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Soil Fertility Mapping in Kaleshwaram Project Command Area of *Erstwhile* Karimanagr District, Telangana using GIS

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ABSTRACT: The Present Investigation was directed to study the soil fertility status of command area under Kaleshwaram project in erst while Karimnagar district during post rainy season during 2019-2020, mainly concentrated in soil nutrient status and fertility mapping of study area by using QGIS to support future land use planning, it is necessary to investigate the fertility state of the kaleshwaram project command area of the erstwhile Karimnagar soil. Soil samples collected at 51 GCP locations after harvest of crops and were analyzed in the laboratory for soil quality parameters and the results were interpreted that soils are slightly alkaline pH (7.86), low level of salinity (EC 0.35 dS m^{-1}), an average soil available nitrogen is low (221 kg ha^{-1}), available phosphorus (123 kg ha^{-1}) and available potassium (304 kg ha^{-1}) are high. The DTPA extractable micronutrients- Zn (0.86 mg Kg^{-1}) is marginal in availability, Cu (1.20 mg Kg^{-1}), Fe (12.60 mg Kg^{-1}) and Mn (15.03 mg Kg^{-1}) are adequate in availability. From the results obtained in laboratory analysis, the soil fertility maps were generated by using QGIS software employing IDW interpolation technique wherein each parameter has been classified in to several classes.

Keywords: Kaleshwaram Project, Erstwhile Karimnagar district, soil fertility map, RS&GIS.

INTRODUCTION

At present, the greatest challenge before Indian agriculture is to boost food production and productivity as well as sustainability of agriculture as a whole (FAO 2017). There are some problems that inflict limits on these goals which raise serious concerns on national food security. These include deterioration of soil fertility, increase in cost of production, and low diversity of production systems (Gomiero, 2016). However, the need for improved crop productivity is more now than ever because of the increasing population and the consequent pressures from competing demands for land over time. Management of the fertility of Indian soils demands its build up of Soil fertility to enhance the capacity of a soil to supply essential nutrients to produce adequate food to feed the rapidly increasing population. Proper management of soil fertility mainly stress on careful identification of constraints of current deficiency status of nutrients and monitoring of changes in soil fertility to predict its deficiency. These deficiencies need to be alleviated through sound and proven practices of nutrients, water, crops and energy to soil management, so as to sustain food production at a reasonable level to ensure continual enhanced productivity in the future. Thus management of soil fertility vis-à-vis nutrient management at optimum level is one of the key factors in achieving high and sustainable productivity.

Soil quality can be assessed by using remote sensing and GIS to generating maps of large areas helps in soil resources management and preventing soil degradation by using them optimally (Abdel Rahman *et al.,* 2017).

MATERIAL AND METHODS

Study area. The *erstwhile* Karimnagar district is located under Northern Telangana zone lies approximately between the latitudes 17° 50' and 19° 05' N and longitudes 78° 29' and 80° 22' E. Karimnagar district is bordered by Nizamabad district in the West, Madhya Pradesh State in the east, Adilabad district in the North,Warangal and Medak districts in the South. The general elevation is 280 m MSL. This district is forms a part of the Godavari river basin. The area under forest cover constitutes 21.50 % of total geographical area of the district (Ground water Annual report 2016). The average normal rainfall in the district is 991.8 mm and actual rainfall is 916.3, most (83%) of it is received during the south-west monsoon. Out of 5.31 lakh ha of net area sown in the year 2012, only 45 % is under irrigation by different sources.

The soils of *erstwhile* Karimnagar district are highly heterogeneous in nature. The major rock types occurring in the district are granites, gneisses, sandstone, limestone, shale, quartzite *etc*. The major soil types in this district are black soils (55%) and red sandy loam soils (45%).

