



Digital Soil Nutrient Mapping using Geo-spatial Technology- A Case Study in Khordha District of Odisha

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ABSTRACT

Background: Soil, valuable non-renewable resource provides essential support to ecosystems. Since it is the basic substrate for any production system, understanding its characteristics, extent and spatial distribution is crucial. Integration of geospatial technologies like GPS, GIS and soil survey data base have augmented the efficiency of soil fertility analysis.

Methods: In this research, digital soil fertility maps of Khordha district of Odisha were prepared by using geospatial technology which can assist the decision making process regarding site specific nutrient management for sustainable crop production. 300 soil samples were collected from three types of land categories such as high land, medium land and low land @10 samples/land type/block and characterized for pH, electrical conductivity (EC), organic carbon (OC), nitrogen (N), phosphorous (P), potassium (K). Nutrient indices of N, P and K were calculated basing on their low, medium and high availability status.

Result: Block wise digital soil nutrient fertility status maps were prepared by the help of ArcGIS software which can be used as one of the decision making tool for crop selection and also helps in management of soil fertility on local and regional basis.

Key words: ArcGIS, Digital soil resource map, Geo spatial technology, Remote sensing.

INTRODUCTION

Among the various vital natural resources, soil is essential to many ecosystem functions and it promotes agricultural expansion and upholds the quality of human life (Gachene *et al.*, 2019). Inherent capacity of soil to provide essential nutrients is responsible for sustenance of crop growth and production. In order to maintain crop output, it is necessary to introduce and embrace the scientific use of plant nutrients due to dwindling landholdings and rising input costs. Soil heterogeneity occurs at the regional level as well as at the farm level itself (Feng *et al.*, 2008). Substantial amount of vital soil nutrients get depleted every year due to multiple reasons. For efficient nutrient management in various crops, a full understanding of the soil fertility status is important for sustained crop production. Moreover, land use and soil management strategies have an impact on soil fertility and productivity. Fertility management based on soil tests has been shown to be a successful strategy for enhancing the productivity of agricultural soils with substantial geographical variability brought on by a combination of physical, chemical and biological processes.

Typically, farmers apply fertilizers without knowing the crop's nutrient requirements or the fertility level of the soil in their field. A nutritional gradient or imbalance becomes evident throughout the farming areas by the uneven distribution of various nutrient sources (Kavitha and Sujatha, 2015). Hence, understanding the fertility status of the soil is crucial for sparing use of fertilizers and to increase the crop yields. To address the issue of mismatch between fertilizer application rates and the actual crop nutrient demand, it is quite imperative to understand the location-specific variability in nutrient availability in order to

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administer nutrients based on soil fertility level. Soil properties vary spatially and temporally because of soil formation processes, land use pattern, fertilizations *etc.* (Gopal *et al.*, 2024). Hence, geographic information system (GIS) and global positioning system (GPS) technologies have been widely used in soil surveys to improve soil and other resource management for sustainable crop production (Palaniswami *et al.*, 2011). Besides that, GIS and GPS are also crucial instruments for measuring the geographical variability of the soil. Hence, GIS and GPS can be considered as potent package of tools that may be used to collect, conserve and consolidate spatial data (Iftikar *et al.*, 2010). Soil thematic maps made with a GPS tool assists in manifesting soil fertility, land use and cover and also aids in formulating location-specific nutrient management strategies for that area (Mishra *et al.*, 2014).

In precision agriculture, soil fertility maps for nutrient management based on Geographic Information Systems (GIS) are also helpful in devising solutions to resource management problems like land management, soil erosion and degradation, water quality and township planning and more importantly it also functions as a decision support tool for sustainable nutrient management (Tomlinson, 1987; Habibie *et al.*, 2021). The availability of spatially continuous covariates, the integration of remote sensing technologies, the advancement of better quantitative methodologies and enhanced computing power have all increased the potential for digital soil mapping, enabling the creation of high-resolution digital soil maps both nationally and globally (Rajalakshmi *et al.*, 2023) which determine the fertility state of the soils in the research area and display the plot wise status of the various nutrients that are accessible. GIS processing included vectorizing the features using Arc GIS software and georeferencing different thematic maps (Nalina *et al.*, 2016). According to McCartney *et al.* (2003) and Lagacherie *et al.* (2006), digital soil mapping (DSM) is the process of creating and populating spatial soil information through the use of field and laboratory observational methods in conjunction with both spatial and non-spatial soil inference systems. The hands-on information regarding the soil fertility status depicted through the soil fertility maps of Khordha district of Odisha has been scanty. Hence, this scientific study has been carried out in ten (10) blocks of Khordha districts which has been prepared using geospatial technology and this in turn will act as decision support tool w.r.t site specific nutrient management for sustainable crop production and will certainly ensure the soil productivity in the years to come.

Study area

The study area was chosen as Khordha District belonging to south eastern part of Odisha state with coordinates varies from 19°40' to 20°25'N latitude and 84°55' to 86°05'E longitude with an elevation of 42 m above mean sea level. Total geographical area is 2813 square kilometers. The area is divided into ten blocks for administrative purposes *i.e.* Khordha, Begunia, Bolagarh, Bhubaneswar, Jatni, Baliana, Balipatana, Tangi, Chilika and Banpur being the District Headquarters. It experiences hot and humid climate with the annual average rainfall 1436.1 mm, mostly received from July to September. The average ambient temperature remains 26.6°C, varies from 10.3°C to 37.8°C with an average relative humidity remains around 76.9% ranges from 28.2% to 98.4%.

