

Evaluating Potentials of Riverine Floodplain Soils for Management of Rice (*Oryza sativa* L) in Majuli River Island, Assam, India

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ABSTRACT

Land evaluation analysis in Majuli island is to determine suitability of riverine floodplains for sustainable rice (*Oryza sativa* L.) production using geographical information system. The land capability and soil quality for rice production in hydric soils was assessed using soil map having twenty four land mapping units defined as soil series association. Results showed that about 35 percent of total geographical area was evaluated as suitable for rice cultivation as against the current cropped area of 7.2 percent. The soil quality of hydric soil units in active and old floodplains were rated as medium with six indicators (pH, organic carbon, base saturation, effective rooting depth, structure and texture) meeting the threshold value above 0.4. The determination of soil quality was found useful to design best management practices for wetlands in the region that ensure sustainable land use. Major constraints identified in these pedons are poor soil texture, with poor water management and suboptimal nutrient contents. Thus for a sustained and continuous rice production on these soils, it is important that nutrient balance be maintained with recommended dose of both organic and inorganic fertilizers and appropriate water management strategies in relation to soil texture.

Key Words : Hydric Soils; Floodplain Wetlands; Land Evaluation; Soil Survey; Brahmaputra Valley

INTRODUCTION

The land suitability assessment is based on matching soil and climatic qualities with crop requirements. Various workers used FAO (Food and Agriculture Organization) guidelines for the land evaluation system (Bhaskar et al. 2016, Bhaskar et al. 2017). The island has low cropping intensity (102%) with an average productivity of rice 487 kg ha⁻¹ in post rainy season (November to February) and 1325 kg ha⁻¹ in rainy season (June to October) as against district average productivity of 1700 kg ha⁻¹. Rice is grown on wet soils during raining season and described as the “bread basket” in the region. The conversion of wetlands into agricultural use has resulted in more occurrence of severe flooding, severe bankline erosion, disruption of water flow regulation and deterioration of soil environment in this region. Therefore, the development of agriculture in the island can only be possible with proper assessment of wetland resources

for sustainable land use planning (Vadivelu et al. 2005, Bhaskar et al. 2010a). The extensive occurrence *aquepts* and *fluvents* in Brahmaputra valley with stratified textures, free carbonates and high organic carbon in surface layers were reported (Dey and Sehgal 1997, Bhaskar et al. 2008). The knowledge of soil fertility is a prerequisite for assessing the long-term impact of new intensive rice production technologies on paddy soils (Dobermann and Oberthür 1997). It is emphasized that spatial assessment and monitoring of the biophysical limitations for rice cultivation at regional scales is needed to identify the problem areas and for making strategic agronomic decisions (Kavitha and Sujatha 2015). Moreover, pedological characterization of soil series is an important aspect to address fertility issues in the basis of sustainable agriculture (Singh and Mishra 2012). These lowlands are important for agricultural development but less information is available for its utilization and intensification on a sustainable basis.

Therefore, in order to achieve sustainable production of rice in the island, and in similar paddy fields in Brahmaputra valley of Assam, the study objectives were: (1) to develop a user-friendly, inexpensive and credible soil fertility index to evaluate the paddy fields and to identify specific soil limitations for rice cultivation.

MATERIALS AND METHODS

Study Area

The Majuli island (93°30' - 94°35' E and 26°50' and 27°10' N) is situated in north of Jorhat district. The elevation on the island varies from 60 to 85 m above mean sea level. The island is bounded by three important rivers *viz.*, Kherkutia Suti, the Subansiri in the north and the Brahmaputra river in the south (Figure 1). The island is marked by seventy *bils* (local name for water bodies), which break the monotony of flat relief. The historical records mention that the Brahmaputra river was located north of Majuli during the late part of the 17th century. There is no dependable record mentioning southward migration of the Brahmaputra. The migration was caused probably due to the frequent earthquakes and floods that

occurred between 1661-1696 (Bhuyan 1968). Since 1930, two mega earthquakes (magnitude 8.7), five major (magnitude 7.0) and several smaller magnitude earthquakes have occurred in this area (Valdia 1987). Movements along active basement faults have caused tilting of the recent alluvium leading to the shifts in the courses of many rivers (Sarma and Phukan 2004).

Climate and Vegetation

The climate in the island is subtropical with warm humid summer and cool dry winter with mean annual rainfall of 1900 mm. According to Köppen system, this island enjoys “Cwg” - a humid mesothermal Gangetic type of climate (Barthakur 2004). This island predominantly receives southwest tropical monsoons during April through October and occasional winter showers. The monsoon season receives maximum amount of rainfall (62-65 % of annual rainfall) followed by pre-monsoon (20-23%), post-monsoon (6-8%) and winter (2-3%) season (Bhaskar et al. 2010b). The average maximum temperature ranges from 23.6 °C to 31.7 °C and minimum temperature varies from 10.0 °C to 24.2 °C. The average minimum temperature is about 10 °C during December-January while maximum of 32 °C is attained during July-