Methodology. For collection of soil samples 53 GCP location were pinned in respective study area by using GNSS viewer mobile application. Composite surface soil samples (0-15cm) were collected from fields of study area. The samples are air dried in shade and crushed with a wooden pestle and mortar, sieved through sieve (2 mm) and stored in properly labelled polythene bags for further analysis. The soil samples were analyzed in the laboratory for soil fertility parameters viz., soil texture, pH, EC (Jackson, 1973), available nitrogen (Subbiah and Asija 1956), phosphorus (Olsen *et al*., 1954), potassium, and DTPA extractable micronutrients (iron, manganese, copper and zinc) (Lindsay and Norvell 1978) by following the standard procedures. The results from laboratory analysis and location point files of Excel file are generated in ESRI shape file and imported in to QGIS software. Soil maps were generated using Inverse Distance Weighing (IDW) interpolation and employing kriging (Ravi *et al*., 2017) function for each soil quality parameter and the classes were assigned for the parameters based on standard USDA soil classification. Similar procedure was followed for the generation of all soil maps.

RESULTS AND DISCUSSION

The soil data analyzed for pH, EC, soil available N, P_2O_5, K_2O, Fe, Mn, Cu and Zn were presented in detail in the below sections. Based on the results of the laboratory analysis, a total of 8 soil quality maps were generated using the QGIS software.

Physico-Chemical Properties. Soil pH. The pH data of 53 sample locations are interpolated to generate maps are indicated that soils are slightly alkaline reaction (Fig. 2).The pH of the surface soils of different mandals of *erstwhile* Karimnagar district varied from 6.67 to 8.73 with overall mean value of 7.86 (Ravi *et al*, 2014). Low pH was noted in Korutla mandal (7.44) and high pH was recorded in Chandurthi mandal (8.24) soils (Table 2). The majority of soils in *erstwhile* Karimnagar district are neutral to strongly alkaline pH. Some soils in Mallapur, Raikal, Koratla and Konaraopeta mandals are neutral in reaction as depicted in Fig. 2. The observations on soil reaction of surface soils shown that 1.88% samples are acidic, 15.09% samples are neutral and 83.01% samples are alkaline in reaction (Table 1).

Soil EC (1:2.5). The electrical conductivity of soils from study area of *erstwhile* Karimnagar district ranged from 0.11 to 1.05 dS m^{-1} (Table 2) with an overall mean value of 0.35 dS m^{-1}. In general almost all soils of had low level of salinity and suitable for growing all crops. The observations on soil reaction of surface soils shown that 1.88% samples are acidic, 15.09% samples are neutral and 83.01% samples are alkaline in reaction (Table 1). Highest EC was recorded in Metpalli mandal (0.69) and least was in Konaraopet mandal (0.19) (Table 2).

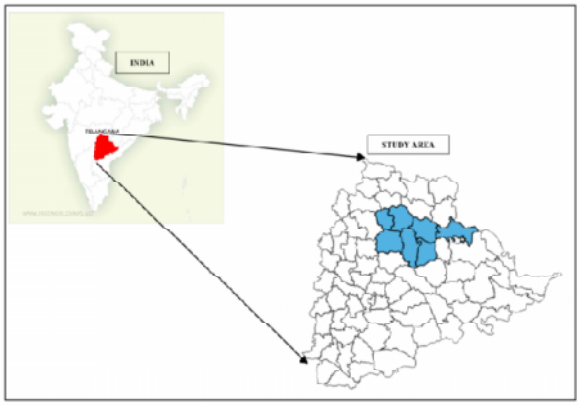

Fig. 1. Study area.

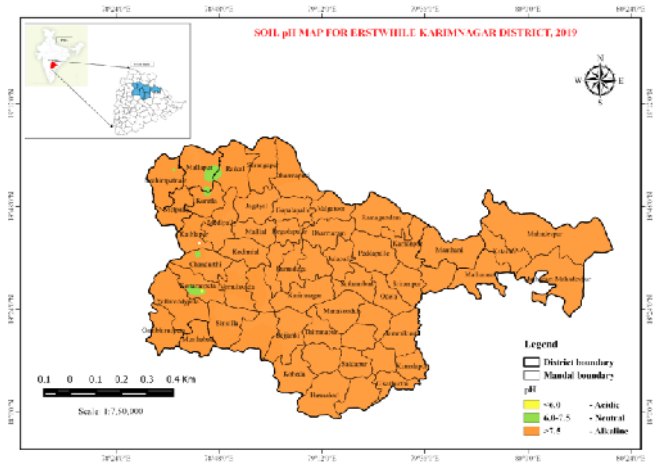

Fig. 2. Soil pH map for *Erstwhile* Karimnagar district.

