRODUCTION

Mangroves are taxonomically diverse group of salt tolerant, mainly arboreal flowering plants that grow primarly in tropical and subtropical regions (Ellison and Stoddart, 1991). Mangrove forests are one among the most productive ecosystem having so many ecological, socioeconomic and physical (Rambok et al, 2010). One of the important functions of mangrove to environment is to provide mechanism for trapping sediment and thus the mangrove forest are considered as an important sink of suspended sediment (Wolanski, 1994 and Furukawa et al, 1997) .

Mangrove ecosystem currently cover 146530 km of the tropical shoreline of the world (FAO, 2003). India has a mangrove cover of about 6749km^2,fourth largest mangrove area in the world (Naskar and Mandal, 1999). Reports on mangrove habitat of Kerala revealed that the states once had a mangrove cover of 700km^2 that now drastically declined 17km^2. It indicates that as in many other parts of the world the vegetation has diminished in its extend severely and has acquired a threatened status in Kerala (Basha, 1991).

The loss of mangroves has been significant in recent decades although in some places mangroves are still extensive (Spadling, 1998). Meanwhile existing mangroves suffer from direct impacts of environmental pollutants such as heavy metals that are associated with anthropogenic activities (Cuong et al., 2005). A large fraction of mangroves in India was destroyed due to aquaculture and agriculture expansion. Because of high caloric value and high strength of mangrove wood, people

are destroying mangroves for firewood, charcoal and timber (Sahu et al., 2015).

Restoration and rehabilitation of existing or former mangrove forest areas is extremely important today. Mangrove restoration is re-introduction and re-establishment of assemblages of native mangrove species to sites that can support them to be developed into mangrove ecosystems which perform similar functions as that were there originally. Mangrove restoration programs are necessary for the protection of coastal areas. Restoration or rehabilitation may be recommended when a system has been altered to such an extent that it can no longer undergo a self-renew. Under such conditions, ecosystem homeostasis has been permanently stopped and the normal processes of secondary succession or natural recovery from damage are inhibited in some way (Clements, 1928).

The present study has been carried out to demarcate the ideal sites for mangrove afforestation on the basis of seasonal assessment of sediment quality parameters like pH, Electrical conductivity, salinity, alkalinity, chloride, moisture percentage, organic carbon and texture along the coastal and inland aquatic environments of Malappuram District, Kerala, India.

MATERIALS AND METHODS

Study Area

District of Malappuram, Kerala state, India is bounded by Nilgiri hills on the east, Arabian Sea on the west and has three distinct topographic features. The coastal environment of the district, extending from Chaliyam to Perumpadappu covering a distance of approx.50kms is characterized by a network of estuaries, back waters and confluence point of major rivers like Chaliyar, Kadalundy, Tirur and Bharathapuzha. 38 sites represented by 4 habitats were selected for the study. There were 12 marine coasts, 15 estuarine, 10 riverine and 1 freshwater habitats.

Collection and analysis of sediment samples

Sediment samples were collected from 38 sites (Plate 1) along the coastal and inland aquatic environments of

Plate 1. Sampling sites along the Coastal stretches of Malappuram District.

Sampling sites along the Coastal stretches of Malappuram District.

Malappuram district during three seasons representing Pre-monsoon, Monsoon and Post-monsoon respectively. Sediment samples from each site were analyzed for its physico- chemical parameters like pH, Electrical Conductivity, Salinity, alkalinity, Chloride, Soil moisture, Organic carbon, Texture following standard procedures (Trivedi,1987).

RESULTS AND DISCUSSION

A total of 38 sediment samples were collected from different coastal and inland aquatic ecosystems of the Malappuram district. Results of the analysis of various qualities attributes of sediment during Pre monsoon, Monsoon and Post monsoon seasons are depicted in Table 1, 2 and 3 respectively. Among various parameters studied, organic carbon has been found to have supreme influence on the growth and development of mangrove species. This was in accordance with other attributes which likely or unlikely affected the growth progress of the mangroves on a seasonal basis. The ranges of each parameter in all the seasons and sites pertaining to maximum and minimum values have been discussed in the following.

pH

The ranges of pH during premonsoon, monsoon and post monsoonal seasons were 6.15 - 7.96, 4.56 - 7.09 and 3.12 - 7.06 respectively. Maximum pH has been noticed at S 36 (Tanur) durind pre monsoon season and minimum at S 27 (Olipram Kadavu) during post monsoon season.

