Properties of Soils from the Offshore Islands of Bangladesh

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Abstract

Physical and chemical properties of some soils from the offshore islands of Bangladesh have been studied. Results of particle size distribution, pH, ECe, organic carbon, total nitrogen and cation exchange capacity (CEC) of the soils on profile basis have been determined. The predominantly loamy texture of the soils indicate that they are physically suitable for agricultural use.

Daily tidal inundation during the monsoon months and moderate salinity along with poor drainage conditions are the characteristic features of these soils which may favour the growth of mangrove species. In fact, in some of the older islands the mangrove species such as keora *(Sonneratia apetala)* are growing luxuriantly.

সারসংক্ষেপ

বাংলাদেশের সমুদ্রতট সংলগ্ন দ্বীপসমূহের মৃত্তিকা নমুনার ভৌত ও রাসায়নিক গুণাগুণ পর্যবেক্ষণ করা হয়েছে। মৃত্তিকা কণার বন্টন (বুনট), পি-এইচ, ঈসি, জৈব কার্বন, পূর্ণ নাইট্রোজেন এবং ক্যাটায়ন বিনিময় ক্ষমতা (সি.ই.সি) সম্পর্কিত ফলাফল নিরূপণ করা হয়েছে। দোআঁশ বুনটের প্রাধান্যযুক্ত এ মৃত্তিকার ভৌতিক গুণাগুণ থেকে দেখা যায় যে এ সকল মাটি কৃষি কাজে ব্যবহারের জন্য উপযোগী।

বর্ষা মৌসুমে দৈনিক জোয়ারের পানিতে নিমজ্জিত, মাঝারি লবণাক্ততাসম্পন্ন এবং অপ্রতুল নিষ্কাশন ব্যবস্থাযুক্ত এ সকল মৃত্তিকা ম্যানগ্রোভ উদ্ভিদ জন্মাতে সহায়ক ভূমিকা পালন করে থাকে। বস্তুত কিছু কিছু পুরাতন দ্বীপে ম্যানগ্রোভ প্রজাতি যেমন কেওড়া বৃক্ষের ভাল বৃদ্ধি পরিলক্ষিত হচ্ছে।

Key words : Bangladesh, mangrove species, offshore islands, soil properties

Introduction

Bangladesh has quite a large number of offshore islands to its south in the Bay of Bengal spreading from east to west but their main concentration is in the Meghna estuary. These islands are tidally affected and are of varying shape, size and stabilization. Both erosion and deposition is rampant, and natural environment is very much unstable and fragile (Pramanik 1989). Some islands may appear at the surface of the water and again disappear after few years. While one part of an island is eroded by strong current that flows from the north, in another part fresh sediments may be accreted (Siddiqui 1989). Counting the number of islands in the offshore belt is difficult because they are constantly being formed, eroded and reformed, and many of them are in the varying stages of stabilization. Some parts of these islands are inhabited by man while another part may be open mud and still another part is afforested with mangrove species. One major advantage of this afforestation is that it works as a shield against tropical cyclones and the associated storm surges which with immense ferocity hit the coastal belt of Bangladesh.

Since these islands are tidally affected the soil materials tend to remain in unripened state containing high quantity of interstitial water. During ripening subsidence occurs and some of them may disappear unless there is fresh and continuous sedimentation.

Around 2.5 billion tons of sediments are brought annually by the river water that pass through Bangladesh (Rahman 1989). Only a portion of this sediment load is deposited within the Bangladesh territorial water. Rest of it is carried to the sea further south. The huge sediment load becomes a dominant agent in the geomorphological dynamics in the offshore areas of Bangladesh. The shallow funnel-shaped northern part of the Bay of Bengal is the seat of most of the offshore islands of Bangladesh. Administratively most of these offshore islands belong to Barguna, Patuakhali, Bhola, Noakhali, Chittagong and Cox's Bazar district. Both tidal and wind actions are unusually strong in these islands. Tropical cyclones and their associated storm surges are common features.

In this paper some physical and chemical properties of the soils and sediments of some selected spots of few offshore islands of the central region have been presented in an effort to determine their suitability for afforestation with mangrove species.

Materials and methods

Soil samples were collected from the offshore islands in the month of December when the sea remains calm. Samples were collected from mostly new islands where sedimentary deposition is still going on. A total of 34 soil samples were collected from 10 selected locations on the islands. The approximate location of the offshore islands and their sampling sites are marked in Fig. 1. The soil samples were collected on depth basis as the soils have very little genetic horizon formation. The soil samples were processed and analyzed in the laboratory for physical and chemical properties.