Soil available Macronutrients

Soil Available Nitrogen. The available N in soils under study area of *erstwhile* Karimnagar district varies from 63 to 550 kg ha^{-1} with an overall mean value of 221 kg ha^{-1} (Table 2) which is lower than the critical limit suggested by USDA. The entire study area of *erstwhile* Karimnagar is low to medium in available nitrogen. Lowest nitrogen content recorded at Rudrangi mandal (119.70 kg ha^{-1}) and highest was recorded at Korutla mandal (425.07 kg ha^{-1}). Some soils from the Mallapur, Ibrahimpatnam, Koratla and Konaraopeta mandals are medium in available Nitrogen (Fig. 3). About 75.47% of samples out of 53 samples are fall under low available nitrogen (<280 kg ha^{-1}) and 24.52% of samples are medium availability (280-560 kg ha^{-1}) (Table 1). Similarly Ravi *et al.* (2017) reported 61.7% of 154 samples from rice growing area where under low N content. Madhavi *et al*. (2013) also reported that all mandals had low to medium nitrogen content in Nizamabad district.

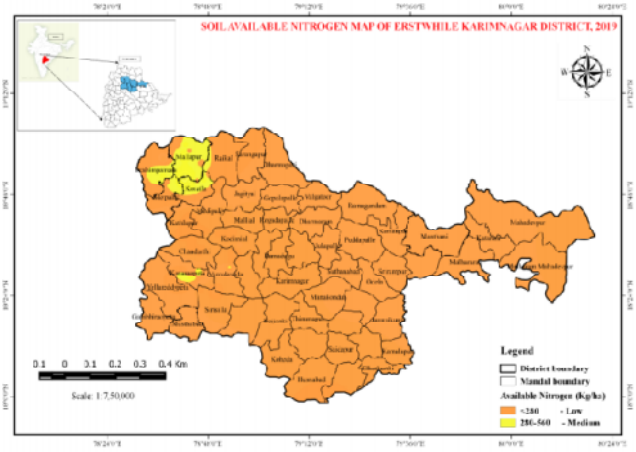

Fig. 3. Soil available nitrogen map for *Erstwhile* Karimnagar district.

Soil Available Phosphorus. The available Phosphorus content of the soils from study area range varied from 5 to 322 kg ha^{-1} with an overall mean value of 123 kg ha^{-1}. It depicted in Fig. 4 indicated that entire soils from study area are high in available phosphorus content except few soils from *erstwhile* Karimnagar (Fig. 4). The available P_2O_5 recorded least (43.63 kg ha^{-1}) at Raikal mandal and was highest (205.85 kg ha^{-1}) at Vemulawada mandal (Table 2). Similar results were reported by Ravi *et al*., 2017 in rice growing soils from *erstwhile* Karimnagar district. About 96.22 percent of *erstwhile* Karimnagar was delineated to have high available phosphorus and 3.7 percent of samples with low available phosphorus contents, respectively (Table 1).

Table 1: Soil classification under different parameters as per the classes assigned for soil quality mapping of the study area.

Parameter	Class	No of Samples	Percentage of Samples
pH	Acidic (<6.5)	1	1.88
	Neutral (6.5-7.5)	8	15.09
	Alkaline (>7.5)	44	83.01
N	Low (<280 kg ha^{-1})	40	75.47
	Medium (280-560 kg ha^{-1})	13	24.52
	High (>560 kg ha^{-1})	0	0
P_2O_5	Low (<11 kg ha^{-1})	2	3.77
	Medium (11-25.6 kg ha^{-1})	0	0
	High (>25.6 kg ha^{-1})	51	96.22
K	Low (<120 kg ha^{-1})	0	0
	Medium (120-280 kg ha^{-1})	31	58.49
	High (>280 kg ha^{-1})	22	41.5
Zn	Very Low (<0.3 ppm)	2	3.77
	Low (0.3-0.6ppm)	19	35.84
	Marginal (0.6-1.5ppm)	26	49.05
	Adequate (>1.5ppm)	6	11.32
Cu	Very Low (<0.1ppm)	0	0
	Low(0.1-0.2ppm)	0	0
	Marginal (0.2-0.4ppm)	10	18.86
	Adequate (>0.4ppm)	43	81.13
Mn	Very Low (<1ppm)	3	5.66
	Low (1-2ppm)	11	20.75
	Marginal (2-4ppm)	17	32.07
	Adequate (>4ppm)	22	41.5
Fe	Very Low (<2.5ppm)	1	1.88
	Low (2.5-4.5ppm)	8	15.09
	Marginal (4.5-7.5ppm)	8	15.09
	Adequate (>7.5ppm)	36	67.92