MATERIALS AND METHODS

For soil sampling, the area was divided into random grids using point shape file and the latitude and longitude values of these grid points were noted by GPS recorder. In the year 2021, a total of 300 soil samples were collected from

10 blocks of Khordha district (30 samples from each block in three land types *i.e.* 10 each from low land, medium land and high land). After sampling, they were processed, dried under shade, crushed and the laboratory analysis were carried out in soil testing laboratory of Department of Soil Science, College of Agriculture Bhubaneswar under Odisha University of Agriculture and Technology (OUAT) as per Indian Standard (IS) procedures to determine their physico-chemical properties mostly pH, organic matter, available nitrogen, phosphorus and potassium.

Nutrient indices of nitrogen, phosphorous and potassium were calculated basing on their nutrient status level *i.e.* high, medium or low.

$$\text{Nutrient index} = \frac{(1 \times A) + (2 \times B) + (3 \times C)}{\text{TNS}}$$

Where,

A= Number of samples in low category.

B= Number of samples in medium category.

C= Number of samples in high category.

TNS= Total number of samples.

After calculating the nutrient indices for N, P and K for high, medium and low land separately, nutrient index map was prepared for different land types in ArcMap through IDW interpolation technique. Result obtained from laboratory analysis of collected soil samples, are presented in Table 1 to table 4 block wise containing the parameters like pH, organic carbon, available nitrogen, phosphorus, potassium.

RESULTS AND DISCUSSION

Soil pH (1:2.5)

Soil pH of high land soils of Khordha district varied from 3.35 to 6.65. Minimum pH obtained was 3.35 in Jatni block and maximum pH observed in Banapur block with a mean value of 4.96. Similarly, in medium land, maximum and minimum pH was obtained in Chilika block (7.20) and Jatni block (4.22), respectively with a mean value of 5.39. In low land soil category, pH varies from 4.32 (Begunia block) to 8.01 (Chilika block) with a mean value of 5.79. Distribution of area under each land category presented in Table 4 reveals that, while 74.91% of soil is categorized as acidic, 18.26% of soil is regarded as neutral. Only 6.83% of the soil in Khordha district of Odisha is classified as alkaline. Variation in soil reaction status is also observed with respect to land category, as presence of alkaline soil is only seen in low land soil, accounting 7744.75 ha of area. Area covered under acidic soil follows a decreasing pattern from high land to low land. On the contrary, area under neutral soil increases with decrease of elevation.

Soil organic carbon (OC)

In high land, soil OC varied from 0.03% (Bhubaneswar) to 1.42% (Khordha block) with a mean value of 0.48%. Medium soil observed with a range varied from 0.045%

Table 1: Abstract of soil chemical parameters of Balianata, Balipatana and Banapur blocks.

Parameters	Balianata			Balipatana			Banapur		
	High land	Medium land	Low land	High land	Medium land	Low land	High land	Medium land	Low land
pH	4.68-5.12	5.01-5.31	5-5.55	4.60-5.55	4.98-6.25	5.53-6.62	5.08-6.65	5.50-6.66	5.80-7.65
	4.85	5.14	5.21	5.03	5.57	5.92	5.66	6.03	6.82
OC (g kg ⁻¹)	2.8-10.8	3.5-11	4.6-11.5	2.5-6.1	4.1-8.5	4.7-10.6	2.1-5.5	2.9-6.2	3.9-6.5
	6.2	6.4	7.9	4.4	6.7	7.3	4.4	4.5	5.34
N (kg ha ⁻¹)	110-212	115-274	110-388	115-277	132-511	113-502	75-179	129-261	156-310
	148	171	228	221	251	300	114	186	210
P ₂ O ₅ (kg ha ⁻¹)	0.60-20.07	0.56-28.43	4.95-65.45	6.00-36.60	9.08-36	9.22-65.23	0.29-14.76	0.45-24.28	0.16-42.34
	10.73	15.73	18.77	13.88	16.95	24.71	8.14	11.13	15.30
K ₂ O (kg ha ⁻¹)	80-210	70-360	90-480	80-310	70-340	80-460	120-210	150-260	110-350
	121	141	178	139	175	211	164	183	242

Table 2: Abstract of soil chemical parameters of Begunia, Bhubaneswar, Bologarh blocks.

Parameters	Begunia			Bhubaneswar			Bologarh		
	High land	Medium land	Low land	High land	Medium land	Low land	High land	Medium land	Low land
pH	4.25-5.50	4.39-5.65	4.32-6.55	3.65-5.78	4.87-5.81	4.95-7.56	4.45-5.43	4.50-6.65	4.95-7.26
	4.79	4.98	5.40	4.84	5.21	5.74	4.95	5.39	5.6
OC (g kg ⁻¹)	1.3-5.6	2.5-8.5	2.3-9.7	0.3-7.2	0.5-9.0	2.1-8.4	1.9-7.8	2.8-4.9	4.2-10.2
	3.6	4.5	6.0	3.2	3.7	5.1	4.7	3.6	6.1
N (kg ha ⁻¹)	92-271	129-291	124-310	90-213	105-258	100-284	93-130	109-170	112-180
	158	240	250	130	151	201	107	137	157
P ₂ O ₅ (kg ha ⁻¹)	0.50-7	0.16-13	0.25-34.50	0.50-43.25	1.75-46.50	2.15-8.9	1.20-8	2.40-28	4.86-27.50
	3.23	4.61	6.06	12.92	17.71	22.64	4.00	7.80	13.60
K ₂ O (kg ha ⁻¹)	60-170	70-360	50-460	40-240	68-320	60-390	80-240	40-360	121-490
	102	152	158	107	176	189	117	144	208

