CHARACTERIZATION OF DEGRADED LANDS IN COASTAL AGRO ECOSYSTEM OF NORTHERN TAMIL NADU, INDIA

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***Abstract*:** The coastal agro-ecosystem provides protective, productive and economic benefits to the coastal communities. Sustainability of coastal agro-ecosystem is dependent on its food production system, water quality and biodiversity. The natural resources such as carbon and other elements that are stored in ecosystems are now being extracted and exploited, and the land becomes depleted from its original vegetation and abandoned as degraded lands. The soils are generally saline, poor in nutrients and low in water holding capacity. The status and extent of degraded lands in the coastal agro ecosystem of Northern Tamil Nadu were assessed and confirmed using surface soil analytical results. Based on the soil texture, drainage class and LGP, the villages of Northern coastal agro ecosystem of Tamil Nadu was divided in to seven agro ecological sub zones *viz*., Northern Cauvery delta, Ponaiyar delta, Pondicherry region, South Palar delta, North Palar delta, Mahabalipuram region and North Chennai. The profile soil samples were also subjected to various analyses to characterize the physico-chemical properties of each degraded site.

Keywords: degraded lands, land capability classification, soil salinity, waste lands

1. INTRODUCTION

Soil resource is of vital importance for survival and welfare of the people in the world and for the sustainability of the ecosystem. Nature takes almost 1,000 years to produce an inch of topsoil which is highly vulnerable to degradation. Nevertheless, of late the pressure on this imperative resource has increased to such an extent that the relationship between the living beings and the soil has become critical. This has resulted in various kinds of land degradation, environmental pollution and decline in crop productivity and sustainability of the ecosystem. A sizeable area in India is either barren or does not yield satisfactorily due to one or more reasons (Mythili and Goedecke, 2016). Such types of soils have been commonly called as degraded lands.

The main causes of land degradation are natural processes such as water erosion/wind erosion, man-made such as mining/ quarrying/urbanization or a mix of natural and human induced such as vegetation degradation, water logging, salinity/alkalinity etc. Increasing population (both human and cattle), over exploitation of natural resources, un-sustainable land use practices, frequent natural hazards, extreme weather conditions and climate changes are accelerating the processes of land degradation. The physical status of the land is also a critical factor towards its vulnerability to land degradation, *e.g*., a land without vegetation cover and loose soil is more susceptible to erosion by water or wind. Actions are required for preventing productive land getting transformed to degraded land (Bhattacharyya, 2015; Anon, 2018).

According to the estimate of actual land use and vegetation cover by the National Remote Sensing Agency and Forest Survey of India based on satellite imagery, 80 m. ha out of 142 m. ha under cultivation is substantially degraded and about 40 m. ha out of 75 m. ha under the forest has a canopy cover of less than 40 per cent. Nearly 11 m ha of pasturelands are also substantially degraded. Thus, a total of 131 m. ha representing about 40 per cent of the country's landmass has productivity well below its potential (Anon, 2004). According to the wastelands atlas of India, the total wastelands area is about 63.85 m. ha which accounts for 20.17 per cent of the total geographical area (Anon, 2000).

The Central Soil and Water Conservation Research and Training Institute estimated that, India loses nearly 74 m. t. of major nutrients annually due to erosion. However, nearly 61 per cent of the eroded soil is merely moved, and the effective loss is the remaining 39 per cent. Thus, the country losses 0.8 m. t of nitrogen, 1.8 m. t of phosphorus and 26.3 m. t of potassium every year. According to Government of India, the quantity of nutrients lost due to erosion every year ranges from 5.8 to 8.4 m. t (Anon, 2001). In India land degradation by water logging is estimated to about 8.52 m. ha of the land surface and loses 1.2 to 2.0 m. t of food grain production every year due to water logging (Singh and Sharma, 1999). Out of the total estimated degraded land of the country, about 1.67 m. ha is degraded due to water logging in the drainage basins of the major rivers of India and 41.58 thousand ha in the coastal deltaic areas of Tamil Nadu (Anon, 2004). In India, it is estimated that nearly 8.4 million ha is affected by soil salinity and alkalinity (Ritzema *et al*., 2008) of which 0.43 m ha occurs in Tamil Nadu (Anon, 2004).

Coastal agro ecosystem can be described as adjacent cultivated land area up to 60 km inland from the coast and is a homogenous geographical area, however from an ecological perspective there should be no fixed boundary since the influencing factors will be varying depending on the location. Sustainability of coastal agro ecosystem is dependent on its food production system, water quality and biodiversity, changes in the shoreline physiography, besides exposure to the vicissitudes of human intervention like tourism, construction, rapid industrial development and resources exploitation along the coast. The natural resources such as carbon and other elements that are stored in ecosystems are now being extracted and exploited, and the land becomes depleted from its original vegetation and abandoned as wastelands. It destroys the land use system almost permanently at the site and for significant distances around the sites (Eswaran and Reich, 2002).

Tamil Nadu has a coastline of 1000 km (15 per cent of total coastal length of India) under 13 districts comes under 18th agro ecological region of India namely Eastern Coastal Plain, Hot Sub Humid to Semi arid Eco region with coastal alluvium derived soils (S7CD 2-5) (Anon, 1992 and Venkateswarlu *et al*., 1996). This region is the ideal and common working unit of all agricultural developmental activities, but the presence of considerable extent of degraded soils hindered the agricultural productivity. Today barely five per cent of the land under this region is under natural vegetation (Meher, 2002). The major constrains in the reclamation of potentially available arable lands in the coastal districts of Tamil Nadu are saline / alkaline soils 1.81 m. ha, degraded sandy coastal lands 0.48 m. ha and water logged soils 0.38 m. ha (Anon, 2000). Many of these sites are affected with salinity and experience standing water through much of the rainy season due to an underlying restrictive layer, most often a canker pan, resulting in an anaerobic atmosphere for roots and subsequently poor survival of vegetation. In addition to the above, the degraded coastal lands experience frequent summer drought, which also contributes to reduced vegetation. The presence of considerable degree of degraded soils hindered the agricultural productivity of coastal agroecosystem of Tamilnadu and characterization offer a scope for scientists to reclaim and re-instate to its original form (Rex Immanuel *et al*., 2018).

Agro ecology is the application of ecological concepts and principles to the design and management of sustainable agricultural systems (Gliessman, 1992). Agro ecological zone is a land resource mapping unit, having a unique combination of land form, soil and climatic characteristics and/or land cover having a specific range of potentials and constraints for land use (Anon, 1996). The agro ecological zone approach presents a useful preliminary evaluation, and ensures that representation is maintained at an appropriate biogeographic scale for regional sustainable development planning (Sivakumar and Valentin, 1997).

India with 329 million hectares of the geographical area, the country presents a large number of complex agro climatic situations. Therefore, efficient crop planning, proper understandings of agro climatic conditions are required. Four basic units' *viz*., soil, physiography, length of growing period (LGP) and bioclimate are required to delineate agro ecological regions, agro ecological sub region and agro ecological zone at state and agro ecological unit at watershed level (Mandal *et al*., 1999). Depending upon the soil, bioclimatic type and physiographic situations, India has been grouped into 20 agro ecological regions and 60 agro ecological sub regions (Velayutham *et al*., 1999). The present classification suffers from several limitations due to over generalizations such as grouping together the areas having different physiography, temperature and soil in the respective zones (Patel *et al*., 2000). Patel (2003) and Wart *et al*. (2013) reported

that agro ecological zoning and sub zoning is applicable in micro or local level sustainable agricultural development planning of a region and assesses basically the yield potentialities of various crop conditions; evolves future plan of action involving crop diversification; determines suitability of different crops for optimizing land use, disseminates research results and agro technology. With this context, the present investigation has been scheduled to assess the status and extent of degradation in the coastal agro ecosystem of Northern Tamil Nadu and to identify the sub zones for the development of suitable site specific agro reclamation measures.

