

ESTIMATION OF SOIL NUTRIENT (Ca, Cu, Fe, & Zn) IN THE POLDERISED AREA OF COASTAL ZONE: A CASE STUDY OF *BEEL DAKATIA*, KHULNA

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Abstract: Soil samples were collected from the three locations of Umvita, Ghona Madar Danga, and Taligati. Among the three locations, Umvita and Ghona Madar Danga were divided into two polders i.e., Polder-25 (*Beel Dakatia*) and Polder-27. However, Taligati was in Polder- 25 (*Beel Dakatia*) only. Soils were analyzed for moisture content and soil nutrients (Ca, Cu, Fe, Zn). The moisture content in the soil of Polder-27 was relatively lower than that of the moisture content in the soils of Polder-25 (*Beel Dakatia*), which indicated the presence of high concentration of organic carbon and humic acid. The average concentration of essential macronutrient Ca and micronutrient Fe and Zn were found to be lower in the soil of Polder-25 (*Beel Dakatia*) compared with the soil in Polder-27. However, the concentration of Cu was higher in Polder-27 in comparison with Polder-25 (*Beel Dakatia*). The lower value of soil nutrients in *Beel Dakatia* indicated loss of soil fertility.

Key words: Soil nutrient; Coastal zone; *Beel Dakatia*; Moisture content

Introduction

Coastal embankment project in Bangladesh covers a large area in the coastal district of Khulna. *Beel Dakatia* is one of the significant polderised areas (Polder 25) in Khulna district. At present *Beel Dakatia* is known as one of the environmentally degraded areas of Bangladesh. This is due to the construction of flood preventing polders. Since 1960 when polder for flood protection was put up in the area, the flow of sediment was diminished due to non-functioning of sluice gates. As a result of stagnant water, the soil of *Beel Dakatia* has undergone several changes resulting in infertility (Alam, 1992). The infertility of the land created traditional problems of low agricultural production of the area. The soil nutrients such as calcium, iron, copper, zinc etc are essential for the fertility of soils, which again are vital to agricultural productivity (Black, 1967). The present

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investigation was undertaken to assess soil fertility in *Beel Dakatia* with particular reference to the concentrations of Ca, Cu, Fe and Zn.

Materials and Methods

Soil samples were collected from three locations during December to February in order to avoid rainy season. The locations (Umvia and Ghona Madar Danga) were divided into two polders i.e. polder-25 (*Beel Dakatia*) and polder-27. These two polders were separated from each other by embankment. The location Taligati was in Polder-25. Samples 1-5 were collected from Umvita (Dumuria, Khulna); samples 6-10 were collected from Ghona Madar Danga (Dumuria, Khulna) and samples 11-15 were collected from Taligati (Fulbarigate, Khulna). The study area is shown in Fig. 1.

General descriptions of the soils are presented in Table-1. Pit was dug at the selected place and the soil sample was taken in a polythene bag. The bags were numbered properly and brought to the Chemistry Department, Jahangirnagar University for analysis.

