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Research Article

Assessment of the Quality of Soil and Environmental Impact for Netrokona Sadar in Mymensingh Using Satellite Imaging and Soil Mapping with GIS.

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Abstract

Netrokona is a district of the Mymensingh division in northern Bangladesh. In this study, we analyze the soil profile in Netrokona Sadar using digital soil mapping and land formation using the satellite image technique. This study also analyzes the soil profile using remote sensing data of 4 different points in selected area. The main focus of the study is analyzing the soil profile for the structural compatibility and environmental impact for that. After analyzing the soil we found that the soil of that area is mainly clay loam and clayey loam and the soil contains low coarse fragement which is 5.6-8% but we need at least 15-30% coarse fragement in the soil. The soil of this area needs good management to improve its drainage.

Keywords: Soil Mapping, Soil Profile, GIS Technology, Structural Compatibility, Satellite Imaging

1. Introduction

The main goal of the structural compatibility analysing is to reduce the risk of building failure by determining the land requirement for better soil classification. Digital soil mapping is one of the best way for soil analysis because of the development of technology. Geographic Information System (GIS) and Remote Sensing (RS) techniques are very useful for preparing these digital maps. We can gather and analyse data from various database that use remote sensing technologies. In recent studies, researches use GIS and RS technologies in their recent studies [1-21].

In this study, we also use satellite image which is the hyper spectral image that can indicate due to rapid growth of population there is a high demand of land that is prepared for construction. In different countries various investigations and search is carried out for appropriate site for construction mainly for residential building. One of the most important parameters that should be taken seriously is the environmental impact for the structural development. The scope of this paper is to examine the various factors for structural development and define their relationship with various soil properties. The goal was to create a digital soil map using GIS and satellite image to identify the soil quality of that area whether the soil is suitable for construction or not additionally we also try to evaluate the environmental impact for that.

We used soilgrid database to analyse various soil property such as percentage of sand, silt, clay, bulk density, coarse fragment, organic carbon, cation exchange capacity (at Ph-7), nitrogen, soil organic carbon, PH water, volume of water content at-10 Kpa, volume of water content at-33 Kpa, volume of water content at-1500 Kpa for our selected study area. The SoilGrids database is a convenient online resource that offers global assessments of soil quality at different depths. It is managed by ISRIC (International Soil Reference and Information Center) and provides detailed soil information.

2. Methodology

In this study, we obtained the location map from simplemaps.com and digital soil map which we collected from Food and Agriculture Organization [FAO]-UNESCO Soil Map of the World. We made our study area maps through ArcGIS 10.7.1 version. The satellite image was collected from USGS.gov website. The four points that is used to identify the soil type are selected from the satellite image and Global Positioning System (GPS). Hyper spectral photos are used to evaluate the land formation and land type. The soil property data such as percentage of sand, silt, clay, bulk density, coarse fragment, organic carbon, cation exchange capacity(at Ph-7), nitrogen, soil organic carbon, PH water, volume of water content at-10 Kpa, volume of water content at-33 Kpa, volume of water content at-1500 Kpa are obtained from soil gride database.

2.1 Selecting and Making Maps of Study Location

Our study area was Netrokona Sadar which is a sub-district (upazila) situated in the Netrokona District, part of the Mymensingh Division in Bangladesh. The area of the Netrokona Sadar is 340.4 km^2.We took four location points to analyse soil properties of this area. [Figure: 1]

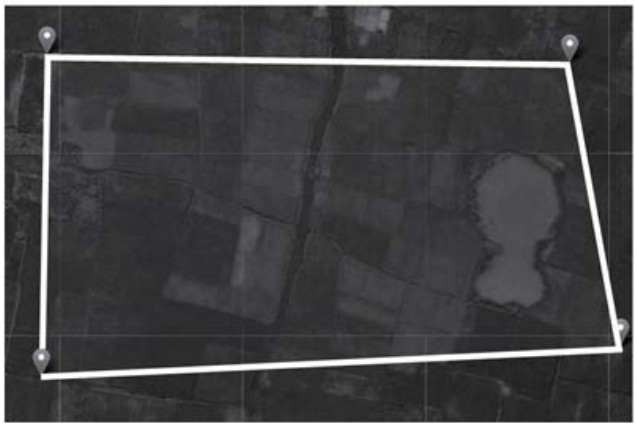

Figure 1: Satellite Image of Four Study Location Points

For making the location map we used GIS based software named as ArcGIS [10.7.1].[fig:2]