2. MATERIALS AND METHODS

2.1. Selection of study area

Based on the soil, bioclimatic type and physiographic situations, India is grouped in to 20 agro-ecological regions and 60 agro-ecological sub regions (Velayutham *et al*., 1999). From among them, North Tamil Nadu Coastal Plains (S7Dm 4) was selected purposively because of the presence degraded soils which hampered the agricultural productivity. The study sites are located from Northern Coleroon river basin to North Chennai and covering the coastal areas of Cuddalore, Villupuram, Kanchipuram and Thiruvalluar districts. It is geographically located from 11° 22′ to 13° 28′ N latitude and 79° 45′ to 80° 20′ E longitude with an average altitude of +5.57 m above mean sea level. The local reliefs of the degraded soils are mostly coastal plains and the previous natural vegetation was mainly scrub jungle or mangrove vegetation in the low lying wetlands. The farmers transformed the land to rain fed agriculture excepting far a few hundred hectares of lands in the deltaic areas were canal water is used for cultivation of paddy during monsoon and millets/pulses as a post monsoon crop.

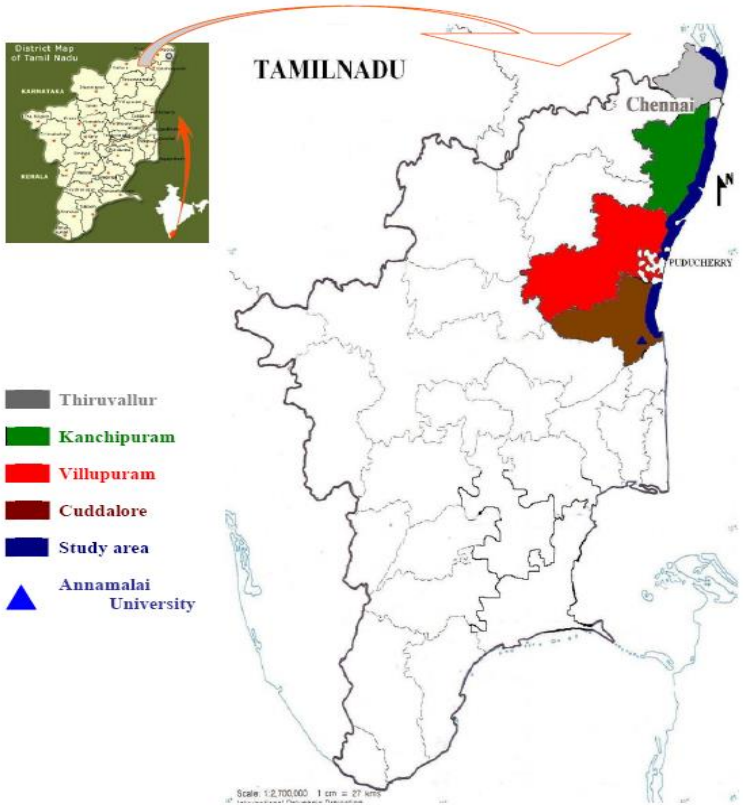


Fig 1 Location map of the study area

The coastal agro-ecosystem of the region extends from semi arid to sub-humid climate with mean annual rainfall of 1120 mm, of which 80 per cent is received during North-East monsoon (October – December) and the remaining is through South West monsoon and summer showers (Fig. 2). The potential evapotranspiration varies from 1700 to 1900 mm resulting in an annual water deficit of 580 – 780 mm. The mean annual maximum and minimum temperatures are 33.5° C and 23.5° C, respectively. The length of growing period varies from 80 to 120 days.

2.2. Survey of degraded lands

A pilot survey was made in the coastal agro ecosystem of Northern Tamil Nadu to find out the nature of degradation. The basic information and soil maps were generated for the present study area comprising the coastal village cadastral maps of Cuddalore, Villupuram, Kanchipuram and Thiruvallur districts of Tamil Nadu, India. A quick walk along the coastal zone (detailed reconnaissance survey) was made, to survey the biophysical and socioeconomic characteristics of the area. Transects were drawn on the basis of information obtained during the quick walk. An imaginary transect line was made by traversing a distance of five kilo meters along the agricultural fields from the coast line to inland. A semi detailed soil survey was undertaken to collect the soil samples in the coastal villages as per procedures outlined in the USDA Soil Survey Manual (USDA, 1999). Sampling sites were selected by grid method. Uniformly spaced grids were drawn on the village cadastral maps. Intersections were numbered in order. Sampling places were selected on the basis of random numbers. In each coastal village, one site was selected having an area of 15 ha and ten soil samples were chosen from every site for the present investigations. An extensive soil survey was conducted to collect soil samples throughout the study area. Soil sampling was done at 0 – 15 cm depth by using a soil auger. The profiles also analyzed to know the severity of degradation. The soil samples were analyzed for its physico-chemical properties using standard analytical procedures.

2.3. Sub zoning of degraded coastal agro ecosystem

For the convenience and to develop site specific agro techniques, the coastal agro ecosystem of Northern Tamil Nadu will be divided in to homogeneous sub zones. The criteria used for agro ecological sub zoning are physiography, soil texture, physico-chemical properties and drainage class as per the reports of Sehgal *et al*. (1992), Mandal *et al*. (1999) and Saxena *et al*. (2001). To ensure a high reliability of the site classification, most of the map polygons were inspected during reconnaissance and ground inspections, if required, polygon boundaries and modifiers were revised.

3. RESULTS

3.1. Extent of degraded lands

The study area of the coastal agro ecosystem of Northern Tamil Nadu was from Northern Cauvery delta of Cuddalore district to Pulicat lake of Thiruvallur district with a surveyed area of 18,852 ha and out of which 21.54 per cent were affected by varying magnitudes of soil degradation. The coastal villages of Chidambaram taluk recorded 938 ha of degraded lands, of which 41.58 per cent was moderately degraded, 31.77 per cent extremely degraded and 26.65 per cent strongly degraded. In Cuddalore taluk, 494 ha were affected and out of which 62.15 per cent moderately degraded, 25.30 percent strongly degraded and 12.55 per cent extremely degraded. The coastal villages of Vanur taluk recorded 262 ha of degraded lands of which 58 .78 per cent strongly degraded and 41.22 per cent moderately degraded. In Tindivanam taluk, 319 ha are affected and the degree of degradation was strong (68.65 per cent). Cheyyar taluk recorded 517 ha of degraded lands and the degree ranges from moderate (55.32 per cent) to strong (36.94 per cent). The coastal villages of Tiruklukundrum taluk recorded 456 ha of degraded lands, of which 51.32 per cent moderately degraded and 33.11 per cent strongly degraded. In Chenglepet taluk degradation extends to an area of 368 ha, of which 53.53 per cent slightly, 26.63 per cent strongly and 19.84 per cent moderately degraded. In Ponneri taluk, 706 ha are degraded and out of which 65.30 per cent strongly degraded.