(Bhubaneswar) to 1.1% (Balianta block) with an average value of 0.55%. In low land soil category, minimum OC value 0.21% obtained in Bhubaneswar block with maximum value 1.21% in Khordha block with an average of 0.66%. Soil organic matter of the study area ranges between very low to high. 60.86% of soils of Khordha district observed with medium range of organic matter followed by 28.45% of area lies under low organic matter range.

Soil available nitrogen

High land soil of Khordha district observed with minimum soil available N 43.5 kg ha⁻¹ in Jatni block with a maximum value of 317.56 kg ha⁻¹ in Chilika block with a mean value of 141.44 kg ha⁻¹. In medium soil, soil N varied from 22.59 kg ha⁻¹ (Jatni block) to 510.71 kg ha⁻¹ Balipatana block with a mean value of 182.83 kg ha⁻¹. In low land soil, the value varied between 81.59 kg ha⁻¹ (Tangi block) to 502 kg ha⁻¹ (Balipatana) with a mean value of 220.64 kg ha⁻¹. 88.34% soils of Khordha district lies in very low nitrogen fertility status, furthermore, high and medium land show low to medium N availability status where only 0.01% of soils show in high N availability status.

Soil available phosphorous

Soil available phosphorous in high land soil of Khordha district varied from 0.12 kg ha⁻¹ to 43.25 kg ha⁻¹ found in Tangi and Bhubaneswar block respectively with a mean

value of 8.84 kg ha⁻¹. In medium soil, lowest available P₂O₅ value (0.16 kg ha⁻¹) was obtained in Begunia block whereas, maximum value (46.50 kg ha⁻¹) was obtained in Bhubaneswar block with a mean value of 11.74 kg ha⁻¹. In low land soil, lowest and the highest P₂O₅ value was observed in Banapur (0.16 kg ha⁻¹) and Bhubaneswar block (89.0 kg ha⁻¹), respectively with an average value of 15.45 kg ha⁻¹. Major portion i.e 51.56% soil of Khordha district resulted with low P fertility status, while, P fertility status increases in lower elevation of land.

Soil available potassium

Soil available potassium in high land soil of Khordha district varied between 40 to 340 kg ha⁻¹ in Bhubaneswar and Khordha block, respectively, with an average value of 132.74 kg ha⁻¹. In medium land soil Bhubaneswar block observed with minimum value (68 kg ha⁻¹) of available K₂O whereas, Khordha block was observed with the highest value (440.0 kg ha⁻¹) with district mean of 171.27 kg ha⁻¹. In lowland soil, soil available K₂O was found to be varied between 50 kg ha⁻¹ and 490 kg ha⁻¹ observed in Begunia and Bolagarh block respectively, with an average value of 212.51 kg ha⁻¹. Average soil K₂O value of Khordha district varied from low to medium status accounting 79.51% of area with value ranged in medium status followed by area of 15.42% area in low K fertility status.

Table 3: Abstract of soil chemical parameters of Chilika and Jatni, blocks.

Parameters		Chilika			Jatni		
		High land	Medium land	Low land	High land	Medium land	Low land
pH	Range	4.50-6.15	5.64-7.20	5.75-8.01	3.35-4.42	4.22-4.52	4.68-5.51
	Mean	5.26	6.30	6.65	3.85	4.38	5.00
OC (g kg ⁻¹)	Range	0.5-10	5.3-10.7	6.0-10.9	3.3-6.7	4.3-8.8	5.0-9.1
	Mean	5.4	6.9	8.0	5.2	6.0	7.3
N (kg ha ⁻¹)	Range	114-317	141-358	140-379	43-130	22-264	105-274
	Mean	191	254	270	91	123	216
P ₂ O ₅ (kg ha ⁻¹)	Range	1.09-15.05	10.82-18.22	10.56-26.14	1.24-9.52	4.55-14.08	2.07-31.05
	Mean	12.20	13.75	17.27	5.26	8.28	9.98
K ₂ O (kg ha ⁻¹)	Range	70-250	80-420	110-480	60-220	110-280	180-320
	Mean	142	224	292	124	180	223

Table 4: Abstract of soil chemical parameters of Khordha and Tangi blocks.