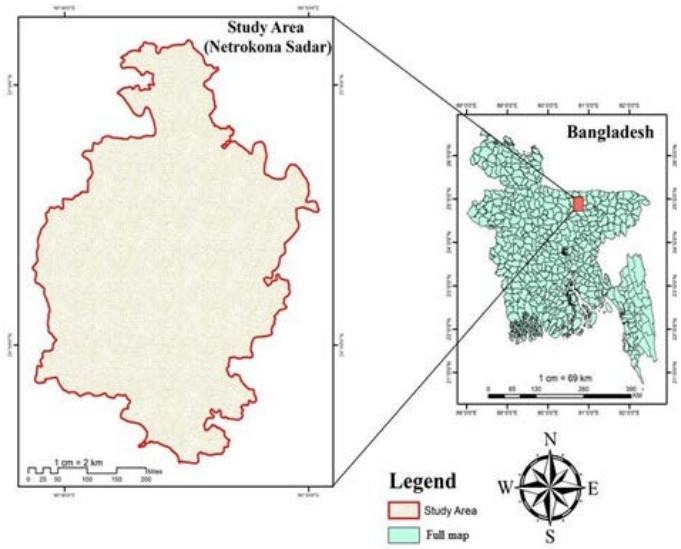

Figure 2 : Study Area (Netrokona Sadar)

2.2 Making Soil Map

We obtained world digital soil map from FAO website. After that we extracted only Bangladeshi soil part from world soil map. We predicted our study area Netrokona Sadar and it was marked with blue color. According to FAO soil classification we found that the type of the soil is Eutric Gleysols [Ge] [figure: 3]

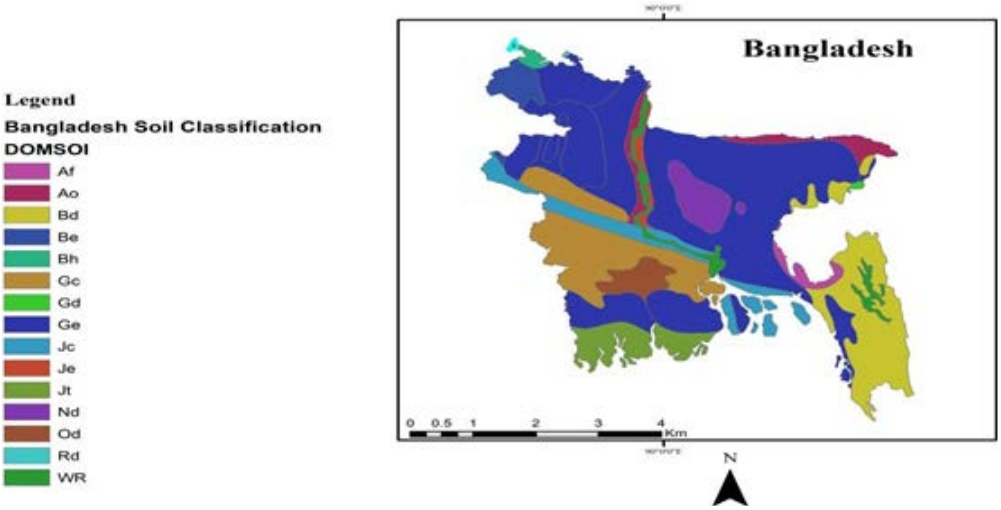

Figure 3: Soil Classification Map of Study Area [Netrokona Sadar]

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Another figure also classify the type of soil in our selected area. [Figure -4]