Table 1. Extent of degraded lands and mode of degradation in Northern coastal Tamil Nadu

S. No	Taluk / District	Sampled coastal villages	Area in ha		Degree of degradation	Chemical deterioration	Physical deterioration	Causative factors
			Surveyed	De-graded				
1	Chidambaram (CDM),	1 T.S. Pettai	350	92	Extreme	Cs, Cn	Pw, Pc	P, A, F
		2 Pichavaram	542	158	Moderate	Cs, Cn	Pw	P, F
		3 Killai	820	206	Extreme	Cs, Cn	Pw, Pc	G, A, F
		4 Kathuvazhkai	165	35	Strong	Cs	-	F
		5 C. Manambadi	210	22	Strong	Cs, Cn	Pw	A

	Cuddalore Dt	6 Thirukallipalai	180	40	Strong	Cs	Pw	A
		7 Ambikapuram	158	27	Moderate	Cn	Pw	P, A
		8 Parangipettai	325	32	Moderate	Cn	-	P, F
		9 Chinnur	235	46	Strong	Cs	Pw	P, A
		10 Vellingarayanpetai	250	20	Moderate	Cn	-	A
		11 Pudupettai	360	45	Strong	Cn, Cs	-	A, P
		12 Pudukuppam	350	58	Moderate	Cn	-	A
		13 Kumarapettai	250	62	Strong	Cn	Pw	F
		14 Samiyarpettai	290	45	Moderate	Cs	-	A
		15 Madavapallam	260	50	Moderate	Cn	Pw	A, F
Taluk Total			**4745**	**938**	Extreme : 298 ha Moderate: 390 ha		Strong : 250 ha Slight : -	
2	Cuddalore (CUD), Cuddalore Dt	1 Andarmullipallam	305	55	Strong	Cs	Pw	F
		2 Kayalpattu	365	78	Moderate	Cn	-	G
		3 Thiruchopuram	290	40	Moderate	Cn	-	A
		4 Thiyagavalli	215	45	Moderate	Cn	Pw	A
		5 Kudikadu	209	53	Moderate	Cn, Cs	Pw, Pc	A, I
		6 Pachayankappam	325	40	Strong	Cs	Pw, Pc	U, I
		7 Cuddalore	375	30	Strong	Cs	Pw	U, I
		8 Sugauppalavadi	235	40	Moderate	Cn, Cs	-	A
		9 Nanamedu	209	27	Extreme	Cs	Pw	F
		10 Kilingipattu	256	51	Moderate	Cn, Cs	-	A
		11 Madalapattu	190	35	Extreme	Cs	-	F
Taluk Total			**2974**	**494**	Extreme : 062 ha Moderate: 307 ha		Strong : 125ha Slight : -	
3	Vanur (VNR), Villupuram	1 Kottaikuppam	218	38	Moderate	Cn	-	G, F, Wr
		2 Bommayapalayan	290	84	Strong	Cn	-	G, F, Wr
		3 Mathur	195	49	Moderate	Cn	-	A, F, Wr
		4 Kozhuveri	123	21	Moderate	Cs, Cn	-	A, Wr
		5 Karattai	180	28	Strong	Cs, Cn	-	A, F
		6 Kilapakkam	162	42	Strong	Cs, Cn	Pw	A
Taluk Total			**1168**	**262**	Extreme : - Moderate: 108 ha		Strong : 154 ha Slight : -	
4	Tindivanam (TVM), Villupuram	1 Kilputhupattu	325	59	Strong	Cs	-	A
		2 Koonimedu	340	48	Moderate	Cs	Pw	A
		3 Chettikuppam	160	20	Moderate	Cn, Cs	-	F, A, We
		4 Anumandai	200	32	Slight	Cn	-	A, We
		5 Panchamedu	110	47	Strong	Cs, Cn	-	A, We
		6 Alapakkam	120	30	Strong	Cs	Pw	P, A
		7 Marakanam	415	83	Strong	Cs, Cn	Pw	S, P, F
Taluk total			**1670**	**319**	Extreme : - Moderate: 068 ha		Strong : 219 ha Slight : 032 ha	

5	Cheyuur (CYR), Kancheepuram	1 Vembannur	320	47	Strong	Cs	Pw	S, A
		2 Panaiyur	300	65	Moderate	Cn	-	S, F, We
		3 Mudaliyarkuppam	265	38	Moderate	Cn, Cs	-	S, A
		4 Paramankeni	185	50	Moderate	Cn, Cs	-	A, We
		5 Sikkinankuppam	265	62	Strong	Cs	Pw	A
		6 Mugaiyur	300	51	Moderate	Cn	-	S, A, We
		7 Vadapatinam	265	40	Slight	Cn	-	A
		8 Kodapattnam	120	68	Moderate	Cn	-	S, A
		9 Kanattur	95	25	Strong	Cs, Cn	Pw	S, F
		10 Kilarkollai	110	14	Moderate	Cn	-	A
		11 Kadalur	230	57	Strong	Cn, Cs	-	S, A
Taluk Total			**2455**	**517**	Extreme : - Moderate: 286 ha		Strong : 191 ha Slight : 040 ha	
6	Tiruklukundrum	1 Vayalur	290	36	Slight	Cn, Cs	-	S, A
		2 Pudupattinam	270	24	Moderate	Cs, Cn	-	A, S
		3 Sadurangapattinam	175	61	Moderate	Cn	-	S, A

	(TKM), Kanchipuram	4 Meyyur	110	35	Moderate	Cn	Pw	S, F
		5 Kalpakkam	290	22	Moderate	Cn	-	U
		6 Edaiyur	220	54	Moderate	Cs	Pw	F, A
		7 Kokkilamedu	185	38	Moderate	Cn	Pw	F
		8 Karayarkuppam	190	35	Slight	Cs, Cn	-	A, We
		9 Venparasattan	225	53	Strong	Cn	-	U, A
		10 Ponjeri	190	48	Strong	Cs	-	F, U
		11 Kotharakkan	125	50	Strong	Cn	-	A, We
Taluk Total			**2270**	**456**	Extreme : - Moderate: 234 ha		Strong : 151 ha Slight : 071 ha	
7	Chengalpat (CPT), Kanchipuram.	1 Saluvankuppam	110	31	Moderate	Cs	-	A, We
		2 Pattipalam	295	42	Moderate	Cs	-	A, We
		3 Krishnankaranai	115	38	Slight	Cs, Cn	Pw	S, F
		4 Nemmeli	315	82	Slight	Cs, Cn	Pw	S, A
		5 Vadanemeli	90	35	Slight	Cn	-	A, F
		6 Thiruvidanthai	235	20	Strong	Cs, Cn	-	S, A
		7 Alathur	105	42	Strong	Cs, Cn	-	F
		8 Muttukadu	232	46	Strong	Cs, Cn	Pw, Pc	U
		9 Kamathurreddika	220	32	Strong	Cs	-	U
Taluk Total			**1717**	**368**	Extreme : - Moderate: 073 ha		Strong : 098 ha Slight : 197 ha	
8	Ponneri (PNI), Thiruvallur	1 Vallur	165	38	Strong	Cn	-	U, I
		2 Ennur	225	60	Strong	Cs, Cn	-	I
		3 Puzhidhvakkam	260	106	Moderate	Cs, Cn	Pw	F
		4 Kattupalli	190	59	Moderate	Cs	-	F, A
		5 Kalanji	165	86	Strong	Cs, Cn	Pw	A
		6 Karungali	140	60	Strong	Cn	-	F
		7 Thanagalperumbulam	185	80	Moderate	Cs, Cn	Pw	F, A
		8 Pulicat	250	122	Strong	Cs	Pw, Pc	P, F
		9 Karimanal	273	95	Strong	Cs, Cn	-	A
Taluk Total			**1853**	**706**	Strong : 461 ha		Moderate : 245 ha	
Total area			**18852**	**4060**	**Extreme : 360 ha** **Moderate: 1711 ha**		**Strong : 1649 ha** **Slight : 340 ha**	

A: Unscientific agriculture - related activities; **Cn**: Loss of nutrients; **Cs**: Salinization; **F**: Deforestation and removal of natural vegetation for domestic use; **G**: Overgrazing; **I:** industrial activities; **S**: Salt pans; **P**: Shrimp culture; **Pw**: Water logging; **Pc**: Crusting compaction; **U**: Urbanization / Tourism; **We**: Wind erosion; **Wr**: Water erosion; **Slight:** Somewhat reduced agricultural productivity; **Moderate**: Greatly reduced agricultural productivity; **Strong**: Un reclaimable at the farm level; **Extreme**: Un reclaimable and economically not feasible to restore.