Parameters		Khordha			Tangi		
		High land	Medium land	Low land	High land	Medium land	Low land
pH	Range	5.21-5.93	5.33-6.02	5.79-6.41	4.09-5.27	4.87-6.45	4.90-6.86
	Mean	5.61	5.72	6.04	4.79	5.22	5.50
OC (g kg ⁻¹)	Range	4.3-14.2	4.6-9.9	5.2-12.1	1.7-5.4	1.9-5.8	2.9-8.4
	Mean	7.1	6.8	8	3.8	4.3	5.3
N (kg ha ⁻¹)	Range	105.-146	103-259	113-257	66-187	80-276	62-262
	Mean	122	142	175	131	171	198
P ₂ O ₅ (kg ha ⁻¹)	Range	6.32-27.74	7.80-28.43	9.02-65.45	0.12-22.50	0.32-25.31	0.33-27.65
	Mean	12.80	14.43	18.47	5.26	7.01	7.69
K ₂ O (kg ha ⁻¹)	Range	50-340	70-440	110-490	70-190	90-220	100-237
	Mean	194	214	296	116	125	135

Soil nutrient index of N, P and K

Soil nutrient index value was calculated from the proportion of soils under low, medium and high available nutrient categories and classified as.

<1.33 = Very low; 1.33-1.66 = Low; 1.67- 2.0 = Marginal; 2.0-2.33= Adequate; 2.33-2.66 = High; 2.66 = Very high.

The nutrient index for nitrogen, phosphorus and potassium of all the 300 samples were calculated and the results obtained is presented in Table 10. Data displayed in above table depicts that, nitrogen index for high land soils of the study area showed a status of very low to low availability with nutrient index varied from 1 to 1.3. In medium land soil the index showed very low to marginal range of availability. Looking into the N status in low land soils, it was found to be varied between 1.2 to 1.8 indicating a range of very low to marginal. Phosphorus index of soil samples varied from 1 to 2 in overall study area. In high land soil, the range varied between 1 to 1.9, while in medium land soil, it varied between 1.1 to 2 (and low land soil it ranged between 1.2 to 2 indicating a P availability status of very low to marginal irrespective of land categories. Overall

Potassium status varied 1.3 to 2.4 in all types of soil. Particularly, in high land soil, the range varied from 1.3 to 2.1, in medium land soil, it ranged from 1.6 to 2.1 and in low land soil, it varied from 1.6 to 2.4. In high and medium land soil, the K index was found to be low to adequate in availability while in low land soil, it was low to high in status.

Land category wise soil nutrient maps with their distribution of different soil parameters are presented from Fig 1 to 5 and from Table 5 to Table 9.

Results obtained from the observations showed that, out of the total agricultural area, 74.91% of agricultural land was determined to be acidic, 18.26% to be neutral and the remaining 6.83% to be alkaline. The soil pH of Khordha district was found to vary between 3.35 to 8.01 indicating a range from acidic soil reaction status to alkaline status. In high land particularly, 90.30% area was found to be acidic in nature and 9.70% was treated to be neutral in nature. Looking into the medium land soil reaction status, the area quantified as 82.63% area as acidic and 17.37% area as neutral in nature. Similarly, low land resulted with 59.57%, 23.85% and 16.58% of land in acidic, neutral and alkaline

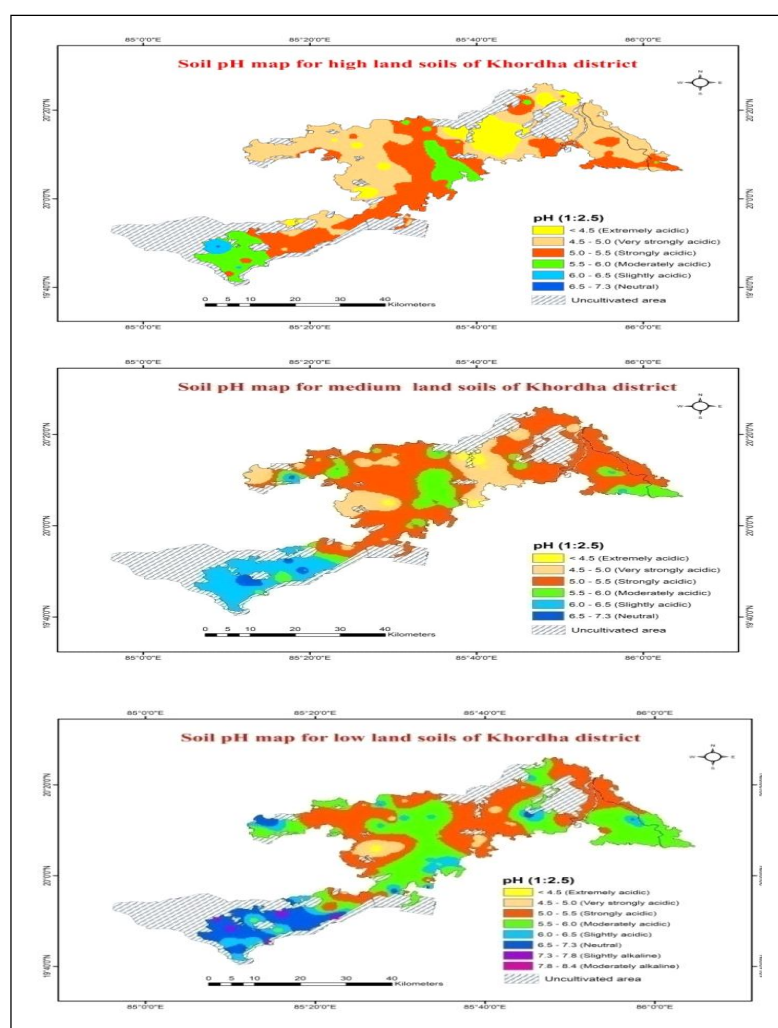


Fig 1: Soil pH map of Khordha district.