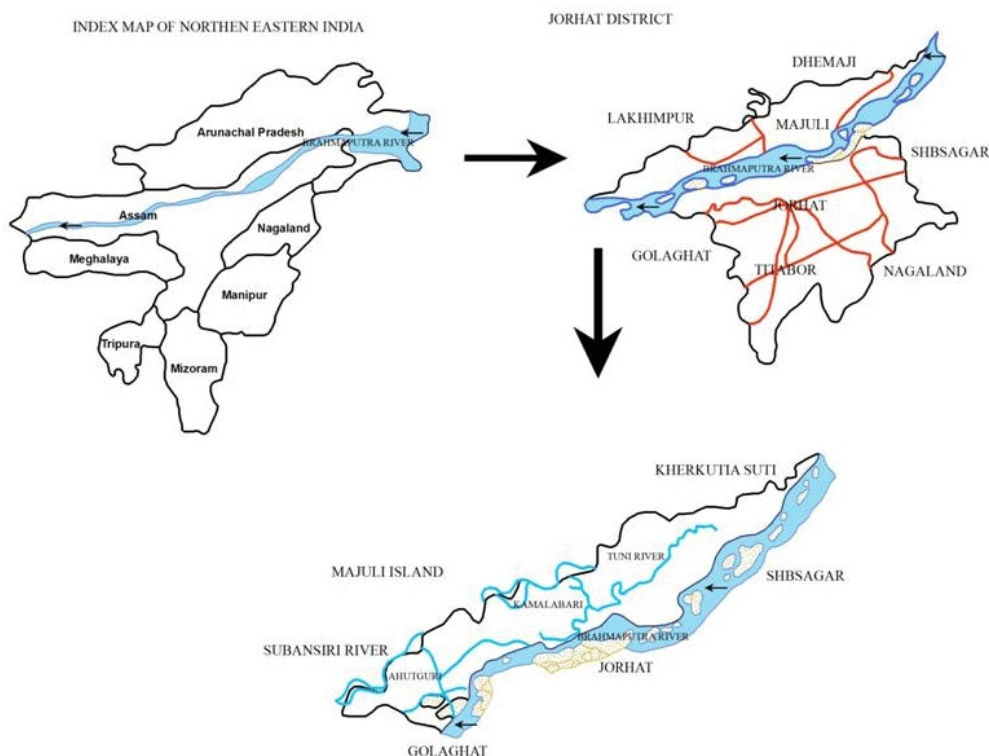


Figure 1. Location map of Majuli island

August. However, the minimum temperature drops to as low as 6 °C while maximum shoots up to 37 ° in some years. On an average, the relative humidity is more than 80% throughout the year. Even during dry winter months, the average relative humidity is never below 75% in the region. The rainfall analysis for the period of 1986 to 2002 was made and worked out the percent seasonal contribution of rainfall in the island (Figure 2). The results show that the south west monsoon (June to September) contributes 40 to 60 % of annual rainfall and 15 to 35 rains in summer (March to May), 5 to 25% rains in post monsoon (October to November) and winter (December-January).

The Majuli island experiences subtropical monsoonic climate with aquic/udic soil moisture regime and hyperthermic soil temperature regimes. The island supports the growth of evergreen, semi-evergreen and deciduous trees, grasses and marshy vegetation (Bhagabati 2001). The grasses in wetlands include *Phragmites karka*, *Arundo donax*, *Chrysopogon aciculatus* (Retz.) Trin., *Imperata cylindrica*, *Cynodon dactylon* and *Vetiveria zizanioides*. The marshy vegetation includes *Eichhornia crassipes*, *Pistia stratiotes*, *Nymphaea nouchali*, *Nelumbo nucifera*, *Trapa bispinosa*, *Euryale ferox*, *Cyperus rotundus*, *Alisma plantago*, *Polygonum hydropiper*, *Alpinia allughas* (Retz.) Roscoe and *Ipomea reptans* Poir.

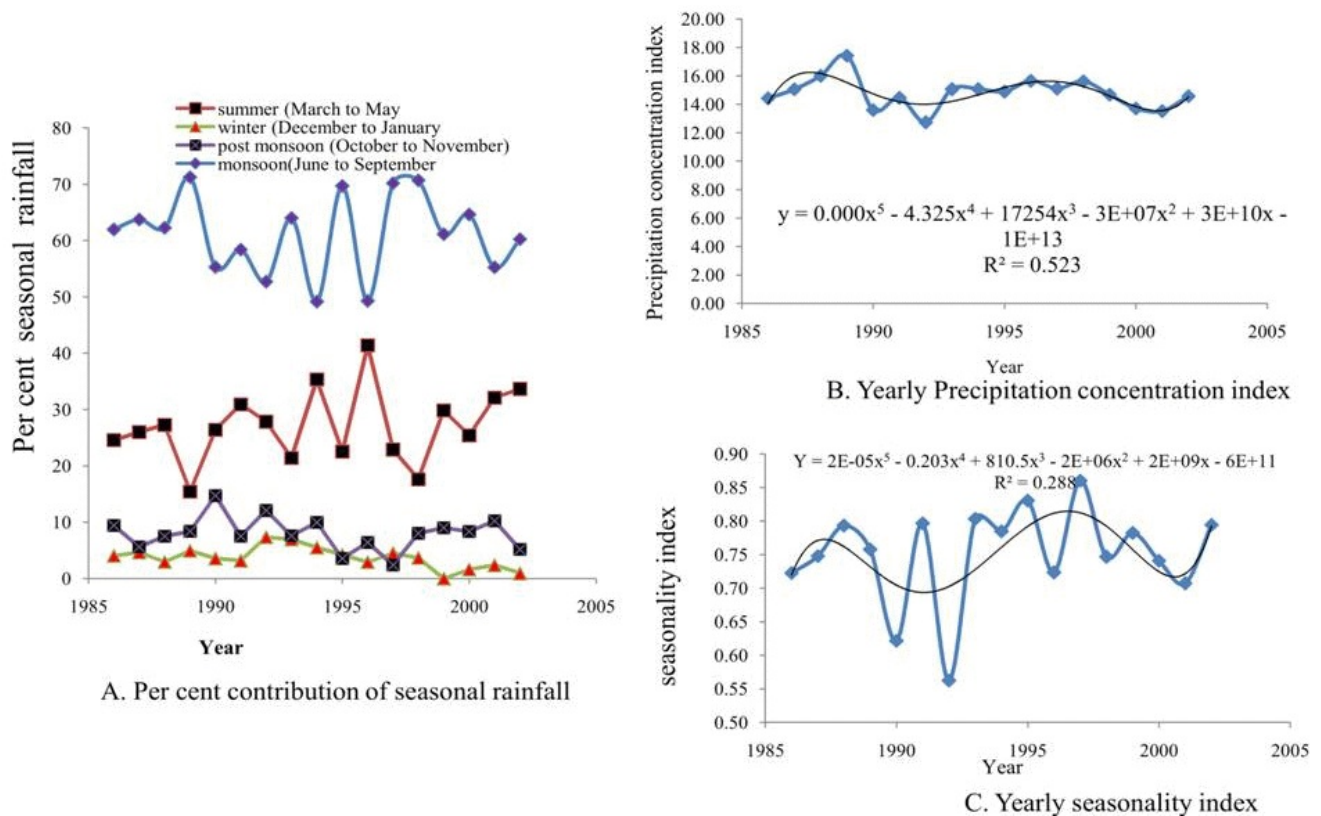


Figure 2. Monthly rainfall analysis of Majuli island (1986-2002)