3.2. Characterization of soils in coastal agro ecosystem of Northern Tamil Nadu

3.2.1. Physico - chemical characteristics

Soil survey was conducted to confirm the degradation status of the study area. Village wise soil samples were collected and analyzed. Based on the soil analytical results sample village and taluk wise degraded area have been identified and presented in Table 2&3. The results confirmed the degradation of study area and estimated that 4,060 ha were affected by degradation. The texture of the degraded soil varies from sandy to clay. The samples collected from Chidambaram and Cheyyar taluks recorded higher values of pH (8.4) compared to other taluks. Cuddalore, Thirukklukundrum and Ponneri taluks were next in the order (8.3), while Vannur taluk recorded a neutral pH value of 6.9. With regard to EC_e Cuddalore taluk recorded a higher value of 11.21 dSm^{-1} and was followed by Chidambaram (10.46 dSm^{-1}), Ponneri (10.40 dSm^{-1}), Cheyyar (10.07 dSm^{-1}), Chenglepet (9.48 dSm^{-1}), Tindivanam (9.21 dSm^{-1}) and Thirukkalukundrum (8.89 dSm^{-1}) while Vannur taluk recorded the least EC_e of 4.22 dSm^{-1}. Due to the higher pH and EC_e the soils of this agro ecosystem could be characterized as strongly saline soils with the pH range of 8.2 - 8.4 and EC_e range of 8.89 - 11.21 dSm^{-1}. The soil nutrient status are low in organic carbon (ranges from 0.16 – 0.23 per

cent) and available nitrogen (141.11 – 176.44 kg ha^{-1}), low to medium in available P_2O_5 (7.52 – 11.75 kg ha^{-1}) and K_2O (138.75 – 194.36 kg ha^{-1}).

Table 2. Average Physico-chemical properties of the degraded soils in the coastal villages

S. No	Village	Texture	MWHC (%)	BD (mg/m^3)	PD (mg/m^3)	pH (1:2.5)	EC (dSm^{-1})	OC (%)	N_2	P_2O_5	K_2O	SAR (%)
									(kg ha^{-1})			
Chidambaram talulk (CDM)												
1	T.S. Pettai	Scl	38	1.26	2.38	8.5	8.70	0.19	184	07.5	195	7.5
2	Pichavaram	Scl	40	1.25	2.59	8.0	9.54	0.15	147	06.9	160	6.1
3	Killai	Cl	36	1.17	2.21	8.6	9.90	0.27	168	07.2	145	8.2
4	Kathuvazhkai	C	38	1.21	2.27	8.3	12.76	0.29	143	11.0	285	7.0
5	C. Manambadi	C	41	1.30	2.43	8.5	9.12	0.17	179	05.5	100	7.2
6	Thirukallipalai	Scl	30	1.24	2.07	8.2	8.80	0.22	270	07.2	145	5.5
7	Ambikapuram	L	31	1.30	2.78	7.9	9.54	0.29	214	12.5	120	4.5
8	Parangipettai	Scl	35	1.24	2.76	8.5	10.00	0.17	158	08.7	228	6.5
9	Chinnur	Scl	30	1.13	2.14	8.1	13.15	0.32	165	07.7	190	6.0
10	Vellingarayanpettai	S	20	1.23	2.30	8.4	10.80	0.27	108	06.5	210	5.3
11	Pudupettai	S	22	1.20	2.12	8.0	10.76	0.21	133	05.0	150	7.8
12	Pudukuppam	S	29	1.20	2.14	8.6	9.85	0.29	124	11.5	195	6.5
13	Kumarapettai	Sil	36	1.13	2.50	8.9	11.73	0.19	261	09.7	225	7.0
14	Samiyarpettai	Scl	35	1.24	2.34	8.2	11.40	0.15	183	07.3	110	7.5
15	Madavapallam	Scl	34	1.21	2.21	8.5	10.83	0.22	171	06.1	160	8.5
Cuddalore taluk (CUD)												
1	Andarmullipallam	Cl	36	1.37	2.21	7.8	9.2	0.22	135	07.5	127	9.5
2	Kayalpattu	Scl	28	1.40	2.20	8.0	11.4	0.22	166	10.5	156	7.5
3	Thiruchopuram	Sl	35	1.22	2.21	8.5	12.8	0.27	110	09.2	183	9.0
4	Thiyagavalli	Sl	28	1.27	2.55	7.9	10.2	0.13	254	12.5	195	9.8
5	Kudikadu	S	17	1.23	2.45	8.4	12.3	0.16	116	08.3	226	10.1
6	Pachayankappam	S	24	1.24	2.28	8.3	12.8	0.23	156	06.7	242	9.4
7	Cuddalore	Sl	27	1.30	2.55	8.1	10.88	0.14	110	09.4	275	7.9
8	Sugauppalavadi	Sil	37	1.32	2.30	8.5	10.72	0.13	170	12.5	195	8.7
9	Nanamedu	Sl	32	1.17	2.89	8.2	9.85	0.12	165	08.7	167	8.5
10	Kilingipattu	Cl	36	1.27	2.15	8.5	10.12	0.22	103	11.2	185	7.5
11	Madalapattu	Cl	41	1.17	2.21	8.5	13.08	0.22	133	09.8	187	7.3
Vanur taluk (VNR)												
1	Kottakuppam	Sl	35	1.27	2.50	5.8	0.25	0.27	124	09.5	138	-
2	Bommayapalayan	Scl	42	1.21	2.63	5.9	0.48	0.13	221	13.2	225	-
3	Mathur	Scl	35	1.24	2.28	5.9	0.31	0.16	183	08.5	120	-
4	Kozhuveri	Scl	34	1.33	2.34	7.6	4.26	0.23	171	11.4	098	6.3
5	Kavattai	Sl	30	1.30	2.00	8.1	10.25	0.10	166	14.5	143	6.8
6	Kilapakkam	Sl	26	1.29	2.34	7.9	9.80	0.19	135	12.7	116	7.1
Tindivanam taluk (TVM)												
1	Kilputhupattu	Scl	38	1.20	2.02	7.9	8.80	0.16	110	13.5	150	4.6
2	Koonimedu	Sl	33	1.21	2.28	8.2	7.65	0.28	254	09.7	195	5.0
3	Chettikuppam	Sl	28	1.20	2.30	8.4	8.44	0.16	116	10.8	125	4.0
4	Anumandai	Sl	25	1.38	2.42	8.3	10.15	0.22	142	06.1	213	7.5
5	Panchamedu	Sil	30	1.27	2.21	7.9	8.22	0.18	129	08.7	168	8.5
6	Alapakkam	Sil	25	1.27	2.61	8.5	10.20	0.22	194	07.5	190	8.5