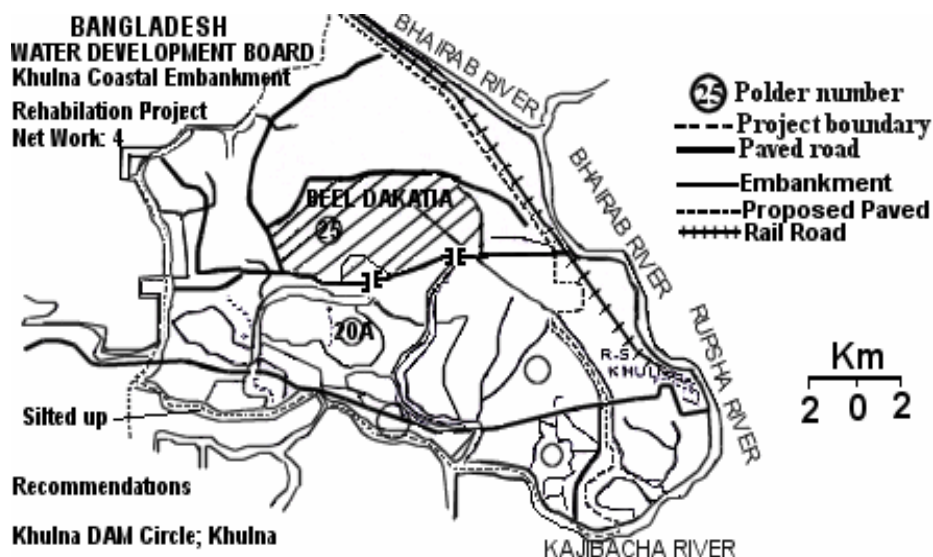


Fig. 1. Geographical location of the study area at *Beel Dakatia*.

Estimation of Moisture Content: Moisture percentage was determined by drying a known amount of collected sample in an oven (below 105°C) until the weight of the soil became constant. The loss of moisture from the soil was then determined.

Estimation of Calcium, Copper, Iron and Zinc: The collected soil samples were dried in sun light until constant weight and then powdered in a glass mortar through a 0.5 mm sieve. The powdered samples were stored in a reagent bottle. Then, a 0.5 g powdered sample was kept overnight in 10 ml of freshly prepared aquaregia and the mixture then evaporated to nearly dryness. 5 ml of concentrated and analar grade HNO₃ was added and

evaporated to nearly dryness. Then, again 5-6 ml deionized water was added and evaporated and the mixture was warmed up with 10 ml deionized water containing 2 drops of concentrated HNO₃ and filtered quantitatively through Whatman 42 filter paper into a 10 ml volumetric flask and the volume was made upto the mark with deionized water (Latif, 1992). The concentration of calcium, copper, iron and zinc in the soil sample solutions was determined, using a Perkin Elmer Model 560 Atomic Absorption Spectrophotometer at Atomic Energy Center, Dhaka.

Table 1. Soil characteristics, topography, vegetation and sampling depth of polder 25. and 27.

Location		Topography	Vegetation	Sample no.	Depth (inch.)	Soils
Umvita, Dumuria, Khulna	Polder 27	Lowland, Deeply flooded, Drainage system free.	Grass, Paddy, Crops.	1	0-6"	Light Grey, root was present
				2	12-15"	Deep Grey/black, root was present
				3	36-39"	Light Grey, root was present
Polder 25	Depression, Stagnant water, Drainage system blocked.	Nil	4	0-6"	Light Grey	
			5	12-15"	Light Grey	
Ghona Madar Danga, Dumuria, Khulna.	Polder 27	Lowland, Deeply flooded, Drainage system free.	Grass, Paddy, Crops	6	0-6"	Light brown, root was present
				7	12-15"	Light Grey, root was present
				8	36-39"	Deep Grey, root was present
Polder 25	Depression, Deeply flooded, stagnant water, Drainage system blocked.	Nil	9	0-6"	Light Grey	
			10	12-15"	Light Grey	
Talgati, Fulbarigate, Khulna. Polder 25	Delta like highland	Delta like, Deeply flooded, Stagnant water, Drainage system blocked.	Grass	11	0-6"	Deep Grey, root was present granulated clay.
				12	12-15"	Deep Grey, root was present
				13	36-39"	Deep Grey
Low land Under water	Depression, Deeply flooded, Stagnant water, Drainage system blocked.	Nil	14	0-6"	Black Clay	
			15	12-15"	Black clay	

Results and Discussion

Moisture content: The effect of varying periods of heating on the moisture content of the soils is given in Table 2. It is apparent that the moisture content in the soils of polder-27 was relatively lower than that of the soils of *Beel Dakatia* (polder-25). The moisture content in the soils of polder-27 varied from 23.2% to 30.1% (Samples 1-3 and 6-8) but

the moisture content in the soils of polder-25 varied from 35.4% to 42.8% (Samples 4,5,9 and 10 and 11-15) at different depths. The higher value of moisture content was attributed to higher concentration of organic carbon and humic acid (Haque, 1993). Humic acid plays an important role in aggregation and water stability of soils. The soil organic compounds increase the cohesion of the particles within the aggregates and decrease the wettability of the soil constituents. Thus the pressure of trapped air decreases during immersion in water (Jouany and Chassin, 1987). The higher moisture content may also be related to very negligible upland flow even during the rainy season. The water stands there for a long time because of flood preventing polders. Many researchers have suggested that humic acids display hydrophilic character in soils (Tschapek *et al.*, 1973; Giovannini and Sequi, 1976; Chen and Schnitzer, 1978).

