CHARACTERISATION OF PEDOLOGICAL DEVELOPMENT IN SOILS OF CHAR KUKRI MUKRI, BANGLADESH

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KHAN, Z. H., TARAQQI, A. K. , HUSSAIN, M. S., MAZUMDER, A. R. & RASHID, M. H. 2002. Characterisation of pedological development in soils of Char Kukri Mukri, Bangladesh. An investigation of the morphological and physicochemical characteristics of five soil profiles from Char Kukri Mukri, a remote offshore island of Bangladesh, was undertaken in an effort to evaluate their pedogenesis and to establish their taxonomy. The soils were very young, loamy textured with high percentage of silt and were also neutral to alkaline in reaction with high percentage of base saturation. Mica was the dominant clay mineral followed by kaolinite with small amounts of vermiculites and interstratified minerals. Composition of soil parent materials and the associated aquic moisture regime dominantly influenced the genesis of these soils. These soils were classed as Typic Endoaquents.

Key words: Offshore island - morphology - pedochemistry - soil genesis - taxonomy

KHAN, Z. H., TARAQQI, A. K., HUSSAIN, M. S., MAZUMDER, A. R. & RASHID, M. H. 2002. Pencirian perkembangan pedologi tanih di Char Kukri Mukri, Bangladesh. Penyelidikan tentang ciri-ciri morfologi dan fiziko-kimia lima profil tanih di Char Kukri Mukri, pulau luar pesisir pantai yang terpencil di Bangladesh, telah dijalankan untuk menilai pedogenesis serta untuk menentukan taksonominya. Tanihnya sangat muda, bertekstur lom dengan peratusan tinggi lodak. Tanih tersebut juga neutral hingga alkali dalam tindak balas dan mempunyai peratusan ketepuan bes yang tinggi. Mika merupakan galian tanah liat dominan diikuti kaolinit dengan vermikulit dan galian antara strata yang sedikit. Kandungan bahan induk tanih yang berasosiasi dengan regim kelengasan akuik mempengaruhi secara dominan genesis tanih ini. Tanih ini dikelaskan sebagai Tipik Endoakuent.

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Introduction

Bangladesh has quite a number of offshore islands to its south in the Bay of Bengal, especially in the Meghna estuary. These islands were formed by huge quantity of sediment load received from the Ganges-Brahmaputra-Meghna river system (Rahman 1989). These islands are at the frontal part of the Bengal delta and are tidally affected. They vary in size, shape and stage of stabilisation. The natural environment is very fragile (Pramanik 1989) and natural calamities such as tropical cyclones make the situation even worse.

Char Kukri Mukri is one of the sparsely populated small offshore islands of Bangladesh, lying about 5 km to the south of Bhola. Administratively, it is a union under Char Fession Thana of Bhola district. This island is about 16 km long in the north-east to south-west direction and about 6 km wide from east to west comprising an area of about 4800 ha. Its area is increasing gradually with new sedimentary formations in the south. This island was being afforested with mangrove species with surprising success under the coastal afforestation programme of Bangladesh Forest Department. The soils of this island have not been subjected to any scientific study as yet. The present paper aims at reporting some intrinsic properties of the soils of Char Kukri Mukri in an effort to evaluate their pedochemistry and the genetic processes that have taken place in the formation of these soils. It is hoped that this may serve as a useful reference for forest planters and agricultural scientists.

Materials and methods

Site description

Char Kukri Mukri in the Meghna estuary is located near the crossing of 21° 55'N latitude and 90° 40' E longitude near the coast of Bangladesh. Physiographically, it is a recently formed deltaic flatland with an elevation of 0.5–1.0 m above sea level (asl). During the monsoon season, especially at the time of high tides, a very large part of this island is inundated by tidal water. The climate of the area is humid tropical monsoon, with a mean annual rainfall of 3000 mm. Tropical cyclones, along with tidal surges, are common. Only a portion of the island is now under human habitation. More than 70% of the island is under mangrove plantation. The major species are keora *(Sonneratia apetala)*, baen *(Avicennia officinalis)*, gewa *(Excoecaria agallocha)* and golpata *(Nypa fruticans)*. These man-made forests are 20 years old. Fresh deposition of raw mud occurs in many parts of the island, which are still unvegetated.