in nature, respectively. The topography variation was found as a result of bases being washed out of highland soil, which made it more acidic in nature; conversely, bases being deposited on low lying areas made the soil less acidic and more alkaline. The pH variation may be caused by the natural heterogeneity of the soils. The occurrence of different soil types within the blocks across the land types, such as red, mixed red and black and, to some extent, the influence of parent material and resource region-specific differences in the farmers' cultural and fertilizer management practices might be the possible causes. Soil organic carbon of Khordha district ranged from 0.03% to

1.21% which was found to range between very low to high status. The average OC value obtained as 0.48%, 0.56% and 0.66% in high, medium and low land soil, respectively. It was observed that, the organic carbon content increased when progressed from high land to low land category which might be ascribed to the fact that, more of runoff of rain water in high land resulted with washing away of top soil along with organic matter which conversely deposited in the low land areas. But there are some areas even in uplands with high organic matter content which might be nearer to the forest areas. Nitrogen content of 300 samples collected from entire Khordha district recorded a variation

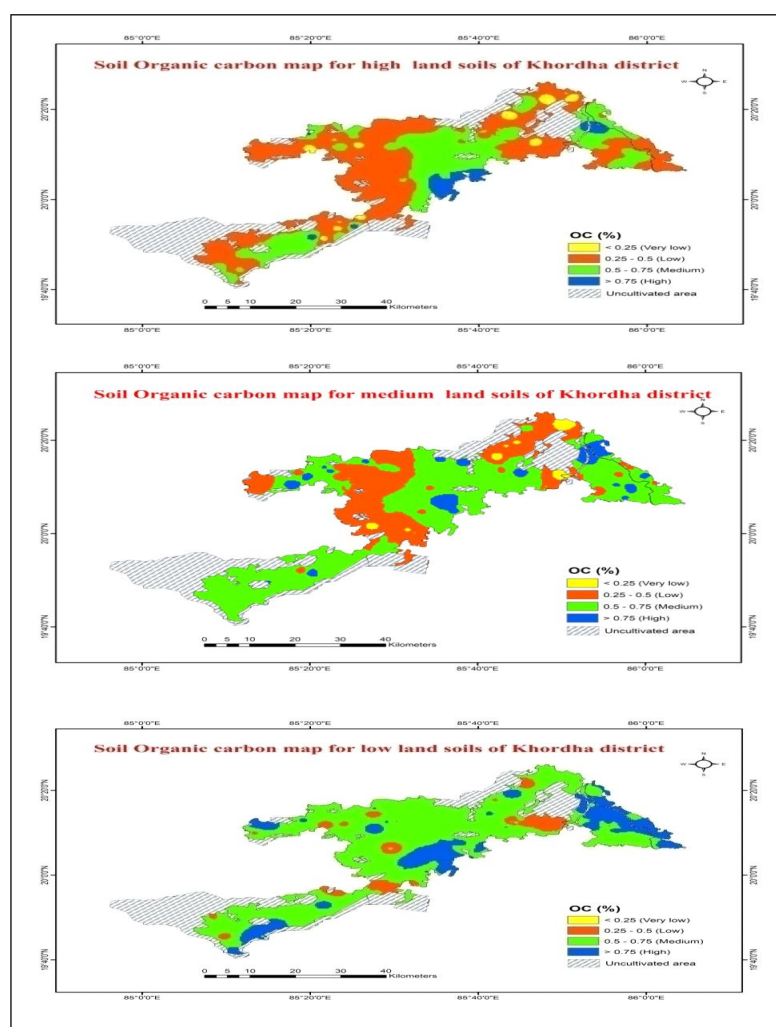


Fig 2: Soil organic carbon map of Khordha district.

Table 5: Area distribution of soils in Khordha district with respect to reaction status.