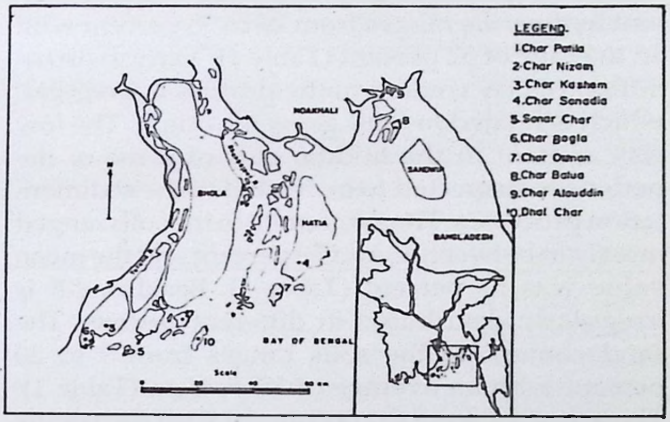

Figure 1. Location of the soils collected from the offshore islands of Bangladesh.

Particle size distribution was determined by the hydrometer method (Day 1965). Before the hydrometer reading the soil samples were treated with hydrogen peroxide to destroy organic matter, and thereafter dilute NaOH solution was used to disperse the soil in the suspension medium. The pH of the soils was determined with a Pye pH meter at a soil : water ratio of 1:2.5. Organic carbon content in the soils was estimated by wet oxidation method as described by Jackson (1967). Total nitrogen was determined by micro kjeldahl distillation method (Jackson 1967) and the cation exchange capacity (CEC) by neutral 1*N* ammonium acetate method (Black 1965). Electrical conductivity (ECe) was measured on a saturation extract of the soils using a conductivity meter (USSL Staff 1954).

Results and discussion

Particle size distribution

Soils of the offshore islands in Bangladesh have loamy textures with high content of clay (Table 1). The particle size analysis of the soils/sediments indicated that silt is the dominant size fraction followed by clay and sand. The clay content in the soils ranges from 26 to 38 percent with an average of 32 percent (Table 1). Vertical distribution of clay content in the profiles is irregular, which is related to their geogenic origin. The low clay content in the middle part of some of the pedons is suspected to be related to the sedimentation processes. The silt content in the soils ranged mostly in between 46 and 59 percent and the mean value was 53 percent (Table 1). Besides, silt is irregularly distributed in different pedons. The sand content in the soils ranges from 9 to 20 percent with an average of 15 percent (Table 1). These results were in conformity with the results reported by SRDI Staff (1967) and Hossain and McConchie (1994) for some similar soils of Bangladesh.

The sand/silt ratio of the soils ranges from 0.16 to 0.42 with a mean of 0.29. This indicates that the quantity of sand is small. The vertical distribution pattern of the sand / silt ratio is irregular. This shows that the soil materials that were deposited at different time had variation during depositional process. There is influence of stratification in the nature of the parent materials. The ratio of silt to clay ranges from 0.7 to 2.3 with a mean of 1.6 (Table 1). The soils under the present investigation are young and therefore there was little possibility of movement of clay downward and their subsequent accumulation in the B horizon. In fact, there is no textural B horizon in these soils. The more or less silt/clay ratio indicates this fact.

The varation in the distribution of sand, silt and clay in different pedons of the offshore islands is small, the existing textural uniformity over the large area might be a special feature of this region. The mean grain size of the sediments normally decreases seawards as the velocity in distributory systems decreases (Lewis 1981). However, significant quantities of sand are found in some offshore deposits where its presence reflects close proximity of distributory currents with high mean velocities or the winnowing away of finer sediments by wave action or both.

Soil reaction (pH)

The pH values of the soils under study range from 7.2 to 8.2 with a mean value of 7.9 (Table 2), which indicate that the soils of the offshore island are slightly to moderately alkaline. There is a trend of constant pH with depth in most of the pedons. This may be explained by the alternation of oxidation-reduction conditions in the floodplain soils (Ponnamperuma 1985). The almost equal range of pH in all of the soil profiles is probably due to the existence of strong buffering systems very much similar to those operating in normal marine environments (McConchie 1990).

Organic carbon and total nitrogen

The organic carbon content in the studied soils is low to medium and ranges from 0.6 to 1.8 percent (Table 2). Like the other coastal plain soils of Bangladesh, organic carbon content is higher at the suface soils and shows a gradually decreasing pattern with depth (Hassan 1984, Hussain *et al.* 1989, Hussain *et al.* 1992). The generally low organic carbon content is thought to be due to its rapid decomposition caused by high rainfall and temperature.