Land Resource Data

Semi detailed soil survey was carried out as per Soil Survey Staff (1998) using 1:50,000 scale Survey of India toposheets and corresponding geocoded IRS-1D –LISS-III (Indian remote sensing satellite) images of 18th January, 2003 to prepare landform map. During survey, thirteen soil series identified and derived soil map with twenty five mapping units as soil series association. The

soil suitability for irrigated rice was evaluated using the criteria of Dengiz (2003) as presented in Table 1.

The land quality attributes used in evaluation included computation of two main indices:

$$\text{Nutrient Availability Index (NAI)} = N \times P \times K \times Zn$$

where N = total nitrogen (%), P= Available phosphorus (mg kg⁻¹), K = available potassium (mg kg⁻¹), and Zn = DTPA extractable Zn (mg kg⁻¹)

Table 1. Land quality rating for rice in Majuli island

Land quality parameters	Diagnostic factor	unit	Factor rating			
			1.0	0.8	0.5	0.2
1. Nutrient availability index	N	%	>0.2	0.1-0.2	<0.1	
	P	mg kg ⁻¹	>25	10-25	<10	
	K	mg kg ⁻¹	>60	30-60	<30	
	Zn	mg kg ⁻¹	.0.7	0.5-0.7	.0.5	
2. Soil quality index	SQI = R × T × D × F × Y × P × G × S × K × H					
Drainage (R)						
Texture (T)		%	CL, SiCL, SiL, C, SC	L,SCL,SiC	SL,fSL,Si	G,S,LS
Depth (D)		cm	>50	25-50	15-25	<15
Topography (F)	Land form/slope		Flood plain or 1-2%	Low terrace or 2%–4%	Middle terrace or 4%–6%	High terrace/ mountain or >6%
Surface stoniness (Y)		%	<20	20-35	35-55	>55
Hard pan (P)		cm	>90	90-50	50-20	<20
Hydraulic conductivity (G)		cm h ⁻¹	<0.5	0.5-2.0	2.0-6.25	>6.25
Salinity hazard or Exchangeable sodium (S)		dS m ⁻¹	0-3.1	3.2-4.0	4.1-5.0	>5.1
Lime (K)		%	<10	10-20	>20	>20
Soil reaction (H)	pH		0-5	5-15	15-20	.20
			5.5-7.3	7.4–7.8	7.9–8.4	>8.4
				5.1–5.5	4.0–5.0	<4.0

Abbreviations used = CL=clay loam; SiCL= silty clay loam, SiL=silty loam, C = clay, SC=sandy clay, L=loam; SCL=sandy clay loam; SiC=silty clay; SL= sandy loam; fSL= fine sandy loam; Si=silty; G=gravelly, S=sand, LS= loamy sand

Soil Quality Index (SQI) =

$$R \times T \times D \times F \times Y \times P \times G \times S \times K \times H$$

where R = drainage, T = texture, D= soil depth (cm), F = topography, Y = surface stoniness, P = hard pan, G = hydraulic conductivity (cm h⁻¹), S = salinity or exchangeable sodium percent, H = soil reaction.

These attributes were rated and developed into a suitability index as :

$$\text{Suitability Index (SI)} = \text{NAI} \times \text{SQI}$$

The suitability for rice was worked out and classified in 4 classes as given below:

Definition	Suitability class	Index value
Highly suitable	S1	1.00 – 0.25
Moderately suitable	S2	0.25 - -0.1
Marginally suitable	S3	0.1 – 0.025
Not suitable	N	<0.025

Using the above criteria, 24 soil mapping units generated in semi-detailed soil survey of Majuli island were evaluated and rice suitability map was generated using ARC/INFO ver.8.0. The schematic chart showing land characteristics and indices developed for suitability assessment is shown in Figure 3. The rating of soil mapping units as series association was made by multiplying the proportion of each soil series and its summation to get respective final soil rating and divided by 100 (AAFRD 2004)

In the present study, The agronomical interpretations were made using fertility capability classification (FCC, Sanchez et al. 2003) system. This method had two categorical levels such as type/substrata type that describes topsoil and subsoil texture as expressed in capital letters (S-sandy throughout; SC-sandy topsoil underlain by a clayey subsoil, for example) and 17 condition modifiers affecting plant growth with quantitative limits.