Soil Available Potassium. The available potassium content ranged between 135 to 630 kg ha^{-1} with an overall mean value of 304 kg ha^{-1} in soils collected from the study area of *erstwhile* Karimnagar district (Table 2.). The soils in this district are medium to high available K_2O (Fig. 5). The results represented that 58.49 percent samples were contended with medium available soil potassium, while 41.50 percent of the regions were categorized as high available soil potassium, respectively. The highest available potassium was recorded at Ibrahimpatnam mandal (505.34 kg ha^{-1}) and lowest was recorded at Metpalli mandal (155.52 kg ha^{-1}) (Table 1). The similar results reported by Kamalakar *et al*. (2020) in sugarcane growing soils of Nizamabad district.

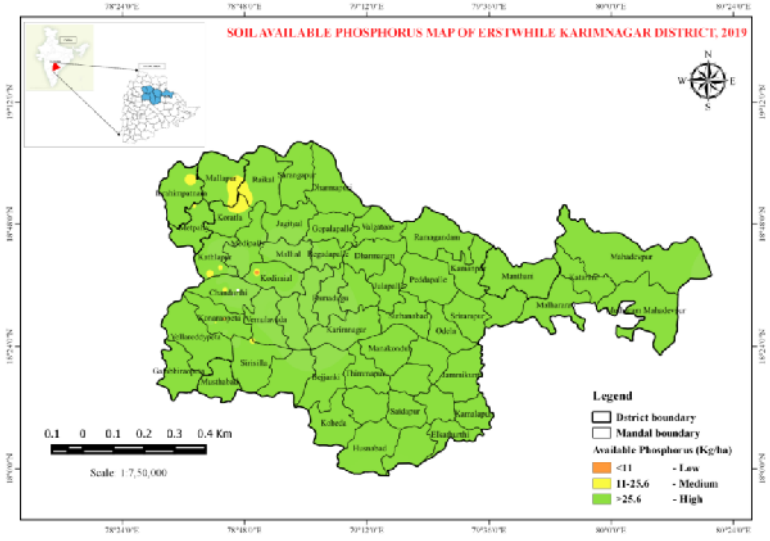

Fig. 4. Soil available Phosphorus map for *Erstwhile* Karimnagar district.

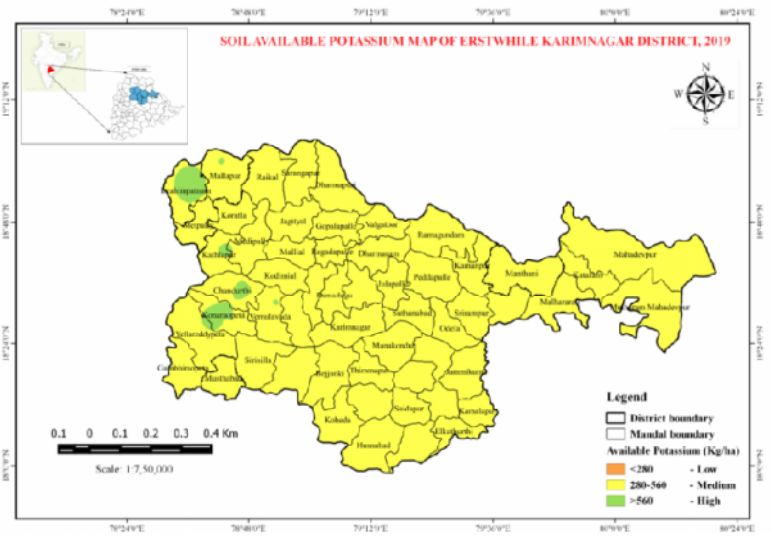

Fig. 5. Soil available Potassium map for *Erstwhile* Karimnagar district.