Sample collection and analysis

The Char Kukri Mukri was traversed and the principal soil types described, sampled and characterised. After initial traversing, five sites were selected for soil sample collection. The sampling sites were selected to represent all types of soil conditions. A ground map procured from the Bangladesh Forest Department was used as a field base map for this purpose (Figure 1). The names of the soil sampling sites are Hanzipur, Muslimpur, Shahbajpur, Kukri Forest and Kukri Village. Pits were dug in the selected sites (Figure 1) and the soil profiles were described morphologically in the field according to procedures outlined in the *Soil Survey Manual* (Anonymous 1993). A total of 32 soil samples were collected from the five selected pits on depth basis as the soils have very little genetic horizon formation. The soil samples were processed and analysed in the laboratory for physicochemical and clay mineralogical properties.

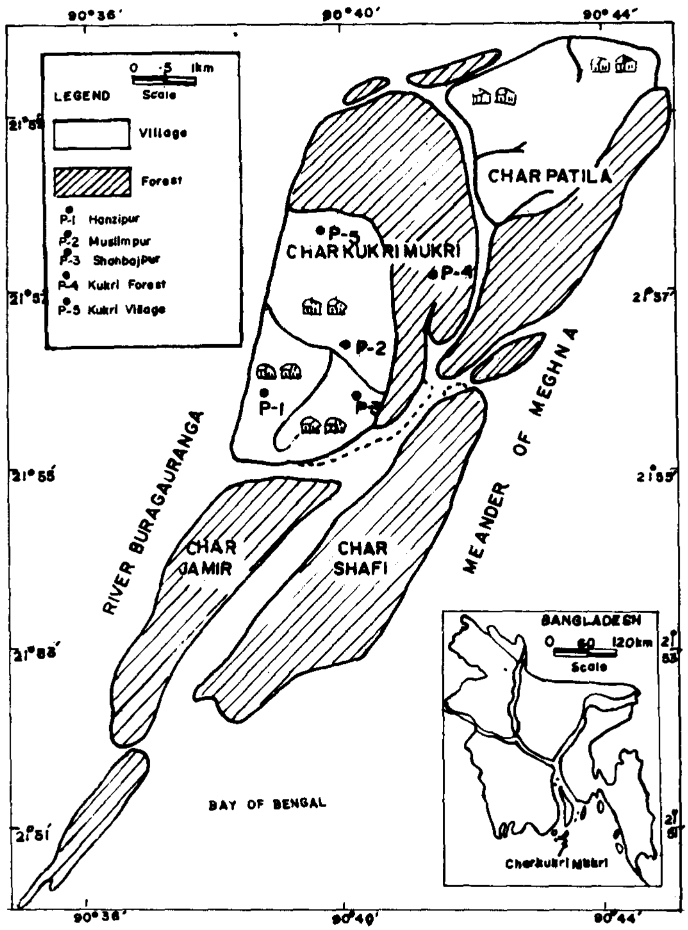

Figure 1 Map of the island of Char Kukri Mukri with some nearby islands

The following standard laboratory determinations were performed on all horizons: pH (Jackson 1967), particle size analysis (Day 1965) as well as organic carbon and total nitrogen (Jackson 1967). Organic carbon was measured by Walkley - Black wet oxidation procedure and total nitrogen estimated by digestion of the soil in sulphuric acid followed by a Kjeldahl distillation. Cation exchange capacity (CEC) was measured with 1 N ammonium acetate solution at pH 7 after 12-h extraction. In alkaline soil samples (pH > 7.5) the lecheates for exchangeable Ca and Mg were extracted as described by Richards (1954). Exchangeable Ca and Mg were determined using atomic adsorption spectrophotometer and K and Na were determined using flame photometer. Electrical conductivity (ECe) was measured on a saturation extract of the soils using a conductivity meter (Richards 1954).