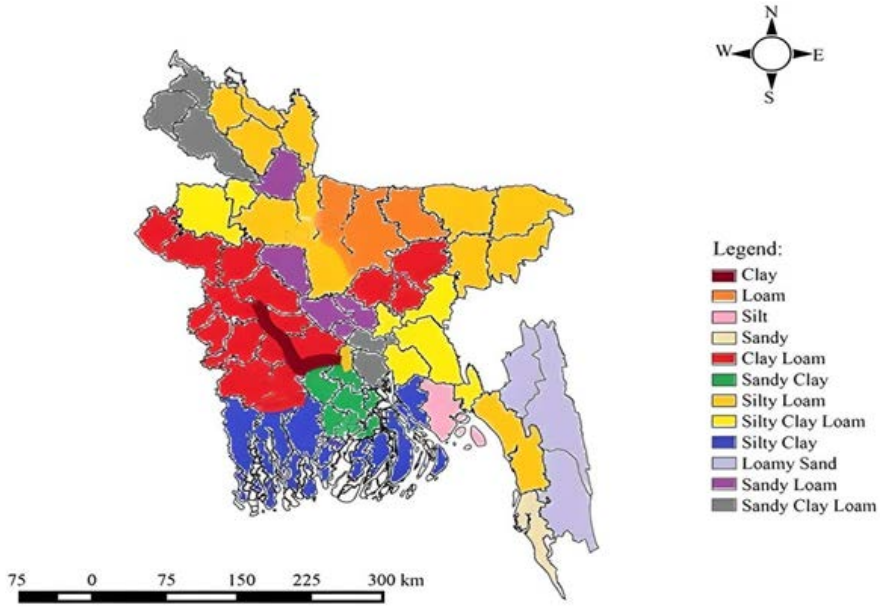

Figure 4: Soil Classification Map of Study Area [Netrokona Sadar] [22]

2.3 Analysing Soil Properties

We took 4 location points which were 1st [*Lat*: $24^0 53' 17''$, *Lon*:$90^0 44' 43'' E$], 2nd [*Lat*: $24^0 53' 18''$, *Lon*:$90044' 29'' E$], 3rd [*Lat*: $24^0 53' 10''$, *Lon*:$90^0 44' 29'' E$], 4th [*Lat*: $24^0 53' 11''$, *Lon*:$90^0 44' 44'' E$].

We took soil properties data from soil grid and analyses it for structural compatibility also environmental impact for this area. [Table 1, 2].

Station	Location Point	Depth (cm)	Bulk Density (cg/cm^3)	Clay content (%)	Sand (%)	Silt (%)	Coarse fragment (cm^3/dm^3)	Organic Carbon density(Hg/m^3)	Cation exchange capacity(at Ph-7) mmol©/Kg	Nitrogen (Cg/Kg)	soul organic Carbon (Dg/Kg)	PH water in pH*10	Volume of water content at-10 Kpa in(10-2 cm3 cm-3)*10	Volume of water content at-33 Kpa in(10-2 cm3 cm-3)*10	Volume of water content at-1500 Kpa in(10-2 cm3 cm-3)*10
1	Lat: 24°53'17" N, Lon:90°44'43" E	0	130	28.6	31.3	40.2	62	288	173	135	171	58	373	321	165
		5-15	131	30.3	30.3	39.4	57	258	165	129	134	58	374	318	175
		15-30	135	35.6	28	36.4	59	169	165	81	102	58	374	322	182
		30-60	137	38.5	26.3	35.2	73	119	161	85	81	59	381	324	223
		60-100	138	36.7	27.9	35.4	79	99	158	89	67	59	388	322	228
		100-200	138	34	30.3	35.6	78	52	163	77	62	59	382	324	236
2	Lat: 24°53'18" N, Lon:90°44'29" E	0	130	276	31.3	41.1	70	293	172	137	173	58	375	322	162
		5-15	132	293	30.3	40.3	65	256	164	126	133	58	376	320	170
		15-30	135	346	28	37.4	63	172	165	84	107	58	376	323	179
		30-60	138	382	25.9	35.9	77	115	160	87	80	59	383	325	222
		60-100	139	361	27.6	36.3	83	99	158	82	70	59	389	321	225
		100-200	140	333	30.1	36.6	86	52	162	78	64	59	385	324	235
3	Lat: 24°53'10" N, Lon:90°44'29" E	0	130	26.6	32.1	41.3	66	294	180	131	168	57	373	321	160
		5-15	131	28.6	30.8	40.6	62	249	164	121	132	57	372	320	167
		15-30	135	33.2	28.7	38.1	63	180	165	84	78	57	372	324	174
		30-60	137	37.7	26.1	36.2	73	113	162	88	80	57	378	327	220
		60-100	140	36.2	27.4	36.4	84	297	159	83	68	58	384	325	222
		100-200	140	33	30	36.9	86	52	166	80	61	58	381	325	228
4	Lat: 24°53'11" N, Lon:90°44'44" E	0	130	26.8	32.4	40.8	68	296	177	134	166	57	373	319	162
		5-15	132	28.8	31.1	40.1	64	253	166	122	136	57	373	317	170
		15-30	135	34	28.6	37.5	64	174	166	83	83	57	372	320	177
		30-60	137	38.3	26	35.7	73	105	162	89	83	57	379	323	221
		60-100	139	37	27.2	35.9	80	94	159	83	69	58	385	321	223
		100-200	139	33.9	29.7	36.4	77	55	166	81	62	58	382	323	232