Soil available micronutrients (Fe, Mn, Cu and Zn)

Zinc. The data presented in Table 2 revealed that available Zn content in soils from study area of *erstwhile* Karimnagar district varied from 0.23 to 2.01 mg Kg^{-1} with overall mean value of 0.86 mg Kg^{-1} (Ravi *et al*, 2014). The availability of Zn in study area of this district was very low to adequate. The lowest value of available Zn recorded at Metpalli mandal (0.36 mg Kg^{-1}) and highest was recorded in Chandurthi mandal (1.28 mg Kg^{-1}). About 3.77%, 35.84% 49.05% and 11.32% of samples are found to be very low, low, marginal and adequate in available Zn content respectively (Table 1).

Copper. The amount of copper ranged from 0.24 to 6.72 mg Kg^{-1} in the soil of study area of *erstwhile* Karimnagar district with an overall mean value of 1.20 mg Kg^{-1} (Reddy *et al*., 2014). The lowest value of available copper recorded at Chandurthi mandal (0.39 mg Kg^{-1}) and highest recorded at Raikal mandal (3.53 mg Kg^{-1}) (Table 2). An average 18.86% and 81.13% samples are marginal and adequate in available Cu content (Table 1). Fig. 7 depicts that most of study area is adequate in available copper.

Iron. The DTPA extractable iron content in soil from the study area of *erstwhile* Karimnagar district are

ranged from 2.03 to 43.23 mg Kg^{-1} with an overall mean value of 12.60 mg Kg^{-1} (Narsaiah *et al*., 2018). Lowest value of available iron recorded at Metpalli mandal (2.59 mg Kg^{-1}) and highest was recorded at Konaraopet mandal (24.33 mg Kg^{-1}) (Table 2). About 1.88%, 15.09%, 15.09% and 67.92% samples are fall under very low, low, marginal and adequate (Fig. 8) in available Fe content (Table 1).

Manganese. The available Mn content in soils from study area of *erstwhile* Karimnagar district varied from 0.87 to 40.71 mg Kg^{-1} with overall mean value of 15.03 mg Kg^{-1} (Kamalakar *et al.*, 2020). The availability of Mn in study area of this district was very low to adequate. The lowest value of available Mn recorded at Kodimial mandal (1.80 mg Kg^{-1}) and highest was recorded in Mallapur (22.67 mg Kg^{-1}) (Table 1). The 5.66% samples are very low, 20.75% samples are low, 32.07% samples are marginal (Fig. 9) and 41.50% samples are adequate in available Mn content in soils (Table 1).

Correlation study from Table 3 reported that all the nutrients are positively correlated with soil reaction except Nitrogen , copper and Iron which are negatively correlated with soil reaction (r = -0.45, -0.03, -0.08) respectively (Table 3). Whereas Phosphorus, Potassium and Iron are negatively correlated with salinity (r = -0.31, -0.11, -0.24) respectively.