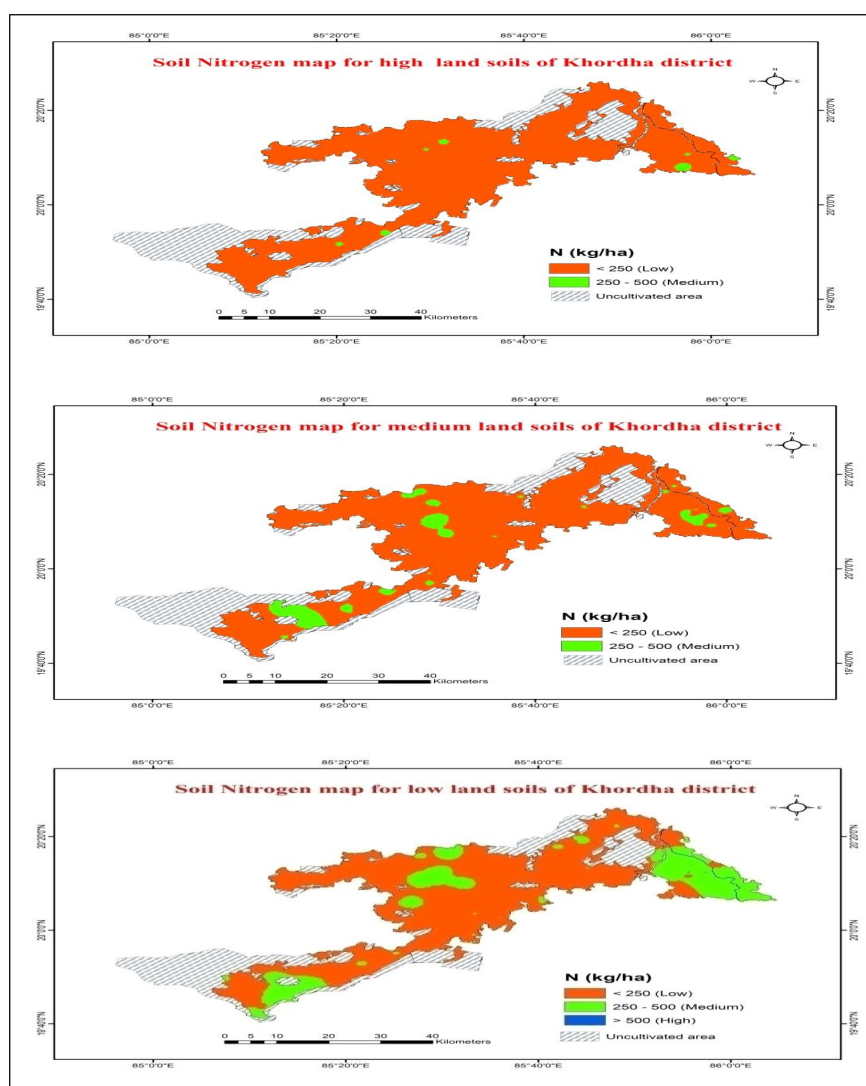
Soil type	High	Medium	Low	Total	% of area
Acid	23848.32	33248.24	27826.00	84922.56	74.91
Neutral	2561.78	6994.12	11140.68	20696.58	18.26
Alkaline	0.00	0.00	7744.75	7744.55	6.83
Total	26410.10	40242.36	46711.44	113363.90	100

Table 6: Area distribution of soils in Khordha district with respect to organic carbon.

Classification	High	Medium	Low	Total	% of area
Very low	488.59	583.51	84.08	1156.18	1.02
Low	16870.77	11956.01	3428.62	32255.40	28.45
Medium	8113.18	25734.99	35150.36	68998.53	60.86
High	937.56	1967.85	8048.38	10953.79	9.66
Total	26410.10	40242.36	46711.44	113363.90	100

Table 7: Area distribution of soils in Khordha district with respect to available nitrogen.

Classification	High	Medium	Low	Total	% of area
Low	26153.92	37373.07	36626.44	100153.43	88.34
Medium	256.18	2869.28	10080.33	13205.79	11.65
High	0	0.01	4.67	4.68	0.01
Total	26410.10	40242.36	46711.44	113363.90	100

**Fig 3:** Available soil nitrogen map of Khordha district.

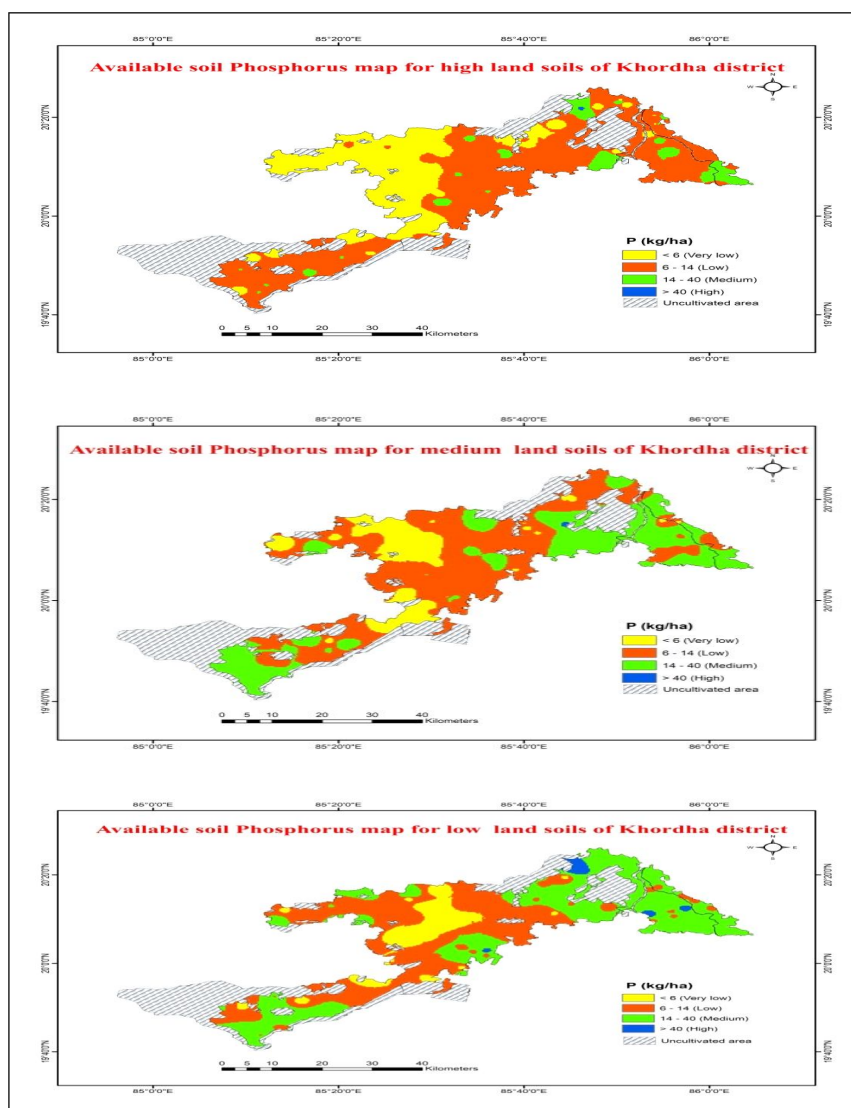


Fig 4: Available soil phosphorus map of Khordha district.