Table 2 shows that the moisture content in polder-27 increased from the surface down the profiles while it decreased down the profiles in polder-25. The evaporation was rapid in first two hours but continued slowly thereafter and complete evaporation took 7 hours in case of polder-27 (Sample 1-3 and 6-8) but 11 hours in case of polder-25 (*Beel Dakatia*) (Samples 4,5,9,10 and 11-15). As water continued to evaporate from the soil, the force of adhesion or cohesion tightly held inner water. Hence, when the soil was nearly saturated, it was easy to remove the substantial amount of water but as the amount of moisture becomes less in the soil, an increasingly greater force is necessary to remove an equal volume (Latif, 1992).

Macro and Micronutrient: The calcium content of the investigated soils is presented in Table 3. The average concentration of calcium in the soils of polder-25 (*Beel Dakatia*) was relatively lower than that of polder-27. The concentration decreased with depth. However, in some cases the concentration remained constant with depth in the soils of polder-25.

The lower concentration of calcium was attributed to geochemical carbon cycle in the soils (Latif, 1992). Fresh sediment flow is diminished in *Beel Dakatia* because of flood preventing polders. Hence transportation of calcium is low. This might be the reason for the lower concentration of calcium in *Beel Dakatia*.

The concentration of copper varied from 52.23 ppm to 87.14 ppm at different depths (Table 4). It is apparent from Table 4, that the average concentration of copper in the soils of polder-25 was relatively higher than that of polder-27. In polder-27, the soils in between 12-15" inches of each locations had higher content of copper but in polder-25, the surface soil of each locations had higher content of copper and the concentration decreased with depths.

In rare instances metallic copper may be found in soil. It is usually in the form of insoluble minerals such as chalcopyrite, bronite, chalcocite, covellite, cuprite, tenorite, malachite and azurite. Copper also exists in soils in the form of insoluble salts such as phosphites, hydroxides and carbonates. Probably a relatively large amount of copper is held in an unavailable form in the organic matter. There are also very small quantities of water-soluble copper, which are held as an exchangeable cation in the clay and organic

materials. A good deal of evidence points to the fact that copper is tightly held in soils and little is lost by leaching (Leeper, 1964).

The higher concentration of copper in the soil of *Beel Dakatia* was due to the insoluble copper compounds, which were accumulated in the soil, and the leaching water was comparatively unable to carry downward in *Beel Dakatia* because of stagnant water.

Table 2. Effect of varying period of heating the moisture -content of the soils of polder 25 and 27.

