Assessment of soil fertility and ~~creation of~~ thematic mapping ~~in~~of the coastal soils of Ramanathapuram block, Ramanathapuram district in Tamil Nadu, India

ABSTRACT

Aims:~~A view~~To assess and map the soil fertility status of Ramanathapuram block in Ramanathapuram district of Tamil Nadu, India, ~~the present investigation was undertaken~~ using GPS and GIS techniques.

Study design: In this study, a systematic set of 100 georeferenced soil samples were collected from 100 selected villages and analyzed for 10 chemical parameters and the data along with GPS readings were used for the preparation of soil fertility maps using GIS.[Which samples – Topsoil? Subsoil?]

Place and duration of study: Ramanathapuram is one of the coastal districts bounded on the north by Sivagangai and Pudukottai districts, on the east and south by the Bay of Bengal, and on the west by Thoothukudi and Virudhunagar districts. The district headquarters is located at Ramanathapuram. The district lies between 9^{o} 05 and 9^{o} 5' North Latitude and 78^{o} 1' and 79^{o} 27' East Longitude. The general geographical information of the district is simple and flat. Vaigai river and Gundar river are flowing in the district and they will be dry during the summer season. The total geographical area of the district is 4,175 sq.km. The month of July, 2019.[Remove and transfer to main text as part of methodology.]

Methodology: Hundred soil samples were collected from the sixteen revenue villages of Ramanathapuram block, Ramanathapuram district, Tamil Nadu during the pre-monsoon season with lat-long co-ordinates by using GPS to evaluate the soil fertility. Ramanathapuram block is the middle- coastal block of Ramanathapuram district of Tamil Nadu. It lies between 9.05° 'to 9.50°' North latitudes and 78.10° 'to 79.27° 'East longitudes at an elevation of 2 m. The Geographical area of this Ramanathapuram district has an area is 4,123 km^2 of rural and urban area. The main source of irrigation is Sarugani River, Manimuthar River, Vaigai River and Vaippar River in Ramanathapuram district.[This looks like a mere repetition of the above. What we want here is how you took your samples, how you analyzed them and the procedures used, other data management approaches used like statistics, GIS interpolation algorithms, etc.]

Results: In present study, the mean soil values of pH (8.16), EC (0.74 dSm^{-1}), organic carbon content (2.52 g/kg), Available N (159.36$kgha^{-1}$), Available P (30.83 $kgha^{-1}$), Available K (355.39$kgha^{-1}$) and DTPA extractable micronutrients *viz.,* Fe (7.21), Zn (0.16), Mn (6.46) and Cu (1.36) ppm were recorded respectively in Ramanathapuram block of Ramanathapuram district.[How about the thematic maps?]

Conclusion: It can be concluded that based on thematic maps, a major area of Ramanathapuram block, Ramanathapuram district was alkaline, non-saline, low in OC, low, high and medium in available N, P and K, respectively; with regard to available DTPA micronutrients, Zn was predominantly deficient and Cu was moderate while , Fe and Mn were in sufficient status.[This appears to fit better under Results than conclusion.]The georeferenced sampling sites can be revisited with the help of GPS, which helps in monitoring the soil fertility changes over long run. Further, it will be useful to the researchers, planners, policy makers, extension workers of the State Department of Agriculture, fertilizer industries and farmers.

Keywords: *pH, EC, organic carbon, available NPK and DTPA extractable micronutrients*

[Why have you segmented the abstract into subsections? Is it the requirement of the journal? It is unusual nevertheless.]

Introduction

Agriculture is animperative sector for sustained growth of Indian economy. About 70 percent of rural households and eight percent of urban household are still dependent on agriculture for employment. Soil is the basic natural resource for agriculture and it supplies essential nutrients for plant growth, the food security and necessary components of human and animal food and the nutritional security of the country. However continuous cropping of high yieldingvarieties without proper substitution of inorganicfertilizers or organic manures/ composts and non-addition of micronutrientshave caused excessive removal of essential nutrients from the soil solution/ reserves that eventually led to the deficiencies of major, secondary and in particularly micronutrients in soils. The deficiency may either be primarily due to their low contents or secondarily by soil factor that reduce the availability (Sharma and Chaudhary, 2007).

Among the tools currently used in monitoring soil fertility variation over time, the Global Positioning System (GPS) helps in collecting a systematic set of geo-referenced samples and generating spatial data about the distribution of nutrients (Sharma, 2004), while the Geographical Information System (GIS) analyzes and provides meaning to the data. The estimation, characterization and comparison of spatial variation of micronutrients are important issues in the site-specific crop management, precision farming and sustainable agriculture (Nayak*et al.,* 2006). Soil nutrient maps covering large areas improve understanding of the nature and extent of nutrient problems, and aid in determining their relationships with climate, soil properties, and soil genetic characteristics determined at similar scales. Intermediate scale maps can be useful in delineating specific areas where deficiencies or toxicities are likely for agriculture, and in determining localized soil characteristics that may be associated with such problems. The thematic maps for individual nutrient (Fe, Zn, Mn and Cu) is prepared by using GIS software (Minakshi*et al.,* 2005 and Nayak*et al.,* 2006) and multi micronutrient maps are generated by integrating individual maps of Fe, Zn, Mn and Cu in the GIS (Sood*et al.,* 2004). This will also help in monitoring changes in micronutrient status over a period of time.

Materials and Methods

Ramanathapuram block is the middle- coastal block of Ramanathapuram district of Tamil Nadu. It lies between 9.05° 'to 9.50°' North latitudes and 78.10° 'to 79.27° 'East longitudes at an elevation of 2 m. The Geographical area of this Ramanathapuram district has an area is 4,123 km^2 of rural and urban area. The main source of irrigation is Sarugani River, Manimuthar River, Vaigai River and Vaippar River in Ramanathapuram district. The total cropped area of the district/ zone is 1,72,469 ha (as per 2016-17 G-return). The area under irrigated agriculture is 63,800 ha, while 1,37,099 hectare is under rainfed Agriculture. The major food grain crops cultivated are Paddy (*Oryza sativa*), cholam(*Zea mays*), cumbu(*Pennisetumglaucum*), Ragi (*Eleusinecoracana*)and Blackgram(*Vigna mungo L.*). Cotton (*Gossypiumhirsutum*) is the major non-food crop grown. [It may add value to your paper if you add an administrative map of your study area showing your "revenue" villages, for ease of understanding the thematic soil maps.]