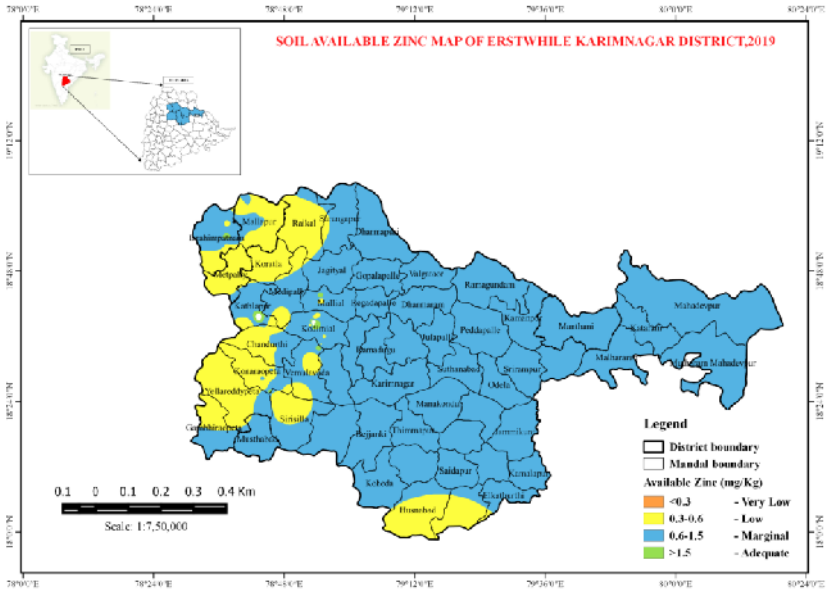

Fig. 6. Soil available Zinc map for *Erstwhile* Karimnagar district.

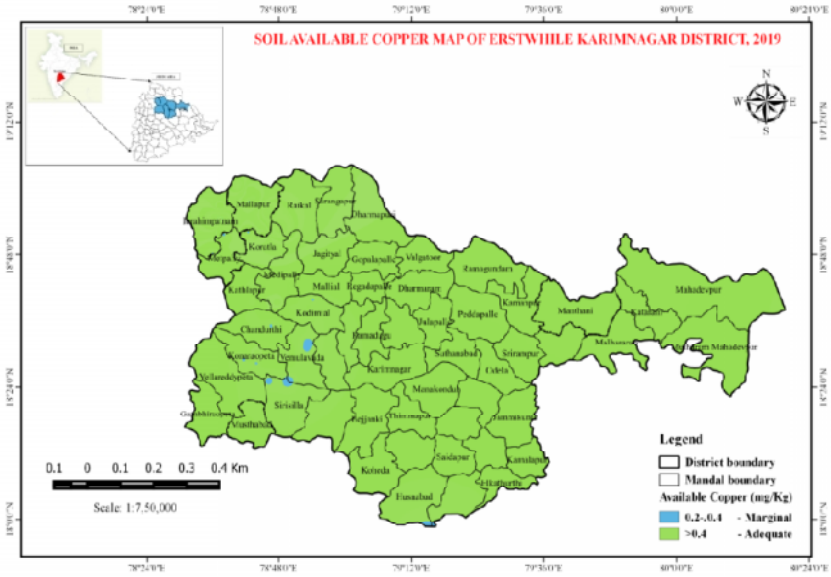

Fig. 7. Soil available Copper map for *Erstwhile* Karimnagar district.

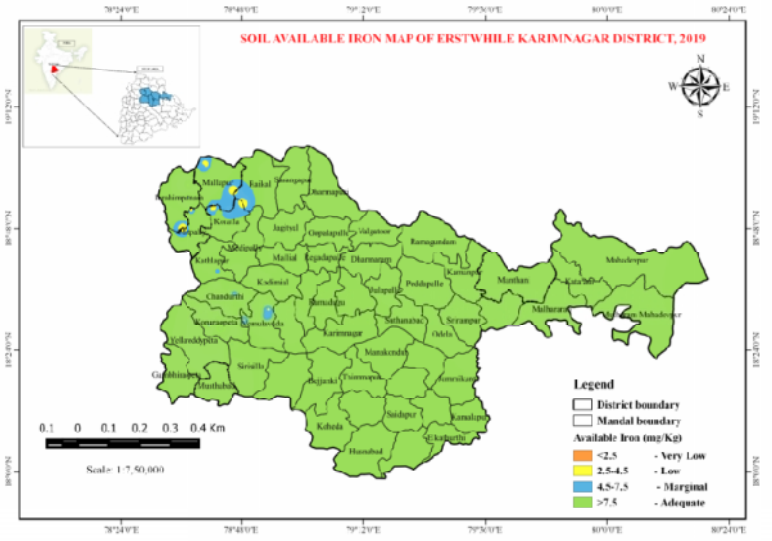

Fig. 8. Soil available Iron map for *Erstwhile* Karimnagar district.