Electrical conductivity (EC)

103.3-5336µS, 11.80 -1891µS, 27.37-7.06 µS were the ranges of electrical conductivity during pre monsoon, monsoon and post monsoon seasons. The maximum electrical conductivity was reported at S 28 (Athanikal Bridge) and minimum at S 2 (Uppungal Kadavu).

Salinity

Ranges of salinity during pre monsoon, monsoon and post monsoon seasons were (5.56-3402 ppm), (27.46-994.40 ppm) and (21.76 - 1187 ppm) respectively. Salinity was highest in pre monsoon season at S 13 (Puthuponnani Bridge East) and lowest during post monsoon season at S 17(Eswaramangalam).

Alkalinity

200 - 2800 mg/l, 100 - 2000mg/l, 125 - 750 mg/l were the ranges of alkalinity during pre monsoon, monsoon and post monsoon seasons respectively. Highest value of 2800mg/l has been noticed at S 26 (Paravanna) and S 33 (Alungal) during pre monsoon season and lowest value of 100mg/l at S 34 (Poorapuzha Eastern side) and S18 (Athaloor Nedat kadavu) during monsoon season.

Chloride

The ranges of chloride concentration during pre monsoon, monsoon and post monsoon seasons were (1106.56 - 24344.41 mg/l),(88.52 - 6904.98 mg/l) and(132.78 - 5090.21mg/l), respectively. Highest concentration has been reported at S13 (Puthuponnani Bridge east) during pre monsoon season and lowest at S 38 (Thayyilakadavu) during monsoon season.

Moisture percentage

Ranges of moisture percentage during pre monsoon, monsoon and post monsoons were (11.52 - 57.20%), (6.97 - 46.53%) and (0.08 -15.44%) respectively. Moisture percentage was maximum at S 29 (Kadalundi community reserve) during pre monsoon season and minimum at S 36 (Tanur) during monsoon season.

Organic carbon

0.13 -16.56%, 0.03 -29.70%, 0.08 -15.44% were the ranges of organic carbon during pre monsoon, monsoon

Table 1. Result of analysis of sediment quality parameters during pre monsoon season