To delineate the soil fertility, 100 soil samples were collected from the sixteen revenue villages of Ramanathapuram block, Ramanathapuram district, Tamil Nadu during pre-monsoon season, i.e., in the month of July, 2019. The samples were collected in such a manner that it represented the soil fertility of all the revenue villages and overall soil fertility of Ramanathapuram block. The soil samples were collected randomly from georeferenced points with respective GPS co-ordinates recorded. From each revenue village, a minimum of two to a maximum of twenty-four soil samples were collected, properly labelled and brought to the laboratory for further chemical analysis. [How did you take the samples? Disturbed or undisturbed? Topsoil or subsoil? Say it here.]

The collected soil samples were analyzed for various parameters by adopting the standard procedures *viz.,* pH by Potentiometry (Jackson, 1958), EC by Conductometry (Jackson 1973),Available Nitrogen by Alkaline Permanganate method (Subbiah and Asija, 1956), Available Phosphorus 0.5 M $NaHCO_3$ extract (Olsen, 1965), Available Potassium by Neutral Normal[1.0 N?]Ammonium Acetate extraction method(Stanford and English, 1949), Organic carbon by Chromic acid wet digestion method (Walkley and Black, 1934) and DTPA extractable micronutrients by Atomic Adsorption spectrophotometer (AAS), (Lindsay and Norwell, 1978). Thematic maps pertaining to soil fertility were prepared using Arc GIS software 10.1.[It may add value to the paper if you expound more on how you prepared these thematic maps.] The analytical results of each soil sample were categorized as low, medium and high categories for OC and macronutrients and as deficient, moderate and sufficient based on the critical limits for available micronutrients as followed in Tamil Nadu.

Chart 1 :USDA system of Soil fertility classification

Parameter	Ranges	Soil Fertility Classes

pH	<6.0	Acidic
	6.0 – 8.5	Neutral
	> 8.5	Alkaline
EC (dSm^{-1})	<1.0	Non – saline
	1.0 – 2.0	Slightly saline
	2.0 – 4.0	Moderately saline
	>4.0	Saline
Nitrogen ($kg\ ha^{-1}$)	<280	Low
	280 – 480	Medium
	>480	High
Phosphorus ($kgha^{-1}$)	<11	Low
	11 – 22	Medium
	>22	High
Potassium ($kg\ ha^{-1}$)	<118	Low
	118 – 280	Medium
	>280	High
Organic carbon (gkg^{-1})	<5	Low
	5 – 7.5	Medium
	>7.5	High

Chart 2 :Micronutrient classification

Parameter (ppm)	**Low (Deficient)**	**Medium (Moderate)**	**High (Sufficient)**
Iron (Fe)	<3.7	3.7 – 8.0	>8.0
Zinc (Zn)	<1.2	1.2 – 1.8	>1.8
Manganese (Mn)	<2.0	2.0 – 4.0	>4.0

Copper (Cu)	<1.2	1.2 – 1.8	>1.8

[What about sending the above tables to the appendices (end of paper)?]

Results and Discussion

Soil fertility status of Ramanathapuram block

pH and Electrical Conductivity

The pH (Table 1) of the soil ranged from 6.07 to 9.81 with a mean of 8.16, respectively. Among the revenue villages, the lowest pH of 6.07 was recorded in Therkutharavai which was followed by 6.35 at Ramanathapuram. The highest pH of 9.81 was recorded in peravoor which was followed by 9.65 at kavanoor. Around 73 percent of samples fell under Neutral category (pH 6.0-8.5), 27 percent in Alkaline category and 0 percent in Acidic category. The soils of Ramanathapuram block were predominantly neutral to alkaline. The variation in pH may be due to inherent heterogeneity of soils and also due to the nature of parent material and differences in cultural and fertilizer management practices (Vijayakumar*et al.,* 2015).

The EC of the soil ranged from 0.05 to 8.88dS m^{-1} with a mean of 0.74dS m^{-1}**,** respectively. Among the revenue villages, the lowest EC of 0.05dS $m^{-1}$was recorded in Madakottan which was followed by 0.06dS m^{-1} at Therkutharavai. (Table1) The highest EC of 8.88dS $m^{-1}$was recorded in Ramanathapuram which was followed by 6.45dS m^{-1} at pullankudi. Around 80 percent of samples fell under Non – saline category (<1.0 dS m^{-1}), 13 percent in slightly saline category, 2 percent in moderately saline category and 5 percent in saline category. The variation in soil samples might be due to proper management and inherent properties of soil as also reported by Sharma *et al*. (2008). The soil samples analysed were found to be non-saline in nature, which might be attributed to light textured soils resulting in free drainage (Verma*et al.,* 2005; Vijayakumar*et al.,* 2015).[Are you sure that light-textured soils cannot be salt-affected? Not sure either. Better check.]

Organic carbon (g kg^{-1})

The overall OC status of the soil (Table 2) ranged from 0.60 to 8.70 gkg^{-1} with a mean value of2.52 gkg^{-1}. Among the revenue villages, the lowest OC of 0.60gkg^{-1}were recorded in both Therkutharavai, Ramanathapuram and Kavanoor which was followed by 0.70 gkg^{-1}at Kusavankudi and Madakottan. The highest OC of 8.70 $gkg^{-1}$was recorded at Chidharkottai which was followed by Pullangudi (6.60 gkg^{-1}) and Melakottai (6.30 gkg^{-1}). About 95 per cent of the soil samples in the Ramanathapuram block mostly belonged to the Mandapam Soil series which is having loamy sand texture (Very coarser in texture) and with less cultivation due to less water availability which may cause less organic carbon content in the

block. The low organic carbon statusis primarily due to high temperature leading to higher rate of organic matter decomposition (Kameriya 1995) and also due to little or no organic matter additions (Regoet *al.* 2003).

Available N, P and K

The overall available N status (Table 3) ranged from 42 to 455 kg ha^{-1} with a mean value of 159kg ha^{-1}. Similar to OC, a major percentage of soil samples (95%) were under low status. The minimum available N of 42kg $ha^{-1}$was recorded in Sathankulam which was followed by 45 kg ha^{-1}at Kusavankudi. The maximum available N of 455kg $ha^{-1}$was recorded at Chidarkottai which was followed by Melakottai (328kg ha^{-1}). Around 95 per cent of samples fell under low category (<280 $kgha^{-1}$), 5 per cent in medium category and none in high category. As majority of soils is alkaline in nature [but you said earlier that 73% were neutral!] and having light texture, the applied fertilizers would have been subjected to various losses which resulted in low amount of available N in the soil. This might be due to the fact that being alkaline in major area of the district, applied N in soil is lost through various mechanisms like ammonia volatilization, nitrification succeeding denitrification, chemical and microbial fixation, leaching and run off (De Datta and Buresh1989) which would have resulted in low amount of available N in soil. The flooded condition during the monsoon leads to leaching losses and barren soil after monsoon leads to volatilization losses in the district.