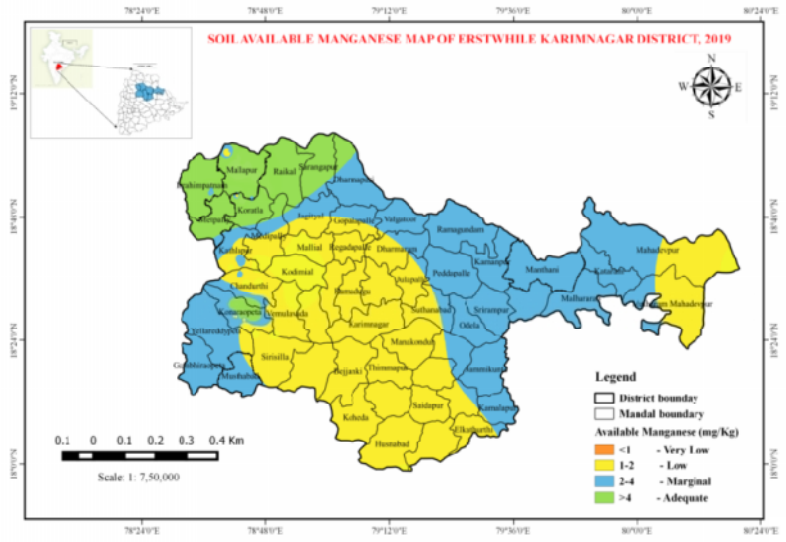

Fig. 9. Soil available Manganese map for *Erstwhile* Karimnagar district.

Table 2: Soil physico-chemical properties and nutrients status in Kaleshwaram project area of *Erstwhile* Karimnagar district of Telangana state.

S. No	Mandal	No. of Samples		Physico-chemical properties		Available macronutrients(Kg ha-1)			DTPA-micronutrients(ppm)			
				pH	EC(dS m^{-1})	N	P_2O_5	K_2O	Zn	Cu	Fe	Mn
1	Ibrahimpatnam	4	Range	7.46 - 8.01	0.23 - 1.05	176.58 - 375.91	53.48 - 111.57	487.96 - 521.81	0.76 - 2.01	0.43 - 6.72	5.68 - 27.65	4.53- 20.57
			Mean	7.72	0.54	293.18	84.50	505.34	1.11	2.81	19.96	9.49
2	Metpalli	2	Range	7.51- 7.82	0.59-0.80	243.06- 253.02	62.33- 73.50	137.15- 173.89	0.35- 0.37	0.35- 0.43	2.52- 2.65	10.84- 11.02
			Mean	7.66	0.69	248.04	67.92	155.52	0.36	0.39	2.59	10.93
3	Mallapur	5	Range	7.56 - 8.24	0.22 - 0.35	201.32 - 415.67	70.35 - 88.21	239.47 - 415.78	0.23 - 1.32	0.43 - 2.68	2.03 - 11.62	0.87 - 45.75
			Mean	7.94	0.29	301.79	79.66	330.46	0.80	1.49	8.02	22.67
4	Raikal	3	Range	6.67 - 8.14	0.14 - 0.34	259.73 - 368. 97	34.10 - 56.59	247.29 - 253.45	0.35 - 0.64	2.56 - 4.02	2.54 - 6.24	10.05 - 17.06
			Mean	7.47	0.24	301.38	43.63	259.21	0.45	3.53	3.79	14.67
5	Korutla	3	Range	7.13 - 7.62	0.67 - 0.94	258.60 - 550.63	57.20 - 86.86	145.35 - 278.46	0.34 - 0.72	0.38 - 1.67	2.64 - 8.59	3.58 - 20.89
			Mean	7.44	0.82	425.07	75.02	220.60	0.51	0.97	5.32	10.03
6	Mallial	2	Range	8.15 - 8.29	0.32 - 0.37	170.10 - 220.50	210.00 - 219.29	326.25 - 360.00	0.49 - 1.69	1.01 - 1.12	14.20 - 15.40	2.14 - 2.15
			Mean	8.22	0.35	195.30	214.64	343.13	1.09	1.06	14.80	2.15
7	Kodimial	9	Range	7.45 -	0.17 -	138.60 -	5.00 -	135.00 -	0.48 -	0.39 -	10.64 -	0.92 -