7	Marakanam	Sil	25	1.26	2.09	8.3	10.96	0.12	116	08.2	138	4.5
Cheyur taluk (CYR)												
1	Vembannur	S	15	1.28	2.14	7.9	9.80	0.24	077	06.9	173	5.9
2	Panaiyur	Sil	23	1.24	2.25	8.5	12.71	0.15	184	12.5	114	5.7
3	Mudaliyarkuppam	Sil	27	1.17	2.90	8.4	11.54	0.15	187	13.8	130	4.8
4	Paramankeni	S	17	1.15	2.56	8.9	9.90	0.22	200	13.0	125	5.5
5	Sikkinankuppam	Sil	26	1.22	2.30	8.3	9.65	0.19	170	08.5	105	8.0
6	Mugaiyur	S	18	1.17	2.87	7.8	10.12	0.16	165	14.7	158	5.0
7	Vadapatinam	Sil	25	1.27	2.15	8.3	9.62	0.28	103	13.5	120	6.8
8	Kodapattnam	Sil	27	1.17	2.21	8.4	9.46	0.16	133	09.7	185	5.5
9	Kanattur	Sil	27	1.29	2.50	8.2	9.92	0.22	124	11.6	213	4.7
10	Kilarkollai	Sil	28	1.21	2.63	8.6	8.78	0.18	261	08.0	167	6.5
11	Kadalur	Sl	26	1.24	2.28	8.4	9.30	0.22	183	12.8	189	6.0
Tiruklukundrum (TKM)												
1	Vayalur	Sl	28	1.33	2.34	8.5	8.89	0.12	171	14.5	120	7.5
2	Pudupattinam	Sil	28	1.30	2.00	7.6	9.65	0.24	135	11.5	207	6.8
3	Sadurangapattinam	Sil	27	1.29	2.34	8.0	7.54	0.15	110	12.2	131	9.0
4	Meyyur	Sl	18	1.20	2.02	7.8	10.54	0.15	166	12.5	165	10.2
5	Kalpakkam	Sl	16	1.21	2.28	7.6	9.80	0.22	154	11.3	178	8.5
6	Edaiyur	S	15	1.20	2.30	8.5	10.22	0.29	116	07.6	149	7.3
7	Kokkilamedu	Sil	26	1.38	2.42	8.7	8.63	0.17	142	15.1	235	8.0
8	Karayarkuppam	Sl	26	1.30	2.25	9.2	8.41	0.22	219	07.6	110	5.9
9	Venparasattan	S	18	1.27	2.21	8.5	7.27	0.29	194	05.5	140	4.5
10	Ponjeri	S	15	1.27	2.61	7.9	8.67	0.17	116	10.5	092	5.3
11	Kotharakkan	Sil	24	1.26	2.09	8.5	8.19	0.22	177	11.2	107	6.4
Chengalpat (CPT)												
1	Saluvankuppam	Sil	25	1.28	2.14	8.3	8.88	0.27	184	12.4	195	7.5
2	Pattipalam	S	14	1.24	2.25	8.4	9.65	0.21	187	06.5	160	8.5
3	Krishnankaranai	Sl	33	1.17	2.90	8.1	9.89	0.28	194	11.0	162	5.5
4	Nemmeli	S	15	1.15	2.56	7.9	9.42	0.24	162	08.4	198	4.4
5	Vadanemeli	Sl	27	1.27	2.55	8.5	9.30	0.15	184	12.5	135	2.5
6	Thiruvidanthai	Scl	36	1.23	2.06	8.0	10.80	0.17	187	13.5	160	6.0
7	Kovalam	Sl	32	1.17	2.85	7.5	9.70	0.22	168	11.2	147	6.0
8	Muttukadu	Sil	35	1.24	2.28	8.5	8.65	0.29	143	08.0	285	5.5
9	Kamathurreddika	Sil	34	1.30	2.55	8.3	9.16	0.17	179	09.5	200	4.5
Ponneri (PNI)												
1	Vallur	Sil	38	1.26	2.78	8.5	11.40	0.22	170	07.2	176	5.5
2	Ennur	Cl	42	1.17	2.28	8.1	8.82	0.29	114	05.5	130	4.5
3	Puzhidhvakkam	Cl	34	1.31	2.21	8.5	10.20	0.17	158	08.7	121	5.9
4	Kattupalli	C	41	1.33	2.48	8.7	9.31	0.22	125	10.1	190	3.8
5	Kalanji	Sl	30	1.17	2.30	7.9	9.80	0.27	170	09.5	118	5.9
6	Karungali	Sl	34	1.26	2.38	8.5	8.76	0.21	167	07.5	150	7.0
7	Thanagalperubulam	Sl	37	1.25	2.08	8.0	10.54	0.19	123	06.2	195	5.5
8	Pulicat	S	17	1.17	2.21	8.5	12.90	0.17	141	05.4	146	4.4
9	Karimanal	S	22	0.92	2.10	8.3	11.86	0.13	102	07.6	094	9.1

Table 3. average Physico-chemical properties of degraded soils in coastal taluks

Taluk	Degraded area (ha)	Soil texture	pH	EC_e (dSm^{-1})	OC (%)	Soil nutrient status (kg ha^{-1})		
						N	P_2O_5	K_2O
Chidambaram	938	C, Cl, S, Sl, Scl	8.4	10.46	0.23	173.87	07.61	175.17
Cuddalore	494	Cl, Scl, Sl, S	8.3	11.21	0.19	147.09	09.66	194.36
Vannur	262	Scl, Sl	6.9	4.22	0.18	166.67	11.63	140.00
Thindivanam	319	Sl, Sil	8.2	9.21	0.16	151.57	09.03	168.43
Cheyyur	517	S, Sil	8.4	10.07	0.19	171.54	11.75	138.75
Thirukkalukundrum	456	S, Sl	8.3	8.89	0.20	154.54	10.86	148.55
Chenglepet	368	S, Sil	8.2	9.48	0.22	176.44	10.33	182.44
Ponneri	706	S, Sl, Cl	8.3	10.40	0.21	141.11	07.52	146.67
Average	-	-	8.13	9.24	0.20	160.35	9.80	161.80

3.2.2. Sub zoning of coastal agro ecosystem of Northern Tamil Nadu

The coastal agro ecosystems of Northern Tamil Nadu greatly differed from each other in soil textures, salinity and drainage class. To develop a site specific agronomic management measures, the entire study area was divided in to seven agro ecological sub zones *viz*., Northern Cauvery delta (SZ_1), Ponaiyar delta (SZ_2), Pondicherry region (SZ_3), Southern Palar delta (SZ_4), Northern Palar delta (SZ_5), Mahabalipuram (SZ_6) and Northern Chennai (SZ_7). The location map of the agro ecological sub zones in Northern Tamil Nadu are presented in Fig. 3. The geographic distributions of degraded sub zones are demarcated are summarized in Table 4.