The Olsen-P (Table 3) ranged from 7.2 to 89.6kg ha^{-1} with an overall mean value of 30.8kg ha^{-1}, respectively. Among the revenue villages, the lowest available P of 7.2$kgha^{-1}$was recorded in Devipattinam which was followed by 9.40$kgha^{-1}$at Chidharkottai. The highest available N of 89.6$kgha^{-1}$was recorded at Madakottan which was followed by Ramanathapuram and Peravoor (78.4$kgha^{-1}$). Around 68 per cent of samples fell under high category (> 22 $kgha^{-1}$), 22 per cent in medium category and 10 per cent in low category. The high P percentage in majority of the soils might be due to the continuous application of rice crop cultivation for prolonged period with the application ofphosphatic fertilizerslike Di-Ammonium Phosphate (DAP) that would have built-up soil available P status as the efficiency of applied P is very low (Aulakh and Pasricha, 1999).

The range of available K was 245.60 to 462.20kg ha^{-1} with a mean of 355.39kg ha^{-1} and the per cent samples under low, medium and high categories was nil, 6 and 94%, respectively. The minimum available K of 246kg $ha^{-1}$was recorded in Kavanoor which was followed by 247 kg ha^{-1}at Ramanathapuram. The maximum available N of 462kg $ha^{-1}$was recorded at Ramanathapuram which was followed by Pullangudi (461kg ha^{-1}). 'High' available K in these soils may be attributed to the continuous drain of K from the soil reserve over the years with inadequate supply of chemical fertilizers to meet the crop need, mining of K has started appearing in the soils which is a matter of concern. [Check and verify this reason, it is doubtful.] This shows that if sufficient quantity of potassium is not added externally there

will be potassium mining from the soil. These results are in confirmation with the findings of Bhangu and Sidhu, (1991), Naidu *et al.* (2011).

Available micronutrients

The available Fe status (Table 4) varied from 1.5 to 19.8 ppm with a mean of 7.2 ppm. Deficient, moderate and sufficient Fe status was noticed in 31, 36 and 33% of the samples, respectively. Among the revenue villages, the lowest DTPA- Fe of 1.5 ppmwas recorded in Valantharavai and Ramanathapuram which was followed by 1.9 ppm at Therkutharavai. The highest DTPA-Fe of 19.8 ppm was recorded at Thoruvalurand followed by Kavanur (19.5 ppm). This might be due to precipitation of Fe^{2+} in higher pH of the sodic soils in these soils [You haven't indicated sodic soils anywhere before.] which was also reported by Verma*et al.* (2007). Similar results were also reported for villages of northern Madhya Pradesh by Rajput *et al.* (2015), Karajanagi*et al.* (2016) for Malaprabha command area of Karnataka, for Patan district by Patel *et al.* (2016), Wagh*et al.* (2016) for Nagpur district of Maharashtra.[Check again the dynamics of Fe in soils.]

The available Zn status (Table 4) ranged from 0.10 to 0.23ppm with a mean of 0.16ppm. All the soil samples were deficient in available Zn with an overall soil status very low; the results in line with the findings of Velu*et al*. (2008). The findings of Shyampura and Seghal (1995) and Katyal and Datta (2004) also subscribe to this view. Climatic conditions, parent materials, and management appeared to be largely responsible for the distribution of Zn in the soil. Coarse texture, high pH, diminishing OC and leaching often accentuated the Zn deficiency (Katyal and Rattan 1993). Zinc content in the investigated soils might be due to the low OC values in these blocks. The results of the present investigation are in the conformity with those of Takkar*et al*. (1997) who envisaged that when the soils are low in organic matter and not supplemented by mineral fertilization they are prone to Zn deficiency.

The available Mn status (Table 1) varied from 0.30 to 16.4 ppm with a mean of 6.46 ppm. Deficient, moderate and sufficient Mn status was noticed in 14, 25 and 61% of the samples, respectively. Among the revenue villages, the lowest DTPA- Mn of 0.3 ppm was recorded in Melakottai and Ramanathapuram which was followed by 0.4 ppmat Therpooki. The highest DTPA-Mn of 16.4 ppm was recorded at Sathankulam and followed by Valantharavai (14.7 ppm). The Mn bearing minerals in the parent material of these soils might be the reason for higher Mn content of soils. Which may be due to the formation of insoluble higher- valence oxides of Mn at high pH (Naheed et al., 2010).

The available Cu status (Table 4) varied from 0.22to 3.89 ppm with a mean of 1.36ppm. Deficient, moderate and sufficient Cu status was noticed in 51, 33 and 16% of the samples, respectively. Among the revenue villages, the lowest DTPA- Cu of 0.22 ppm was recorded in pullangudi which was followed by 0.23 ppmatValuthur. The highest DTPA-Cu of 3.89 ppm was recorded at Sathankulam and followed by Kavanur (3.87 ppm).The study area which might be due to the fact that decomposition of organic matter

releases micronutrients and also reduces the pH of the soil around the plant roots which helps in increasing the solubility of cationic micronutrients (Sharma and Chaudhary 2007).Hence, deficiencies of micronutrients in the soils are reported to affect the chances of vegetation growth (Arvind Kumar Rai *et al*., 2011). Thus, this shortfall of micronutrients is adjusted by adding the essential nutrients to the soil either naturally or by artificial fertilizers.

Table1. Range of values for pH, EC of soil samples of Ramanathapuram block

S. No.	Village Name	No. of samples	pH			EC (dSm^{-1})		
			Min	Max	Mean	Min	Max	Mean
1	Kusavankudi	4	7.13	8.72	7.64	0.09	0.17	0.13
2	Sathankulam	4	7.45	8.70	8.21	0.19	0.90	0.46
3	Pattinamkathan	4	6.79	8.55	7.60	0.13	1.45	0.61
4	Therkutharavai	5	6.07	8.79	7.54	0.06	1.15	0.35
5	Madakottan	9	6.60	8.69	7.89	0.05	1.03	0.46
6	Melakottai	4	7.89	8.86	8.33	0.17	1.33	0.63
7	Devipattinum	5	7.87	9.47	8.29	0.35	0.73	0.46
8	Valanthantharai	8	6.60	8.79	7.80	0.13	1.05	0.58
9	Valathoor	2	8.30	9.09	8.70	0.21	0.85	0.53
10	Pullankudi	6	7.84	8.66	8.19	0.36	6.45	1.65
11	Ramanathapuram	24	6.35	9.50	8.11	0.11	8.88	1.51
12	Chidharkottai	7	7.31	8.76	7.84	0.12	0.89	0.48
13	Therpooki	5	7.57	8.70	8.23	0.24	2.91	1.49
14	Thoruvalur	3	8.45	8.90	8.67	1.04	1.53	1.25
15	Peravoor	2	8.20	9.81	9.01	0.35	1.50	0.93
16	Kavanoor	8	7.49	9.65	8.56	0.17	0.49	0.36