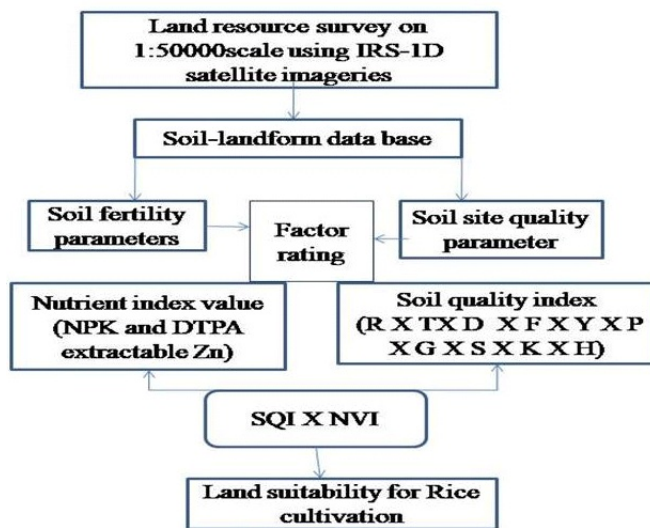


Figure 3. Schematic chart showing land suitability assessment for rice cultivation

RESULTS

Soils

The morphological characteristics of thirteen major soil series of hydric soils are discussed. The dominant soil series on active floodplains are Kamalabari (Kb, Humaqueptic Fluvaquents), Puranibari (Pb, Fluvaqueptic Endoaquepts), Dakshinpat (Dh, Humic Endoaquepts) and Bhakat (Bt, Typic Fluvaquents). This unit covers 16.3 percent of the total area. These soils have Ap-AC-C horizons sequence. These soils are dark grey (10YR4/1), clay loam to silt loam textured Ap horizons and dark grey and loamy textured AC horizons. The C horizons are loamy sand textured with moderately well drained conditions. Adielengi (Ae) and Chilkala (Ch) soil series on old floodplains are classified as Typic Endoaquepts. These soils have B horizons with grey matrix, silty loam to silty clay textures and sandy C horizons. The Gayangaon (Gy, Typic Endoaquepts) and Boritika (Ba, Fluvaqueptic Endoaquepts) in channel fills have olive grey (5Y5/2), silty clay loam Ap horizons and dark grey (5Y3/1) or dark greyish brown (2.5Y4/2) with yellowish brown mottled B horizons. The Sonaribari series (Sb, Typic Endoaquepts) on natural levees have sedimentary layering with olive grey matrix. The sand bars cover 43.2% of area. The dominant soil series are Majuli (Mj, Typic Fluvaquents) and Garumara (Ga, Typic Endoaquepts) series with olive grey to dark grey matrix. The

Bharaki (Bi, Fluvaqueptic Endoaquepts) and Bongaon (Bn, Typic Fluvaquents series on swamps have dark grey matrix and silty loam textures (Table 2). These soils are neutral to slightly alkaline except Kamalbari soil (P1) on active flood plains. The organic carbon content is 1.5 g kg^{-1} (Bhakat series, Bt) to 8.9 g kg^{-1} (Dakshinpat series, Dh) in Ap horizons. Calcium is dominant exchangeable base with values of $2.4 \text{ cmol(p+) kg}^{-1}$ (Garumara, Ga) to $10 \text{ cmol (p+) kg}^{-1}$ (Sonaribari series, Sb) followed by Mg of $1.2 \text{ cmol (p+) kg}^{-1}$ (Adielengi, Ae) to $5.2 \text{ cmol (p+) kg}^{-1}$ (Bongaon, Bn), sodium of 0.31 to $0.8 \text{ cmol (p+) kg}^{-1}$ and K of 0.08 to $0.5 \text{ cmol (p+) kg}^{-1}$. The cation exchange capacity is $5.1 \text{ cmol (p+) kg}^{-1}$ in Bongaon series to $14.4 \text{ cmol (p+) kg}^{-1}$ in Dakshinpat and Boritika (Table 2). The nutrient status of surface soils indicated that these soils are in general low in organic carbon, high to medium in available nitrogen and potassium, low in available phosphorus and DTPA extractable Zn (Table 3).

Soil Map

The soil map was generated with twenty five mapping units as series association (Figure 4 and Table 4). The soil series association was named in the order of dominance of soil occurrence. These associations in the island were recognized by knowing textural sequence, flooding frequency and surface organic carbon contents. There are twenty mapping units in active floodplains that covers 17991 ha (16.3% of total area). The sand bars cover 46371 ha with eleven mapping units. Out of eleven units, only four dominant mapping units are 10.Ga-Bn (5885 ha), 14.Mj-Ga (11789 ha), 15.Mj-Kb (16048 ha) and 24.Sb-Mj-Pb (4801 ha) covering 83.07% of sand bars. The swamps cover 14931 ha (13.6%) with sixteen mapping units wherein three units viz., 3. Bi-Ch-Ae (2022 ha), 4.Bt-Ga-Gn (2977 ha) and 23. Sb-Mj-Bn (2393 ha) have more than 2000 ha of land. The old floodplains cover 6.3% of area (6946 ha) with twelve mapping units. Out of twelve units, four mapping units near by tuni river in Kamalabari area (1.Ae-Bt-Ch-1311 ha; 2.Ba-Bt-Ga-1022 ha, 3.Bi-Ch-Ae-1810 ha and 4.Bt-Ga-Bn-1232 ha) covers 77% of area in old flood plains. The channel fills cover 12953 ha (11.8%) with fifteen mapping units. The mapping units viz., 19. Sb-Ba-Bt and 20. Sb-Ba-Mj covers 5849 ha accounting 45%. The natural levees occupy 8.9% of area with two dominant mapping units such as 15.Mj-Kb (5789 ha) and 24.Sb-Mj-Pb (3208).