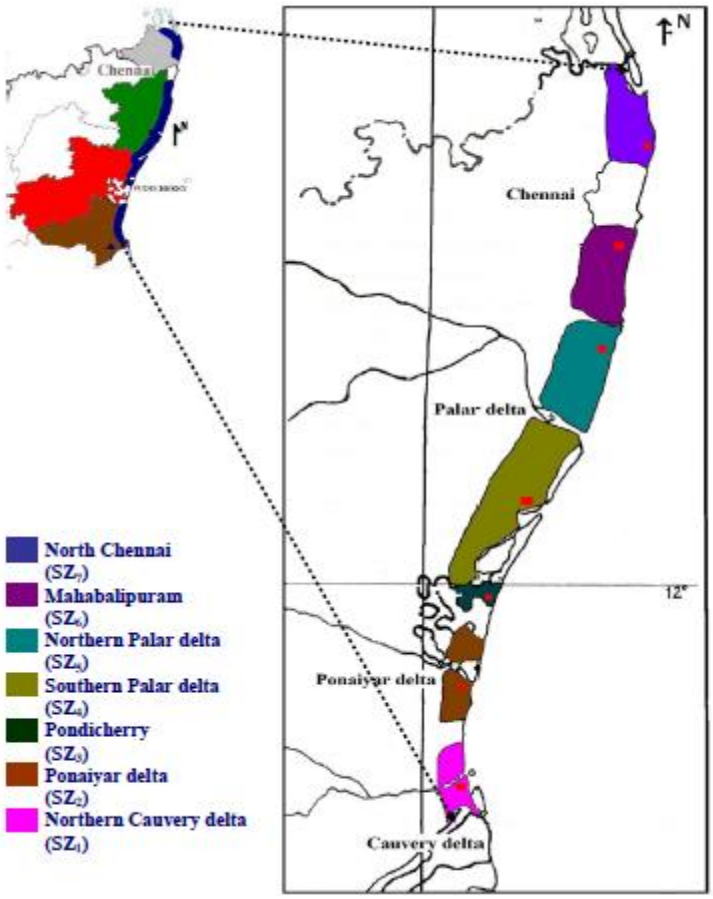


Fig. 3. Agro-ecological subzones

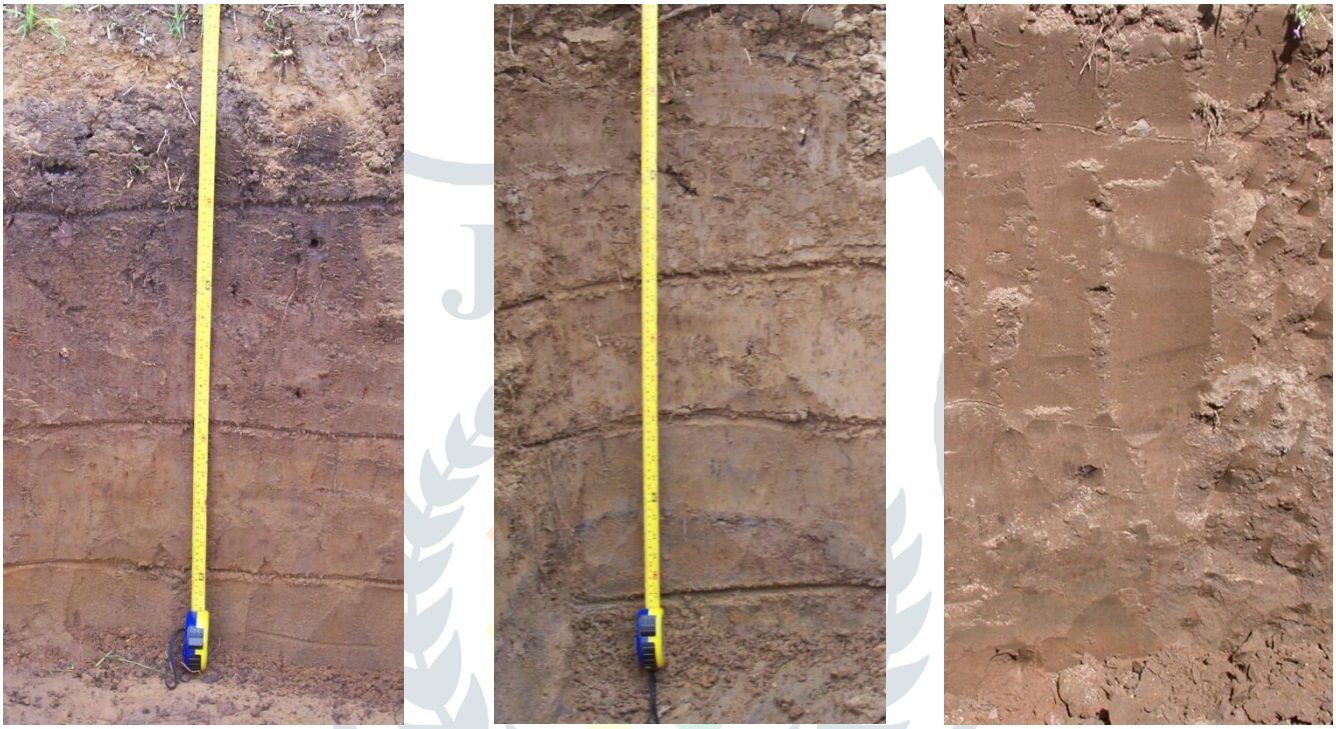
Table 4. Agro ecological sub zones of the Northern coastal Tamil Nadu

Agro-ecological Region	Agro-ecological Sub region	Agro ecological Sub Zones	Location
Eastern Coastal Plain, hot sub humid to semiarid eco-region (S7Cd 2-5)	North Tamilnadu Coastal Plains. (S7Dm 4)	1. Northern Cauvery delta (CDM 1 - 14)	$11^0$22’ - $11^0$32’ N Latitude $79^0$41’ - $79^0$48’ E Longitude
		2. Ponaiyar delta (CUD 1 - 6, CUD 8 - 11)	$11^0$37’ - $11^0$44’ N Latitude $79^0$45’ - $79^0$47’ E Longitude
		3. Pondicherry (VNR 1 - 5)	$11^0$58’ - $12^0$04’ N Latitude $79^0$48’ - $79^0$52’ E Longitude
		4. Southern Palar delta (VNR 6, TVM 1 - 7, CYR 1 -11)	$12^0$12’ - $11^0$29’ N Latitude $79^0$52’ - $80^0$03’ E Longitude
		5. Northern Palar delta (TKM 1 - 6)	$12^0$29’ - $12^0$37’ N Latitude $80^0$09’ - $80^0$11’ E Longitude
		6. Mahabalipuram (TKM 7 - 11, CPT 1 - 8)	$12^0$37’ - $12^0$48’ N Latitude $80^0$08’ - $80^0$14’ E Longitude
		7. North Chennai (PNI 3 - 10)	$13^0$20’ - $13^0$28’ N Latitude $80^0$11’ - $80^0$20’ E Longitude

3.3. Characteristics of the degraded soil profile

3.3.1. Profile morphology

All the profile studied field soils were deep, the colour of the soils in Northern Cauvery (SZ_1) and Ponaiyar delta (SZ_2) were black, Pondicherry (SZ_3), it was red and in other sub zones it was yellow to yellowish brown. The texture varied from clay to sandy soils in all the sub zones. In Northern Cauvery delta (SZ_1) the top soil texture was sandy loam and hard clay canker layer occurred in sub soil. In Ponaiyar delta (SZ_2) the texture is clayey, hard when dry and very sticky when wet. In Pondicherry (SZ_3) and Northern Palar delta (SZ_5), the soil texture is sandy clay loam. The degraded soil of Southern Palar delta (SZ_4) is sandy loam in texture, while in Mahabalipuram (SZ_6) and North Chennai (SZ_7) experimental sites it is sandy in texture.



Northern Cauvery delta **Ponaiyar delta** **Northern Palar delta**

Plate 4. Soil profiles of degraded sub zones

3.3.2. Physical and chemical properties

The perusal of data on soil physical properties of degraded location revealed that the bulk density of the soil varied from 1.08 to 1.71 per cent. The pore space ranges between 36.5 and 55.8 per cent and the WHC is also diverse between 19.6 and 40.7 per cent (Table 5). The results of the soil analysis showed that the pH of the soil ranges between 7.90 and 8.41. The EC_e varied from 6.02 to12.68 dSm^{-1}. The pH and higher EC_e values indicated that the degraded soils in the coastal agro ecosystem of Northern Tamil Nadu were strongly affected with salinity (Table 6). The field experimental soil exhibited low organic carbon (0.12 – 0.36 per cent) and available N (68.83 – 156.54 kg ha^{-1}), low to medium P_2O_5 (6.75 – 13.25 kg ha^{-1}) and K_2O (70.25 – 206.45 kg ha^{-1}). The micronutrients *viz*., sulphur (4.38 – 11.45 ppm) and zinc (0.25 – 0.59 ppm) were low, copper (0.09 – 0.36 ppm) low to medium, boron (0.14 – 0.43 ppm) medium, manganese (6.56 – 17.31 ppm) and molybdenum (0.17 – 0.84 ppm) medium to high and iron (10.30 to 54.26 ppm) high in the coastal soils.