Total nitrogen content in the soils ranges from 0.05 to 0.14 percent with a mean value of 0.09 percent (Table 2). These values are in line with the results reported by Hossain and McConchie (1994) for some soils from the offshore islands of Bangladesh.

Table 1. Physical properties of some soils from the offshore islands of Bangladesh.

Soils	Depth (cm)	Horizon	Particle size distribution			Sand/silt ratio	Silt/clay ratio	Textural class
			Sand (%)	Silt (%)	Clay (%)			
Char Patila	0-30	A	16	50	34	0.32	0.7	Silty clay loam
	30-60	C1	16	52	32	0.31	1.9	Silty clay loam
	60-90	C2	11	54	35	0.20	1.5	Silty clay loam
	90-120	C3	19	51	30	0.37	1.7	Silty clay loam
Char Nizam	0-25	A	9	55	36	0.16	1.5	Silty clay loam
	25-60	C1	12	53	35	0.23	1.5	Silty clay loam
	60-90	C2	12	52	36	0.23	1.4	Silty clay loam
	90-120	C3	13	51	36	0.25	1.4	Silty clay loam
Char Kashem	0-37	A	18	50	32	0.36	1.5	Silty clay loam
	37-75	C1	19	53	28	0.36	1.8	Silty clay loam
	75-110	C2	13	54	33	0.24	1.6	Silty clay loam
Char Sonadia	0-30	A	19	47	34	0.51	1.4	Silty clay loam
	30-60	C1	16	46	38	0.46	1.2	Silty clay loam
	60-100	C2	14	51	35	0.27	1.4	Silty clay loam
Sonar Char	0-15	A	15	54	31	0.28	1.7	Silty clay loam
	15-45	C1	20	47	33	0.42	1.4	Silty clay loam
	45-80	C2	15	59	26	0.25	2.2	Silty clay loam
	80-120	C3	16	54	30	0.30	1.8	Silty clay loam
Char Bogla	0-50	A	15	53	34	0.28	1.6	Silty clay loam
	50-90	C1	17	50	33	0.34	1.5	Silty clay loam
	90-120	C2	15	51	34	0.29	1.5	Silty clay loam
Char Osman	0-30	A	14	54	32	0.26	1.6	Silty clay loam
	30-75	C1	17	52	31	0.32	1.8	Silty clay loam
	75-120	C2	12	53	35	0.23	1.5	Silty clay loam
Char Balua	0-30	A	11	53	36	0.21	1.4	Silty clay loam
	30-60	C1	11	56	33	0.20	1.7	Silty clay loam
	60-90	C2	10	55	35	0.18	1.5	Silty clay loam
	90-120	C3	15	53	32	0.28	1.6	Silty clay loam
Char Aluaddin	0-35	A	17	51	32	0.33	1.6	Silty clay loam
	35-90	C1	16	54	30	0.30	1.8	Silty clay loam
	90-120	C2	19	50	31	0.38	1.6	Silty clay loam
Dhal Char	0-25	A	17	57	26	0.30	2.1	Silty clay loam
	25-70	C1	15	58	27	0.26	2.1	Silty clay loam
	70-110	C2	15	55	30	0.27	1.8	Silty clay loam
	Mean		15	53	32	0.29	1.6	Silty clay loam

Table 2. Chemical properties of some from soils the offshore islands of Bangladesh.