Minimum	6.07	8.55	7.54	0.05	0.17	0.13
Maximum	8.45	9.81	9.01	1.04	8.88	1.65
Mean	7.37	8.98	8.16	0.24	1.96	0.74
SD	0.72	0.40	0.43	0.24	2.35	0.47
Std. Err	0.07	0.04	0.04	0.02	0.23	0.05

Table2. Range of values for OC of soil samples of Ramanathapuram block

S.No.	Village Name	No. of samples	OC (g/kg)		
			Min	Max	Mean
1	Kusavankudi	4	0.70	3.90	2.23
2	Sathankulam	4	0.80	2.80	1.88
3	Pattinamkathan	4	1.40	4.80	2.33
4	Therkutharavai	5	0.60	1.80	1.12
5	Madakottan	9	0.70	4.20	2.18
6	Melakottai	4	0.90	6.30	2.98
7	Devipattinum	5	1.10	1.80	1.38
8	Valanthantharai	8	1.50	4.30	3.03
9	Valathoor	2	2.70	3.90	3.30
10	Pullankudi	6	2.10	6.60	3.65

11	Ramanathapuram	24	0.60	4.80	1.95
12	Chidharkottai	7	1.10	8.70	3.29
13	Therpooki	5	1.10	4.20	2.32
14	Thoruvalur	3	3.90	5.30	4.70
15	Peravoor	2	1.30	2.10	1.70
16	Kavanoor	8	0.60	4.00	2.35
Minimum			0.60	1.80	1.12
Maximum			3.90	8.70	4.70
Mean			1.32	4.34	2.52
SD			0.90	1.83	0.92
Std. Err			0.09	0.18	0.09

Table 3. Range of values for N, P and K of soil samples of Ramanathapuram block

S. No.	Village Name	No. of samples	N (kg ha^{-1})			P (kg ha^{-1})			K (kg ha^{-1})		
			Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
1	Kusavankudi	4	45	246	148	10.2	44.8	30.6	293	400	332
2	Sathankulam	4	42	188	126	11.2	56.0	33.6	249	376	329
3	Pattinamkathan	4	78	277	134	9.2	56.0	35.9	330	385	346
4	Therkutharavai	5	64	137	94	10.2	33.6	24.4	270	379	327

5	Madakottan	9	50	216	129	9.2	89.6	38.4	317	418	361
6	Melakottai	4	95	328	178	22.4	56.0	42.0	294	365	340
7	Devipattinum	5	95	126	112	7.2	67.2	30.6	318	457	399
8	Valanthantharai	8	106	241	179	11.2	44.8	25.2	267	369	333
9	Valathoor	2	154	204	179	34.8	44.1	39.5	437	452	444
10	Pullankudi	6	115	319	207	10.1	44.8	20.4	250	461	338
11	Ramanathapuram	24	50	266	141	11.2	78.4	32.7	247	462	347
12	Chidharkottai	7	101	455	200	9.4	33.6	17.3	291	426	361
13	Therpooki	5	76	266	157	10.2	22.4	15.5	326	418	364
14	Thoruvalur	3	227	300	263	22.4	44.8	33.6	314	350	337
15	Peravoor	2	112	182	147	33.6	78.4	56.0	337	368	353
16	Kavanoor	8	73	213	156	9.5	33.6	17.9	246	446	375
Minimum			42	126	94	7.2	22.4	15.5	246	350	327
Maximum			227	455	263	34.8	89.6	56.0	437	462	444
Mean			93	248	159	14.5	51.8	30.8	299	408	355
SD			46.91	80.79	41.45	8.83	18.70	10.65	48.71	38.95	30.41
Std. Err			4.69	8.08	4.15	0.88	1.87	1.07	4.87	3.90	3.04

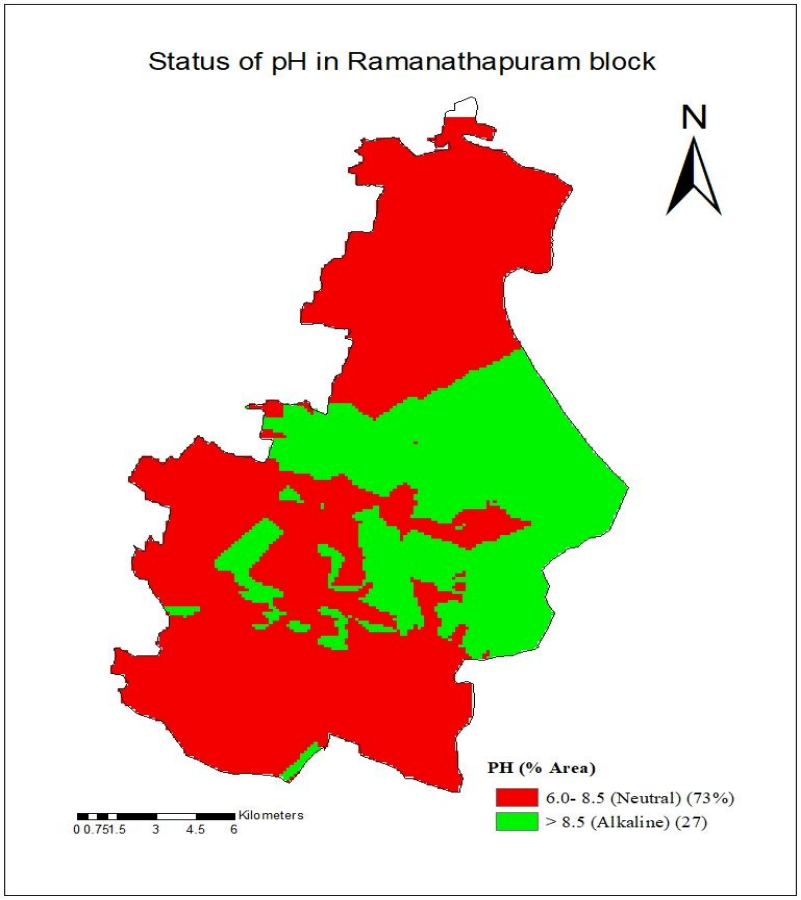
Table4. Range of values for Fe, Zn, Mn, and Cu of soil samples of Ramanathapuram block