Table 5. Soil physical and chemical properties of degraded ecosystem

Sub zones	Texture (g cc^{-1})	Bulk density	Pore space	WHC (%)	Salinity/ Alkalinity			Macronutrients			
					pH	EC_e	SAR	OC	N	P_2O_5	K_2O

		(%)	(%)			(dsm^{-1})		(%)	(Kg ha^{-1})		
1	C	1.62	36.5	39.6	8.32	7.58	10.86	0.23	137.35	6.75	153.76
2	C	1.71	38.7	40.7	8.41	9.08	12.84	0.36	108.25	9.00	206.45
3	Scl	1.22	48.2	36.2	7.90	6.02	10.40	0.20	101.28	11.82	107.37
4	Sl	1.40	45.9	27.8	8.24	9.78	6.15	0.27	68.83	7.34	164.13
5	Scl	1.21	47.6	32.1	8.33	8.80	12.63	0.18	156.54	13.25	149.65
6	S	1.11	52.6	20.7	8.26	7.44	8.38	0.12	116.53	10.51	87.78
7	S	1.08	55.8	19.6	8.41	12.68	11.93	0.16	91.25	6.80	70.25

Table 6. Soil chemical (micro nutrients) and biological properties of degraded ecosystem

Sub zone	Micronutrients							Biological		
	S	Zn	Cu	Fe	Mn	B	Mo	Bacteria (x10^6)	Fungi (x10^3)	Actinomycetes (x10^4)
	(ppm)									
1	5.08	0.36	0.16	16.18	9.51	0.22	0.79	5.18	2.14	1.02
2	7.16	0.59	0.09	24.24	7.60	0.34	0.42	4.39	1.88	0.76
3	11.45	0.29	0.31	54.26	6.56	0.41	0.29	4.26	1.47	0.47
4	4.38	0.45	0.15	23.75	11.46	0.17	0.84	3.95	1.71	0.69
5	9.74	0.28	0.36	21.41	17.31	0.43	0.26	4.12	1.89	0.61
6	11.02	0.25	0.12	13.44	6.86	0.25	0.17	2.97	1.22	0.42
7	8.81	0.28	0.21	10.30	10.89	0.14	0.25	3.68	1.63	0.53

3.3.3. Biological properties

The results of the soil analysis revealed that the microbial population of the experimental soil was low. The bacterial population of the soil ranges from 2.97 to 5.18 x10^6 CFU g^{-1}, fungal population ranging from 1.22 to 2.14 x 10^3 CFUg^{-1} and the actinomycetes population varied from 0.42 to 1.02 x 10^4 CFUg^{-1} (Table 6).

3.4. Land capability classification (LCC) of degraded soil

The results of soil profile analysis clearly revealed the extremes of soil properties. The values of pH, EC_e and SAR confirmed the salinity in soils. The heavy textured soils and canker layer in Northern Cauvery delta (SZ_1) and Ponaiyar delta (SZ_2) were prone to water logging. The sandy and sandy loam nature of soils in other locations showed that the water holding capacity was low. Further the macro and micro nutrients were also low. Due to the severe limitations *viz*., salinity, poor drainage, drought and low fertility status the degraded soils of coastal agro ecosystem of Northern Tamil Nadu comes under LCC class of IV and V and the locations could be grouped as moderately saline waterlogged clay soil (SZ_1), strongly saline waterlogged clay soil (SZ_2), moderately saline non-waterlogged sandy clay loam soil (SZ_3), strongly saline non-waterlogged sandy loam soil (SZ_4), strongly saline non-waterlogged sandy clay loam soil (SZ_5), moderately saline non-waterlogged sandy soil (SZ_6) and strongly saline non-waterlogged sandy soil (SZ_7) (Table 7).

Table 7. Land capability classification (LCC) of degraded soils

S. No.	Sub zones	LCC	Limitations	Status of location
1.	Northern Cauvery delta	IVw	Salinity, poor drainage, hard pan,	Moderately saline waterlogged clay soil

			cracks	
2.	Ponaiyar delta	IVw	Salinity, poor drainage, heavy texture, cracks	Strongly saline waterlogged clay soil
3.	Pondicherry	Ve	Salinity, runoff, low fertility	Moderately saline non-waterlogged sandy clay loam soil
4.	South Palar delta	IVc	Salinity, too dry, low fertility	Strongly saline non-waterlogged sandy loam soil
5.	North Palar delta	IVc	Salinity, too dry, low fertility	Strongly saline non-waterlogged sandy clay loam soil
6.	Mahabalipuram	Vc	Salinity, light textured, too dry, low fertility	Moderately saline non-waterlogged sandy soil
7.	North Chennai	Vc	Salinity, light textured, too dry, low fertility	Strongly saline non-waterlogged sandy soil

(w – wetness, e – erosion hazard and c – too dry)

4. DISCUSSION

Considering the growing multiple demands of the fast increasing population and rapidly declining land: man ratio, it is imperative to utilize the hitherto lying degraded soils of the coastal agro ecosystem in the country for sustainable utilization. Land degradation is increasing in the agro ecosystems due to natural and anthropogenic factors which in turn cause a decline in soil productivity and crop yield, which results in severe degradation of the bio environment. Degraded soils occupy a large extent of about 63.89 m. ha in India. Tamil Nadu state shares about 2.3 million hectares of which 0.32 million hectares are spread over in the coastal districts of Cuddalore, Villupuram, Kanchipuram and Thiruvallur (Anon, 2004). Evidence on the land degradation on the coastal agro ecosystem and possible strategies for overcoming land degradation is still sparse. However, the degraded land in the coastal agro ecosystem of Northern Tamil Nadu can be utilized advantageously for the future requirements *viz*., agro forestry and forestry by systematic and integrated planning.

The Cuddalore, Villupuram, Kanchipuram and Thiruvallur districts of Northern Tamil Nadu comprising of 79 coastal villages having 18,852 ha cultivated area, of which 21.54 per cent of the land area is affected by varying magnitudes of degradation *viz.*, 42.14 per cent moderately degraded, 40.62 per cent strongly degraded, 8.87 per cent extremely degraded and 8.37 per cent slightly degraded. The results of the present study clearly indicated that substantial area has been found to be strongly degraded and rehabilitation of this vast area may contribute significantly in enhancing the sustainability of the coastal agro ecosystem.

Periodic cyclonic precipitation and frequent flooding by overspill and backwater during monsoon period caused severe degradation of agro ecosystem. Further lack of well defined drainage and poor infiltration rates in the clay sub soil layers cause extensive seasonal water logging followed by raising of salt concentration to the surface soil layers which hampered agricultural productivity and increased degradation of the agro ecosystem (Fig. 3). This is concomitant with the findings of Kathiresan (2008) who reported that improper distribution of rainfall, unseasonal heavy downpour and extended soil moisture deficit periods which in turn hampered the productivity of the coastal agro ecosystem.

The above factors coupled with unscientific intensive agricultural practices and deforestation caused soil compaction, surface sealing, runoff, decreasing soil organic matter and nutrients, which effectively allow increased evaporation, build up of salinity and further degradation of agro ecosystem. Uncontrolled pumping of groundwater for intensive agricultural practices in coastal regions breaks the ground water pathways of hydrological cycle and leads to incursion of salt water in to the aquifers. Continuous use of

saline water for irrigation followed by evapotranspiration gradually increased the salt concentration of agricultural fields. Similar results were observed by Baskaran (2004) and Kaiser (2004) who reported that alternative wetting and drying increased the salt concentration of agricultural lands which in turn leads to severe degradation of the agro ecosystem.

Further the development of shrimp farms in the coastal regions is also responsible for the degradation of agro ecosystem. These farms are largely dependent on the use of brackish water for shrimp culture which subsequently affects the neighbouring agricultural land. The storing of brackish water nearer to the agricultural fields increases the salinity of ground water and the polluted salty water from the prawn tanks are swept into agricultural field thereby decreasing the soil and crop productivity (Goldy, 2004; Hossain *et al*., 2013; Rex Immanuel *et al*., 2018).