Location	Polder no	Sample no	Depth Inch/Layer	% of weight loss of the soil samples (moisture content)											
				1 hour	2 hour	3 hour	4 hour	5 hour	6 hour	7 hour	8 hour	9 hour	10 hour	11 hour	12 hour
Umvia, Dumuria, Khulna.	Polder-27 Low land	1	0-6"	11.3	17.3	19.9	21.8	22.9	23.1	23.2	23.2	23.2			
		2	12-15"	16.8	22.5	24.8	25.8	26.9	27.1	27.1	27.1	27.1			
		3	36-39"	17.9	23.3	24.9	25.5	26.4	28.1	28.9	29.3	29.3	29.3		
	Polder-25 Stagnant Water	4	1 st layer	18.3	22.2	26.5	30.8	33.1	37.2	38.9	39.7	40.8	41.2	41.4	41.4
		5	2 nd layer	16.9	21.9	27.5	29.8	32.9	34.6	36.4	37.9	38.1	38.1	38.1	38.1
Danga, Dumuria Khulna.	Polder-27 Low land	6	0-6"	11.9	18.4	19.1	20.4	21.3	22.9	23.4	23.4	23.4	23.4		
		7	12-15"	16.7	24.1	26.3	27.1	27.9	28.6	28.8	28.8	28.8			
		8	36-39"	17.4	24.9	25.9	27.1	28.1	29.5	29.9	30.1	30.1	30.1		
Ghona Madar	Polder-25 Stagnant Water	9	1 st layer	20.2	23.8	24.9	27.0	29.2	33.5	38.8	39.7	40.3	41.8	42.7	42.7
		10	2 nd layer	18.4	22.7	24.1	26.3	30.1	35.6	38.1	38.9	39.0	39.2	39.2	39.2
Taligati, Fulbarigate, Khulna	Polder-25 Delta like Highland	11	0-6"	18.6	23.2	25.8	28.5	31.2	32.5	33.0	34.9	36.2	38.5	39.5	39.5
		12	12-15"	17.3	23.9	26.2	28.5	31.6	32.7	33.5	34.5	35.0	35.9	36.1	36.1
		13	36-39"	18.7	24.2	26.9	28.3	30.8	32.1	33.8	34.5	34.9	35.2	35.4	35.4
	Polder-25 Stagnant Water	14	1 st layer	20.1	25.3	29.5	35.2	37.1	38.8	39.9	41.2	41.9	42.1	42.1	42.1
		15	2 nd layer	19.3	25.6	30.7	34.3	36.2	37.4	38.2	38.2	39.2	39.4	39.4	39.4

The concentrations of iron found in the investigated soils are illustrated in Table 5. The concentration varied from 400 ppm to 800 ppm at different depths. The average concentration of iron in the soil of polder-25 was relatively lower in comparison with that of the soils of polder-27. The concentration of iron decreased from the surface down in both the soils of polder-27 and polder-25.

The low value of iron content was due to high value of organic carbon and humic acid (Haque, 1993). Humic acid chelates with iron and this iron humate supplies available iron to plants for a much longer time than most soluble iron salts. The organic matter extract chelates with iron, holds it for a time in a soluble condition so that it can be transported within the plant tissues (Leeper, 1964). The humic acid content in the soil of polder-25 (*Beel Dakatia*) was much higher than that of polder-27 (Haque, 1993). This was the main cause of lowering iron content in the soil of polder-25. The higher value of iron in the soil of polder-27 was due to chemical weathering and low value of organic matter.

Table 6 shows the concentration of zinc in different soil samples. The concentration varied from 67.12 ppm to 100.98 ppm at different depths. The average concentration of zinc in the soils of polder-25 (*Beel Dakatia*) was relatively lower than that of polder-27

Table 3. Concentration of calcium in the soils of polder 25 and 27.

Location	Polder No.	Sample No.	Depth (inch)	Ca (ppm)	Average
Umvita, Dumuria, Khulna.	Polder-27	1	0-6"	1100	1500
	Low land	2	12-15"	1500	
		3	36-39"	1900	
	Polder-25 Stagnant Water	4	0-6"	1100	1100
		5	12-15"	1100	
Ghona Madar Danga, Dumuria, Khulna.	Polder-27	6	0-6"	1200	1533
	Low land	7	12-15"	1600	
		8	36-39"	1800	
	Polder-25 Stagnant Water	9	0-6"	1000	1000
		10	12-15"	1000	
Taligati, Fulbarigate, Khulna	Polder-25	11	0-6"	1100	1016
	Dalta like Highland	12	12-15"	1000	
		13	36-39"	950	
	Polder-25 Stagnant Water	14	0-6"	1100	1050
		15	12-15"	1000	

Table 4. Concentration of copper in the soils of polder 25 and 27.