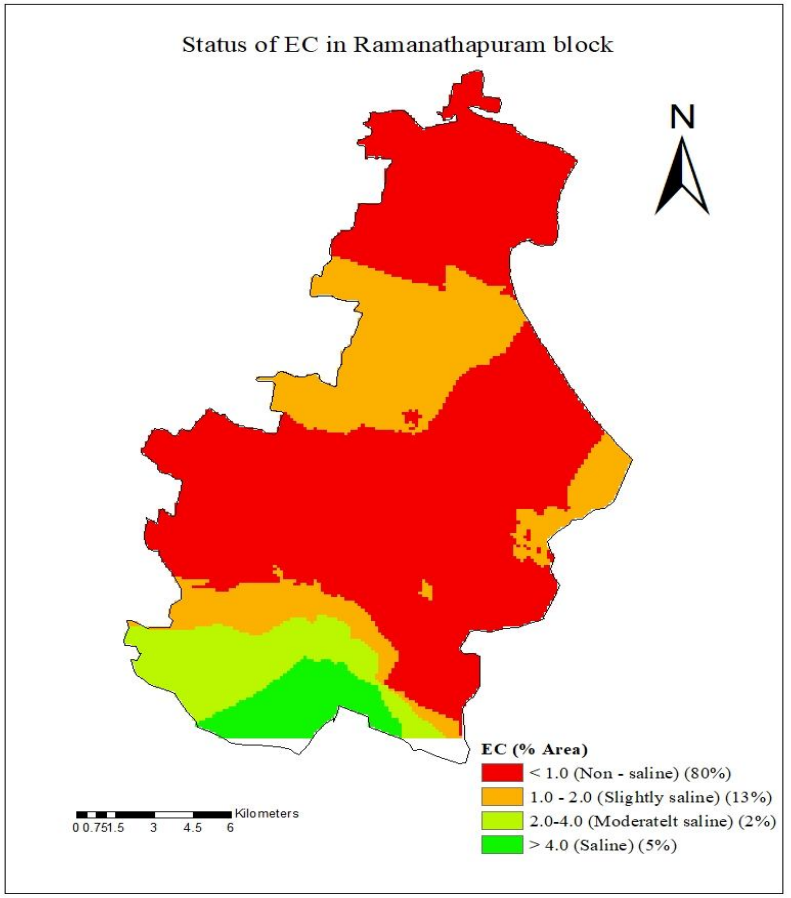
S.No.	Village Name	No. of samples	Fe (ppm)			Zn (ppm)			Mn (ppm)			Cu (ppm)		
			Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
1	Kusavankudi	4	2.8	13.2	7.4	0.11	0.17	0.14	5.0	11.3	8.4	1.23	3.51	1.98
2	Sathankulam	4	3.3	11.7	6.6	0.11	0.20	0.18	4.1	16.4	9.8	0.80	3.89	2.06
3	Pattinamkathan	4	7.5	15.9	12.2	0.20	0.22	0.21	1.9	8.5	5.0	1.13	1.44	1.28
4	Therkutharavai	5	1.9	14.4	6.5	0.11	0.21	0.16	3.1	14.1	10.2	0.59	3.01	1.88
5	Madakottan	9	2.5	12.9	5.6	0.12	0.19	0.15	3.1	13.9	6.9	0.30	1.51	1.06
6	Melakottai	4	6.8	19.0	11.9	0.12	0.17	0.15	0.3	9.5	4.2	0.63	3.60	1.90
7	Devipattinum	5	3.1	7.5	5.2	0.11	0.16	0.13	0.7	12.7	6.7	0.34	2.52	1.35
8	Valanthantharai	8	1.5	7.8	4.0	0.11	0.19	0.15	2.7	14.7	9.1	0.34	1.53	1.00
9	Valathoor	2	2.0	3.2	2.6	0.15	0.19	0.17	0.7	4.5	2.6	0.23	1.11	0.67
10	Pullankudi	6	2.6	14.4	7.8	0.12	0.19	0.16	1.5	12.3	6.5	0.22	1.90	1.08
11	Ramanathapuram	24	1.5	15.2	7.3	0.11	0.19	0.15	0.3	12.5	5.8	0.36	3.82	1.30
12	Chidharkottai	7	2.6	14.8	7.4	0.11	0.19	0.15	1.5	12.9	6.0	0.38	3.01	1.45
13	Therpooki	5	2.4	18.8	7.1	0.11	0.17	0.15	0.4	11.5	3.6	0.55	1.19	0.93
14	Thoruvalur	3	3.8	19.8	9.5	0.10	0.19	0.14	0.5	7.0	3.6	1.15	1.82	1.47
15	Peravoor	2	2.8	3.4	3.1	0.13	0.19	0.16	5.1	10.4	7.7	0.66	1.03	0.85
16	Kavanoor	8	4.7	19.5	11.0	0.12	0.23	0.18	0.5	14.2	7.3	0.59	3.87	1.58
Minimum			1.5	3.2	2.6	0.10	0.16	0.13	0.3	4.5	2.6	0.22	1.03	0.67

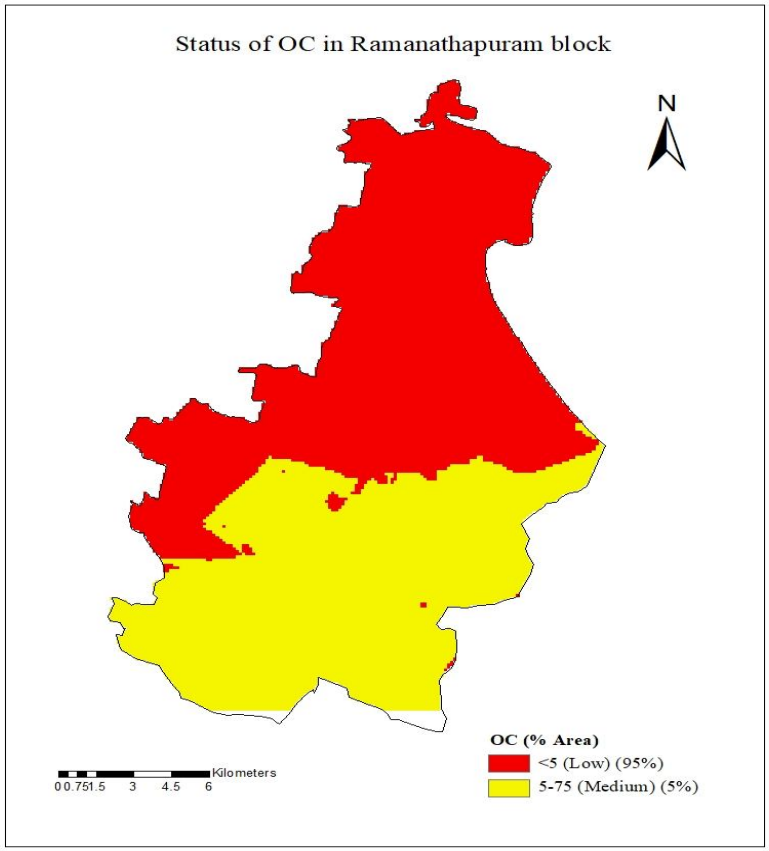
Maximum	7.5	19.8	12.2	0.20	0.23	0.21	5.1	16.4	10.2	1.23	3.89	2.06
Mean	3.2	13.2	7.2	0.12	0.19	0.16	2.0	11.6	6.5	0.59	2.42	1.36
SD	1.7	5.3	2.9	0.02	0.02	0.02	1.7	3.1	2.3	0.33	1.09	0.43
Std. Err	0.2	0.5	0.3	0.002	0.002	0.002	0.2	0.3	0.2	0.03	0.11	0.04