For clay mineralogical analysis the soil samples were treated with sodium acetate to destroy carbonates and with hydrogen peroxide to decompose organic matter. The samples were finally treated with sodium dithionite-citrate-bicarbonate to remove free oxides of iron and manganese (Mehra & Jackson 1960). Thereafter, the samples were dispersed and clays (< 2 m) separated from soil suspensions by gravity sedimentation (Jackson 1975).

Four slides of each pretreated soil clays were prepared from samples of (1) Mg-saturated and air dried, (2) Mg-saturated and glycerol solvated, (3) K-saturated and air dried and (4) K-saturated and heated at 550 °C for one hour. These slides were scanned with GEOL X-ray diffractometer with Ni filtered Cu Kα radiation (at 30 kV, 40 mA) at a scanning speed of 2° 2θ per minute from 2° to 30° 2θ .The minerals in the clay fractions were identified following the method of Jackson (1975). A semi-quantitative estimation of minerals in the clay fraction of the soils was carried out following the method of Johnson *et al.* (1963).

Results and discussion

Soil morphology

Coded morphological features of the studied soil profiles are presented in Table1. The soil matrix had a mixture of olive grey, light grey and dark grey colours, with values ranging from 3 to 6. The chroma ranged from 1 to 3, possibly due to prolonged submergence during the monsoon season. The alternate wetting and drying environments in these soils resulted in the release of iron from Fe-bearing minerals, which were concentrated in the form of mottles in various horizons. Moreover, all the soils have dark brown to dark yellowish brown mottles, prominent in the middle zone of the profiles where oxidation-reduction conditions alternate (Brammer 1971, Saheed & Hussain 1992). The occurrence of a gleyed horizon in the lower zone and a mottled horizon in the middle of the profile are the characteristic features of these hydromorphic soils (Brinkman 1977).

In Hanzipur profile there was a weak, very coarse prismatic structure in the B horizon. This horizon has been considered as an incipient cambic B (Anonymous 1975). The remaining soils lacked in structure development in the control section. The absence of structure suggested minimal pedogenic activity and lack of reorganisation of original skeletal grains as well as redistribution of plasma leading to development of structural peds. The textures of the soils vary from silt loam to silty clay loam. The consistency was hard to very hard, sticky and plastic, which was indicative of moderate water retention of these soils.