Table 2. Properties of soils in Majuli Island

Soil series	Textural Sequence	Particle size distribution (%)			pH	OC gkg ⁻¹	Exchangeable bases cmol(p+) kg ⁻¹				CEC cmol(p+)kg ⁻¹
		Sand	Silt	Clay			Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺	
Sonaribar (Sb)	sicl-sil-l-sil	12.9	69.9	17.2	7.6	8.5	10.0	4.2	0.50	0.50	12.7
Bharaki (Bi)	sil-sl-l-sil-sicl	28.8	54.4	16.8	7.4	3.7	5.3	4.3	0.46	0.21	13.3
Bhakat (Bt)	sil-sl-ls-sl-s	76.6	16.4	7.0	7.9	1.5	8.7	1.2	0.31	0.08	7.2
Boritika (Ba)	l-sl-sicl-s	55.5	27.9	16.6	7.4	5.2	4.3	2.2	0.34	0.15	14.4
AdiElengi (Ae)	sil-sicl-sil-s	71.9	15.7	10.6	7.1	3.8	3.4	1.2	0.47	0.08	6.7
Puranibari (Pb)	sl-l-s-sl-sil-sicl	31.4	45.9	22.7	6.5	3.3	4.3	2.5	0.53	0.17	17.1
Kamalabari (Kb)	l-sil-l-ls	57.1	33.2	9.7	6.9	3.6	3.3	1.3	0.8	0.24	10.3
Chilkala (Ch)	sill,sic, sicl-s	65.8	17.8	16.4	6.9	4.0	3.0	2.4	0.7	0.15	7.1
Gayangaon (Gn)	sil-l-s	52.4	33.7	13.9	7.0	4.6	3.4	2.1	0.7	0.12	10.1
Dakshinpat (Dh)	sicl-sic-sil-s	35.4	47.4	19.7	7.1	8.9	5.5	3.5	0.7	0.10	14.4
Bongaon (Bn)	sil-l-sl-l-s	63.5	31.0	5.6	7.8	3.0	7.8	5.2	0.7	0.13	5.1
Garumara (Ga)	l-sl-s	57.9	31.2	11.9	6.1	4.7	2.4	2.0	0.8	0.16	10.1
Majuli (Mi)	ls-l-l	61.6	31.8	6.6	7.3	2.2	3.0	2.7	0.7	0.08	7.1

Table 3. Nutrient status in surface horizons of soils

Soil series	Available (kg ha ⁻¹)			DTPA extractable (mg kg ⁻¹)			
	N	P ₂ O ₅	K ₂ O	Mn	Fe	Cu	Zn
Sonaribari (Sb)	874 (H)	46.2(M)	584 (H)	17.3	128	10.4	0.84
Bharaki (Bi)	655 (H)	12.6(L)	206 (M)	4.9*	110	9.7	0.46*
Bhakat (Bt)	437 (M)	8.4 (L)	172 (M)	2.3*	23.0	3.6	0.34*
Boritika (Ba)	582 (H)	37.8(M)	275 (M)	13.3	444	6.0	0.54*
AdiElengi (Ae)	509 (M)	46.2(M)	310 (H)	5.1*	1.5	4.4	0.48*
Puranibari (Pb)	655 (H)	37.8(M)	344 (H)	30.8	2500	3.3	0.52*
Kamalabari (Kb)	655 (H)	5.2(L)	378 (H)	11.0	114	4.7	0.54*
Chilkala (Ch)	291 (M)	23.6(L)	344 (H)	1.0*	156	7.5	0.58*
Gayangaon (Gn)	801 (H)	25.2(L)	378 (H)	3.6*	101	5.7	0.36*
Dakshinpat (Dh)	1456 (H)	26.2(L)	447 (H)	30.0	495	10.5	0.52*
Bongaon (Bn)	510 (M)	25.2(L)	206 (M)	7.5*	82	3.9	0.30*
Garumara (Ga)	582 (H)	31.2(M)	344 (H)	23.6	226	3.8	0.62*
Majuli (Mi)	582 (H)	25.1(L)	104 (L)	9.5	34	7.4	1.28

* values below critical limit for rice

Land Evaluation for Rice

Among the thirteen soil series identified, the nutrient availability index is less than 0.5 is recorded in six soil series, of which these soils are low in available phosphorus and medium in available K status. These soils are mostly deficient in DTPA extractable Zn (<0.5 mg kg⁻¹). The mean NAI is 0.46 with standard deviation (SD) of 0.17 and coefficient of variation of 37.04% (Table 5). The mean soil quality index is 0.41±0.31 and categorized

into three classes where low is rated as <0.1, medium as 0.11 to 0.4 and high as more than 0.41 to 0.70. Out of thirteen soil series, five soil series are rated as high soil quality but low in Puranibari (Pb) and Majuli(Mi) series. These alluvial soils are frequently subjected to floods and receives silt from adjoining areas. The among factor ratings, texture, drainage and hydraulic conductivity are identified as major quality parameters for deciding suitability of rice cultivation.

Table 4. Soil mapping units and their extent in each geomorphic units

Soil mapping unit	Area of Geomorphic units (ha)							Total (ha)
	Active floodplains	Sand bars with grass cover	Sand bars	Swamps	Old floodplains	Channel fills	Natural levees	
1. Ae-Bt-Ch	--	-	-	119	1311	-	-	1430
2. Ba-Bt-Ga	94	-	-	677	1022	-	-	1792
3. Bi-Ch-Ae	261	-	-	2022	1810	-	-	4093
4. Bt-Ga--Bn	1051	-	-	2977	1232	225	-	5485
5. Ch-Ae-Bt	250	-	-	39	-	1076	-	1364
6. Dh-Ae-Kb	13	-	-	1086	-	-	-	1099
7. Dh-Bt-Bi	3456	-	-	-	343	20	-	3819
8. Dh-Bt-Ga	745	-	-	-	-	595	-	1340
9. Dh-Kb-Gn	711	-	-	-	-	1549	-	2260
10. Ga-Bn	744	4539	1346	1979	-	39	-	8647
11. Gn-Bn-Ga	-	-	26	448	85	-	-	559
12. Kb-Ga-Ch	3579	-	-	59	230	640	-	4508
13. Kb-Pb-Bn	139	-	-	370	75	1816	-	2398
14. Mj-Ga	199	2629	9160	-	-	108	-	12096
15. Mj-Kb	700	1137	14911	-	86	-	5789	22623
16. Mj-Sb	30	820	4456	-	-	81	-	5381
17. Pb-Kb-Mj	1653	-	736	58	-	487	108	3042
18. Pb-Sb	3376	615	355	806	38	49	-	5239
19. Sb-Ba-Bt	62	-	926	315	179	2323	-	3805
20. Sb-Ba-Mj	241	-	-	623	-	3526	-	4390
21. Sb-Bn	-	-	-	-	536	-	178	714
22. Sb-Ga-Mj	455	-	-	961	-	421	42	1879
23. Sb-Mj-Bn	-	109	74	2393	-	-	344	2921
24. Sb-Mj-Pb	-	4441	360	-	-	-	3208	8009
25. Sb-Mj-Kb	231	112	765	-	-	--	78	1186
Total	17991	14402	31969	14931	6946	12953	9747	110085
Percent	16.3	13.1	30.1	13.6	6.3	11.8	8.9	100