Location	Polder No.	Sample No.	Depth (inch)	Cu (ppm)	Average
Umvita, Dumuria, Khulna.	Polder-27 Low land	1	0-6"	55.75	58.24
		2	12-15"	66.73	
		3	36-39"	52.23	
	Polder-25 Stagnant Water	4	0-6"	86.28	80.11
		5	12-15"	73.93	
Ghona Madar Danga, Dumuria, Khulna.	Polder-27 Low land	6	0-6"	74.98	71.00
		7	12-15"	84.85	
		8	36-39"	53.18	
	Polder-25 Stagnant Water	9	0-6"	83.96	78.54
		10	12-15"	73.12	
Taligati, Fulbarigate, Khulna	Polder-25 Delta like Highland	11	0-6"	87.14	75.98
		12	12-15"	74.28	
		13	36-39"	66.53	
	Polder-25 Stagnant Water	14	0-6"	84.25	79.30
		15	12-15"	74.35	

(Table 6). In polder-27, the soil in between 12-15 inches of each location had higher content of zinc but in polder-25, the surface soil of each location had higher content of zinc and the concentration decreased with depths.

Zinc enhances heat frost resistance of plants by stabilizing to some extent their respiration during sharp temperature changes. There is evidence that zinc affects the uptake of phosphorus by plants. When zinc is deficient, plants accumulate large amount of inorganic phosphorus. There have been reports that zinc changes the rate of phosphorus accumulation in roots and slows down phosphorus translocation into the above ground organs. Zinc is also known to be found in the soil with phosphorus

Table 5. Concentration of iron in the soils of polder 25 and 27.

Location	Polder No.	Sample No.	Depth (inch)	Fe (ppm)	Average
Umvita, Dumuria, Khulna.	Polder-27	1	0-6"	700	566
	Low land	2	12-15"	600	
		3	36-39"	400	
	Polder-25	4	0-6"	600	550
	Stagnant Water	5	12-15"	500	
Ghona Madar Danga, Dumuria, Khulna.	Polder-27	6	0-6"	800	733
	Low land	7	12-15"	700	
		8	36-39"	700	
	Polder-25	9	0-6"	500	450
	Stagnant Water	10	12-15"	400	
Taligati, Fulbarigate, Khulna	Polder-25	11	0-6"	600	500
	Delta like	12	12-15"	500	
		Highland	13	36-39"	
	Polder-25	14	0-6"	500	450
	Stagnant Water	15	12-15"	400	

Table 6. Concentration of zinc in the soils of polder 25 and 27.

Location	Polder No.	Sample No.	Depth (inch)	Zn (ppm)	Average
Umvita, Dumuria, Khulna.	Polder-27 Low land	1	0-6"	86.29	83.98
		2	12-15"	98.34	
		3	36-39"	67.15	
	Polder-25 Stagnant Water	4	0-6"	81.92	79.75
		5	12-15"	77.58	
Ghona Madar Danga, Dumuria, Khulna.	Polder-27 Low land	6	0-6"	97.16	88.42
		7	12-15"	100.98	
		8	36-39"	67.12	
	Polder-25 Stagnant Water	9	0-6"	85.85	82.51
		10	12-15"	79.16	
	Polder-25	11	0-6"	83.18	

Taligati, Fulbarigate, Khulna	Delta like	12	12-15"	79.28	79.52
	Highland	13	36-39"	76.12	
	Polder-25	14	0-6"	80.82	78.40
	Stagnant Water	15	12-15"	75.98	

compounds. Zinc deficiency inhibits the conversion of inorganic phosphates into organic form (Yagodin, 1984). Sediment is the agent of transport of micronutrients, which are usually present in the silt, the suspended load in river. Due to diminished flow, there could be depletion of micronutrients (Safiullah, 1988).

The soils of *Beel Dakatia* are deprived of fresh sediment flow because of the flood preventing polders. For this reason the concentration of zinc in *Beel Dakatia* is low. Most minerals in which zinc occurs are readily weathered and the element is probably held as a cation on the exchange complex of the soil and in organic matter (Leeper, 1964).

Conclusion

From the present investigation, it is clearly observed that the soils of *Beel Dakatia* contained low concentration of calcium, iron and zinc in comparison with the soils in polder-27. The exact reasons for the low value of these metals are difficult to ascertain. However, it could be due to many factors such as total blockage of fresh sediment inputs, slowing down of the biogeochemical cycles of elements, particularly that of carbon and decrease or total stoppage of nutrient mobility of the micronutrients.

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