Table 1 Coded* morphological properties of soils from Char Kukri Mukri

Horizon	Depth (cm)	Colour (moist)		Texture	Structure	Consistency	Boundary
		Matrix	Mottles				
Hanzipur							
Ap1	0 – 9	5Y6/2	c_1p yb	sil	m	msh wss	as
Ap2	9 – 11	2.5Y6/2	c_1p yb	sil	m	wsp	as
B(?)	11 – 36	2.5Y5/2	f_1p db	sil	1vcpr	msh ws	as
C1	36 – 60	2.5Y4/2	f_1p db	sicl	rs	mh ws	as
IIC2	60 – 90	2.5Y5/2	c_1d db	sicl	m	msh ws	as
IIC3	90 – 120	2.5Y4/2	c_1d db	sicl	m	msh ws wp	-
Muslimpur							
Ap	0 – 15	2.5Y3/2	c_1d dyb	sil	m	msh wss	cs
C1	15 – 34	2.5Y5/2	c_1p dyb	sil	rs	msh wss	cs
IIC2	34 – 47	2.5Y4/2	c_2p dyb	sil	m	msh wss	cs
IIC3	47 – 70	2.5Y4/2	c_1p db	sicl	m	msh wss wsp	as
IIC4	70 – 90	2.5Y4/2	f_1p db	sil	m	msh wss wsp	as
IIC5	90 – 120	2.5Y5/2	c_2p db	sil	m	msh wss wsp	-
Shabajpur							
Ap	0 – 12	2.5Y3/2	c_1d dyb	sil	m	mh ws wp	cs
C1	12 – 28	2.5Y5/2	c_1d dyb	sil	rs	mh wss wsp	cs
C2	28 – 48	2.5Y5/2	c_1d dyb	sil	m	msh wss wsp	cs
IIC3	48 – 78	2.5Y3/2	c_1d db	sicl	m	msh wss wsp	cs
IIC4	78 – 95	2.5Y4/2	c_1d db	sicl	m	msh wss wsp	cs
IIC5	95 – 120	2.5Y5/2	c_2d db	sicl	m	msh wss wsp	-
Kukri Forest							
A	0 – 10	5Y5/2	c_1d dyb	sil	rs	msh wss wsp	cs
C1	10 – 17	5Y5/2	c_1d dyb	sil	m	msh wss wsp	cs
IIC2	17 – 33	5Y4/2	c_1d dyb	sil	m	msh wss wsp	cs
IIC3	33 – 40	5Y5/2	c_1d dyb	sicl	m	msh wss wsp	cs
IIC4	40 – 56	5Y6/2	c_1d dyb	sicl	m	msh wss wsp	as
IIC5	56 – 78	5Y6/2	c_1d dyb	sicl	m	msh wss wsp	as
IIC6	78 – 90	5Y5/2	c_1d dyb	sil	m	msh wss wsp	as
IIC7	90 – 120	5Y6/2	c_1d dyb	sil	m	msh wss wsp	-
Kukri Village							
Ap	0 – 10	5Y3/2	c_1d dyb	sil	rs	msh wss wsp	cs
C1	10 – 25	5Y5/2	c_1d dyb	sil	m	msh wss wsp	cs
C2	25 – 40	5Y4/1	c_1d dyb	sil	m	msh wss wsp	cs
C3	40 – 70	5Y4/1	f_1p db	sil	m	msh wss wsp	cs
C4	70 – 85	5Y5/2	f_1p db	sil	m	msh wss wsp	cs
C5	85 – 120	5Y5/2	f_1p db	sil	m	msh wss wsp	-

* The abbreviations used are according to USDA system (Anonymous 1993).

Particle size distribution

The soils contained large quantities of silt, ranging from 51 to 72%, with an average of 64% (Table 2). This high silt content is a characteristic property of these coastal soils (Khan *et. al.* 1998). The clay content ranged from 20 to 40%, with an average of 26%. Sand content was very low, ranging from 5 to 20%, with an average of 10%. These results of particle size distribution conform with those reported by Hassan and Razzaque (1981) who studied tidal flood plain soils of the Ganges. The vertical distributions of the sand, silt and clay fractions in all the profiles were more or less uniform, indicating the uniform nature of the parent material. The sand/silt ratio of the soils was more or less uniform vertically. Moreover, the difference between sand/silt ratio was always less than 0.2 between the two adjacent horizons confirming homogeneity of the parent material.

Table 2 Some physical and chemical characteristics of the soils from Char Kukri Mukri