The unit wise variations in acceptable score for individual indicators are observed indicating geomorphic influence as altered by flooding frequency and intensity in selection of indicators in islands. The soil unit wise indicators showing below threshold values in quality assessments are listed as texture in 9 units, organic carbon in 15 units, total nitrogen in 11 units, available phosphorus, pH, exchangeable bases and cation exchange capacity in 12 units (Table 6). Six mapping units 1,2,3,5,6 and 7 have low quality rating (<0.1) with 1 to 3 soil indicators meeting the threshold requirements for crop production where as eleven mapping units 4, 8, 10, 12,13,15,16,19,20, and 21 have 4 to 5 indicators meeting threshold values of medium quality (0.11-0.40) and eight mapping units 9,11,14,18,22,23,24 and 25 with 6 to 8 indicators meeting high quality rating.

The Puranabari- Sonaribari (18) have high quality of selected indicators above threshold values except total nitrogen content. These soils have medium infiltration rates, periodically saturated with groundwater and neutral to slightly alkaline with low K (potassium) reserves. The low quality rating for Bharaki-Chilkala-Adi Elengi (3) and Dakshninpatt-Bhakat-Bharaki (7) is due two indicators such as pH and total nitrogen and available water holding capacity that meet requirements of crop production function. Eleven soil units covering 10213 ha (9.28 % of the area) have medium quality. The soil quality and its relationship with capability is approximately 50% in agreement and implies that pH and organic matter are crucial in modifying soil structure and its influence on water retention and nutrient availability in chronically flood affected areas. These findings

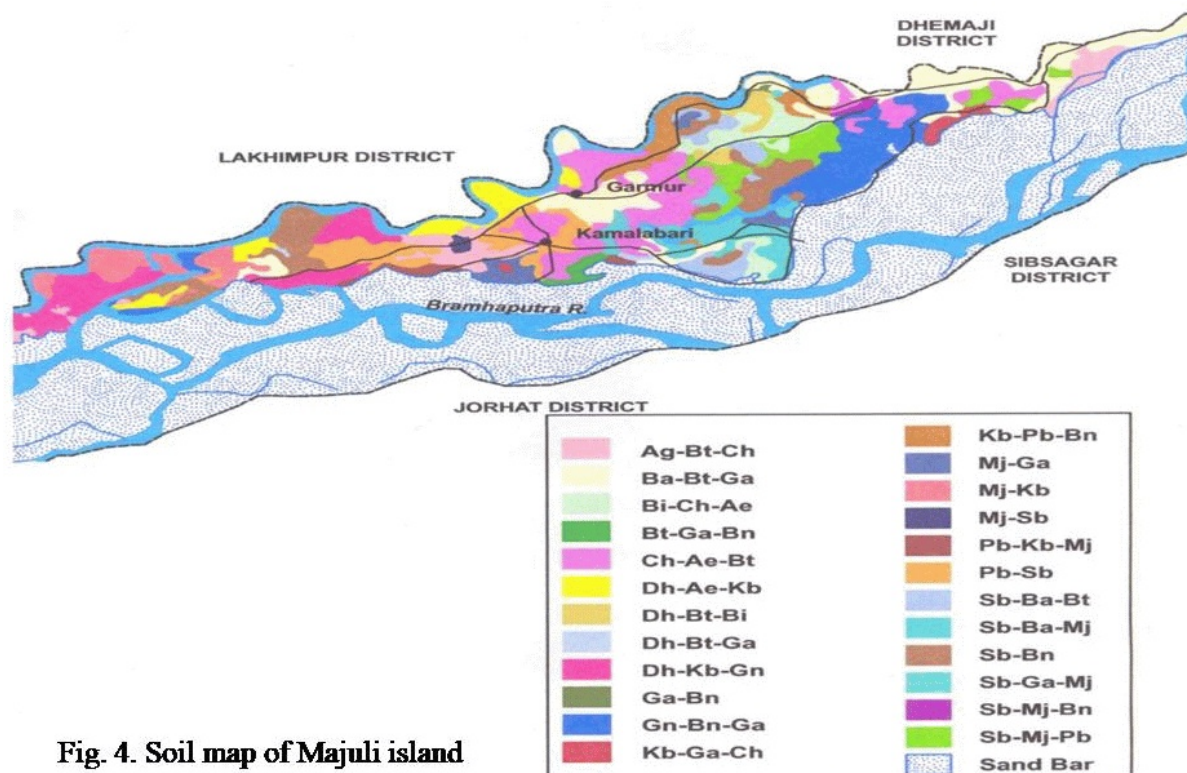


Fig. 4. Soil map of Majuli island

Figure 4. Soil map of Majuli Island

are in agreement with the findings in tropical ecosystems of Southwestern Nigeria (Oluwatosin et al. 2006). The hydric soils in this riverine island have flat to gently sloping plains and are subjected to prolonged waterlogging leads to ferrollysis (Brinkman 1970) and low cation retention capacity. The soil quality assessment is helpful in identifying and delineating the fertility constraints involved in rice systems and to design management systems for productivity enhancement programmes in the island.