ID	pH	Electrical conductivity (µS)	Salinity (ppm)	Alkalinity (mg/l)	Chloride (mg/l)	Moisture Percentage (%)	Organic carbon (%)	Texture		
								Sand (%)	Silt (%)	Clay (%)
S 1	6.85	313.4	121.6	200	4426.27	44.42	6.46	88.59	10.84	0.56
S 2	6.82	169.8	5.56	400	1106.56	19.57	2.07	55.38	43.04	1.57
S 3	6.15	3079	1649	1600	14385.38	16.11	1.54	92.83	6.47	0.69
S 4	6.43	2587	1381	2200	16598.52	18.78	3.27	73.87	25.86	0.25
S 5	7.25	103.3	64.27	800	5532.84	40.03	3.62	79.68	18.55	1.75
S 6	6.95	134.5	68.65	400	2213.13	19.61	0.82	80.55	17.63	1.80
S 7	6.84	255.9	129.6	800	5532.84	22.36	2.45	95.02	3.26	1.71
S 8	6.65	3300	1799	800	15491.95	22.00	2.09	59.64	37.85	2.50
S 9	7.04	2327	1230	600	15491.95	22.54	0.14	71.14	27.71	1.14
S 10	7.28	1896	995.4	1000	12172.24	15.33	1.75	78.48	21.24	0.26
S 11	7.34	1691	888.4	1200	8852.54	11.52	0.16	70.03	28.08	1.87
S 12	7.29	2928	1569	400	16598.52	16.50	7.12	79.65	19.88	0.46
S 13	7.34	1846	3402	800	24344.41	22.29	1.77	81.78	16.75	1.46
S 14	7.22	3852	2471	800	17705.08	15.19	0.61	83.12	15.76	1.10
S 15	7.26	1669	1369	2200	15491.95	16.92	3.85	86.86	13.00	0.12
S 16	7.54	1227	982.5	1400	9959.11	20.42	0.73	96.05	3.81	0.12
S 17	7.60	1168	601.2	600	5532.84	15.39	2.78	64.12	35.03	0.84
S 18	7.52	172.4	88.43	400	3319.70	19.76	6.90	79.08	19.94	0.96
S 19	6.87	2354	1249	400	9959.11	24.87	2.63	82.73	16.27	0.98
S 20	7.02	2236	1177	400	12172.24	17.87	2.25	80.28	18.95	0.76
S 21	7.24	3877	2036	600	15163.31	25.28	1.04	86.74	12.26	0.99
S 22	7.52	3990	2191	600	11065.62	23.49	2.09	76.56	22.55	0.87
S 23	7.40	4908	2703	800	22131.23	20.09	0.77	76.97	22.16	0.86
S 24	7.71	2634	1400	2400	11065.62	18.98	1.45	88.67	10.63	0.69
S 25	7.63	2558	1370	2600	8852.54	22.04	1.58	86.53	12.86	0.60
S 26	7.80	1553	944.5	2800	3319.70	20.95	0.53	84.10	15.55	0.34
S 27	7.56	2840	1528	400	4426.27	19.72	11.12	45.88	25.43	28.68
S 28	7.42	5336	3045	600	4426.27	37.50	14.15	62.57	15.24	22.17
S 29	7.58	4581	3112	200	2213.13	57.20	16.56	49.70	29.04	21.24
S 30	7.85	2133	1136	1000	44262.27	26.38	1.28	86.00	12.51	1.48
S 31	7.49	2767	1496	1200	11065.62	21.98	1.56	87.77	11.71	0.50
S 32	7.35	3398	1837	1400	3319.70	26.67	2.49	97.39	1.68	0.92
S 33	7.57	2228	1219	2800	22131.23	16.23	0.24	88.81	10.90	0.27
S 34	7.50	3296	1796	400	3319.70	19.12	1.60	98.08	1.66	0.25
S 35	7.45	3867	2120	200	7748.95	17.66	1.09	86.29	13.14	0.55
S 36	7.96	1222	1862	2200	15163.31	13.67	0.13	97.11	2.40	0.48
S 37	7.79	2158	1764	600	14385.38	16.58	0.41	88.14	11.60	0.24
S 38	7.48	800.2	448.2	400	2213.23	31.32	9.80	72.15	20.42	1.42

and post monsoon seasons respectively. Both highest and lowest concentrations of organic carbon have been noticed during monsoon season and at S 27(Olipram kadavu) and S 36 (Tanur) respectively.

Texture

Sand

Ranges of percentage sand during pre monsoon, monsoon and post monsoon season were (45.88 - 98.08 %), (42.42 - 99.41%) and (46.70 - 98.71%) respectively. Maximum and minimum values were reported at S36 (Tanur) and S5 (Naranipuzha bridge) during monsoon season.

Silt

1.66-43.04 %, 0.46-54.72% and 0.38-48.44% were the ranges of silt during pre monsoon, monsoon and post monsoon seasons, respectively. Highest vaue was at S5 (Navanipuzha bridge) during monsoon season and lowest was at S20 (Pallikadavu munambam) during post monsoon season.

Clay

Ranges of clay during pre monsoon, monsoon and post monsoon seasons were (0.12 - 28.68%),(0.11 - 24.11%) and (0.25-24.11%) respectively. Highest concentration was at S 27 (Olipram kadavu) during pre monsoon season and lowest at S 36 (Tanur) during monsoon season.

The data revealed that, the mangrove species *Bruguiera gymnoriza, Rhizophora mucronata* and *Avicennia officinalis* are suitable for afforestation along 12 sampling sites (S2, S5, S6, S8, S14, S18, S19, S21, S22, S23 and S30) during pre monsoon season, 5 sites (S1, S6, S7, S8, S18) during monsoon season 7 sampling sites (S1, S3, S18, S22, S25, S31, S32) during post monsoon season. It has been noticed that *Avicennia marina* is not suitable for afforestation during pre monsoon and post monsoon season. In monsoon season, it is suitable for afforestation at S18. Except S3 and S4, all other sites have been noticed to be ideal for afforestation of