Depth (cm)	Sand (%)	Silt (%)	Clay (%)	Sand/ silt ratio	n-value*	pH (H_2O)	ECe (dS m^{-1})	Organic carbon (%)	Total nitrogen (%)	C/N ratio
Hanzipur										
0 – 9	11	63	26	0.17	0.78	7.4	1.35	0.57	0.06	10
9 – 11	6	70	24	0.08	0.81	8.0	1.18	0.50	0.05	10
11 – 36	10	70	20	0.14	0.77	8.1	1.15	0.34	0.04	8
36 – 60	9	51	40	0.18	0.81	8.2	1.16	0.38	0.05	8
60 – 90	9	54	37	0.17	0.79	8.3	1.72	0.29	0.03	9
90 – 120	5	60	35	0.08	0.77	8.4	1.21	0.23	0.03	7
Muslimpur										
0 – 15	8	66	26	0.12	0.76	7.6	1.51	0.65	0.08	8
15 – 34	10	63	27	0.15	0.81	7.8	1.34	0.32	0.05	7
34 – 47	9	70	21	0.12	0.83	7.9	1.35	0.29	0.03	9
47 – 70	8	62	30	0.13	0.80	7.9	1.41	0.31	0.03	11
70 – 90	10	66	24	0.15	0.75	8.1	1.39	0.23	0.02	10
90 – 120	9	67	24	0.13	0.71	8.1	1.43	0.25	0.02	8
Shahbajpur										
0 – 12	8	66	26	0.12	0.73	7.0	1.40	0.70	0.06	11
12 – 28	13	64	23	0.20	0.81	7.5	1.28	0.38	0.05	7
28 – 48	11	62	27	0.18	0.81	7.6	1.30	0.34	0.05	7
48 – 78	7	55	38	0.12	0.75	7.7	1.36	0.38	0.04	9
78 – 95	6	60	34	0.10	0.68	8.1	1.39	0.30	0.03	10
95 – 120	8	62	30	0.13	0.65	8.1	1.37	0.29	0.03	9
Kukri Forest										
0 – 10	7	72	21	0.10	0.82	7.0	1.11	1.60	0.15	10
10 – 17	11	62	27	0.17	0.87	7.2	1.09	0.95	0.12	8
17 – 33	15	64	21	0.23	0.88	7.4	1.04	0.54	0.06	9
33 – 40	8	58	34	0.14	0.85	7.9	1.09	0.34	0.05	7
40 – 56	7	55	38	0.13	0.83	7.9	1.21	0.38	0.04	9
56 – 78	6	60	34	0.10	0.79	8.4	1.35	0.42	0.05	8
78 – 90	20	58	22	0.34	0.77	8.5	1.37	0.36	0.04	9
90 – 120	11	65	24	0.17	0.75	8.5	1.33	0.38	0.04	9
Kukri Village										
0 – 10	9	67	24	0.13	0.88	7.7	1.65	0.94	0.08	12
10 – 25	9	67	24	0.13	0.86	8.0	1.36	0.58	0.05	11
25 – 40	10	70	20	0.14	0.84	8.2	1.35	0.29	0.04	8
40 – 70	10	70	20	0.14	0.75	8.2	1.35	0.38	0.04	9
70 – 85	10	70	20	0.14	0.71	8.3	1.27	0.32	0.03	10
85 – 120	9	69	22	0.13	0.65	8.4	1.39	0.36	0.04	9
Mean	10	64	26	0.15	0.78	7.9	1.39	0.42	0.05	9

$$\text{*n-value} = \frac{A - 0.2R}{L + 3H}$$

Where A = % moisture under field condition; R = % silt + % sand; L = % clay ; H = % organic matter

n-Value

Soils included in the present study had n-values ranging from 0.65 to 0.88 with a mean value of 0.78 (Table 2). All the soils had n-values of > 0.7 in the upper 25-cm depth, which was indicative of low bearing capacity of soils at saturation condition. These soils were in an unripened state because they had high quantity of interstitial water. In classifying these soils Haplaquents (n-value > 0.7) are separated from Haplaquepts (n-value < 0.7) based on their physical properties (n-value) (Anonymous 1975).