Table 1: Properties of Soil from Soil grid

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Station	Soil group	Probability (%)
1	Fluvisols Cambisols Nitisols Gleysols Acrisols	31 19 11 12 9
2	Fluvisols Cambisols Nitisols Gleysols Acrisols	30 19 12 11 6
3	Fluvisols Cambisols Nitisols Gleysols Acrisols	26 23 14 11 9
4	Fluvisols Cambisols Nitisols Gleysols Acrisols	26 23 14 11 9

Table 2: Type of Soil from Soil Grid

3. Results and Discussion

In this paper we exposed the soil properties data of Netrokona Sadar as well as analyse it with the help of soil mapping and satellite image and GIS technique which was done for agricultural purpose but not for structural purpose previously. Our details analyse and result is given below:

3.1 Structural Compatibility

This research has four stations. By these, we define the soil compatibility of soil for the structure in this area. Loam soil is very good and balanced soil type for the structure because it has good drainage capability, and it can hold moisture another advantage of that soil is nutrient retention capability. The approximate proportion for this type of soil is 40-50% sand, 20-30% silt, and 20-30% clay [23]. In the first station point the proportion is 28.6 to 38.5% clay, 27.9 to 31.3% sand and 35.2 to 40.2% silt in different depth of soil. It is a clay loam which has good moisture and nutrients retaining capability [23]. It also has a decent drainage capability. In the 2nd station point there is 27.6 to 38.2% clay, 28 to 31.3% sand and 35.9 to 41.1% silt that is considered as clay loam [23]. In the 3rd point there is 26.6 to 37.7% clay, 26.1 to 32.1% sand and 36.2 to 41.3% silt are found so this is clay loam [23]. In the 4th station point 26.8 to 38.3% clay, 28.6 to 32.45% soil and 35.7 to 40.8% silt are found so this is clayey loam which has a good moisture and nutrient retention capability and moderate drainage capability [23]. All the four soil sample has good moisture and nutrient retention ability and around a decent drainage capability which is good for constructing structure. As we observed from satellite image this block of land is cultivated land. So there is no possibility of landsliding. As the soil is clay loam that means the soil is stable and the value of bulk density is around 140cg/cm3 which is decent for the constructio [24].

The water content data At -10 kPa: Ranges from 372 to 389 At -33 kPa: Ranges from 317 to 327 At -1500 kPa: Ranges from 160 to 236 which shows that the soil has moisture but it is not overly saturated and reasonable for construction (According to google 20-40%). Coarse fragment improves soil stability. 15-30% of total soil is recommended but the four station point soil has 5.7% to 8.6% [25]. The soil need management and adding coarse material and ensuring good drainage is required for soil stability for construction.

3.2 Environmental Impact Assessment

The clay loam has good nutrient retention capability but over excavation can affect the fertility of soil and local ecosystem. The clay content of this soil can make hard for drainage, and it can be cause of erosion and sedimentation. Management of the drainage should be done carefully. Compaction of soil is done for stability of soil, but it can decrease land porosity and water infiltration capability which affect plant growth and increase runoff. Soil that is disturbed for construction can release its stored carbon that can increase the greenhouse gas emission.

3.3 Limitation and Future Aspect

There are some limitations with this work such as soilgrid database doesn't provide 100% accurate data and the data was not compared with field data. Future researcher should work on the soil mapping and accuracy on collected data.

4. Conclusions

Soil mapping allows us to readily obtain data on soil parameters and soil types. Aerial photos and satellite photography may provide precise information on land formations. This study entails generating soil maps and analyzing soil property data for structural compatibility and environmental effect in our elected area. It describes the types of data and procedures that may be used to create soil categorization maps. Soil grid provided most

of the data needed to create these maps. GIS and digital photogrammetric methods were utilized to evaluate this data. The hyper spectral satellite picture is evaluated to obtain the essential data for soil mapping and land creation. Central and local government policymakers, planners, and engineers should use current geoenvironmental studies when determining the best location for residential building. One of the purposes of soil mapping is to offer some reliable and useful data for planning the safe location of residential areas. GIS technique also contributes by altering data and executing relevant analyses in a short period of time at a low cost, as well as by enabling the construction of various scenarios that may be shown visually.

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