DISCUSSION

Traditionally, rice fields are classified as ‘agronomically managed temporary wetland ecosystems’ and farmed for centuries in a sustainable way in river island landscapes with water logging soils and combined cultures of fishing (Fernando 1993). The wetlands in the Majuli river island, are perennially wet (saturated for 6 to 8 months of the year) and occur in level to gently sloping landscapes. This region receives >2000 mm

Table 5. Soil series wise suitability assessment for rice cultivation

Soil series	Nutrient availability index NVI	Soil quality index SQI	SQI*NVI	Suitability class
Sonaribar(Sb)	0.8	0.32	0.26	S1
Bharaki (Bi)	0.4	0.20	0.08	S3
Bhakat (Bt)	0.2	0.20	0.04	S3
Boritika (Ba)	0.4	0.20	0.08	S3
AdiElengi (Ae)	0.5	0.80	0.41	S1
Puranibari (Pb)	0.6	0.10	0.06	S3
Kamalabari (Kb)	0.4	0.16	0.06	S3
Chilkala (Ch)	0.3	0.80	0.26	S1
Gayangaon (Gn)	0.3	0.80	0.20	S2
Dakshinpat (Dh)	0.6	0.64	0.41	S1
Bongaon (Bn)	0.3	0.80	0.26	S1
Garumara (Ga)	0.6	0.32	0.20	S2
Majuli (Mi)	0.6	.01	0.006	N
Mean±SD	0.46±0.17	0.41±0.31	0.18±0.14	
CV(%)	37.04	74.51	76.44	

Table 6. Mapping unit wise soil quality ratings in relation to landforms and capability class

Land forms	Soil Quality Index (SQI)								
	Low (<0.10)			Medium (0.11-0.40)			High (SQI >0.41)		
	Soil mapping unit	Area ha	%	Soil mapping unit	Area ha	%	Soil mapping unit	Area ha	%
Active floodplains	3.Bi-Ch-Ae 7.Dh-Bt-Bi	3717	3.38	5. Ch-Ae-Bt	250	0.23	-	-	-
Old flood plains	--	--	--	1.Ae-Bt-Ch 2.Ba-Bt-Ga	2333	2.12	3.Bi-Ch-Ae 7.Dh-Bt-Bi	2153	1.95
Channel fills	--	--	--	--	--	--	5. Ch-Ae-Bt	1076	0.98
Natural levees	--	--	--	--	--	--	--	--	--
Active floodplains	10.Ga-Bn 12.Kb-Ga-Ch 13. Kb-Pb-Bn 16. Mj-Sb 17. Pb-Kb-Mj	6145	5.59	4.Bt-Ga-Bn 15.Mj-Kb 19.Sb-Ba-Bt 20.Sb-Ba-Mj	2054	1.88	8.Dh-Bt-Ga 14.Mj-Ga	944	0.86
Old flood plains	4.Bt-Ga-Bn 12.Kb-Ga-Ch 13. Kb-Pb-Bn 19. Sb-Ba-Bt 21. Sb-Bn	2252	2.04	-	-	-	15.Mj-Kb	86	0.08
Channel fills	13.Kb-Pb-Bn	1816	1.65	19.Sb-Ba-Bt 20.Sb-Ba-Mj	5849	5.31	4.Bt-Ga-Bn 14.Mj-Ga	333	0.29
Natural levees	--	--	--	15.Mj-Kb	5789	5.26	21.Sb-Bn	178	0.16
Active floodplains	18.Pb-Sb	3376	3.07	9.Dh-Kb-Gn	711	0.65	22.Sb-Ga-Mj 25.Sb-Mj-Kb	686	0.62
Old flood plains	--	--	--	11.Gn-Bn-Ga	85	0.08	18.Pb-Sb	38	0.04
Channel fills	--	--	--	22.Sb-Ga-Mj	421	0.38	--	--	--
Natural levees	--	--	--	--	--	--	23.Sb-Mj-Bn 24.Sb-Mj-Pb	3552	3.22

rainfall causing the water table near the surface during rainy season or flooding to define soil moisture as *aquic* and making profile as hydromorphic. The result is that much of the wetlands is under fallow because of waterlogging and flooding. In the dry season (November to March), It is observed that there is a recession of the water table and water storage depths. The seasonal fluctuation in the depth of the water table indicates the suitability of the wetlands and /or soils for mono-cropping of rice (Bhaskar et al. 2013). The vast area under riverine floodplains have great potential for increases in rice production on a sustained basis. . Moormann (1973) recommended hydromorphic soil areas for the expansion of rice cultivation. These less permeable and silty textured sub-soils with excellent water retention characteristics, favourable rooting depth and root development and terrain of less than 1% slope. When rainfall receded, these soils are then cultivated to

mustard, potato and pea by the smallholder farmers in the area. This has proved lucrative in the area and is drawing attention to the potential productivity of the wet soils (Figure 5).

The soils in the island are saturated for more than 200 days per year with depleted matrix with chroma less than 2 and moderate structural B horizons. The fine loamy soils have mean clay content of 18 to 27% in Puranibari (Pb), Dakshinpat (Dh) but in other soils, the clay content is less than 16%. It is ascertained from the literature that clay textures are superior to silt and sand textures for rice production (Moormann and Dudal 1964). These soils are slightly acid to neutral and have stratic layers with elemental variations specially Fe and Mn oxides as soft nodules near the zone of fluctuating water tables (Vespraskas 2000). These soils are subjected to ferrollysis due to repeated regular cycles of oxidation and reduction leading to silicate clay destruction