Soil chemistry

The soils of Char Kukri Mukri were neutral to alkaline with pH values ranging from 7.0 to 8.5. In all pedons, there was a trend of increasing pH with depth. This increase in pH with depth is a common feature in many of the seasonally flooded Bangladesh soils where ferrolysis is a common soil forming process (Brinkman 1977). The alkaline pH of the soils might be due to the calcareous nature of parent materials. The ECe values of the saturation extract of the soils ranged from 1.04 to 1.72 dS m^{-1} (Table 2) indicating that these soils were all non-saline and non-sodic. These limited values of ECe were observed in the month of November when the sea was calm. Salinity values in some coastal plain soils of Bangladesh vary seasonally; salinity peak in April-June and fall to a minimum around October before gradually rising again (Hassan 1984, Hossain & McConchie 1994).

The organic carbon content in the studied soils ranged from 0.23 to 1.60% (Table 2). These results are in agreement with those reported for some soils from other nearby offshore islands of Bangladesh (Hussain *et al.* 1989, Hossain & McConchie 1994). Large amounts of organic carbon in the surface horizon of Kukri forest soil (Profile 4) might be attributed to the regular addition of organic litter, in the form of twigs and fresh leaves. The low organic carbon content in the surface horizon of the other profiles might be due to the high rate of organic matter decomposition, caused by cultivation under tropical conditions.

Total nitrogen content in the soils ranged from 0.02 to 0.15% (Table 2). Average total N in the surface soils was only 0.08%, which was a relatively low value. The C/N ratio of the soils ranged from 7 to 13 with highest values in the surface horizons (Table 2). This indicated that the organic matter fraction of the soils underwent oxidation by an active microbial flora. The vertical distribution pattern of C/N ratio was irregular in the soil profiles.

The cation exchange capacity of the soils ranged from 15.0 to 29.8 cmol kg^{-1} (Table 3). Higher values of CEC occured in the sub-surface horizons in some of the profiles. The CEC in these soils bore a relationship with the clay content ($r = 0.70^{**}$). Calcium was the dominant cation in the exchange phase of the soils followed by Mg^{2+}, Na^{+} and K^{+} ion. The soils had very high percentage of base saturation. Exchangeable sodium percentage (ESP) in the soils was high but did not exceed 15 in any of the pedons.

Table 3 Cation exchange capacity (CEC) and exchangeable cations ($cmol\ kg^{-1}$) of the soils from Char Kukri Mukri

Depth (cm)	CEC	Exchangeable base				Ca^{++}/Mg^{++} ratio	ESP*	Base saturation (%)
		Ca^{++}	Mg^{++}	K^{+}	Na^{+}			
Hanzipur								
0 – 9	18.80	9.61	6.51	0.43	1.04	1.5	6	93
9 – 11	15.03	6.94	5.23	0.62	1.51	1.3	10	95
11 – 36	15.81	7.73	5.21	0.71	1.60	1.5	10	96
36 – 60	19.04	9.32	6.70	0.40	1.80	1.4	10	69
60 – 90	19.90	9.61	7.03	0.60	2.07	1.4	11	97
90 –120	20.72	11.15	6.91	0.42	1.91	1.6	9	98
Muslimpur								
0 – 15	21.44	8.32	6.91	0.33	2.04	1.2	10	82
15 – 34	20.32	8.13	6.72	0.60	1.60	1.2	8	84
34 – 47	17.71	6.70	6.03	0.34	1.71	1.1	10	83
47 – 70	24.13	10.80	7.42	0.33	1.80	1.5	8	84
70 – 90	29.82	18.33	5.70	0.42	1.71	3.2	6	88
90 – 120	28.33	16.41	6.14	0.53	2.13	2.7	8	89
Shahbajpur								
0 – 12	17.14	6.32	4.42	0.61	2.02	1.4	14	81
12 – 28	17.51	6.23	5.03	0.91	2.01	1.2	14	82
28 – 48	18.14	6.70	5.51	0.32	2.02	1.2	13	82
48 – 78	22.41	8.32	8.23	0.43	2.03	1.0	9	85
78 – 95	22.14	8.14	8.14	0.52	2.01	1.0	10	85
95 – 120	23.13	10.21	7.51	0.61	2.02	1.3	9	88
Kukri Forest								
0 – 10	13.21	6.80	4.51	0.51	1.03	1.3	8	97
10 – 17	16.50	7.90	5.80	0.81	1.04	0.8	5	94
17 – 33	12.91	7.52	2.90	0.52	1.22	0.7	7	94
33 – 40	19.82	12.13	5.72	0.43	1.22	0.8	6	98
40 – 56	21.31	12.80	6.53	0.61	1.02	0.6	13	98
56 – 78	20.70	11.60	5.90	0.52	1.81	2.5	12	96
78 – 90	12.52	7.05	3.63	0.33	1.41	2.2	13	97
90 – 120	13.33	8.13	3.52	0.42	1.05	1.6	11	95
Kukri Village								
0 – 10	23.31	9.90	8.14	1.02	2.01	1.2	12	93
10 – 25	17.42	6.70	6.03	0.71	1.25	1.1	7	88
25 – 40	21.40	13.81	4.53	0.50	1.81	3.1	8	96
40 – 70	18.04	10.90	4.51	0.41	1.61	2.4	9	97
70 – 85	17.81	10.03	4.70	0.60	1.90	2.1	11	97
85 – 120	26.43	18.04	5.52	0.32	1.91	3.3	7	97
Mean	19.57	9.22	5.80	0.53	1.66	1.6	10	88