Table 8: Area distribution of soils in Khordha district with respect to phosphorus.

Classification	High	Medium	Low	Total	% of area
Very low	8501.03	5980.00	5640.25	20121.28	17.75
Low	16027.13	21532.67	20886.77	58446.58	51.56
Medium	1866.18	12691.32	19463.70	34021.2	30.01
High	15.75	38.36	720.72	774.8328	0.68
Total	26410.1	40242.36	46711.44	113363.90	100

Table 9: Area distribution of soils in Khordha district with respect to potassium.

Classification	High	Medium	Low	Total	% of area
Low	10608.94	4229.47	2639.20	17477.61	15.42
Medium	15695.52	34588.31	39854.20	90138.03	79.51
High	105.64	1424.58	4218.04	5748.26	5.07
Total	26410.1	40242.36	46711.44	113363.90	100

of 43.5 to 510.71 kg ha⁻¹, which lies in low to high N content. Majority of the soil (88.34%) resulted with low N content and only 0.01% of soil was found in high N availability status. The reason behind this low availability of N was

due to low OC content in high land soils. But maximum N content of 510.71 kg ha⁻¹ was observed in medium land soil, it might be due to local farming practices and fertilizer management of that particular place. Because of the

Table 10: Soil nutrient index of Khordha district.

Block	N			P			K		
	High land	Med. Land	Low land	High land	Med. Land	Low land	High land	Med. Land	Low land
Balianta	1.0	1.2	1.5	1.5	2.0	1.8	1.5	1.7	1.9
Balipatana	1.3	1.6	2.0	1.5	1.5	1.6	1.4	1.6	1.7
Banapur	1.0	1.1	1.2	1.5	1.6	1.8	2.0	2.0	2.1
Begunia	1.3	1.7	1.8	1.0	1.1	1.3	1.3	1.7	1.7
Bhubaneswar	1.0	1.1	1.5	1.4	1.7	1.9	1.4	1.9	2.0
Bolgarg	1.0	1.0	1.2	1.0	1.3	1.7	1.3	1.8	2.1
Chilika	1.2	1.5	1.7	1.9	1.9	2.0	1.6	2.1	2.4
Jatani	1.0	1.1	1.2	1.0	1.3	1.3	1.4	1.8	2.1
Khordha	1.0	1.1	1.2	1.5	1.6	1.6	2.1	2.1	2.2
Tangi	1.0	1.3	1.6	1.2	1.2	1.2	1.4	1.6	1.6

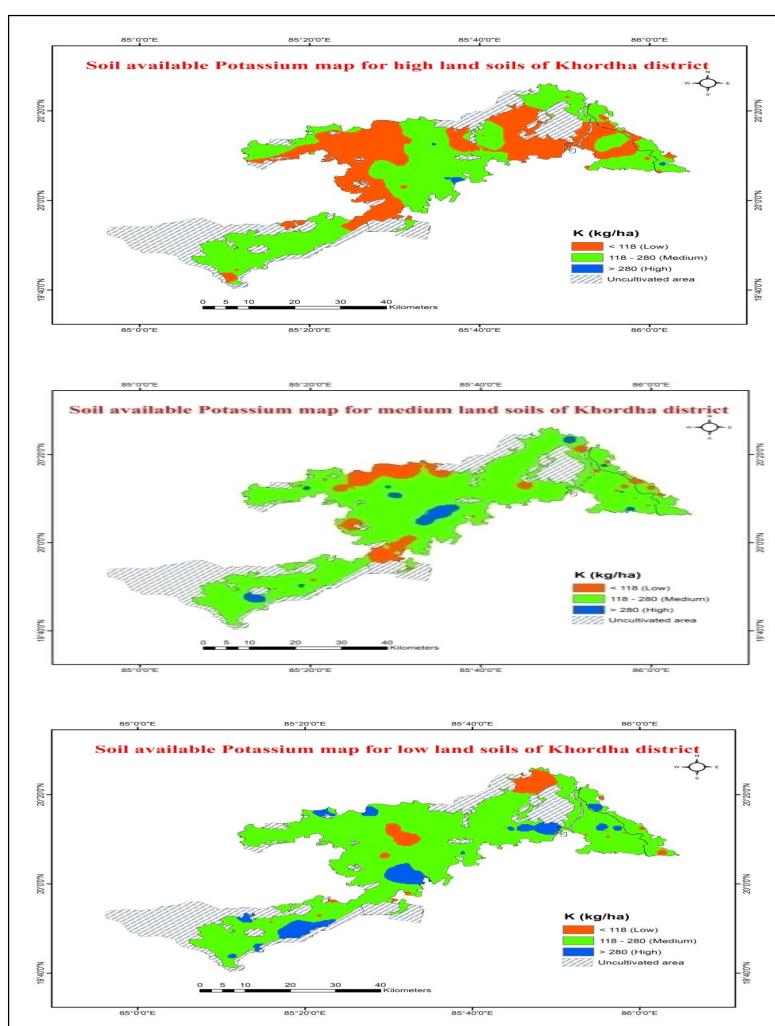


Fig 5: Available soil potassium map of Khordha district.