Table 2. Result of analysis of sediment quality parameters during monsoon season

ID	pH	Electrical conductivity (µS)	Salinity (mg/l)	Alkalinity (mg/l)	Chloride (mg/l)	Moisture percentage (%)	Organic carbon (%)	Texture		
								Sand (%)	Silt (%)	Clay (%)
S 1	4.56	349.80	194.90	400	531.15	29.37	1.67	56.29	41.60	0.98
S 2	6.37	11.80	58.93	1000	221.31	20.09	8.41	84.31	14.74	2.09
S 3	5.95	928.98	419.89	1400	5577.10	12.50	1.92	78.44	21.19	0.36
S 4	6.73	992.70	417.3	1000	6904.98	18.82	0.48	97.18	2.53	0.28
S 5	6.66	112.0	60.06	400	575.41	36.65	19.57	42.42	54.72	2.85
S 6	6.04	73.59	41.47	600	619.67	23.89	4.47	83.56	14.44	1.99
S 7	5.92	53.87	27.46	200	442.62	28.45	3.53	73.93	24.92	1.13
S 8	5.74	604.10	302.10	600	1681.98	43.21	4.36	62.39	36.52	1.07
S 9	6.70	479.90	241.50	1800	663.94	25.75	6.90	80.67	19.05	0.27
S 10	5.79	312.40	150.30	600	4382.09	24.37	2.95	84.55	14.68	0.75
S 11	6.20	1481	757.40	800	7562.92	17.64	3.53	90.64	9.11	0.24
S 12	6.72	410.40	204.70	1200	929.51	17.69	0.57	86.09	12.40	1.50
S 13	4.92	1586	780.20	1200	840.99	19.78	4.97	91.77	7.93	0.28
S 14	7.01	489.90	241.20	600	1549.19	19.10	6.77	84.86	14.87	0.25
S 15	6.03	1863	789.20	400	3629.54	19.04	0.24	92.09	6.94	0.95
S 16	6.13	1034	529.20	600	3363.96	13.66	0.56	85.39	14.20	0.39
S 17	6.68	61.61	36.55	600	619.67	16.55	1.18	88.93	10.92	0.13
S 18	6.78	96.66	53.72	100	309.83	23.95	3.26	78.54	19.56	1.88
S 19	6.05	90.53	48.67	800	398.36	18.11	2.55	92.19	7.24	0.56
S 20	5.03	183.70	65.81	400	354.10	18.60	1.21	95.55	1.54	0.90
S 21	6.15	233.10	134.20	800	1106.56	21.90	1.65	87.74	11.46	0.79
S 22	5.59	387.60	127.90	800	1106.56	17.93	2.17	96.00	3.35	0.64
S 23	7.09	157.10	81.46	1000	354.10	18.82	2.03	91.75	7.70	0.54
S 24	5.44	1831	964.10	1800	5577.10	22.35	0.89	94.98	4.61	0.39
S 25	6.18	922.30	471.70	1000	2832.81	8.22	7.15	71.44	27.44	1.10
S 26	6.17	861.10	435.10	1000	2567.23	6.97	0.21	88.22	11.52	0.25
S 27	6.30	817.30	397.50	600	398.36	24.92	29.70	94.36	2.25	24.11
S 28	6.14	513.70	317.30	400	575.41	44.49	11.39	71.56	4.31	3.38
S 29	5.72	476.30	216.20	1000	1704.78	37.77	17.76	55.27	26.75	17.96
S 30	6.39	369.70	182.90	800	1283.61	24.60	5.83	95.94	3.07	0.97
S 31	5.62	705.30	362.50	800	1681.98	21.12	1.44	92.49	6.88	0.62
S 32	6.54	1667	873.20	1400	3496.75	46.53	5.94	50.57	48.42	1.00
S 33	5.88	1891	994.40	600	6063.99	20.61	2.06	97.28	2.59	0.12
S 34	6.12	116.50	61.89	100	973.77	18.32	2.65	72.51	26.70	0.78
S 35	6.69	84.43	46.95	800	486.88	24.24	11.05	81.28	18.03	0.68
S 36	5.88	957.30	426.01	400	2832.81	9.67	0.03	99.41	0.46	0.11
S 37	5.67	1771	928.10	2000	5532.84	23.09	1.14	87.04	12.71	0.24
S 38	6.36	187.40	98.43	800	88.52	32.94	11.85	76.00	22.46	1.53