*ESP = Exchangeable sodium percentage

Clay mineralogy

X-ray diffractograms of the clay fraction showed the occurrence of various types of clay minerals in soils (Figure 2). The semi-quantitative estimation of clay minerals showed the dominance of mica which occupied more than 50% of the clay fraction of the soils followed by kaolinite which occupied about one-third of the clay fraction (Table 4). A small quantity of vermiculites and interstratified minerals were present in the clay fraction of all the soils. The presence of vermiculites was significant as the clay minerals present in the soils appeared to be mainly inherited from their parent materials with very little *in situ* mineral synthesis. White (1985), however, is of the view that vermiculites in Bangladesh soils may be formed by weathering of mica. The absence of smectite in the clay fraction of the soils of Char Kukri Mukri is surprising as these soils were formed on parent materials derived from the Ganges-Brahmapurta-Meghna river system in which smectite constitute around 35% (White 1985).

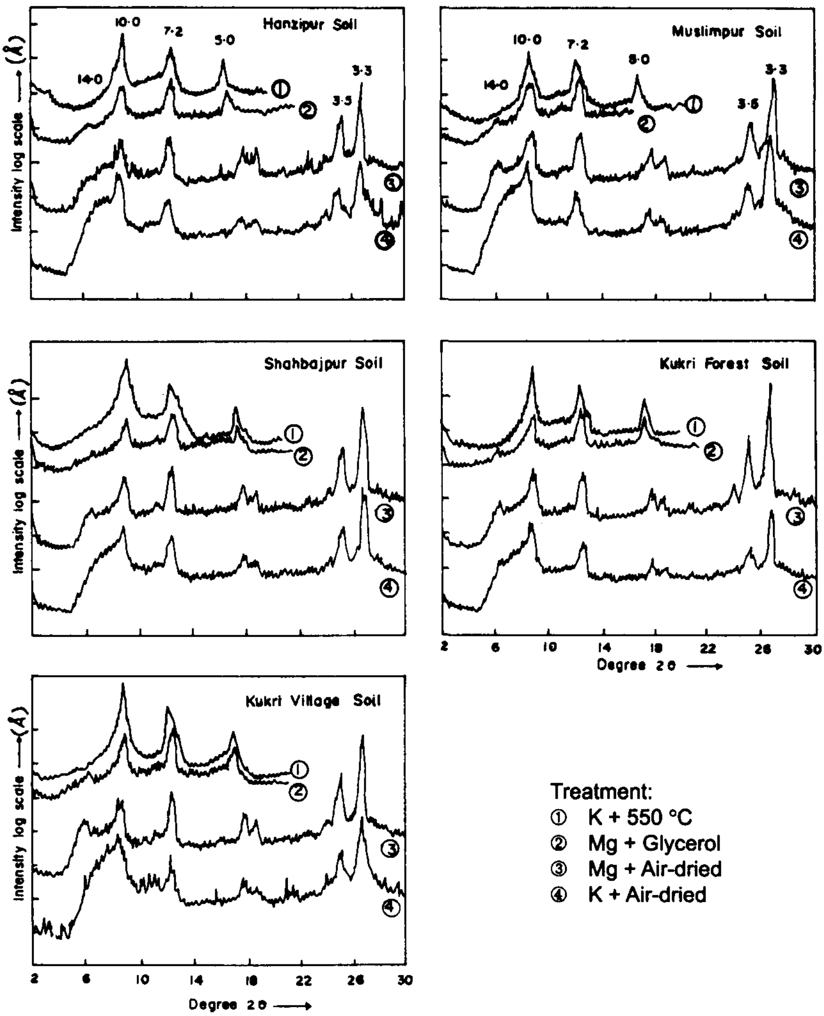

Figure 2 X-ray diffractograms of clay fraction from surface soils of Char Kukri Mukri

Table 4 Estimation of minerals in the clay fraction of the soils

Soil profile	Horizon	Depth (cm)	Clay mineral composition* (%) M	K	V	I
Hanzipur	Ap1	0–9	58	31	6	5
Muslimpur	Ap	0–15	53	37	5	5
Shabajpur	Ap	0–12	48	39	5	8
Kukri Forest	A	0–10	58	27	11	4
Kukri Village	Ap	0–10	62	21	13	4
Mean	-	-	56	31	8	5

* M = mica; K = kaolinite; V = vermiculites; I = interstratified minerals

Pedogenesis and classification

Parent materials of the studied soils were of mixed origin and were at an incipient stage. The soils developed on Char Kukri Mukri showed the marks of hydromorphism. The lower most zone of all the profiles was gleyed. The low exchangeable Ca^{++}/Mg^{++} ratio in some of these soils suggested that the gleization process is strong (Joffe 1968). Moreover, the mixing of organic matter with mineral matter in the surface horizon had caused a darkening in colour. The melanisation process appeared to be quite strong and reflected a luxuriant vegetation.