Soils	Depth (cm)	pH (H_2O)	Organic carbon (%)	Total nitrogen (%)	C/N ratio	ECe ($dS\ m^{-1}$)	CEC [cmol (p+) kg^{-1}]
Char Patila	0-30	7.6	1.8	0.13	14	2.0	30.2
	30-60	7.7	1.0	0.11	9	2.1	25.3
	60-90	8.0	0.7	0.07	10	2.4	24.1
	90-120	7.9	0.6	0.05	12	1.4	26.5
Char Nizam	0-25	8.0	1.7	0.13	13	1.9	24.3
	25-60	7.9	0.9	0.10	9	1.0	26.2
	60-90	8.0	0.8	0.07	11	0.9	23.5
	90-120	8.2	0.6	0.05	12	0.9	27.7
Char Kashem	0-37	8.0	1.6	0.12	13	1.7	20.1
	37-75	7.9	1.3	0.10	13	1.7	19.3
	75-110	8.0	1.0	0.09	11	1.5	21.5
Char Sonadia	0-30	7.4	1.7	0.13	13	4.2	23.3
	30-60	7.5	1.0	0.09	11	3.1	24.5
	60-100	8.0	0.7	0.06	12	3.0	22.9
Sonar Char	0-15	7.5	1.4	0.11	13	0.3	28.1
	15-45	8.1	1.0	0.08	13	0.6	26.3
	45-80	8.0	0.7	0.07	10	0.9	24.2
	80-120	7.9	0.9	0.09	10	1.1	23.1
Char Bogla	0-50	8.0	1.7	0.14	12	2.0	20.3
	50-90	7.8	1.0	0.09	11	1.7	23.4
	90-120	7.9	0.6	0.07	9	2.1	22.6
Char Osman	0-30	7.5	1.1	0.10	11	3.8	21.6
	30-75	7.8	1.0	0.09	11	2.7	22.0
	75-120	8.1	0.6	0.07	9	2.4	20.3
Char Balua	0-30	7.2	1.7	0.13	13	4.0	24.0
	30-60	7.4	1.0	0.11	9	3.6	22.3
	60-90	7.8	0.7	0.08	9	3.2	20.1
	90-120	7.9	0.6	0.07	9	3.3	21.4
Char Alauddin	0-35	8.0	1.5	0.13	12	0.8	19.3
	35-90	8.2	1.0	0.09	11	0.9	20.1
	90-120	8.3	0.7	0.08	9	1.2	22.5
Dhal Char	0-25	8.3	1.5	0.12	13	1.5	20.0
	25-70	8.0	1.0	0.08	13	1.9	17.3
	70-110	8.2	0.7	0.05	12	2.0	21.5
	Mean	7.9	1.4	0.09	12	2.0	22.2

Although very young a regular decrease of total nitrogen content from the surface downwards has been developed in all the pedons. Variation in the total nitrogen content in the profiles follows closely the pattern of total organic carbon.

The C/N ratio of the soils ranges from 9 to 14 with an average of about 12 (Table 2). This indicates that the organic matter fraction of the soils is quite highly oxidized, and the associated microbes are quite active even if these soils are inundated twice daily by high tides during the monsoon months. The vertical distribution pattern of C/N ratio in the profiles is irregular. Similar distribution pattern of C/N ratio has been reported in some soils from Bhola by Hussain *et al.* (1992). A decrease in C/N ratio with depth was reported in some coastal soils of Bangladesh (Hussain *et al.* 1989).

Electrical conductivity (ECe)

The ECe values of the saturation extract of the soils ranges from 0.3 to 4.2 dS m^{-1} with an average of 2.0 dS m^{-1} (Table 2). These results indicate that some of the soils of the offshore islands are affected by low salinity. The ECe values are high in the surface horizon of Char Sonadia and low in the surface soils of Sonar Char. The high salinity in the surface soils of some profiles may be due to the upward movement of salt by capillary action. The vertical distribution pattern of ECe in the profiles is, however, irregular. A trend of decreasing ECe values with depth is noticed in some of the pedons. Salinity values in some coastal plain soils of Bangladesh vary seasonally, peak salinities appear to be reached during April-June and fall to a minimum around October before gradually raising again (Hassan 1984, Hossain and McConchie 1994). It has been noted that in almost all the coastal belt soils, salinity is highest in the top soil in the dry season and is appreciably less in the subsoil but often shows an increasing trend below a depth of one meter (SRDI Staff 1967).

Salt water inundation during high tides and flushing by fresh water during the monsoon season are interrupted by poldering. Salt income due to capillarity and out-go due to runoff were the main features of salt dynamics in the poldered soils. However, in the offshore islands of Bangladesh salt dynamics were regulated by tidal inundation, capillary rise during the dry season and runoff during the monsoon season.

Cation exchange capacity (CEC)

The cation exchange capacity of the soils ranges from 17.3 to 30.2 cmol (p+) kg^{-1} (Table 2). From the above results it can be concluded that the soils of the offshore islands of Bangladesh are rich in clay minerals having high surface charge. The high clay and silt contents, high CEC and high pH of the soils are indicative of the fact that when stabilized they can be good productive soils.

Tidal inundation during the monsoon months along with the poor drainage condition are the characteristic features of the soils of the offshore islands. Under these conditions some mangrove tree species are likely to grow well.In fact, keora *(Sonneratia apetala)* is growing well in some of these islands. It should be noted, however, that selection of species should be done by actual field tests.

Conclusions

With respect to the physical and chemical properties the soils of the offshore islands are similar to those in the Sundarbans mangrove forest. As has been noted above these islands are tidally affected, and the salinity is moderate. Mangrove species have been planted in many areas of these islands where they are growing well. In other islands also similar effects may be expected. Since the afforestation programme with keora in the offshore islands is successful, it should be extensively planted in suitable sites in all the islands.

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