Sonneratia apellata during post monsoon season. In monsoon season S4, S 5, S8, S9, S14, S17, S18 were found to be suitable for afforestation of *Sonneratia apellata* and during post monsoon season S 35 and S38 only were suitable for afforestation. *Sonneratia caseolaris, Vitis vitigenia, Deris trifoliate, Cerbera odollam, Premna seratifolia* were found to be ideal at 10 sampling sites (S1, S2, S3, S10, S15, S18, S22, S25, S31 and S32) during pre monsoon season. During monsoon season 8 sites (S1,S6, S7, S8, S12, S18, S19 and S30) were noticed to be ideal for afforestation of the above species and during post monsoon season S2, S5, S6, S8, S13, S14, S17, S18, S19 and S30 are suitable for planting. None of the sampling sites in all the three season were found to be suitable for afforestation of mangrove species such as *Rhizhophora apiculata, Kandelia kandel, and Acrostichum aureum.*

Table 3. Result of analysis of sediment quality parameters during post monsoon season

ID	pH	Electrical conductivity (µS)	Salinity (ppm)	Alkalinity (mg/l)	Chloride (mg/l)	Moisture percentage (%)	Organic carbon (%)	Texture		
								Sand (%)	Silt (%)	Clay (%)
S 1	3.44	259.6	122.8	500	265.57	17.93	2.76	46.70	48.44	1.73
S 2	4.63	76.32	42.54	500	177.05	29.29	0.46	57.90	40.11	1.98
S 3	5.70	947.5	449.3	250	1106.56	16.15	2.29	75.62	23.19	1.18
S 4	5.15	992.8	502.0	250	2965.60	12.48	0.27	87.78	11.40	0.80
S 5	4.97	225.5	105.2	125	398.36	44.20	4.56	54.86	44.75	0.37
S 6	4.79	171.3	86.83	125	132.78	42.86	6.62	84.58	14.04	1.37
S 7	5.36	39.07	26.47	250	265.57	22.26	7.36	77.59	21.66	0.73
S 8	3.28	1658	870.3	250	309.83	35.66	2.28	72.56	26.79	0.64
S 9	3.50	418.9	209.3	375	2257.39	29.54	7.81	87.29	12.11	0.58
S 10	3.54	360.2	174.9	500	4824.63	14.75	6.44	56.86	41.54	1.59
S 11	4.88	1066	541.3	250	177.05	15.29	0.08	84.35	15.14	0.49
S 12	5.20	293.4	145.9	375	132.78	16.33	4.80	90.35	7.76	1.87
S 13	3.85	1186	604.8	250	2522.97	23.92	1.69	72.63	26.85	0.51
S 14	5.23	653.7	327.1	500	1991.82	20.20	1.06	77.52	22.07	0.39
S 15	5.34	1131	575.5	250	2877.07	17.79	7.16	84.49	14.49	1.01
S 16	5.51	1778	992.8	500	531.15	22.35	5.31	91.23	8.36	0.39
S 17	6.23	27.37	21.76	125	708.20	16.62	0.06	88.93	9.82	1.24
S 18	6.16	29.44	22.59	250	265.57	22.35	2.87	78.54	19.56	1.88
S 19	6.09	29.31	22.38	375	398.36	18.09	1.43	92.19	7.23	0.56
S 20	6.03	29.09	22.48	250	354.10	18.18	0.27	98.71	0.38	0.90
S 21	3.71	173.2	117.4	625	398.36	18.49	0.16	87.74	11.46	0.79
S 22	5.49	392.3	119.5	250	309.83	21.62	1.40	78.13	20.71	1.15
S 23	5.10	92.17	54.40	375	4337	20.68	0.53	78.24	21.21	0.54
S 24	4.91	1709	892.1	625	5090.21	17.5	0.2	94.98	4.35	0.65
S 25	5.74	1913	1015	375	4899.88	19.45	2.05	70.75	28.13	1.10
S 26	6.05	1333	683.7	250	663.94	11.78	0.82	88.77	10.97	0.25
S 27	3.12	991.2	508.1	250	752.46	28.16	15.44	80.28	2.25	17.46
S 28	3.45	442.7	222.8	750	796.72	30.79	14.42	71.56	4.31	24.11
S 29	5.49	426.5	214.1	500	840.99	29.55	13.59	50.07	29.67	19.65
S 30	6.01	391.5	202.3	250	1372.14	29.32	1.59	74.31	25.13	0.54
S 31	5.88	959.3	493.9	500	885.25	21.85	1.38	64.16	34.83	1.00
S 32	6.15	605.2	306.0	250	929.51	26.09	1.54	80.87	18.10	1.02
S 33	6.35	1302	679.9	250	5045.95	20.66	6.59	96.27	3.70	0.26
S 34	6.39	2247	1187	375	619.67	20.02	14.97	70.95	27.81	1.22
S 35	7.06	92.12	55.64	125	486.88	21.32	2.55	98.66	0.80	0.53
S 36	6.27	2470	1205	375	2434.43	19.49	0.16	83.12	16.5	0.33
S 37	6.30	2015	1061	250	1859.03	17.17	0.6	91.19	8.49	0.30
S 38	6.76	248.6	124.3	375	177.05	28.50	14.62	73.25	17.50	9.23