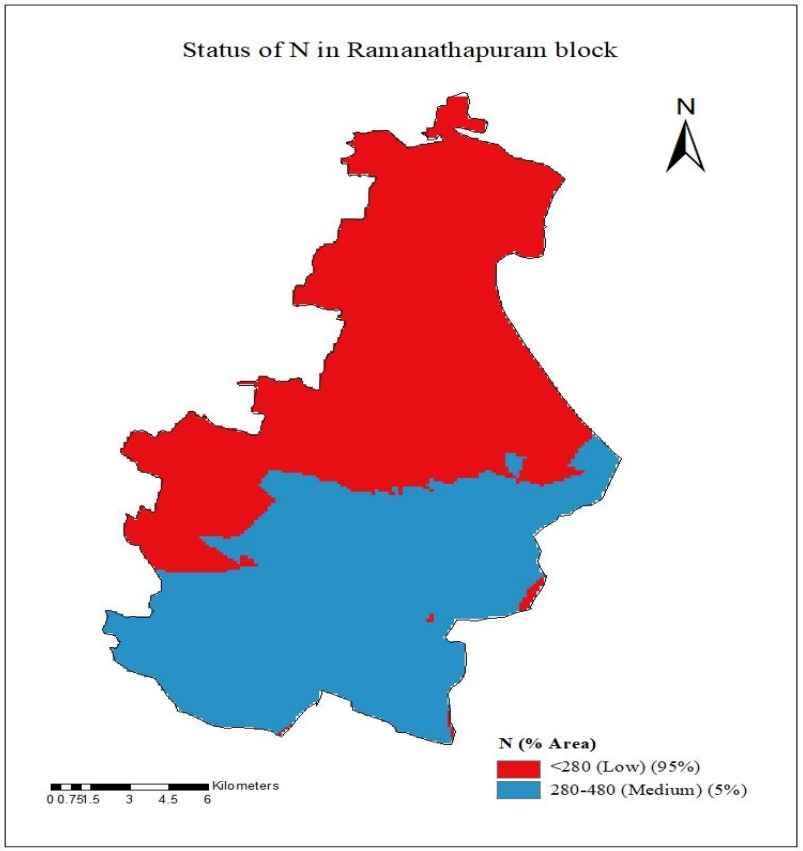
[Tables 1-4 can be presented as appendices and the summary statistics (min, max, mean, SD and Std error) tabulated in text. How about that?]

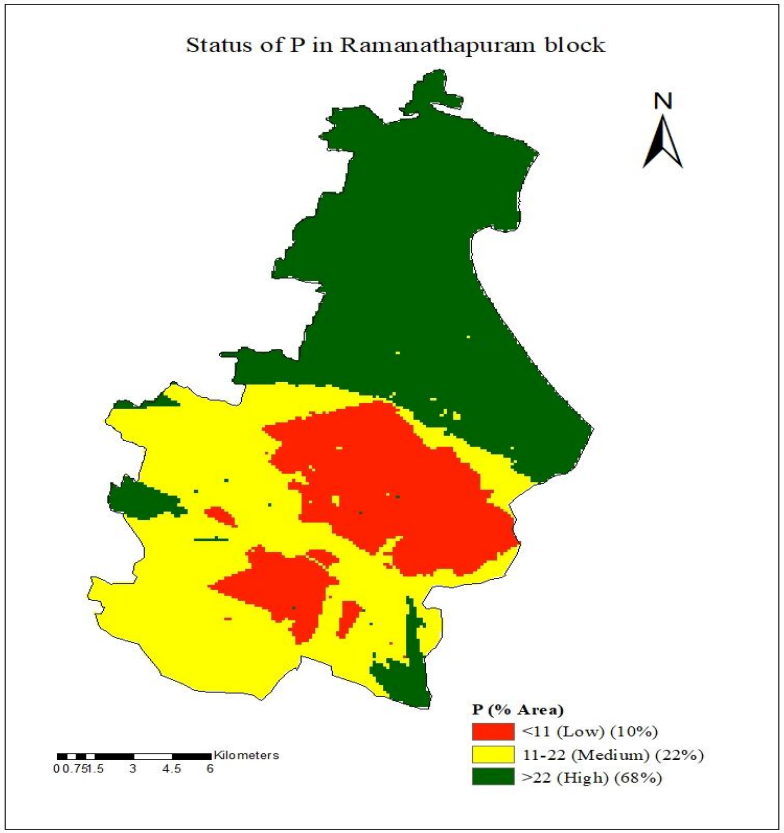
Spatial distribution of different quality parameters of soil fertility in Ramanathapuram block of Ramanathapuram district[Arrange at least 4 maps per page to save space.]