All the soils, except Hanzipur, were young and lack diagnostic horizons other than an ochric epipedon. These soils can, therefore, be classified in the Entisols order. Since Hanzipur profile showed evidence of a structural B (Cambic) horizon, this soil was classified in the Inceptisol order. Based on morphological and other characteristics, the five profiles from Char Kukri Mukri were classified at the subgroup level as follows:

Soil	Classification (Subgroup*)
Hanzipur	Typic Endoaquept
Muslimpur	Typic Endoaquent
Shahbajpur	Typic Endoaquent
Kukri Forest	Typic Endoaquent
Kukri Village	Typic Endoaquent

*According to USDA soil taxonomy (Anonymous 1975, 1998).

Conclusions

From the above studies, it can be concluded that the soils developed on Char Kukri Mukri were pedologically young in the time scale showing high fertility status. The attributes of parent materials and the associated soil moisture regime dominantly influenced the genesis of these soils. With respect to the physical environment and the chemical characteristics, the soils of Char Kukri Mukri are very much similar to those of the Sundarbans Mangrove forest (Hassan *et al.* 1988). As has been noted before, these soils were tidally affected and were non-saline in character. Under these conditions the soils are suitable for growing all types of mangrove species adapted to this island. Since the afforestation programme with mangrove species in offshore islands is successful, it can be extensively practiced in other islands. Human habitation may be restricted in these locations, where natural calamities take a heavy toll on human lives and the cattle population. Since Bangladesh has a much lower acreage under forest cover, it is recommended that mangrove forest be planted in offshore islands.

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