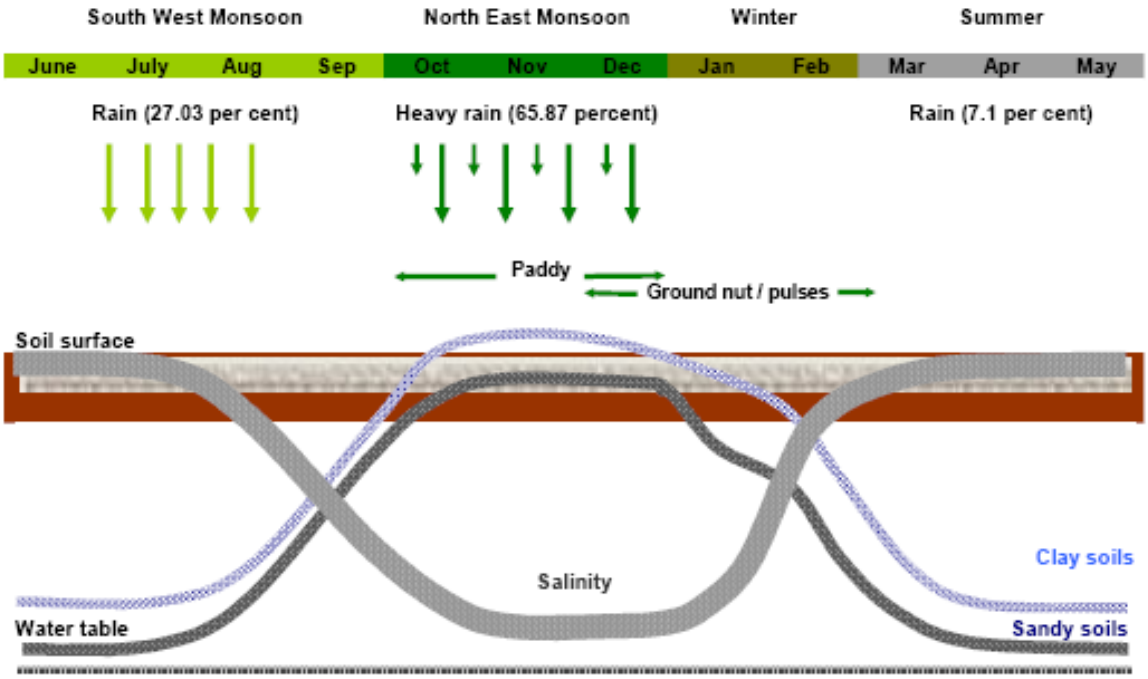


Fig 3 Seasonal changes of salinity and water table in the coastal agro ecosystem of Northern Tamilnadu

4.1. Characterization of coastal agro ecosystem

Among the cultivated area of 18,852 hectares, 21.54 per cent has been found to be degraded in the coastal agro ecosystem of Northern Tamil Nadu. The physio-chemical properties of these area indicated that the locations could be characterized as strongly saline soils with the average pH of 8.13 and ECe of 9.24 dSm^{-1}. The nutrient status of these soils indicated that the OC, available N, P_2O_5 and K_2O were low to medium. The low diversity index of 0.50 and highly variable length of the growing period of crops in the agro ecosystems indicated a certain degree of degradation taking place in the selected coastal villages and also based on the inhabitant's opinion. Accumulations of salts, high pH and EC_e decreased the soil permeability, available water capacity and infiltration rates through swelling and dispersion of clays as well as slaking of soil aggregates and reduced the plant nutrient availability. These sources, coupled with environmental factors (drought and erratic rainfall) caused severe degradation of soils and also changes in the species composition of the agro ecosystems. These modifications further reduced the yield of crops growing on such soils due to lack of local impoverishment.

4.2. Sub zoning of the coastal agro ecosystem of Northern Tamil Nadu

The soil type, physico-chemical properties of the soil and drainage class have been effective tools for delineating soil, landscape variability within the agro ecosystems. Based on these tools, the study area was classified in to seven coastal agro ecological sub zones *viz.*, Northern Cauvery delta (SZ_1), Ponaiyar delta (SZ_2), Pondicherry (SZ_3), Southern Palar delta (SZ_4), Northern Palar delta (SZ_5), Mahabalipuram (SZ_6) and Northern Chennai (SZ_7). Soils of these sub zones vary due to the differences in soil type, physio-chemical properties and drainage class. Each sub zone provides a different environment for plant growth, either in

climatic or soil conditions or both. It helped to develop a different site specific package of practice for rehabilitation of degraded coastal agro ecosystem soils. Site classification organizes ecosystems into groups that have similar site qualities and vegetation potentials, according to the principle of ecological equivalence as suggested by Klinka *et al*. (1999). Terra *et al*. (2004) indicated that sub zoning expected to have similar characteristics and less variability than that of the entire area. The sub zoning of the northern coastal Tamil Nadu is based on the relationship between the degree of intensified degradation and the total bio diversity of coastal agro ecosystem.

4.3. Characteristics of the degraded area

The results of profile soil analysis confirm that the sites are degraded with varying levels. The highest soil pH and EC_e were noted in all the coastal agro ecosystem sub zones. The available nutrient status of these soils indicated that low in OC, available N and micronutrients, and low to medium in available P_2O_5 and K_2O. Similarly lowest microbial populations were observed in all the sub zones. Based on the above factors in the coastal production system a hypothetical sustainability matrix was evolved (Fig.4).

Due to the limitations *viz*., higher salinity, poor drainage, frequent drought and low fertility status, the degraded sites comes under the LCC class of IV and V and classified into seven categories for each zone *viz*., Northern Cauvery delta with moderately saline waterlogged clay soil (SZ_1), Ponaiyar delta with strongly saline waterlogged clay soil (SZ_2), Pondicherry with moderately saline non-waterlogged sandy clay loam soil (SZ_3), South Palar delta with strongly saline non-waterlogged sandy loam soil (SZ_4), Northern Palar delta with strongly saline non-waterlogged sandy clay loam soil (SZ_5), Mahabalipuram with moderately saline non-waterlogged sandy soil (SZ_6) and North Chennai with strongly saline non-waterlogged sandy soil (SZ_7). Data generated at seven sub zones in coastal ecosystem indicated that the annual crops cultivated on land capability Class IV and above are prone to lower yields/risks, and lack of response to inputs. Hence, the soils in these capability classes can be effectively utilized for alternative land uses in which perennial woody tress can constitute as a major component for rehabilitation.

In general, degraded soils are low in macro and micro nutrient owing to poor organic matter content, slower rate of its transformation and mineralization are reported by Chowdhury *et al*. (2007). The hardy nature of clay soil and presence of canker pan in the subsurface layers showed the soils of Northern Cauvery delta (SZ_1) and Ponaiyar delta (SZ_2) were prone to water logging. The sandy and sandy loam nature of soils in Pondicherry (SZ_3), Southern Palar delta (SZ_4), Northern Palar delta (SZ_5), Mahabalipuram (SZ_6) and North Chennai (SZ_7) sub zones the soil moisture content was lower in the surface soil strata during the dry season. This might be due to combination of factors such as soil physical properties, evaporation, salinity and poor organic matter content. The studies reported that in coastal agroecosystems the inadequate drainage during the North – East monsoon season (Sep – Dec) followed by severe drought during summer (Mar – May) have many fold increased the degradation of crop fields (Rex Immanuel *et al*., 2018).

5. CONCLUSION

From the study it is concluded that the coastal agro ecosystem of Northern Tamil Nadu recorded a substantial area of degraded soils. Development and refinement of technologies for rehabilitation of degraded/wastelands in general salt-affected soils in particular need to be considered on high priority. However, characterization of the soil environmental relationship still remains to be a challenge to get the target information. Therefore integrated use of strategic surveys (soil, topography, vegetation, *etc*.) combined with Geographical Information Systems (GIS) modeling is needed to characterize large scale strategy for manage coastal agro ecosystem degradation.

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