				8.27	0.50	242.19	163.57	348.75	1.39	1.11	15.59	2.73
			Mean	8.05	0.33	154.51	111.79	207.00	1.16	0.73	14.01	1.80
8	Medipalle	3	Range	8.15 - 8.20	0.22 - 0.37	138.60 - 144.90	165.00 - 204.29	213.75 - 247.50	0.26 - 0.78	1.32 - 1.71	14.27 - 15.23	1.92 - 2.38
			Mean	8.18	0.30	142.80	183.81	228.75	0.50	1.48	14.90	2.11
9	Chandurthi	4	Range	8.00 - 8.82	0.21 - 0.27	100.80 - 144.90	38.57 - 335.71	146.25 - 630.00	0.69 - 2.54	0.36 - 1.25	4.58 - 15.03	1.72 - 6.66
			Mean	8.24	0.25	124.43	187.86	360.00	1.28	0.77	10.06	3.34
10	Rudrangi	3	Range	7.10 - 8.01	0.17 - 0.49	81.90 - 151.20	37.86 - 275.00	281.25 - 528.75	0.45 - 0.86	0.56 - 1.06	13.58 - 16.18	2.19 - 5.64
			Mean	7.54	0.32	119.70	158.81	386.25	0.59	0.77	14.49	3.77
11	vemulawada	5	Range	7.46 - 8.09	0.14 - 0.57	81.90 - 387. 49	84.23 - 322.14	135.00 - 438. 75	0.33 - 1.75	0.24 - 1.86	4.24 - 13.64	1.03 - 11.60
			Mean	7.83	0.29	222.12	205.85	264.85	0.95	0.79	7.20	4.18
12	dharmaram	4	Range	7.80 - 8.28	0.13 - 0.55	63.00 - 276.34	59.29 - 196.43	191.25 - 315.00	0.44 - 1.70	0.22 - 0.79	7.20 - 24.32	1.22 - 2.75
			Mean	8.08	0.31	165.41	120.71	244.69	0.82	0.49	14.85	1.96
13	konaraopeta	5	Range	6.20 - 8.73	0.11 - 0.09	94.50 - 435.89	10.71 - 193.57	180.00 - 765.00	0.38 - 0.89	0.26 - 2.58	2.92 - 43.23	2.08 - 40.71
			Mean	7.53	0.19	278.72	100.43	471.95	0.65	1.12	24.33	11.23
	Overall Range			6.67-8.73	0.11-1.05	63.00-550.63	5.00-322.14	135.00-630.00	0.23-2.01	0.24-6.72	2.03-43.23	0.87-40.71
	Overal Mean			7.86	0.35	221.58	123.94	304.30	0.86	1.20	12.60	15.03
	S.D			0.46	0.21	110.02	83.19	143.35	0.64	1.19	8.26	62.41

Table 3: Correlation study between soil parameters.

	pH	EC	N	P_2O_5	K_2O	Zn	Cu	Fe	Mn
pH	1								
EC	0.03	1							
N	-0.45	0.37	1						
P_2O_5	0.03	-0.31	-0.25	1					
K_2O	0.07	-0.11	-0.01	0.24	1				
Zn	0.32	0.01	-0.13	0.08	-0.07	1			
Cu	-0.03	0.28	0.15	-0.29	0.25	0.08	1		
Fe	-0.08	-0.24	-0.07	-0.07	0.22	0.00	-0.11	1	
Mn	0.12	0.03	0.11	-0.14	0.12	0.09	0.21	-0.18	1

CONCLUSION

According to a study on the state of soil fertility in the former Karimnagar area, these soils are slightly alkaline pH, low level of salinity, have low to medium levels of accessible nitrogen, high levels of available phosphorus and low levels of available potassium. Zn, Fe, and Mn availability in these soils range from extremely low to good, whereas Cu availability is marginal to adequate. The soils in this study area have low levels of N, Zn, Fe, Mn, and Cu, which are the principal fertility constraints. These soils should be adequately managed and supplemented with the appropriate amount of organic and inorganic fertilizers.

FUTURE SCOPE

Based on the fertility level of the soils in the research area, this study provides support for future land use planning and nutrition management techniques.

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Conflict of Interest. None.

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