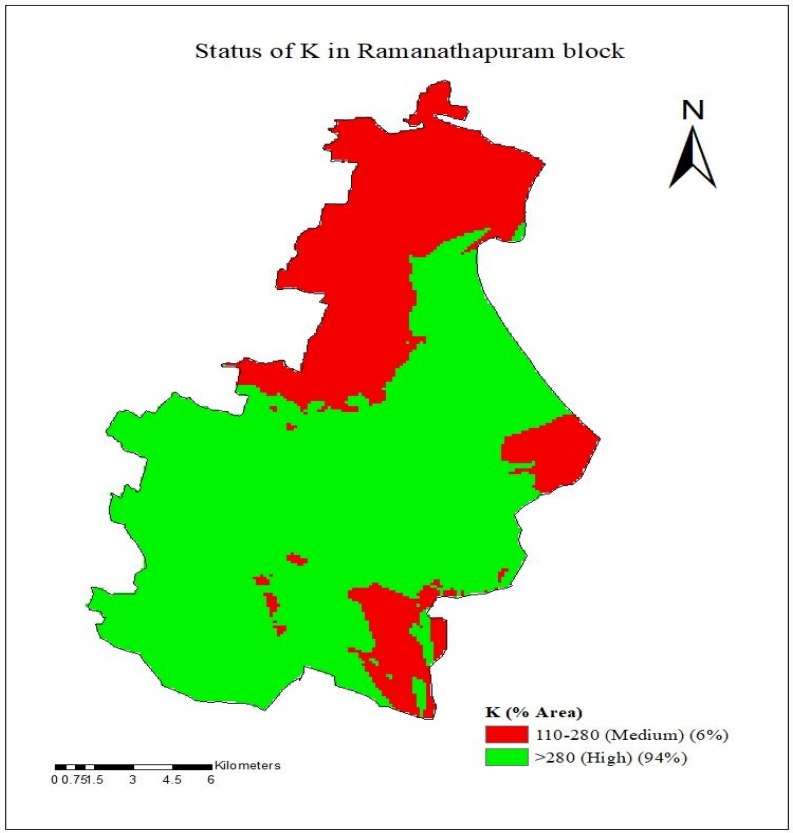

Status of pH in Ramanathapuram block
N
PH (% Area)
6.0- 8.5 (Neutral) (73%)
> 8.5 (Alkaline) (27)
Kilometers
0 0.751.5 3 4.5 6

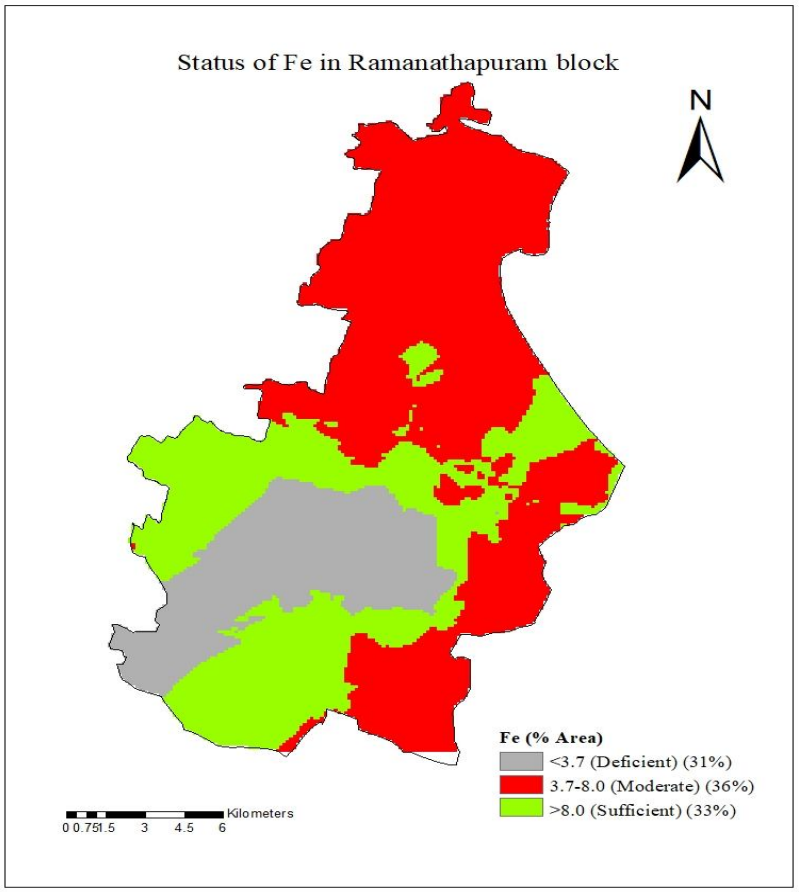

Status of EC in Ramanathapuram block
N
EC (% Area)
< 1.0 (Non - saline) (80%)
1.0 - 2.0 (Slightly saline) (13%)
2.0-4.0 (Moderatelt saline) (2%)
> 4.0 (Saline) (5%)
Kilometers
0 0.751.5 3 4.5 6

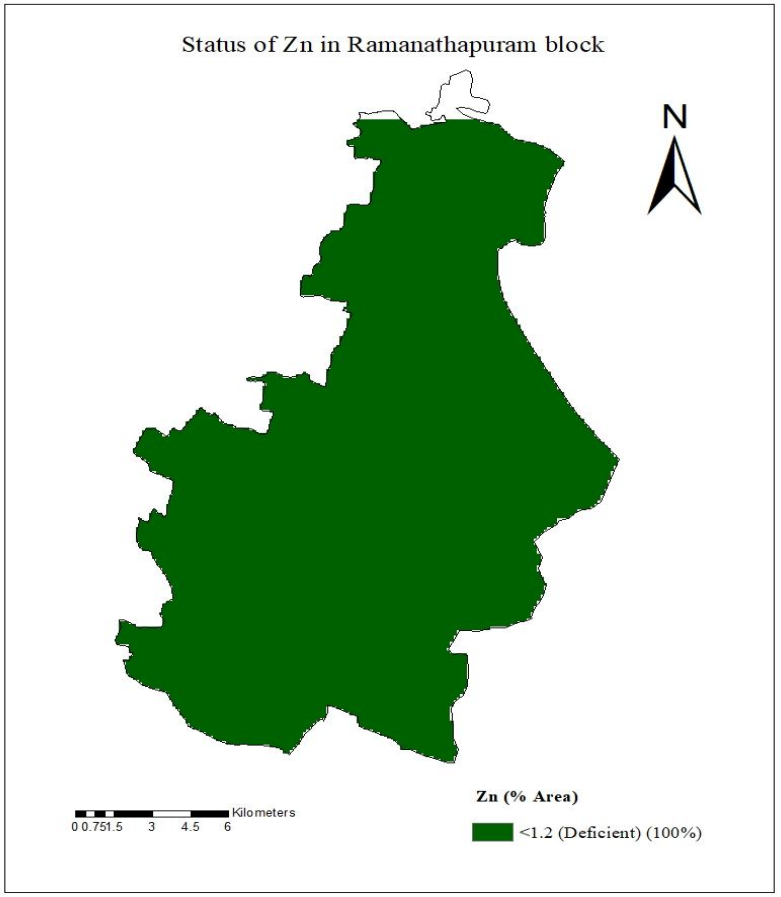

Status of OC in Ramanathapuram block
N
OC (% Area)
<5 (Low) (95%)
5-75 (Medium) (5%)
Kilometers
0 0.751.5 3 4.5 6