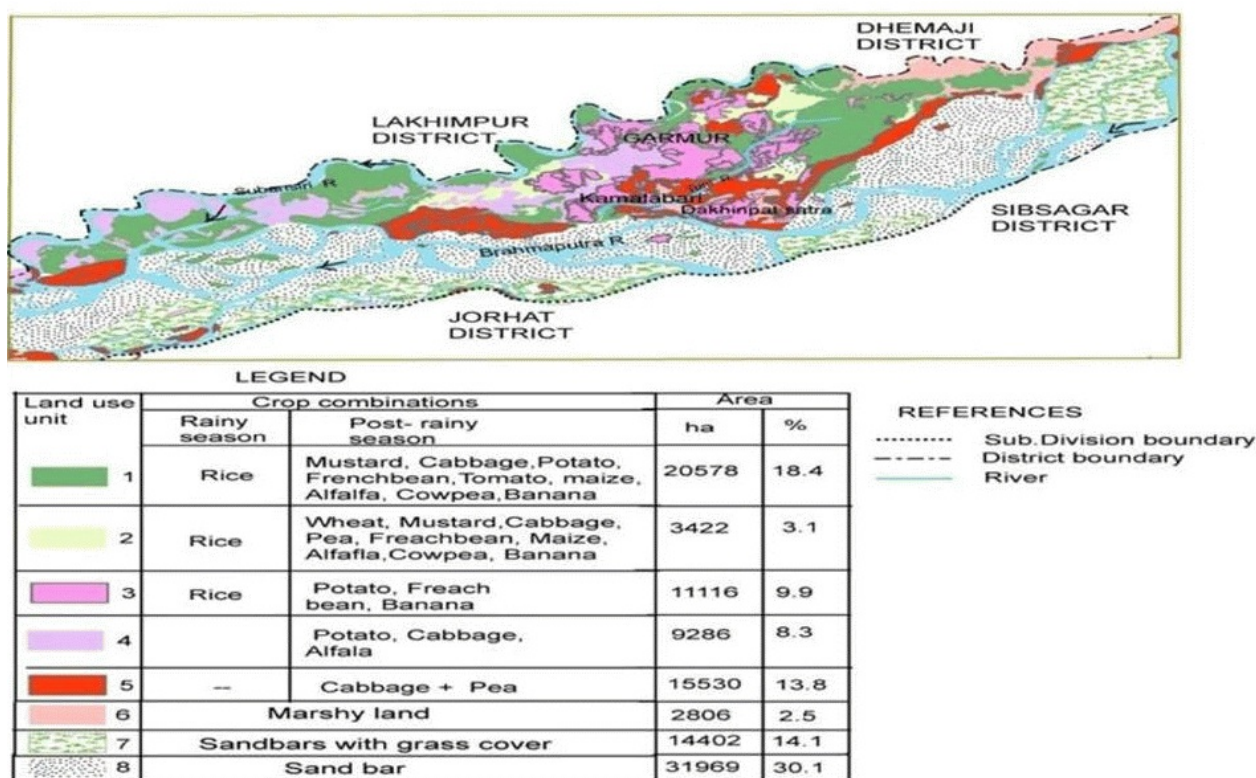


Figure 5. Land use map of Majuli Island

Table 7. Distribution and extent of modifiers in fertility capability units of wetlands

FCC modifiers	Extent of area (ha)			Total area	
	Active flood plains	Old floodplains	Channel fills	(ha)	(%)
g*(pergleyic , soil profile saturated for more than 200 days)	11195 (42.6%)	3565 (13.6%)	11525 (43.9%)	26285	78.6
k-low reserves of potassium and weatherable minerals)	16015 (47.9%)	5911 (17.7%)	11525 (34.45%)	33451	100
b-basic reaction(pH>7.3)	1751 (57.18%)	1311 (42.82%)	-	3062	9.2
e-Low cation exchange capacity	2540 (21.48%)	1022 (8.64%)	8260 (69.86%)	11822	35.3

with abrupt textural changes and leaching of exchangeable bases resulting in poor cation exchange capacity. The modifier “g*” is used as modifier to designate prolonged waterlogging and gleying in these soils with an additional modifier “e” for nitrogen management and “k” for nutrient imbalance such as Ca, K and Mg. All soils are deficient in available potassium where as 9.2% of soils are basic mostly occurring on channel fills with Fe deficiency when aerobic, Zn deficiency when waterlogged and high N volatilization losses from broadcast N

application. 35.3% of soils have low cation exchange capacity less gradual N release and potential Fe toxicity if adjacent uplands have Fe rich soils (Table 7). The flooded rice grown on these soils have high iron favouring deficiencies of phosphorus, potassium (*akagare* type-1) and Zn deficiency-*khaira* type, (Tanaka and Yoshida 1970). The soil units in active and old floodplains have potassium deficiency (Bhaskar et al. 2010b) as the ratio between exchangeable calcium and magnesium to exchangeable potassium is more than 100

(Tandon and Sekhon 1988) and also have K saturation less than 1.5% (Dobermann and Fairhurst 2000).

CONCLUSIONS

The wet land soil resource information of Majuli riverine island with thirteen soil series and twenty five soil mapping units were used to assess soil quality with special consideration to rice production systems dominant over years. The island had 43% of arable land with 12.39% of soil units under medium quality, 8.66% of soil units under low quality and 8.1% of soil units with high quality. Flood frequency and erosion risk hazard were two important factors influencing soil quality controlling factors viz., organic matter, pH, available phosphorus and exchangeable bases. The soil units in channel fills have low cation exchange capacity and low potassium reserves as compared to active and old flood plains. The soil quality is recommended to strengthen the information base and to formulate workable solutions to crop production .

ACKNOWLEDGEMENTS

I wish to thank D.P. Dutta and Pravin Butte for their help in laboratory analysis, Prashant Dutta for GIS work and Subdivisional officer in Majuli island for his cooperation and facilities provided to soil survey staff at the time of field investigation. This study was part of a Project no.993 awarded by the Regional Centre, National Bureau of Soil Survey and Land Use Planning, Jorhat..

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Received 13 November 2018

Accepted 16 April 2019