accumulation and decomposition of organic matter directly affects the storage and conversion of the nitrogen in the soil, organic matter plays a leading role in the content of nitrogen. Therefore, total nitrogen exhibits a similar spatial distribution pattern with organic matter. The phosphorous content of the study area varied from very low status to high status accounting maximum area of 51.56% in low range and minimum area of 0.68% in high range. Variation in P content was observed within land categories. Spatial variation of K content was also observed with changing land categories.

CONCLUSION

The derivation of spatial and temporal agricultural information at the micro level can be effectively achieved through the use of emerging technologies such as high resolution satellite data. Arranging the ground observations, non-spatial attribute data and spatial data obtained from satellites in GIS and GPS environment will augment planning, research and management of natural resources in farming. Soil, being the most essential natural resource of ecosystem, site specific management strategy should be taken to retain its fertility level. Current study provides information regarding soil reaction, nutrient status and nutrient index of major nutrient parameters of different blocks of Khordha district of Odisha in form of maps. Amalgamation of geospatial technology with laboratory analysis emerged as a potential tool for planning and decision making.

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Disclaimers

The views and conclusions expressed in this article are solely those of the authors and do not necessarily represent the views of their affiliated institutions. The authors are responsible for the accuracy and completeness of the information provided, but do not accept any liability for any direct or indirect losses resulting from the use of this content.

Conflict of interest

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REFERENCES

- Feng, Y., Wang, L., Xin, Z., Zhao, L., An, X. and Hu, Q. (2008). Effect of foliar application of zinc, selenium and iron fertilizers on nutrients concentration and yield of rice grain in China. *Washington, USA*. 56: 2079-2084.
- Gachene, C.K., Nyawade, S.O. and Karanja, N.N. (2019). Soil and water conservation: An overview. In: *Zero Hunger. Encyclopedia of the U N Sustainable Development Goals*. Cham: Springer.
- Gopal, B., Amba, S. and Jayaprakash, C.D.Y. (2024). Spatial variability of topsoil chemical properties. *Indian Journal of Agricultural Research*. 49(2): 134-141. doi: 10.5958/0976-058X.2015.00019.0.
- Habibie, M.I., Noguchi, R., Shusuke, M. and Ahamed, T. (2021). Land suitability analysis for maize production in Indonesia using satellite remote sensing and GIS-based multicriteria decision support system. *Geo Journal*. 86(2): 777-807.
- Iftikar, W., Chattopadhyaya, G.N., Majumdar, K. and Sulewski, G.D. (2010). Use of village-level soil fertility maps as a fertilizer decision support tool in the red and lateritic soil zone of India. *Better Crops*. 94: 10-12.
- Kavitha, C. and Sujatha, M.P. (2015). Evaluation of soil fertility status in various agro ecosystems of Thrissur District, Kerala, India. *International Journal of Agricultural Crop Science*. 8: 328-338.
- Lagacherie, P., McBratney, A.B. and Voltz, M. (eds.). (2006). *Digital soil mapping: An introductory perspective*. Developments in Soil Science, Elsevier, Amsterdam.
- McBratney, A.B., Mendonça, S.M.L. and Minasny, B. (2003). On digital soil mapping. *Geoderma*. 117(1-2): 3 -52.
- Mishra, A., Pattnaik, T., Das, D. and Das, M. (2014). Soil fertility maps preparation using GPS and GIS in Dhenkanal District, Odisha, India. *International Journal of Plant and Soil Science*. 3(8): 986-994.
- Nalina, C.N., Kumar A.K.S., Chandrakala, M., Rani S. S., Sujata K., Shree S.K.G., Hegde, R. and Singh, S.K. (2016). Soil nutrient status mapping of Nagenahalli micro-watershed under Eastern Dry Zone of Karnataka by Remote Sensing, Detailed Soil Survey and GIS Techniques. *Indian Journal of Agricultural Research*. 50(5): 389-397. doi: 10.18805/ijare.v0i0F.3762.
- Palaniswami, C., Gopalsundaram, P. and Bhaskaran, A. (2011). Application of GPS and GIS in sugarcane Agriculture Sugar Technology. 13: 360-365.
- Rajalakshmi, P., Mahendran, P.P., Mary, C.N., Ramachandran, J., Kannan, P., Ramesh C. and Selvam, S. (2023). Spatial analysis of soil texture using gis based geostatistics models and influence of soil texture on soil hydraulic conductivity in melur block of madurai district, Tamil Nadu. *Agricultural Science Digest*. doi:10.18805/ag.D-5691.
- Tomlinson, R.F. (1987). Current and potential uses of geographical information systems, The North American experience. *International Journal of Geographical Information Systems*. 1(3): 203-218. doi: 10.1080/02693798708927808.