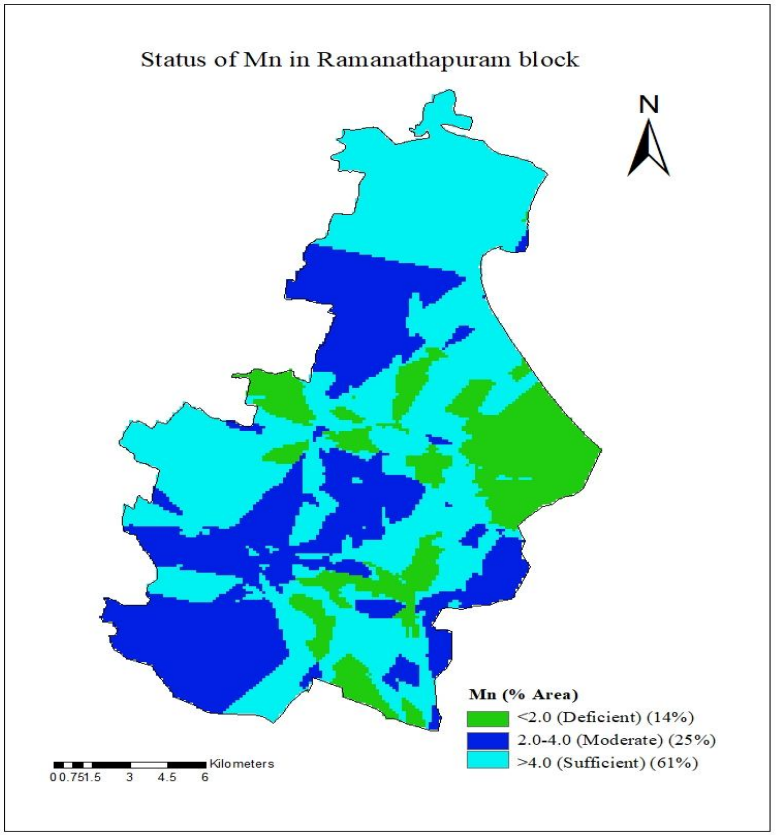

Status of N in Ramanathapuram block
N
N (% Area)
<280 (Low) (95%)
280-480 (Medium) (5%)
Kilometers
0 0.751.5 3 4.5 6

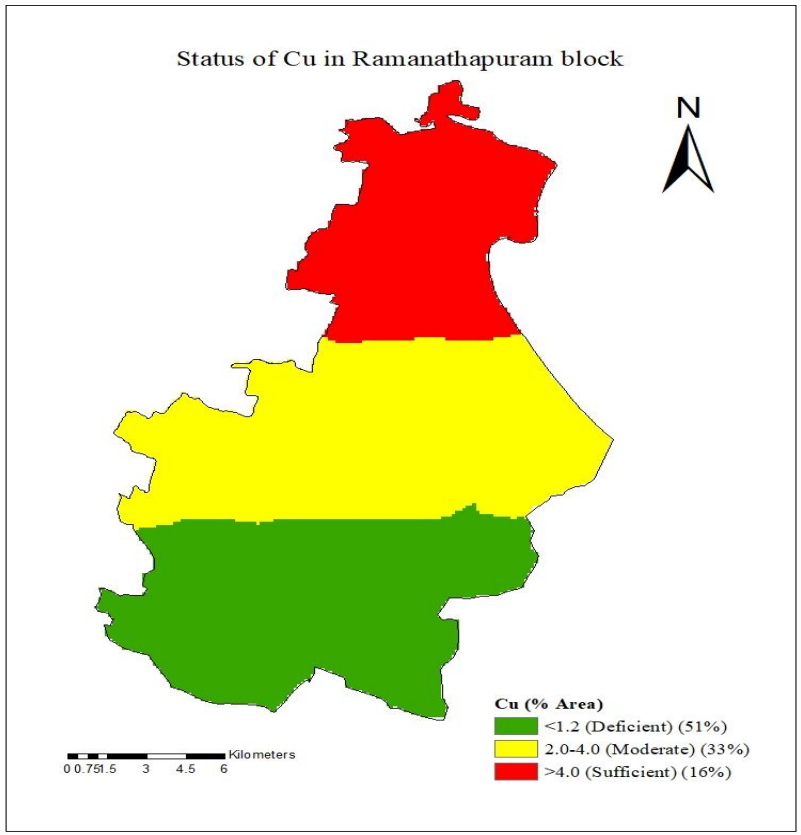

Status of P in Ramanathapuram block
N
P (% Area)
<11 (Low) (10%)
11-22 (Medium) (22%)
>22 (High) (68%)
Kilometers
0 0.75 1.5 3 4.5 6


Status of K in Ramanathapuram block
N
K (% Area)
110-280 (Medium) (6%)
>280 (High) (94%)
Kilometers
0 0.75 1.5 3 4.5 6


Status of Fe in Ramanathapuram block
N
Fe (% Area)
<3.7 (Deficient) (31%)
3.7-8.0 (Moderate) (36%)
>8.0 (Sufficient) (33%)
Kilometers
0 0.751.5 3 4.5 6


Status of Zn in Ramanathapuram block
N
Zn (% Area)
<1.2 (Deficient) (100%)
Kilometers
0 0.751.5 3 4.5 6





[Check if you can improve the colour ramps – they don't appear very eye-friendly. Personal opinion.]

Conclusion

It can be concluded that based on thematic maps, a major area of Ramanathapuram block, Ramanathapuram district was alkaline, nonsaline, low in OC, low, high and medium in available N, P and K, respectively; with regard to available DTPA micronutrients, Zn was predominantly deficient and Cu was moderate while, Fe and Mn were in sufficient status. The georeferenced sampling sites can be revisited with the help of GPS, for monitoring the soil fertility changes over long run. Further, it will be useful to the researchers, planners, policy makers, extension workers of the State Department of Agriculture, fertilizer industries and farmers.The present study reveals that the soils are highly deficient in nutrients and suffers from poor soil fertility status. One of the main reasons for declining productivity is the lack of knowledge, awareness among the farmers and also non adoption of sustainable crop management strategies including comprehensive soil health management. Nowadays there is growing need for balanced fertilization and site specific fertilizer recommendations according to the crop type, yield level and soil conditions. With the obligatory need for intensification of crop production, the demand of crops for readily available soil nutrient increases. Strengthening and finding out right sources of amendments for improving fertility of problem soils, which will also supply more than one nutrient to economize the crop production, may be adopted as a means to improve problem soil and making wealth out of poor fertile lands.[This can either be summarized or removed.]Thus, higher crop productivity through maintaining the soil health and fertility conditions can be achieved through sustainable crop management, Ramanathapuram block, Ramanathapuram district, Tamil Nadu.[You could have discussed your results with reference to the common crops in the area – paddy, cumbu, ragi, blackgram and cotton – or at least some of them.]

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