CONCLUSION

The present study investigated the possibilities of mangrove afforestation along the coastal and inland aquatic environments of Malappuram district in terms of assessment of selected sediment quality parameters. Samples were collected from 38 sites and characterized in the laboratory. Comparison of the present results with earlier standardized optimum growth requirements of selected mangrove species has revealed the possibilities of afforestation practices along the study area in all the season of the year. Seasonal variations in parameters like pH, organic carbon and texture have been found influential on the growth of different mangrove species. Mangrove species such as *Bruguiera gymnoriza, Rhizophora mucronata* and *Avicennia officinalis* have been noticed to be suitable for planting along 12 sites during premonsoon, 5 sites during monsoon and 7 sites during post monsoon season. *Avicennia marina* is only suitable for monsoon season at S18. Mangrove species such as *Rhizophora apiculata, Kandelia kandel,* and Acrostichum aureum were noticed to be unsuitable for afforestation along all the sites during any of the seasons under study.

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Table 4. Optimized ranges of pH, Organic carbon,Texture for the growth of different mangrove species

Sl no	Name of the mangrove species	Range of parameters					Author / Reference
		pH	Organic carbon (%)	Sand (%)	Silt (%)	Clay (%)	
1	*Avicennia marina*		1.675-4.741				Chaudhari.et al (2010)
2	*Avicennia marina*	6.76-8.08	0.32-7.29	8.74-96.94	5.32-71.79	0.80-35.10	Badarudeen et al (2014)
3	*Avicennia officinalis*		1.99-5	23.86-79.97	12.37-50.11	5.35-32.33	Badarudeen et al (2014)
4	*Sonneratia apellata*	6.6-8.08	1.781-3.665				Chaudhari.et al (2010)
5	*Sonneratia caseolaris*		0.32-7.29	8.74-96.94	5.32-71.79	3.87-35.10	Badarudeen et al (2014)
6	*Bruguiera gymnoriza*		0.52-4.89	27.10-93.33	5.86-50.83	0.80-27.69	Badarudeen et al (2014)
7	*Rhizophora mucronata*		1.99-5	23.86-79.97	12.37-50.11	5.35-32.33	Badarudeen et al (2014)
8	*Rhizophora apiculata*		1.99-5	23.86-79.97	12.37-50.11	5.35-32.33	Badarudeen et al (2014)
9	*Kandelia kandel*		1.99-5	23.86-79.97	12.37-50.11	5.35-32.33	Badarudeen et al (2014)
10	*Acrostichum aureum*		1.99-5	23.86-79.97	12.37-50.11	5.35-32.33	Badarudeen et al (2014)
11	*Vitis vitigenia*		0.32-7.29	8.74-96.94	5.32-71.79	3.87-35.10	(Badarudeen et al (2014)
12	*Deris trifoliate*		0.32-7.29	8.74-96.94	5.32-71.79	3.87-35.10	(Badarudeen et al (2014)
13	*Cerbera odollam*		0.32-7.29	8.74-96.94	5.32-71.79	3.87-35.10	(Badarudeen et al (2014)
14	*Premna seratifolia*		0.32-7.29	8.74-96.94	5.32-71.79	3.87-35.10	(Badarudeen et al (2014)

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